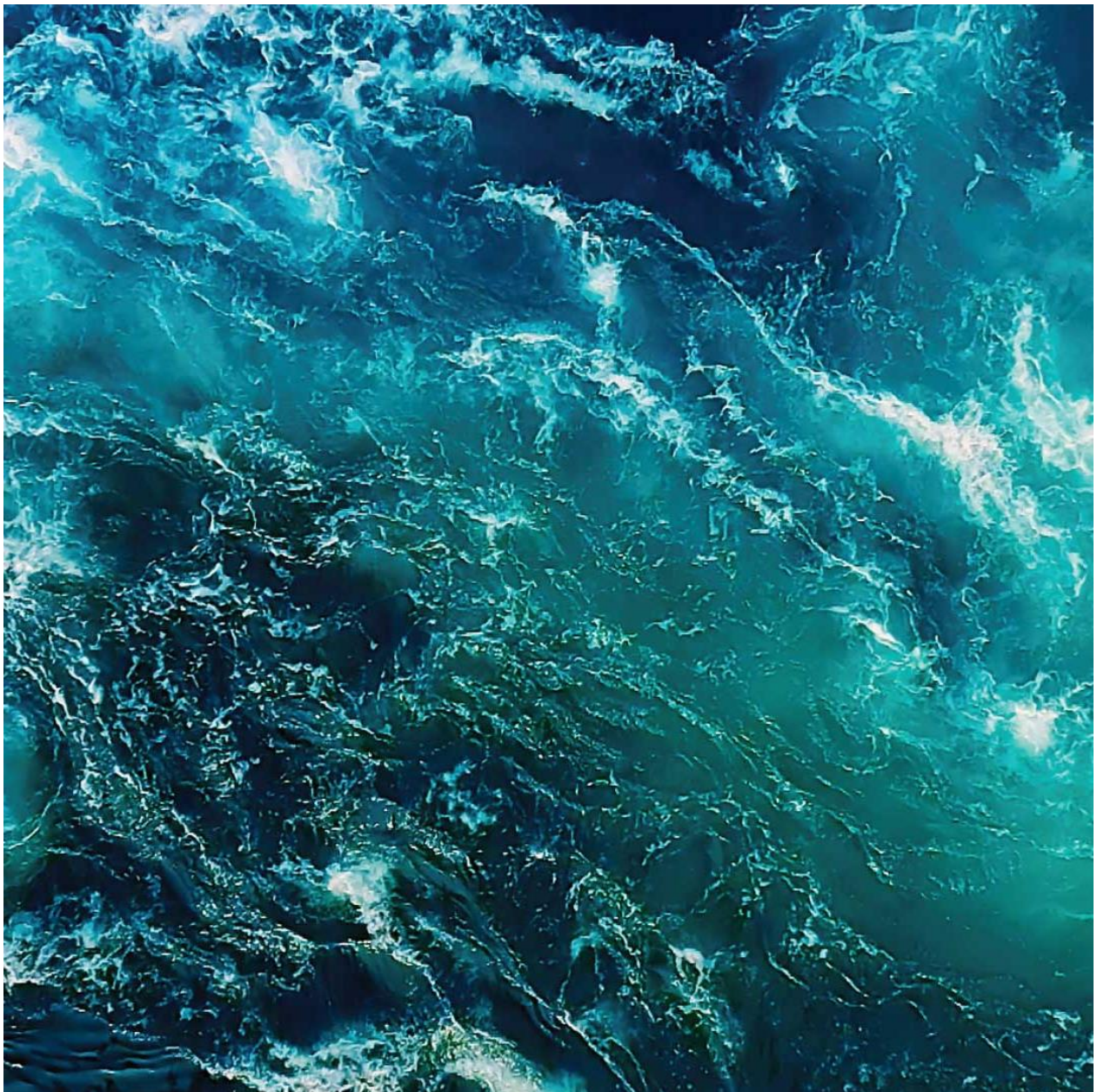


B-survey at Eyri, April 2024 (fallow period), Arnarlax ehf

Akvaplan-niva AS Report: 2024 65850.B01



B survey at Eyri, April 2024 (fallow period), Arnarlax ehf.

Author(s) Snorri Gunnarsson

Date 31.05 2024
Report No. 2024 65850.B01
Number of pages 21
Distribution Through customer
Customer Arnarlax ehf
Contact person Silja Baldvinsdóttir

Summary

Substrate was collected at all 20 sampling stations (100% soft bottom). Sediment samples consisted mainly of olive grey mud in all parts of the local impact zone. Fauna was recorded at all stations with polychaetes being most prominent. No signs of out-gassing were observed at any of the sampling stations. The substrate was of light/grey colour at twelve stations and brown/black at eight stations. The twelve stations with light grey colour had all some thin layer of black organic matter in at the top of the sample. Some light smell of H₂S was at three sampling stations and no smell at the other stations. The grab was full or $\frac{3}{4}$ full at all sampling stations.

Based on the classification of sediment chemistry (pH/Eh) and the sensory assessments all twenty stations of this survey received status 1 - "very good" (Figure 2). Overall, the index score for parameter III (sensory parameters) was higher than the index score for the parameter II (pH/Eh), or 0,70 for parameter III but 0,00 for parameter II.

Taken together the site receives the environmental status was 1 - "good" (average group II-III index = 0.35).

Approval



Project Manager



Quality Control

Key information

Site details and license holder information			
Site ID	Eyri	Site coordinates	65°34,723N 23°58,675V
County	Patreksfjörður	Municipality	Vesturbyggð
MTB (Maximum allowed biomass)	6000 tonnes	Operations Manager / Contact	Silja Baldvinsdóttir
License holder / customer	Arnarlax ehf		

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	<input type="checkbox"/>		
Follow-up survey	<input type="checkbox"/>		
Half maximum load	<input type="checkbox"/>		
Pre-stock	<input checked="" type="checkbox"/>		
Required by the state administrator - baseline survey	<input type="checkbox"/>		
Other	<input type="checkbox"/>		
Last following period:	Start 02.04 2023		

Results from B-survey in accordance with NS 9410:2016 (main results)			
Parameter group and index		Parameter group and status	
Gr. II. pH/Eh	0,00	Gr. II. pH/Eh	1
Gr. III. Sensory	0,70	Gr. III. Sensory	1
GR. II + III	0,35	GR. II+ III	1
Date of fieldwork	23.04 2024	Date of report	31.05 2024
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 ehf in connection with the company's fish farming activities at the site Eyri in Patreksfjörður 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 Patreksfjörður and Tálknafjörður where Eyri is located.

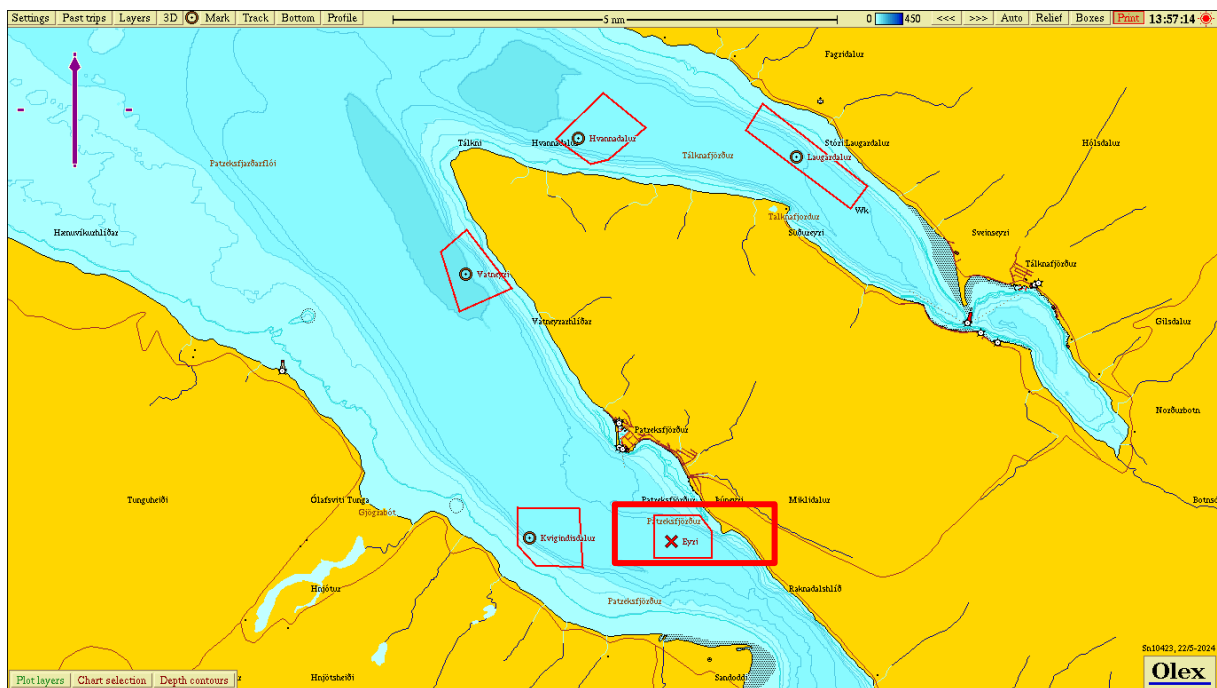


Figure 1. Overview map of Patreksfjörður and Tálknafjörður with Eyri marked by red square and an X. Other aquaculture sites are marked with locality name.

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) beneath and in the close vicinity of the fish cages (near zone). Sediment is collected using a grab (min 250 cm²). 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 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 m²)

Sieve 1 mm: Akvaplan-niva

pH meter: Electrode, YSI Professional Plus

Redox meter: Electrode, YSI Professional Plus

Position determination – GPS mapping tool

Digital camera

3 Site, production and survey design

3.1 Site characteristics and production

The Eyri site is in Patreksfjörður, just outside of Patreksfjörður village and about 2 km southeast from Patreksfjörður harbour. The cages are lined in a west direction from land (270 degrees). The depth under cages ranges from about 52 - 54 m. The fish farm at the site is a 2x7 setup, total 14 cages each with 160 m circumference. During the last production cycle all 14 cages of were used.

There have been farmed two generation farmed salmon at the site. The last generation started with smolt output summer/fall 2021 and finish slaughter 2nd April 2023.

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

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

Generation of fish (G)	Production (tonnes)	Feed use (tonnes)
Generation 2021- 2023	9.163	11.624
Generation 2018- 2020	5.143	7.177

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
23.04.2024	APN 65850.B01	B-survey fallow period	1
18.11.2022	APN 64474.B01	B-survey max biomass	2
28.05.2021	APN 63202.B01	B-survey fallow period	1
05.03.2020	APN-61958.B02	B-survey max biomass	1
17.05.2018	APN-60033.B01	B-pre survey	1

3.3 Hydrodynamic conditions

Measurement of dispersing current was done at the site in March – May 2020 measurements at 43 m depth (Gunnarsson, 2020b). Dominating current (43 m) is in direction north by north-west (330 degrees; Figure 2) with a smaller counter current in south by south-east direction. Average current speed is measured to be 5.0 cm/s. Highest current speed is measured to be 20.8 cm/s and 5.9 % of the measurements are < 1 cm/s.

3.4 Survey design

The placement of the 20 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 52 – 55 m, with a slightly deeper area on northern part of the mooring frame. The sampling stations had a depth varying from 52 to 55 m. Sampling stations were placed to represent the varied environmental conditions within the near zone and cover thus both the deeper and shallower areas in the whole

local impact zone. The 20 stations sampled were distributed with emphasis on areas where station status was condition 2 or less in previous max biomass survey but otherwise spread to cover the whole local impact zone according to guidance in NS 9410, chapter 7.6. The sampling stations had a depth varying typically from 52 to 54 m. The placement of sampling stations is regarded to be in accordance with the requirements outlined in NS 9410:2016.

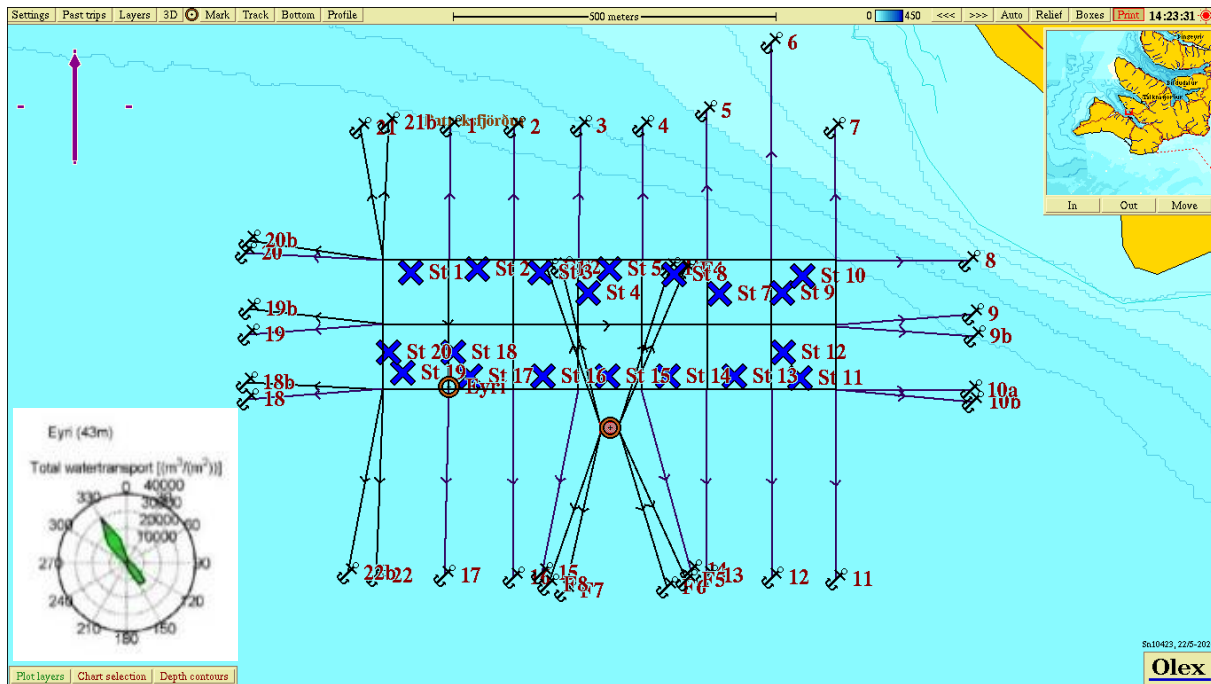


Figure 2. Overview map showing site configuration and local bathymetry at Eyri. Sampling stations are marked by crosses and colour coded to visualise the environmental status at the respective station following the classification outlined in NS 9410:2016, chapter 7.11 (1 = blue, 2 = green, 3 = yellow, 4 = red). The current rose in the lower left corner shows the direction of water transport at dispersal depths at the site (Gunnarsson, 2020b).

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

Station number	Northing	Easting	Depth [m]
St 1	65°34,767	23°59,080	53
St 2	65°34,770	23°58,946	54
St 3	65°34,767	23°58,820	54
St 4	65°34,750	23°58,723	54
St 5	65°34,770	23°58,680	55
St 6	65°34,765	23°58,550	54
St 7	65°34,749	23°58,458	54
St 8	65°34,765	23°58,417	54
St 9	65°34,750	23°58,323	54
St 10	65°34,764	23°58,290	53
St 11	65°34,679	23°58,296	53
St 12	65°34,700	23°58,330	53
St 13	65°34,680	23°58,427	53
St 14	65°34,680	23°58,562	52
St 15	65°34,680	23°58,683	52

Station number	Northing	Easting	Depth [m]
St 16	65°34,680	23°58,815	52
St 17	65°34,680	23°58,960	52
St 18	65°34,700	23°58,995	53
St 19	65°34,683	23°59,096	52
St 20	65°34,700	23°59,125	53

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 Eyri.

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 20 sampling stations (100% soft bottom). Sediment samples consisted mainly of olive grey mud in all parts of the local impact zone. Fauna was recorded at all stations with polychaetes being most prominent. No signs of out-gassing were observed at any of the sampling stations. The substrate was of light/grey colour at twelve stations and brown/black at eight stations. The twelve stations with light grey colour had all some thin layer of black organic matter in at the top of the sample. Some light smell of H₂S was at three sampling stations and no smell at the other stations. The grab was full or $\frac{3}{4}$ full at all sampling stations.

Based on the classification of sediment chemistry (pH/Eh) and the sensory assessments all twenty stations of this survey received status 1 – "very good" (Figure 2). Overall, the index score for parameter III (sensory parameters) was higher than the index score for the parameter II (pH/Eh), or 0,70 for parameter III but 0,00 for parameter II.

Taken together the site receives the environmental status was 1 – "good" (average group II-III index = 0.35).

5 Summary

Applying the indicator thresholds and classification outlined in NS 9410:2016 it is shown that Eyri receives overall site status 1 - "very good" at the time of this B survey (fallow period). Samples were collected with a Van Veen grab (0,025 m²) at 20 stations distributed around the whole local impact zone. All twenty sampling stations received status 1 - "very good".

In previous B survey at max biomass in 2022 (Gunnarsson, 2022) the results indicated some organic load in the local impact zone. There were four stations with status "very bad", located both in the northern and eastern part of the frame and southern and western part. Other stations with reduced environmental condition in 2022 were found both at the northern and southern part of the frame (Figure 2). Signs of organic accumulation are therefore found in most parts of the local impact zone in 2022. The current survey in 2024 was undertaken at fallow period prior to putting out smolts at the site. The results indicate that overall, there is relatively little organic load in the local impact zone and the site status has improved since previous B survey at max biomass (Gunnarsson, 2022) or from status 2- "good" to status 1- "very good".

The site is given environmental status 1 - Very good. In accordance with the frequency of B-surveys specified in NS 9410:2016, the site shall have a new survey at the next maximum load.

6 References

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

Gunnarsson, S., 2018. Eyri, Arnarlax hf. Foreundersøkelse (B-undersøkelse), mai 2018 Akvaplan-niva AS report nr. 60033.01.

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Gunnarsson, S., 2022. Eyri, Arnarlax. B- survey, November 2022 (max biomass). Akvaplan-niva AS report nr. 64475.B01

Gústavsson, A., 2021. Eyri, Arnarlax B-bottom survey, May 2021 (fallow period). Akvaplan-niva AS report nr. 63202.B01.

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. Silja Baldvinsdóttir, Quality manager, Arnarlax. 2024

7 Attachments

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

Sample scheme B.1											
Company	Arnarlax					Date:	23.04 2024				
Site:	Eyri (fallow period)					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	7.47	7.63	7.57	7.51	7.47	7.69	7.56	7.52	7.63	7.55		
	Eh (mV)	ORP	138	38	69	89	38	58	73	29	65	26		
		plus ref. verdi	338	238	269	289	238	258	273	229	265	226		
	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		
	Buffer-temp			10.0 C				Sea temp		3.2 C		Sediment temp		3.0 C
	pH sea			7.99		ORP sea			221.0 mV		Eh sea		421.0 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
Brown/black (2)							2	2			2			
Smell		None (0)	0	0					0	0	0	0	0	
		Light (2)			2	2	2							
		Strong (4)												
Consistency		Solid (0)	0	0	0	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	2	2	2	2	2	
Thickness of sludge (t)		t < 2 cm (0)	0	0	0	0	0	0	0	0	0	0	0	
		2 < t < 8 cm (1)												
		t > 8 cm (2)												
Sum			2.0	2.0	4.0	4.0	8.0	4.0	2.0	4.0	2.0	2.0		
Corrected (**0.22)			0.4	0.4	0.9	0.9	1.8	0.9	0.4	0.9	0.4	0.4		
Status station			1	1	1	1	2	1	1	1	1	1		
Average group II & III			0.2	0.2	0.4	0.4	0.9	0.4	0.2	0.4	0.2	0.2		
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
Site:	Eyri (fallow period)
Fieldworker:	Snorri Gunnarsson

Date:	23.04 2024
Site no.:	0

Gr	Parameter	Point	Sample number										Index	
			11	12	13	14	15	16	17	18	19	20	S%	H%
	Bottom type: S (soft) or H (hard)		S	S	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	0	0	0	0
II	pH	value	7.54	7.62	7.49	7.60	7.48	7.49	7.46	7.60	7.42	7.53		
	Eh (mV)	ORP	91	48	31	75	-26	13	24	38	-18	23		
		plus ref. verdi	291	248	231	275	174	213	224	238	182	223		
	pH/Eh	from figure	0	0	0	0	0	0	0	0	0	0	0.00	
	Status station			1	1	1	1	1	1	1	1	1	1	1
	Status group II			1	Buffer temp	10.0 C		Sea temp	3.2 C		Sediment temp	3.0 C		
	pH sea	7.99	ORP sea	221 mV		Eh sea	421 mV		Reference electrode	200 mV				
	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			
		Brown/black (2)		2		2		2		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)													
	v > 3/4 (2)	2	2	2	2	2	2	2	2	2	2			
Thickness of sledge (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			2.0	4.0	2.0	4.0	2.0	2.0	2.0	4.0	4.0	4.0		
Corrected (*0,22)			0.4	0.9	0.4	0.9	0.4	0.4	0.4	0.9	0.9	0.9	0.70	
Status station			1	1	1	1	1	1	1	1	1	1	1	
Status group III			1											
Average group II & III			0.2	0.4	0.2	0.4	0.2	0.2	0.2	0.4	0.4	0.4	0.35	
Status station			1	1	1	1	1	1	1	1	1	1	1	
Status group II & III			1											
pH/Eh														
Corr.sum														
Index														
Average														
< 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
Site:	Eyri (fallow period)
Fieldworker:	Snorri Gunnarsson


Date:	23.04 2024
Site no.:	0

Sample number	1	2	3	4	5	6	7	8	9	10
Depth (m)	53	54	54	54	55	54	54	54	54	53
Number of trials	2	1	1	1	1	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
	Silt									
	Sand									
	Gravel									
	Shellsand									
Reef										
Rocky bottom (cobble, boulders)										
Echinodermata, count										
Crustaceans, count		1								
Molluscs, count										
Polychaetes, count	7	4	>30	10	>20	>30	>50	>50	>10	>20
Beggiatoa										
Feed										
Faeces										
Comments										
Grab	Area [m ²]	0.025		Grab ID	K-21					
page 3 of 4 pages										



Sample scheme B.2











Company:	Arnarlax
Site:	Eyri (fallow period)
Fieldworker:	Snorri Gunnarsson











Date:	23.04 2024
Site no.:	0











Sample number	11	12	13	14	15	16	17	18	19	20
Depth (m)	53	53	53	52	52	52	52	53	52	53
Number of trials	1	1	1	1	1	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
	Silt									
	Sand									
	Gravel									
	Shellsand									
Reef										
Rocky bottom (cobble, boulders)										
Echinodermata, count										
Crustaceans, count										
Molluscs, count										
Polychaetes, count	>20	>50	>10	3	1	5	2	>30	6	7
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 Images of samples at Eyri

<i>St</i>	<i>Image before sieving</i>	<i>Image after sieving</i>
<i>St 1</i>	 A photograph of a dark, irregularly shaped sample labeled '1' inside an orange container.	 A photograph of the sieved residue for sample 1, showing a dark, granular material on a sieve.
<i>St 2</i>	 A photograph of a dark, irregularly shaped sample labeled '2' inside an orange container.	 A photograph of the sieved residue for sample 2, showing a dark, granular material on a sieve.
<i>St 3</i>	 A photograph of a dark, irregularly shaped sample labeled '3' inside an orange container.	 A photograph of the sieved residue for sample 3, showing a dark, granular material on a sieve.
<i>St 4</i>	 A photograph of a dark, irregularly shaped sample labeled '4' inside an orange container.	 A photograph of the sieved residue for sample 4, showing a dark, granular material on a sieve.
<i>St 5</i>	 A photograph of a dark, irregularly shaped sample labeled '5' inside an orange container.	 A photograph of the sieved residue for sample 5, showing a dark, granular material on a sieve.

St 6		
St 7		
St 8		
St 9		
St 10		

<p><i>St 11</i></p>		
<p><i>St 12</i></p>		
<p><i>St 13</i></p>		
<p><i>St 14</i></p>		
<p><i>St 15</i></p>		

St 16		
St 17		
St 18		
St 19		
St 20		

7.3 3D-bathymetry

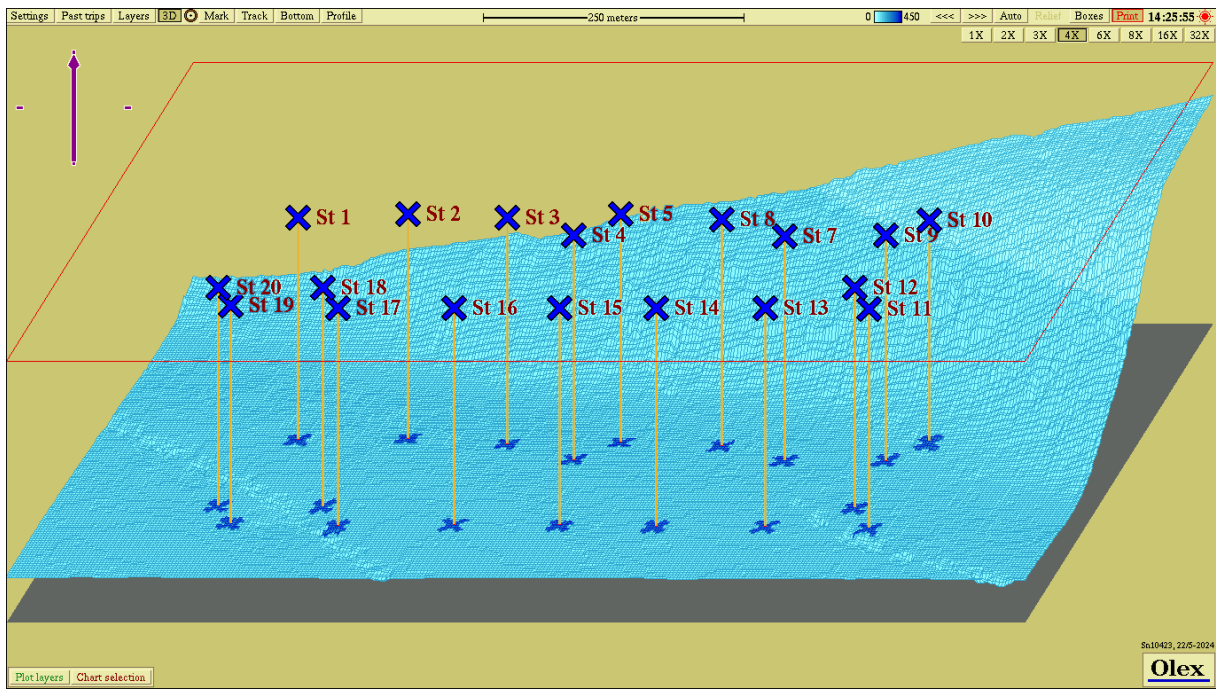


Figure 1.3D-view of bathymetry at Eyri with stations as shown in Figure 2 and Table 4.