B-survey at Hringsdalur, May 2025 (fallow period), Arnarlax ehf

Akvaplan-niva AS Report:
APN 2025 66687.B01

B survey at Hringsdalur May 2025 (fallow period), Arnarlax ehf

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Distribution	Through customer
Customer	Arnarlax ehf
Contact person	Silja Baldvinsdóttir

Summary

Sediment was recovered at all 16 stations (100% soft bottom). The sediments consisted primarily of clay in the whole near zone of the fish farm. Fauna was recorded to be present at all stations mainly in the form of polychaetes. No smell of H_2S was recorded at any of the sampling stations. There were no signs of out-gassing. The substrate was light/grey colour at all ten stations and brown/black at six stations. Grab was full at thirteen stations and 1/4 – ¾ full at three stations.

Based on the classification of sediment chemistry (pH/Eh) and the sensory assessment all twenty stations received status 1 – "Very good" Overall, the index score for parameter III (sensory parameters) was somewhat higher 0.59 compared with the index score for the parameter II (pH/Eh) 0.06.

In summary, the site receives the environmental status 1 - "Very good" (average group II-III index =0.33).

Approval

Project Manager

Eva Synvis
Quality Control

Key information

Site details and license holder information			
Site name	Hringsdalur	Site coordinates	65°44.416' N 23°45.777' V
County	Vesturbyggð	Municipality	Bíldudalur
MTB (estimated max biomass)	8.275 tonnes	Operations Manager / Contact	Silja Baldvinsdóttir
License holder / customer	Arnarlax		

Production status on date of survey			
Biomass at site	0 tonnes	Total feed use	0 tonnes
Farmed species	Salmon	Total biomass produced	0 tonnes
Type/time of survey	Indicated with X	Comments	
Maximum organic load cf. chapter 7.9	☐	Sampling during fallowing period prior to putting next generation smolt to sea. Fallowing period started 03.11.2024 (i.e. about 7 months).	
Follow-up survey	☐		
Half maximum load	☐		
Pre-stock	☒		
Required by the state administrator - baseline survey	☐		
Other	☐		
Last fallowing period:	November 2024 - May 2025		

Results from B-survey in accordance with NS 9410:2016 (main results)			
Parameter group and index		Parameter group and status	
Gr. II. pH/Eh	0.06	Gr. II. pH/Eh	1
Gr. III. Sensory	0.59	Gr. III. Sensory	1
GR. II + III	0.33	GR. II+ III	1
Date of fieldwork	15.05 2025	Date of report	19.05 2025
Environmental status (NS 9410:2016):			**1**

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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 Hringsdalur in Arnarfjörður 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 southern part of Arnarfjörður in Vestfirðir where Hringsdalur farm is located (Hringsdalur in upper left corner).

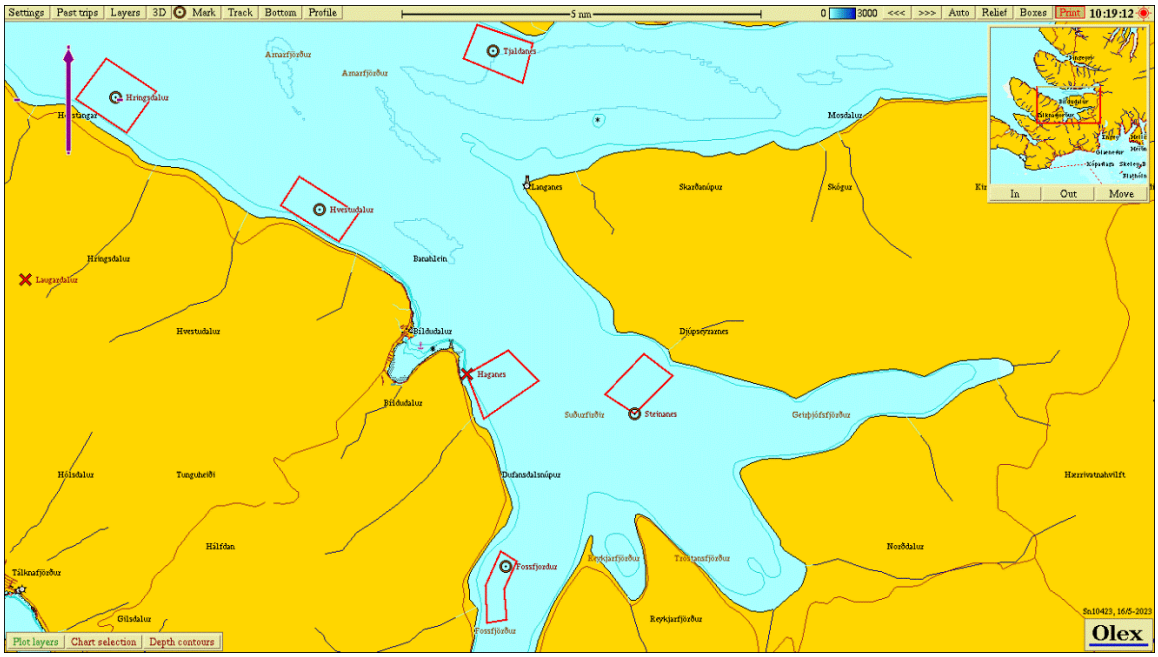

Figure 1. Overview map where Hringsdalur farm is in the upper left corner . Other fish farming areas in the nearest vicinity (Arnarfjörður) are also shown.

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 Environment and Energy Agency (Umhverfis og orkustofnun) 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 of the current generation i.e. 8.275 ton (Personal reference, Rolf Ørjan Nordli, 2025).

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 (0.1 and 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

Hringsdalur is located in the southern part of Arnarfjörður, approximately 6nm northwest of the town of Bíldudalur. The installed frame is suited for up to 18 net-pens with a circumference of 200 m. The frame is positioned in north- northwest direction from land (343°) with depth below the cages ranging from 58 to 88 m.

Previously there has been farmed one generation salmon at the site after the frame was extended (from 6 to 18 net-pens) and moved approximately 300 m eastwards. At the previous placement of the frame there were farmed two generations fish. The last generation was produced in 13 cages. The fallow period started on the 3rd of November 2024.

Table 2 shows production and feed use for the previous generation.

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

Generation of fish (G)	Production (tonnes)	Feed use (tonnes)
Generation 2022- 2024	13.150	15.549
Generation 2018-2020	6.281	7.617
Generation 2016-2018	3.613	3.914

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
15.05 2025	APN-66687.B01 (Gunnarsson, 2025)	Fallow period	1
29.09 2023	APN-65250.B01 (Gunnarsson, 2023)	B survey max biomass	1
26.04.2022	APN 64042.B01 (Gustavsson, 2022)	Fallow period	1
19.11.2019	APN-61656.B01 (Gustavsson, 2020)	B survey max biomass	1
16.05.2018	APN-60320.B01 (Gunnarsson, 2018b)	Fallow period	1
01.11.2017	APN-9187.B02 (Gunnarsson, 2018a)	B survey max biomass	1
22.10.2013	AR131125A (Moe, 2013)	B survey new site	1

3.3 Hydrodynamic conditions

Measurement of dispersing current was done at the site in January – February 2014, measurements at 60 m depth (Moe, 2014). The dominating current at 60 m is in south-eastly direction (120-165 degrees) with a small counter current in opposite direction (Figure 2). Average current speed is 6 cm/s. Highest current speed is measured to be 29 cm/s and 2.54 % of the measurements are zero current.

3.4 Survey design

Sampling stations were placed following an assessment of site configuration and local environmental conditions, i.e. bathymetry and hydrodynamics. An overview of the total 16 sampling stations can be found in Figure 2 with coordinates and depth provided in Table 4. Sampling stations

were placed to represent the environmental conditions within the near zone and cover thus both the deeper and shallower areas. The typical depth in the local impact zone is in the range from 56-88 m with the deepest waters being located in the northern part of the frame area (from land into the fjord). Samples were collected from depths ranging from 62-87 metres. The client has stated that 13 cages at the site were used at some point during this production cycle (pers. Comm Rolf Ørjan Nordli). The station placement is considered representative for an environmental survey of the farm's near-zone and in accordance with the requirements outlined in NS 9410:2016. The plan was to sample 20 stations in this B survey but due to failure in the workboat (crane leaking oil and stopped working) we had to abandon the sampling). Therefore total of 16 stations were sampled but still are considered to give a good coverage of the local impact zone of the farm.

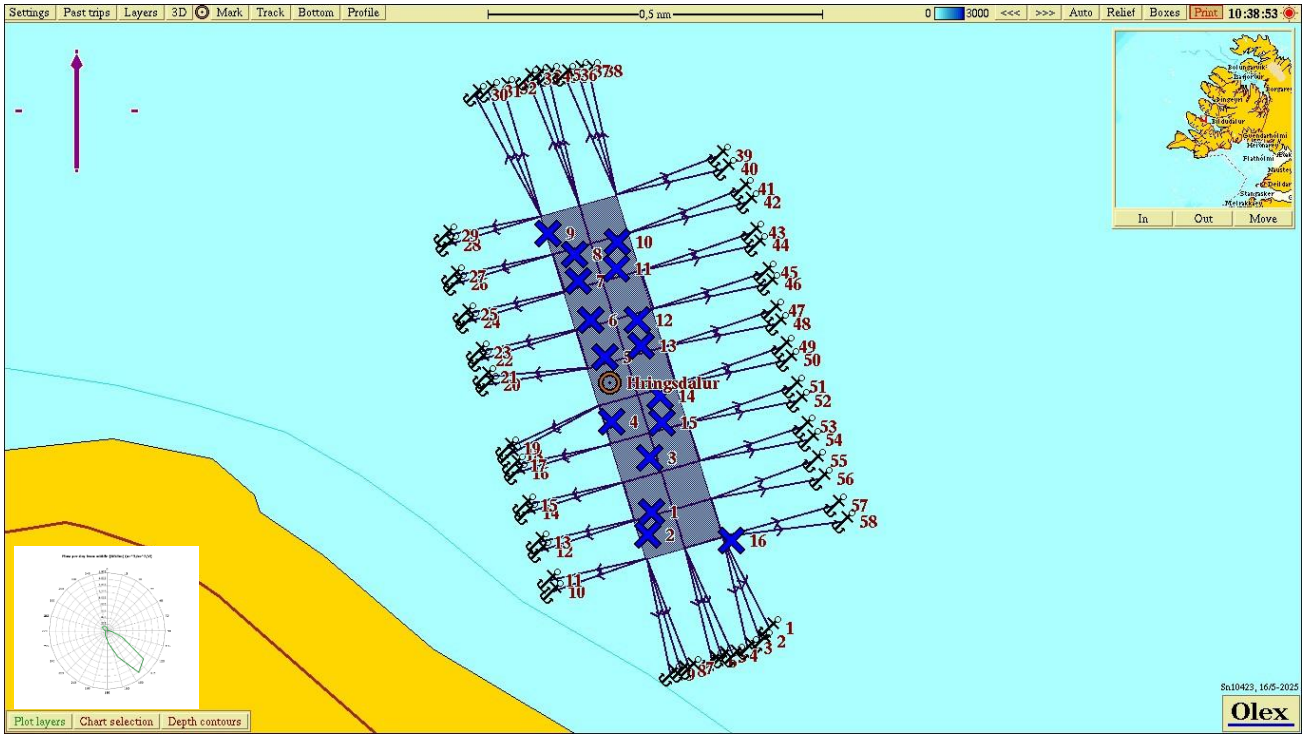

Figure 2. Overview map showing site configuration and local bathymetry at Hringsdalur. Sampling stations are marked by crosses and colour coded to visualise the environmental status at the respective station following the classification outlined in NS 9410:2016, chapter 7.11 (1 = blue, 2 = green, 3 = yellow, 4 = red). The current rose in the left corner shows the direction of water transport at dispersal depths at the site (Moe, 2024).

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

Station number	Northing	Westing	Depth [m]
St 1	65°44,213	23°45,705	66
St 2	65°44,179	23°45,719	62
St 3	65°44,295	23°45,713	73
St 4	65°44,349	23°45,849	74
St 5	65°44,443	23°45,875	81
St 6	65°44,500	23°45,926	83
St 7	65°45,558	23°45,969	85
St 8	65°44,598	23°45,983	85
St 9	65°44,629	23°46,820	86
St 10	65°44,616	23°45,829	87
St 11	65°44,573	23°45,813	86
St 12	65°44,500	23°45,757	84
St 13	65°44,462	23°45,744	83
St 14	65°44,386	23°45,672	80
St 15	65°44,347	23°45,666	77
St 16	65°44,171	23°45,414	70

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 Hringsdalur.

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

Sediment was recovered at all 16 stations (100% soft bottom). The sediments consisted primarily of clay in the whole near zone of the fish farm. Fauna was recorded to be present at all stations mainly in the form of polychaetes. No smell of H_2S was recorded at any of the sampling stations. There were no signs of out-gassing. The substrate was light/grey colour at ten stations and brown/black at six stations. Grab was full at thirteen stations and 1/4 – ¾ full at three stations.

Based on the classification of sediment chemistry (pH/Eh) and the sensory assessment all sixteen stations received status 1 – "Very good" Overall, the index score for parameter III (sensory parameters) was somewhat higher 0.59 compared with the index score for the parameter II (pH/Eh) 0.06.

In summary, the site receives the environmental status 1 - "Very good" (average group II-III index =0.33).

5 Summary

Applying the indicator thresholds and classification outlined in NS 9410:2016 it is shown that the site Hringsdalur receives overall site status of 1 – "Very good" at the time of this B survey (fallow period). Samples were collected with a Van Veen grab (0.1 m^2 at stations 1-3 and 0.025 m^2 at the rest of the stations) at 16 stations distributed around the 13 cages in use during last production cycle. Sediment was successfully collected at all the 16 stations and all stations received status 1 – "Very good".

The survey conducted during the fallow period indicates minimal organic enrichment throughout the entire local impact zone of the fish farm.

Previous B surveys carried out at max biomass for last generation gave the site also an overall environmental status of 1 – Very good (Gunnarsson, 2023). In the 2023 survey twelve stations received status 1 – "very good", four stations received status 2 – "good", three stations status 3 – "bad" and one station status 4 – "very bad". In 2023 the one station with status "very bad" and the three stations with condition "bad" were all located at the eastern part of the frame indicating higher organic load in that part of the local impact zone, which is in line with direction of the spread current at the site. Compared with the current results at fallowing period in 2025 the bottom seems to have recovered significantly during the seven month fallowing period and bottom conditions have improved.

The site is given environmental status 1 – "Very good" following the criteria outlined in NS 9410:2016.

6 References

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

Gunnarsson, S., 2023. Hringsdalur, Arnarlax B survey, September 2023 (max biomass)., APN-65250.B01. Akvaplan-niva AS.

Gunnarsson, S., 2018a. Arnarlax. B-undersøkelse, november 2017 Hringsdalur, APN-9187.B02. Akvaplan-niva AS.

Gunnarsson, S., 2018b. Arnarlax hf. B-undersøkelse, mai 2018 Hringsdalur (undersøkelse ved brakklegging), APN-60320.B01. Akvaplan-niva AS.

Gustavsson, A., 2020. Hringsdalur, Arnarlax ehf B-bottom survey, November 2019 (Maximum biomass survey), APN-61656.B01. Akvaplan-niva AS.

Gustavsson, A., 2022. Hringsdalur, Arnarlax B survey, April 2022 (post fallow), APN-64042.B01. Akvaplan-niva AS.

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

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

Moe, A.A., 2013. Environmental monitoring (MOM B) at finfish farm site Hringsdalur October 2013. AR131125A. Helgeland Havbruksstasjon AS.

Moe, A.A, 2014. Current investigation at finfish farm site Hringsdalur February 2014. Helgeland Havbruksstasjon AS.

Norsk Standard NS 9410:2016. Miljøovervåking av bunnpåvirkning fra marine akvakulturanlegg.

Personal reference. Rolf Ørjan Nordli, COO bilology, Arnarlax. 2025.

7 Attachments

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

Sample scheme B.1

Company	**Arnarlax**	**Date:**	**15.05 2025**
Site:	**Hringsdalur**	**Site no.:**	**SiteItem.LokalitetsID**
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		7,28	7,37	7,42	7,49	7,34	7,63	7,48	7,31	7,51	7,42
	Eh (mV)	ORP		-14	-15	-7	-16	-14	10	-8	-16	-3	-5
		plus ref. verdi		186	185	193	184	186	210	192	184	197	195
	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	12,0 C			**Sea temp**	6,2 C		**Sediment temp**		na C	
		pH sea 8,05	**ORP sea**	224,0 mV			**Eh sea**	424,0 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
		Brown/black (2)						2	2				
	Smell	None (0)		0	0	0	0	0	0	0	0	0	0
		Light (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					
		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		1,0	2,0	2,0	1,0	3,0	4,0	2,0	2,0	2,0	2,0
		Corrected (*0,22)		0,2	0,4	0,4	0,2	0,7	0,9	0,4	0,4	0,4	0,4
		Status station		1	1	1	1	1	1	1	1	1	1
		Average group II & III		0,1	0,2	0,2	0,1	0,3	0,4	0,2	0,2	0,2	0,2
		Status station		1	1	1	1	1	1	1	1	1	1

Grab ID	K-3 and K-21
pH / Eh ID	Ysi professional plus

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Sample scheme B.1

Company:	**Arnarlax**	**Date:**	**15.05 2025**
Site:	**Hringsdalur**	**Site no.:**	**eltem.Lokalitets**
Fieldworker:	**Snorri Gunnarsson**		

Gr	Parameter	Point	Sample number 11	12	13	14	15	16	17	18	19	20	Index S%	Index H%
	Bottom type: S (soft) or H (hard)		S	S	S	S	S	S					100	0
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0						
II	pH	value	7,59	7,54	7,15	7,48	7,54	7,55						
	Eh (mV)	ORP	3	7	-8	-2	-3	-27						
		plus ref. verdi	203	207	192	198	197	173						
	pH/Eh	from figure	0	0	1	0	0	0					0,06	
	Status station		1	1	1	1	1	1						
	Status group II		1	**Buffer temp**	12,0 C		**Sea temp**	6,2 C		**Sediment temp**	na C			
	pH sea	8,05	**ORP sea**	224 mV		**Eh sea**	424 mV		**Reference electrode**		200 mV			
III	Gas bubbles	Yes (4) No (0)	0	0	0	0	0	0						
	Colour	Light/grey (0)	0					0						
		Brown/black (2)		2	2	2	2							
	Smell	None (0)	0	0	0	0	0	0						
		Light (2)												
		Strong (4)												
	Consistency	Solid (0)	0		0	0	0	0						
		Soft (2)		2										
		Aqueous (4)												
	Grab volume (v)	v < 1/4 (0)												
		1/4 < v < 3/4 (1)												
		v > 3/4 (2)	2	2	2	2	2	2						
	Thickness of slidge (t)	t < 2 cm (0)	0	0	0	0	0	0						
		2 < t < 8 cm (1)												
		t > 8 cm (2)												
		Sum	2,0	6,0	4,0	4,0	4,0	2,0						
		Corrected (*0,22)	0,4	1,3	0,9	0,9	0,9	0,4					0,59	
	Status station		1	2	1	1	1	1						
	Status group III		1											
	Average group II & III		0,2	0,7	0,9	0,4	0,4	0,2					0,33	
	Status station		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-3 and K-21
pH / Eh ID	Ysi professional plus

Sample scheme B.2

Company:	**Arnarlax**		**Date:**	**15.05 2025**
Site:	**Hringsdalur**		**Site no.:**	**{{SiteItem.LokalitetsID}}**
Fieldworker:	**Snorri Gunnarsson**			

Sample number		1	2	3	4	5	6	7	8	9	10
Depth (m)		66	62	73	74	81	83	85	85	86	87
Number of trials		1	1	1	1	1	1	2	1	2	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								
	Sand										
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count			16								
Crustaceans, count											
Molluscs, count										2	
Polychaetes, count		6	12	11	6	37	>20	25	>20	>30	>30
Other animals, count											
Beggiatoa											
Feed											
Faeces											

Comments

Used 0.1 m2 grab for stations 1-3 and station 16 but 0,025 grab for resting stations. Plan was to take 20 stations but due to boat failure we had to abandon the sampling (so total 16 stations sampled).

Grab	**Area [m^2]**	0,1	**Grab ID**	K-3 and K-21

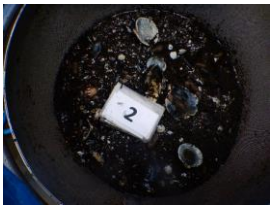
Sample scheme B.2

Company:	**Arnarlax**		**Date:**	**15.05 2025**	
Site:	**Hringsdalur**		**Site no.:**	**{{SiteItem.LokalitetsID}}**	
Fieldworker:	**Snorri Gunnarsson**				

Sample number		11	12	13	14	15	16	17	18	19	20
Depth (m)		86	84	83	80	77	70				
Number of trials		1	1	1	1	1	1				
Gas bubbles (in sample)		No	No	No	No	No	No				
Sediment type	**Clay**	X	X	X	X	X	X				
	Silt										
	Sand										
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count											
Polychaetes, count		>20	>30	>30	>20	>20	>10				
Other animals, count											
Beggiatoa											
Feed											
Faeces											

Comments	Used 0.1 m2 grab for stations 1-3 and station 16 but 0,025 grab for resting stations. Plan was to take 20 stations but due to boat failure we had to abandon the sampling (so total 16 stations sampled).			
Grab	**Area [m^2]**	0,1	**Grab ID**	K-3 and K-21
Signature fieldworker:				page 4 of 4 pages

7.2 Images of samples at Hringsdalur

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		
St 14		
St 15		

St 16		

7.3 3D-bathymetry

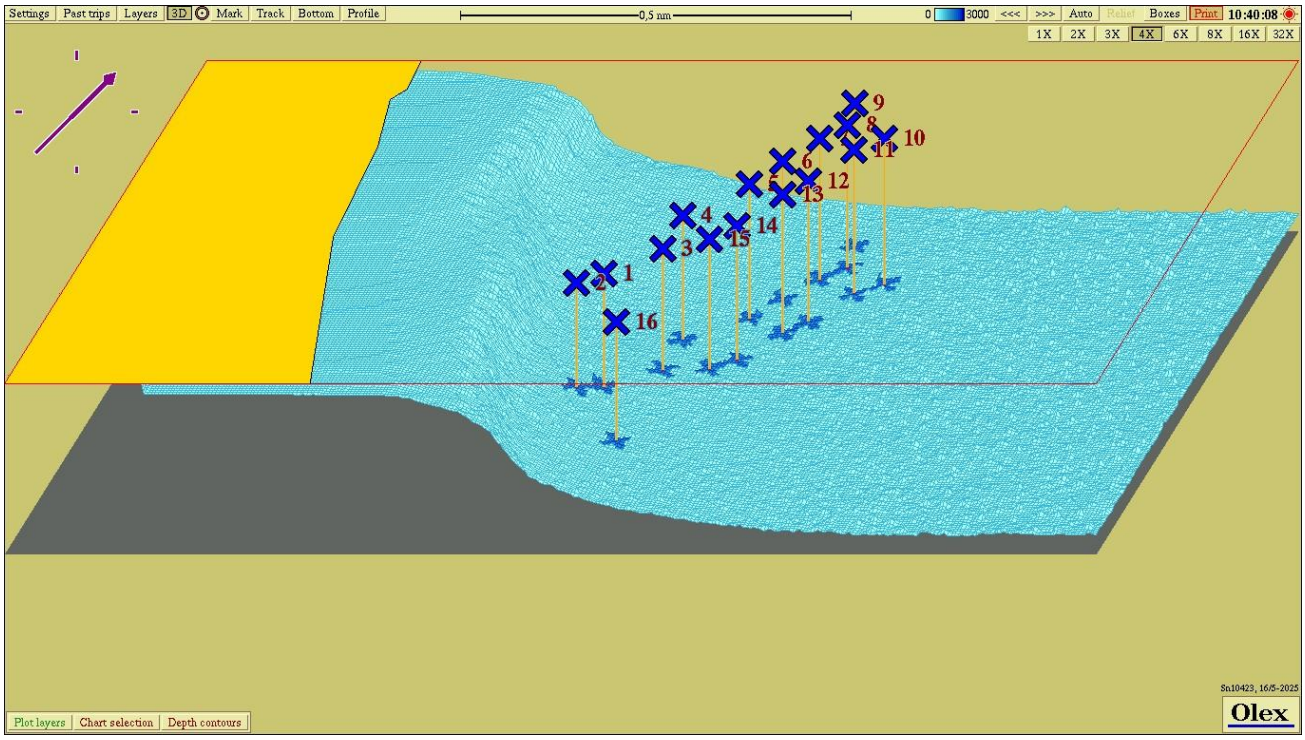


Figure 3. 3D-view of bathymetry at Hringsdalur with stations as shown in Figure 2 and Table 4. The map is oriented towards the northeast.