B-survey at Laugardalur 1, September 2024 (max biomass), Arnarlax ehf

Akvaplan-niva AS Report:
APN 66115.B01

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Customer	Arnarlax ehf
Contact person	Silja Baldvinsdóttir

Summary

Substrate was collected at all 13 sampling stations (100% soft bottom). Sediment samples consisted mainly of a combination of mud and silt in all parts of the local impact zone. Fauna was recorded at all stations with polychaetes being most prominent, some mussels at three stations and echinoderms at two stations. No signs of out-gassing were observed at any of the sampling stations. The substrate was of light/grey colour at twelve sampling stations and brown/black at one sampling station (st. 7). Some light smell of H_2S was observed at two out of the total 13 sampling stations. Faeces in the grab sample were observed at two stations (st. 2 and st. 4).

Based on the classification of sediment chemistry (pH/Eh) and the sensory assessments all 13 stations of this survey received status 1 – "Very good". Overall, the index score for the parameter II (pH/Eh) and for parameter III (sensory parameters) were 0,46 for parameter II and 0,34 for parameter III.

In summary, the site receives the environmental status was 1 – " Very good" (average group II-III index =0.40).

Approval

Project Manager

Quality Control

Key information

Site details and license holder information			
Site name	Laugardalur 1	Site coordinates	65°39,170N 23°55,813V
County	Vesturbyggð	Municipality	Tálknafjöður
MTB (Maximum estimated biomass next generation)	3.565 tonnes	Operations Manager / Contact	Silja Baldvinsdóttir
License holder / customer	Arnarlax		

Production status on date of survey			
Biomass at site	3.565 tonnes	Total feed use	5.178 tonnes
Farmed species	Salmon	Total biomass produced	4.320 tonnes
Type/time of survey	Indicated with X	Comments	
Maximum organic load cf. chapter 7.9	☒		
Follow-up survey	❒		
Half maximum load	❒		
Pre-stock	☐		
Required by the state administrator - baseline survey	❒		
Other	❒		
Last fallowing period:	December 2021 - August 2022		

Results from B-survey in accordance with NS 9410:2016 (main results)			
Parameter group and index		Parameter group and status	
Gr. II. pH/Eh	0.46	Gr. II. pH/Eh	1
Gr. III. Sensory	0.34	Gr. III. Sensory	1
GR. II + III	0.40	GR. II+ III	1
Date of fieldwork	12.09 2024	Date of report	25.10 2024
Environmental status (NS 9410:2016):			**1**

Table of contents

1 Introduction

The present survey was conducted by Akvaplan-niva AS on behalf of Arnarlax in connection with the company's fish farming activities at the site Laugardalur 1 in Tálknafjörður municipality in Vesturbyggð county.

The purpose of a B-survey is to document the environmental status in the near zone of a fish farm by evaluating sediment condition (chemistry, sensory and presence/absence of fauna) in accordance with NS 9410:2016.

The B-survey is a tool for trend monitoring and allows to assess the status of organic enrichment beneath the net pens at different stages of the production cycle.

Figure 1 shows a map of the fjord Tálknafjörður where Laugardalur 1 site is located (upper right corner) and the neighbouring fjord to the south Patreksfjörður.

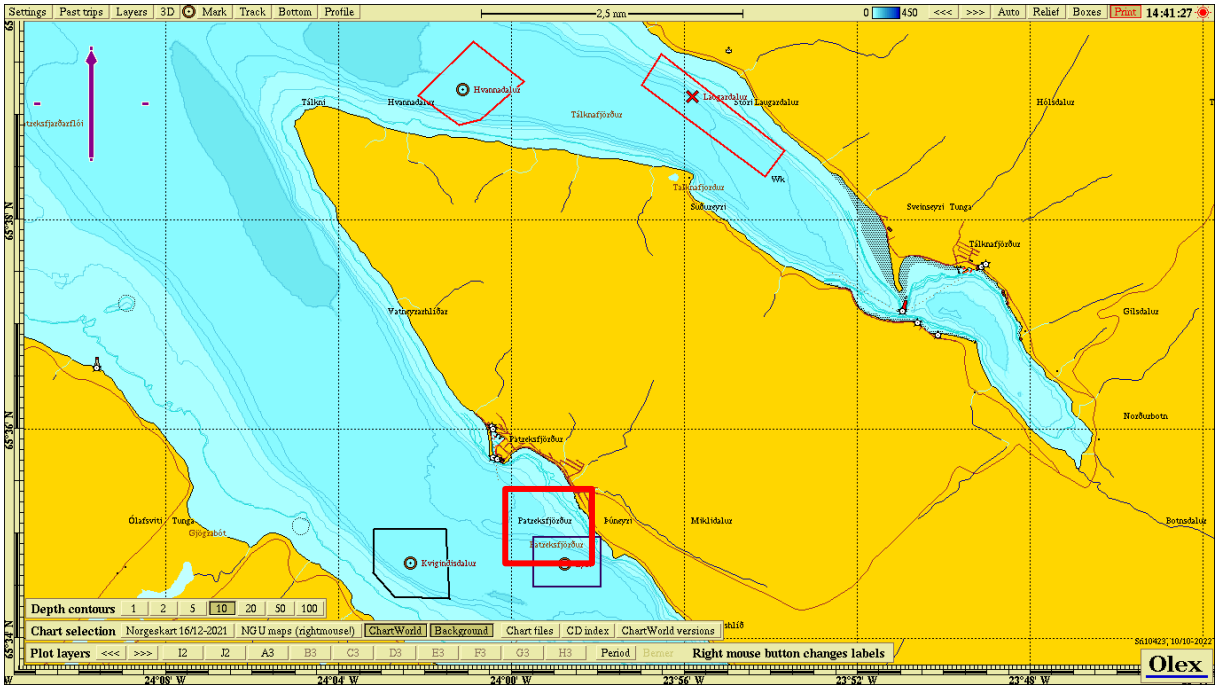


Figure 1. An overview map where Laugardalur 1 farm is marked. Other fish farming areas in the nearest vicinity (Tálknafjörður and Patreksförður) are also shown.

2 Methods

Monitoring of the environmental impact of fish farming activities on the seabed is standardised and regulated. All fish farming sites that are in use must be regularly assessed. This B-survey follows 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) under and in the immediate vicinity of an aquaculture site. Sediment samples are taken using a grab (min. 250 cm^2). Sediment condition for each sample is assessed applying three indicators: sediment chemistry (pH and redox potential), sensory evaluation (gas bubbles; smell, texture, colour of substrate and thickness of deposited sludge) and the presence or absence of fauna. The performance of these indicators against predefined thresholds allows to categorise the site into four different environmental statuses (Table 1), which are used to determine subsequent sampling frequency. The number of sampling stations is based on the site's allocated MTB (here the estimated max biomass next generation at the site).

Table 1. Frequency of B-survey based on environmental status at site.

Environmental status at maximum organic load (near zone)	Monitoring frequency for B survey
1-very good	At the next maximum load
2-good	Pre-stock and again at maximum load
3-poor	Pre-stock If the survey prior to restocking / end of fallowing provides: Status 1 – survey should be carried out at next maximum load. Status 2 – survey should be carried out at half the maximum load and at the next maximum load. Status 3 – survey should be carried out at half the maximum load and at maximum load. Implementation of measures to reduce impact should be planned for the next production cycle. If any surveys show the environmental status to be 4 – "very poor", the site's environmental capacity has been exceeded.
4- very poor	Environmental capacity at site is exceeded. The authorities decide further measures.

The following equipment was used in this survey:
Grab: Van Veen grab (0.025 m^2)
Sieve 1 mm: Akvaplan-niva
pH meter: Electrode, YSI Professional Plus
Redox meter: Electrode, YSI Professional Plus
Position determination – GPS map 62s
Digital camera

3 Site, production and survey design

3.1 Site characteristics and production

Laugardalur1 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-northwest direction from land (297°) with depth below the cages ranging from 24 to 51 m.

The current generation is the fifth being farmed at the Laugardalur 1 site. At the date of the B-survey the standing biomass was 3.565 tons.

Table 2 shows production and feed use for the current and four previous generations.

Table 2. Production and feed use for farm site Laugardalur 1. Data provided by customer.

Generation of fish (G)	Production (tonnes)	Feed use (tonnes)
Generation 2022- 12.09 2024	4.320	5.178
Preceding generation 4	9.410	11.946
Preceding generation 3	9.113	8.107
Preceding generation 2	2.836	3.406
Preceding generation 1	734	959

3.2 Current and past surveys

Table 3 provides an overview on results and time of sampling for the last B-surveys at site.

Table 3. Present and previously conducted B-surveys at the site.

Date of sampling	Report number	Production status	Location condition
12.09.2024	APN 66115.B01	B survey max biomass	1
06.09.2022	APN 64189.B01	Fallow period	1
25.03.2021	APN-62334.B01	B survey max biomass	1
27.05.2019	APN-60938.B01	Fallow period	1
03.11.2017	APN-9207	B survey max biomass	1

3.3 Hydrodynamic conditions

Measurement of dispersing current was done at the site in March – April 2019 measurements at 42 m depth (Heggem, 2019). The dominating current at 42 m is in north-westerly direction (315 degrees) with a small counter current in opposite direction. 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 13 sampling stations is shown in Figure 2 with positions listed in Table 4. Stations are distributed within the near zone of the new frame position following criteria outlined in NS 9410:2016. The typical depth in the local impact zone is in the range from 24 – 51 m, with the deepest area being located in the southern part of the frame area. Sampling stations were placed to represent the varied environmental conditions within the near zone and cover thus both the deeper and shallower areas. The 13 stations sampled were distributed with emphasis around these 13 cages

used during farming of current generation, according to guidance in NS 9410, chapter 7.6. The sampling stations had a depth varying from 32 to 51 m. The placement of sampling stations is regarded to be in accordance with the requirements outlined in NS 9410:2016.

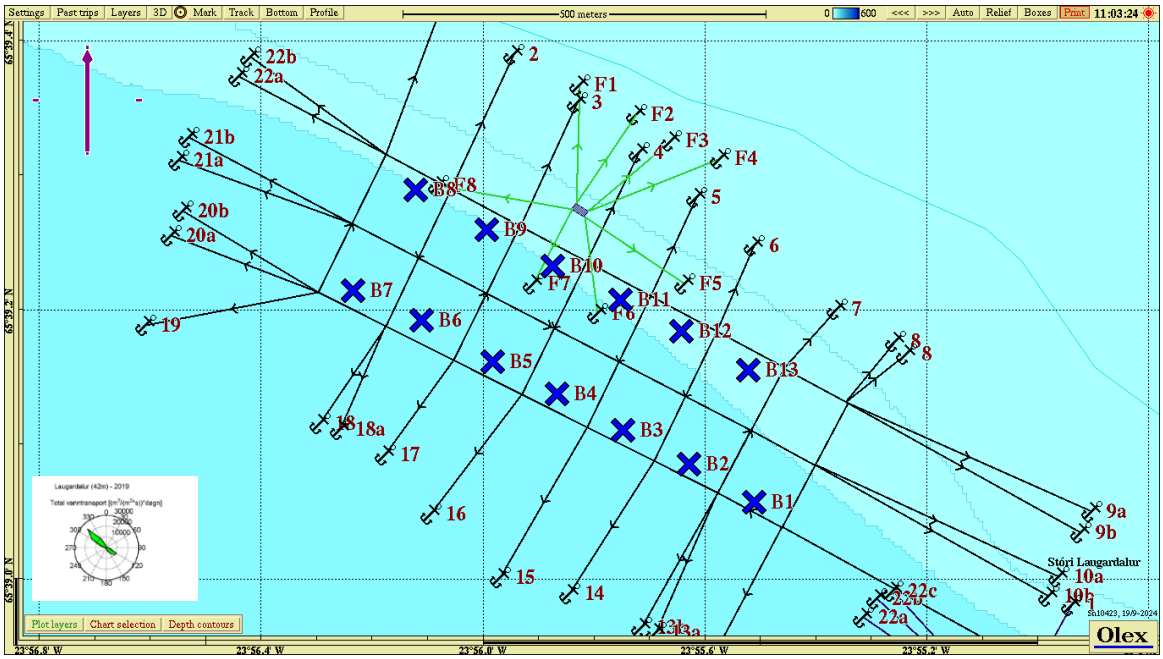


Figure 2. Overview map showing site configuration and local bathymetry at Laugardalur 1. Sampling stations are marked by crosses and colour coded to visualise the environmental status at the respective station following the classification outlined in NS 9410:2016, chapter 7.11 (1 = blue, 2 = green, 3 = yellow, 4 = red). The current rose in the left corner shows the direction of water transport at dispersal depths at the site (Holen, 2022).

Table 4. Position and depth of the sampling stations of this survey.

Station number	Northing	Westing	Depth [m]
St 1	65°39,057	23°55,511	50
St 2	65°39,085	23°55,628	51
St 3	65°39,110	23°55,748	51
St 4	65°39,137	23°55,867	51
St 5	65°39,161	23°55,983	51
St 6	65°39,192	23°55,111	51
St 7	65°39,214	23°55,235	51
St 8	65°39,289	23°55,122	40
St 9	65°39,259	23°55,993	41
St 10	65°39,232	23°55,875	40
St 11	65°39,207	23°55,752	37
St 12	65°39,184	23°55,643	35
St 13	65°39,155	23°55,522	32

4 Results

Classified survey results for the different parameter categories as well as the assigned environmental status of the site are shown in Table 5. The complete survey assessment form with results and classifications for each station can be found in the attachment.

Table 5. Results from the environmental assessment of the near zone of Laugardalur 1.

Parameter	Status
Group II parameters (pH/Eh)	1
Group III parameters (sensory)	1
Group II + III – parameters (mean)	1
Environmental status (site)	1

Substrate was collected at all 13 sampling stations (100% soft bottom). Sediment samples consisted mainly of a combination of mud and silt in all parts of the local impact zone. Fauna was recorded at all stations with polychaetes being most prominent, some mussels at three statins and echinoderms at two stations. No signs of out-gassing were observed at any of the sampling stations. The substrate was of light/grey colour at twelve sampling stations and brown/black at one sampling station (st. 7). Some light smell of H_2S was observed at two out of the total thirteen sampling stations. Faeces in the grab sample were observed at two stations (st. 2 and st. 4).

Based on the classification of sediment chemistry (pH/Eh) and the sensory assessments all 13 stations of this survey received status 1 – "Very good". Overall, the index score for the parameter II (pH/Eh) and for parameter III (sensory parameters) were similar i.e. 0,46 for parameter II and 0,34 for parameter III.

In summary, the site receives the environmental status was 1 – "Very good" (average group II-III index =0.40).

5 Summary

Applying the indicator thresholds and classification outlined in NS 9410:2016 it is shown that Laugardalur 1 receives overall site status 1 – "Very good" at the time of this B survey. Samples were collected with a Van Veen grab (0,025 m^2) at 13 stations distributed around the 13 cages, that were used for farming salmon during present production cycle. All sampling stations received status 1 – "Very good".

The survey was undertaken during the time of max biomass for the present production cycle. The results indicate that overall, there is relatively little organic load in the local impact zone. There was relatively good consistency in the score for parameters II (pH/redox) and III (sensory) and both parameters have the overall condition 1 (Very good).

There are four previous B-surveys done at the site (Table 2) and all of these have also resulted in overall site status 1 (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., 2021. Arnarlax, B-survey local impact zone, Laugardalur, March 2021 (Max biomass). APN rapport nr. 62334.B01. 21 s.

Gunnarsson, S., 2022. Arnarlax, Laugardalur, Arnarlax. B-survey (post fallow), July 2022. APN rapport nr. 64189.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 akvakulturanlegg.

Personal reference. Fannar Freyr Ottósson, Site manager SW, Arnarlax. 2024

7 Attachments

7.1 Form (B.1 and B.2) NS 9410:2016

Sample scheme B.1

Company	**Arnarlax**	**Date:**	**12.09 2024**
Site:	**Laugardalur 1**	**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	7.33	7.43	7.32	7.40	7.38	7.35	7.29	7.51	7.59	7.28
	Eh (mV)	ORP	-127	-21	-95	-82	-106	-149	-13	-46	-72	-161
		plus ref. verdi	73	179	105	118	94	51	187	154	128	39
	pH/Eh	from figure	1	0	0	0	1	1	0	0	0	1
	Status station		1	1	1	1	1	1	1	1	1	1
			Buffer-temp	10.0 C		Sea temp	9.6 C		Sediment temp		9.7 C	
		pH sea 7.95	ORP sea	116.0 mV		Eh sea	316.0 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	0	0
		Brown/black (2)							2			
	Smell	None (0)		0		0	0	0	0	0	0	0
		Light (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)								0	0	0
		1/4 < v < 3/4 (1)										
		v > 3/4 (2)	2	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	4.0	2.0	4.0	2.0	2.0	2.0	4.0	0.0	0.0	0.0
		Corrected (*0,22)	0.9	0.4	0.9	0.4	0.4	0.4	0.9	0.0	0.0	0.0
		Status station	1	1	1	1	1	1	1	1	1	1
		Average group II & III	0.9	0.2	0.4	0.2	0.7	0.7	0.4	0.0	0.0	0.5
		Status station	1	1	1	1	1	1	1	1	1	1

Grab ID	K-21
pH / Eh ID	Ysi prof. Plus

page 1 of 4 pages

Sample scheme B.1

Company:	**Arnarlax**	**Date:**	**12.09 2024**
Site:	**Laugardalur 1**	**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								100	0
I	Animals > 1mm	Yes (0) No (1)	0	0	0									
II	pH	value	7.65	7.51	7.38									
	Eh (mV)	ORP	-26	-163	-148									
		plus ref. verdi	174	37	52									
	pH/Eh	from figure	0	1	1								0.46	
		Status station	1	1	1									
		Status group II	1	**Buffer temp**	10.0 C		**Sea temp**	9.6 C		**Sediment temp**	9.7 C			
		pH sea 7.95	**ORP sea**	116 mV		**Eh sea**	316 mV		**Reference electrode**		200 mV			
III	Gas bubbles	Yes (4) No (0)	0	0	0									
	Colour	Light/grey (0)	0	0	0									
		Brown/black (2)												
	Smell	None (0)	0	0	0									
		Light (2)												
		Strong (4)												
	Consistency	Solid (0)	0	0	0									
		Soft (2)												
		Aqueous (4)												
	Grab volume (v)	v < 1/4 (0)	0	0	0									
		1/4 < v < 3/4 (1)												
		v > 3/4 (2)												
	Thickness of slidge (t)	t < 2 cm (0)	0	0	0									
		2 < t < 8 cm (1)												
		t > 8 cm (2)												
		Sum	0.0	0.0	0.0									
		Corrected (*0,22)	0.0	0.0	0.0								0.34	
		Status station	1	1	1									
		Status group III	1											
		Average group II & III	0.0	0.5	0.5								0.40	
		Status station	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-21
pH / Eh ID	Ysi prof. Plus

Sample scheme B.2

Company:	**Arnarlax**	**Date:**	**12.09 2024**
Site:	**Laugardalur 1**	**Site no.:**	**0**
Fieldworker:	**Snorri Gunnarsson**		

Sample number		1	2	3	4	5	6	7	8	9	10
Depth (m)		50	51	51	51	51	51	51	40	41	40
Number of trials		1	2	3	2	2	1	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		1				4		11			
Polychaetes, count		6	>30	>20	>20	8	>20	8	16	4	5
Beggiatoa											
Feed											
Faeces				X	X						
Comments		St. 1 - 4 Some black organic material in top layer of sample									

Grab	**Area [m^2]**	0.025	**Grab ID**	K-21

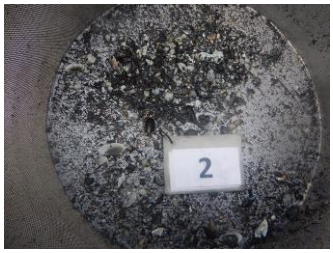
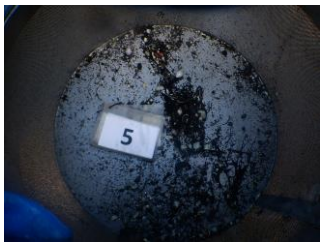
Sample scheme B.2

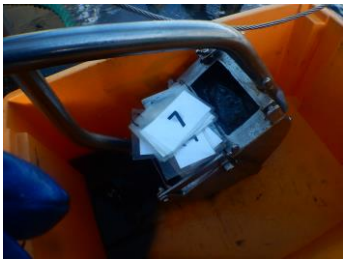
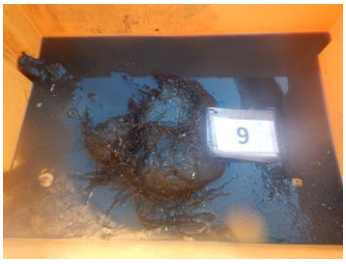
Company:	**Arnarlax**	**Date:**	**12.09 2024**
Site:	**Laugardalur 1**	**Site no.:**	**0**
Fieldworker:	**Snorri Gunnarsson**		

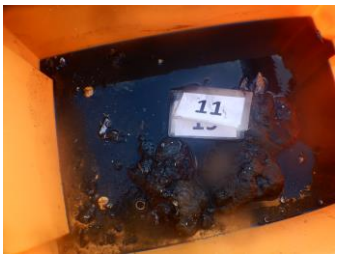
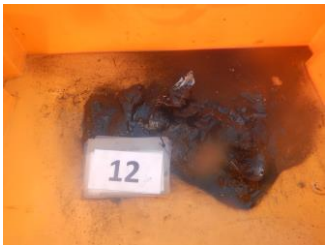
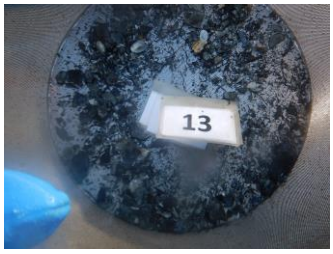
Sample number		11	12	13	14	15	16	17	18	19	20
Depth (m)		37	35	32							
Number of trials		1	1	1							
Gas bubbles (in sample)		No	No	No							
Sediment type	**Clay**	X	X	X							
	Silt	X	X	X							
	Sand										
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count											
Polychaetes, count		9	15	2							
Other animals, count											
Beggiatoa											
Feed											
Faeces											
Comments											

Grab	**Area [m^2]**	0.025	**Grab ID**	K-21
Signature fieldworker:				page 4 of 4 pages

7.2 ages of samples at Laugardalur 1

St	*Image before sieving*	*Image after sieving*
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		

7.3 3D-bathymetry

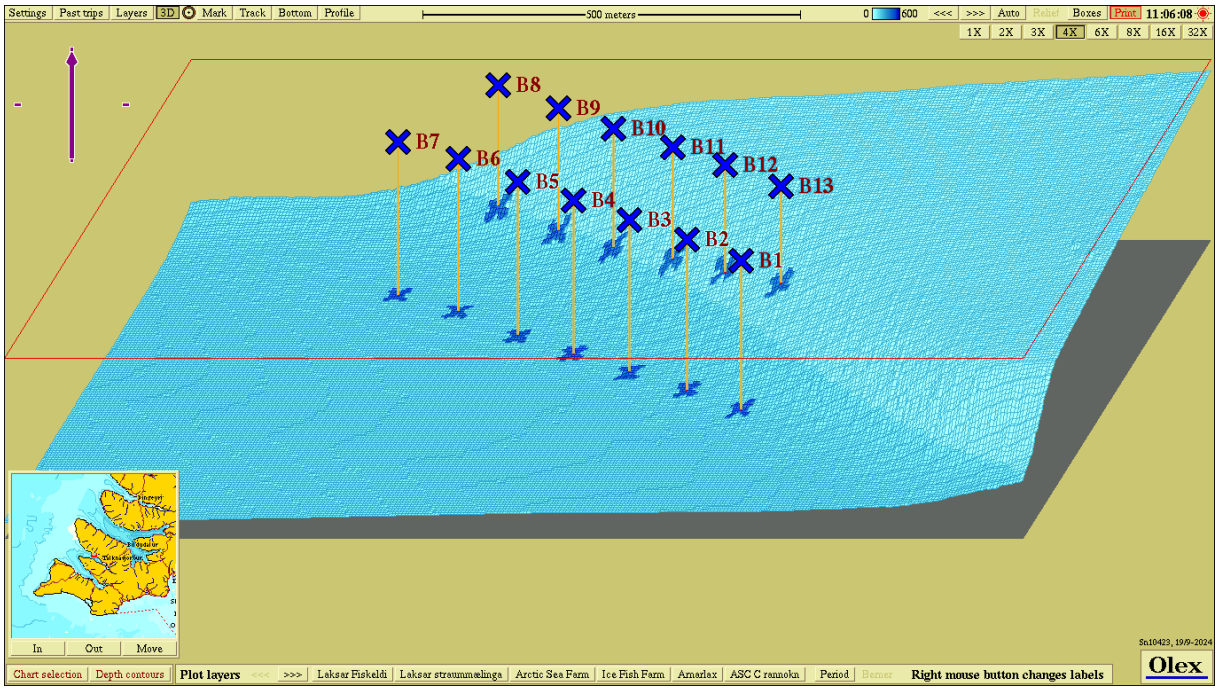


Figure 3. 3D-view of bathymetry at Laugardalur 1 with stations as shown in Figure 2 and Table 4.