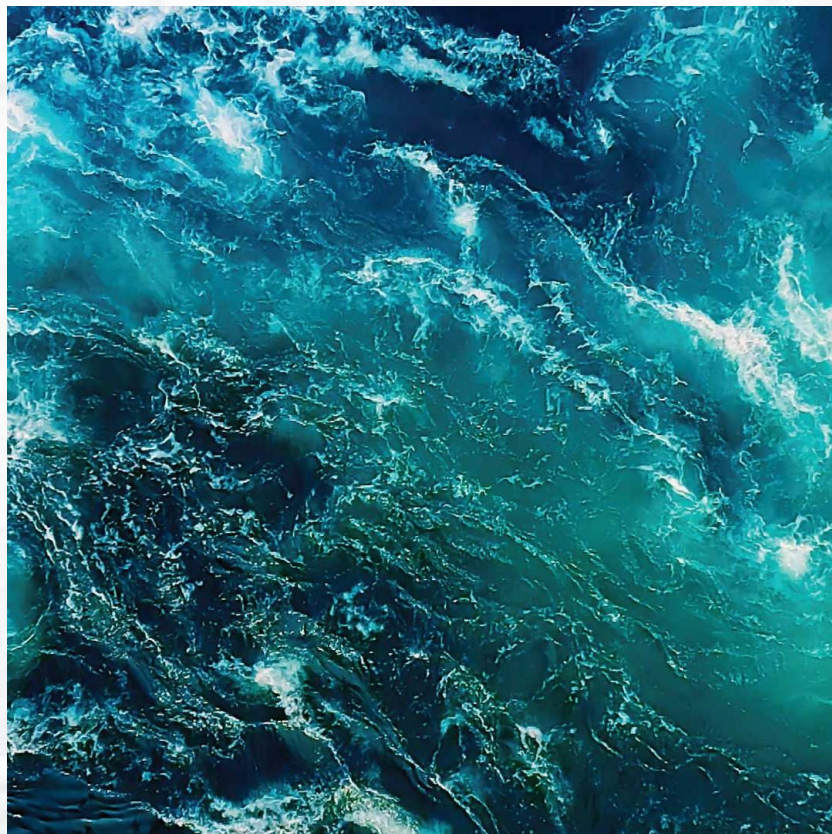


Eyrarhlíð I, Arctic Sea Farm
B survey,
July 2023
(fallow period)



Information client			
Title	Eyrarhlíð, Arctic Sea Farm. B survey (fallow period), July 2023		
Report number	APN-65094.B01		
Site name	Eyrarhlíð I	Coordinates site	65°54,898N 23°40,390V
County	Ísafjarðarbær	Municipality	Ísafjarðarbær
MTB-or estimated max biomass	6.000 tonnes	Site manager/contact	Maria E. Chiarandini
Client name	Arctic Sea Farm		

Biomass/production/status at date of survey			
Biomass at date of survey	-	Feed use	-
Fish type	Salmon	Amount produced	-
Type/time of survey		Comments	
At maximal biomass see kap 7.9	<input type="checkbox"/>		
A follow up survey	<input type="checkbox"/>		
Half maximal biomass	<input type="checkbox"/>		
Survey prior to putting out smolt	<input checked="" type="checkbox"/>		
A pre-survey new site	<input type="checkbox"/>		
Other	<input type="checkbox"/>		
Last fallowing period:	20/02 2023- date of survey		

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	0,50	Gr. III. Sensory	1
GR. II + III	0,25	GR. II+ III	1
Date fieldwork	04.07 2023	Date report	13.07 2023
Site status (NS 9410:2016):			1



Report writing and project leader	Snorri Gunnarsson	Signature	
Quality control	Ann-Cecilie Henriksen	Signature	

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Preface

The B-survey is carried out in accordance to 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 following have participated in the survey:

Snorri Gunnarsson	Akvaplan-niva AS	Project manager.
Snorri Gunnarsson	Akvaplan-niva AS	Fieldwork and Report. Charts (Olex).
Ann-Cecilie Henriksen	Akvaplan-niva AS	Quality assurance.

The sampling at Eyrarhlíð I was done 04.07.2023.

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.



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 Arctic Sea Farm and their personnel for the cooperation during the conductance of this site survey.

Kópavogur 13.07.2023

Snorri Gunnarsson
Project manager

1 Introduction

Sampling was undertaken on 04.07.2023 by Akvaplan-niva AS, who has been contracted by Arctic Sea farm in relation to the company's fish farming activity at the site Eyrarhlíð I in Dýrafjörður, Ísafjarðarbær municipality.

The objective of the B-survey is to document the environmental condition in the near zone (beneath and in the close vicinity) 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 survey was undertaken at the time of fallow period prior to putting out next generation farmed fish at the site. Sampling stations in this survey are placed within the near zone of the current farm location. Eyrarhlíð has an estimated max. biomass of 6.000 t for current generation farmed fish (Frederik Hanssen Mosti, personal reference) and thus a total of 18 stations were sampled.

Figure 1 shows a map of the Dýrafjörður in Vestfirðir where Eyrarhlíð is located.

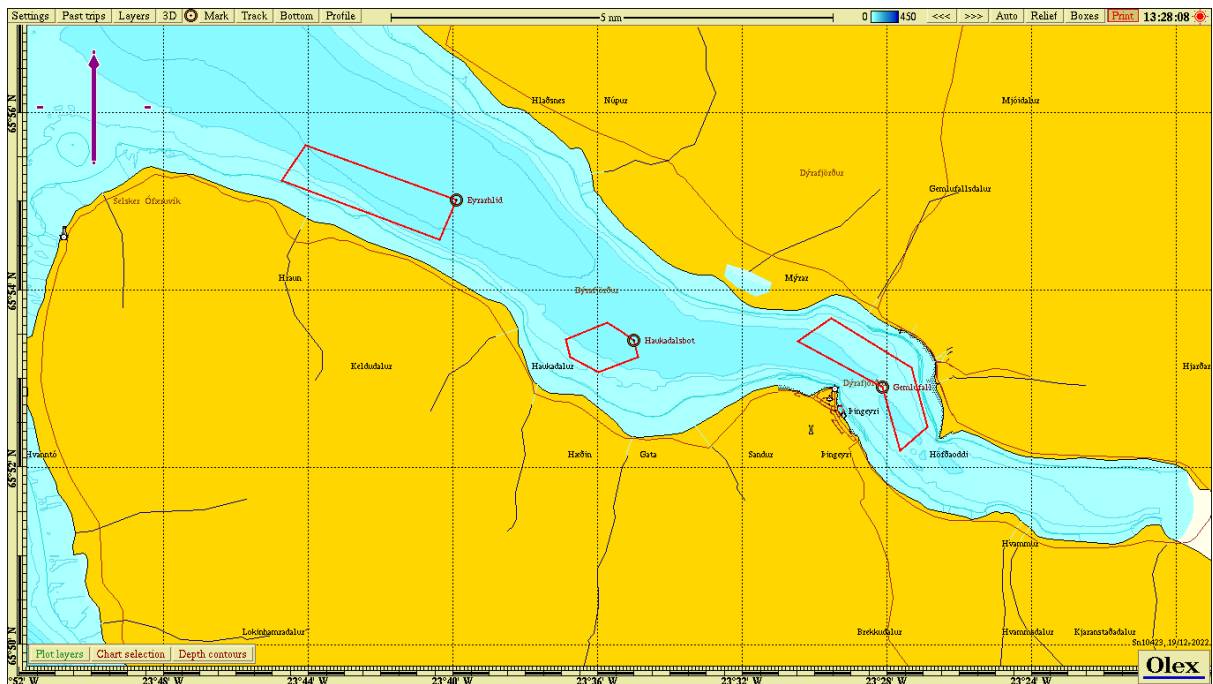


Figure 1. An overview map where Eyrarhlíð I is marked. Other fish farming areas in the nearest vicinity (Dýrafjörður) are also shown.

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. 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 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: <ul style="list-style-type: none">- 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 0,025 m²

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

The Eyrarhlíð site is located in Dýrafjörður about 9 km west from Þingeyri. The cages are lined in a northern direction from land (19 degrees). The depth under cages ranges from about 40 - 42 m. The fish farm at the site is a two-frame mooring system, each frame having 6 cages. In total there is 12 cages, each with 160 m circumference. The site has been in fallow state since 20th of February 2023 until the date of survey (about 4 ½ month).

Previously there has been farmed two generations of fish at the site. The previous generation farmed at the site was started with putting out smolts in 2021 and ended with final slaughter in February 2023.

Table 2 shows the production and feed usage for previous and current generation to sampling date.

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

Generation of fish (G)	Production (tonnes)	Feed usage (tonnes)
Generation 2018 – 2020	8.602	10.079
Generation 2021- 20.02 2023	8.370	10.551

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 Eyrarhlíð I.

Date of sampling	Report number	Survey type	Overall site status
04.07.2023	APN 65094.B01	B-survey fallow period	1
22.11.2022	APN 64476.B01	B-survey max biomass	2
15.04.2021	APN 63090.B01	B-survey fallow period	1
25.03.2020	APN-62008.B02	B-survey max biomass	1
30.01.2020	APN-61859.B01	B-survey half max biomass	1

3.3 Hydrodynamic conditions

Measurement of dispersing current was done at the site in August – September 2019 measurements at 39 m depth (Gustavsson, 2019). Dominating current (39 m) is in direction south-east (130 degrees; Figure 2). with a smaller counter current in north-west direction. Average current speed is measured to be 5.9 cm/s. Highest current speed is measured to be 26.7 cm/s and 3.4 % of the measurements are < 1 cm/s.

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 new frame position following criteria outlined in NS 9410:2016. The typical depth in the local impact zone is in the range from 40 – 42 m, with a slightly increasing depth into the fjord (NNV). 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 40 to 42 m. The placement of sampling stations is regarded to be in accordance with the requirements outlined in NS 9410:2016.

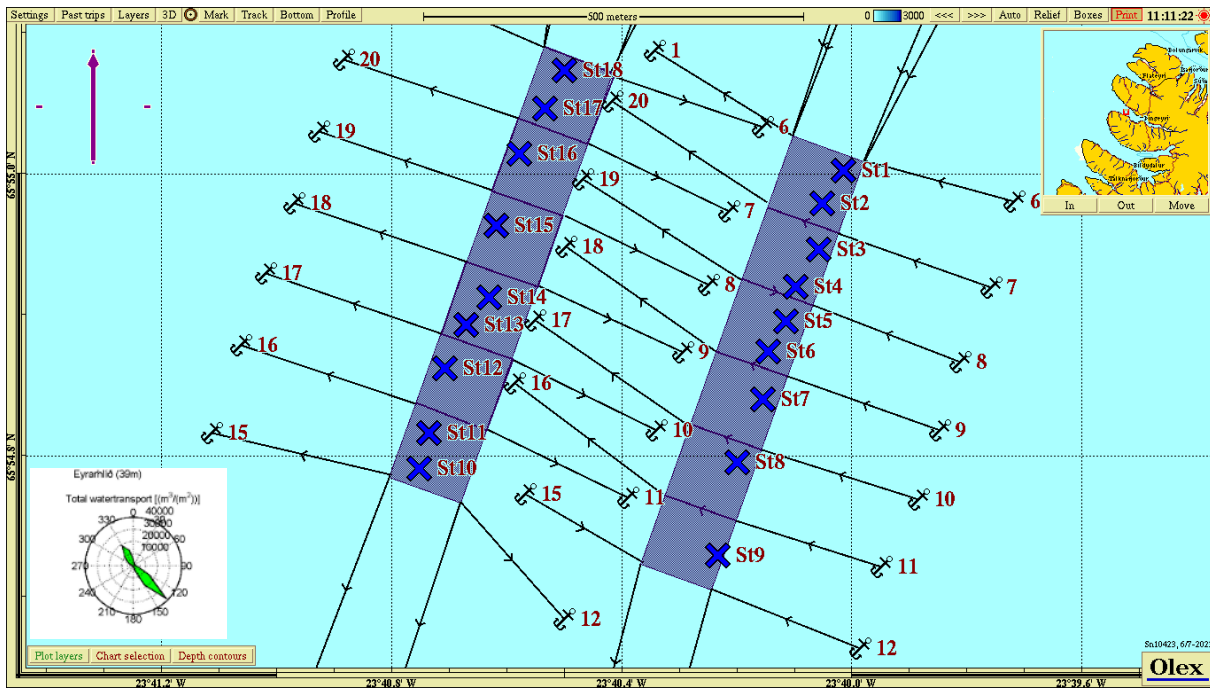


Figure 2. Site specific map of Eyrarhlíð showing frame, mooring lines and farming area. Sampling stations st. 1 – 18 are marked with crosses. The color of each cross represents the environmental condition at the respective station following the classification as outlined in NS 9410:2016, chapter 7.11. Colour codes: Blue = very good, green = good, yellow = bad, red = very bad. Current rose placed in the lower left corner shows main current direction at 39 m (Gustavsson, 2019).

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

Station number	North	West	Depth (m)
St 1	65°55,002	23°40,014	42
St 2	65°54,979	23°40,052	41
St 3	65°54,946	23°40,057	41
St 4	65°54,920	23°40,097	41
St 5	65°54,895	23°40,115	41
St 6	65°54,847	23°40,145	41
St 7	65°54,840	23°40,154	41
St 8	65°54,795	23°40,200	41
St 9	65°54,729	23°40,234	40
St 10	65°54,791	23°40,753	40
St 11	65°54,816	23°40,735	41
St 12	65°54,861	23°40,708	41
St 13	65°54,893	23°40,671	41
St 14	65°54,912	23°40,631	41
St 15	65°54,963	23°40,619	41
St 16	65°55,014	23°40,579	42
St 17	65°55,046	23°40,534	42
St 18	65°55,073	23°40,500	42

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 in all parts of the local impact zone and were overall homogenous. Fauna was recorded at all stations with polychaetes being most prominent. The substrate was of light grey colour at fifteen stations and brown/black colour at the resting three stations. No signs of out-gassing were recorded at any of the sampling stations. No smell of H₂S was recorded at any of the sampling stations. Bacteria *Beggiatoa* was not observed at any of the sampling stations.

Based on the classification of sediment chemistry (pH/Eh) and the sensory assessments all sixteen stations of this survey received status 1 – "very good" (Figure 2).

Taken together the site receives the environmental status was 1 – "very good" (average group II-III index =0.25).

5 Conclusion

Applying the indicator thresholds and classification outlined in NS 9410:2016 it is shown that Eyrarhlíð receives site status 1 – "very good" at the time of this B survey. Samples were collected with a Van Veen grab (0,025 m²) at 18 stations distributed around the 12 cages, which are placed in the two frames during last production cycle. All eighteen sampling stations received status 1 – "very good".

The here presented survey was undertaken during the time of fallowing period that started 20th of February 2023 (about 4 1/2 month period until date of sampling). The results indicate relatively little organic load in the local impact zone.

In previous B-survey at max biomass in November 2022 (Gunnarsson, 2022) the overall site condition was 2 or "good" and the results indicated some organic load in the local impact zone both at the western and the eastern frame and of the total 17 sampling stations two stations received status "very bad", one stations received status "bad" and four stations status "good". The bacteria "*Beggiatoa*" was also observed at four the total 17 sampling stations.

Since previous B-survey at max biomass in 2022 the overall site condition has therefore improved during the current fallow period.

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.

Gallo, C., 2019. Base line monitoring for salmon farming site in Eyrarhlíð, Dýrafjörður. NV nr. 13-19.

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Gunnarsson, S., 2020b. Eyrarhlíð, Arctic Sea Farm. B-bottom survey March 2020 (maximum biomass survey). Akvaplan-niva AS report nr. 62008.B02.

Gustavsson, A. 2019. Arctic Sea Farm hf, measurement of spread current at Eyrarhlíð, fall 2019. Akvaplan-niva AS project nr. 61426.

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. Frederik Hanssen Mosti, Biological Controller, Arctic Sea Farm.

7 Appendix

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

Sample scheme B.1													
Company		Arctic Sea Farm											
Site:		Eyrarhlíð I (fallow period)											
Fieldworker:		Snorri Gunnarsson											
Date:		04.07 2023											
Site no.:													
Gr	Parameter	Point	Sample number										
	Bottom type: S (soft) eller H (hard)		1	2	3	4	5	6	7	8	9	10	
			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	7.70	7.69	7.68	7.76	7.70	7.74	7.58	7.68	7.75	7.65	
	Eh (mV)	ORP	63	21	70	-36	27	23	6	4	-26	-28	
		plus ref. verdi	263	221	270	164	227	223	206	204	174	172	
	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	7.5 C			Sea temp	8.5 C			Sediment temp	7.3 C		
		pH sea	8.15		ORP sea	113.0 mV		Eh sea	313.0 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	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 sidge (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	2.0	2.0	2.0	2.0	2.0	2.0		
	Corrected (*0,22)		0.4	0.9	0.4	0.4	0.4	0.4	0.4	0.4	0.4		
	Status station		1	1	1	1	1	1	1	1	1		
	Average group II & III		0.2	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2		
	Status station		1	1	1	1	1	1	1	1	1		
Grab ID	K-21												
pH / Eh ID	Ysi prof. Plus												

Sample scheme B.1

Company:	Arctic Sea Farm	Date:	04.07 2023
Site:	Eyrarhlíð I (fallow period)	Site no.:	0
Fieldworker:	Snorri Gunnarsson		

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			100	0
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0	0	0				
II	pH	value	7.72	7.80	7.63	7.76	7.72	7.72	7.62	7.69				
	Eh (mV)	ORP	-45	24	13	35	-29	31	-13	27				
		plus ref. verdi	155	224	213	235	171	231	187	227				
	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	7.5 C			Sea temp	8.5 C		Sediment temp	7.3 C		
	pH sea	8.15	ORP sea	113 mV			Eh sea	313 mV		Reference electrode	200 mV			
	Gas bubbles	Yes (4) No (0)	0	0	0	0	0	0	0	0				
	Colour	Light/grey (0)	0		0	0		0	0	0				
		Brown/black (2)		2				2						
Smell	None (0)	0	0	0	0	0	0	0	0					
	Light (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)													
	1/4 < v < 3/4 (1)		1											
	v > 3/4 (2)	2		2	2	2	2	2	2					
Thickness of sludge (t)	t < 2 cm (0)	0	0	0	0	0	0	0	0					
	2 < t < 8 cm (1)													
	t > 8 cm (2)													
	Sum		2.0	3.0	2.0	2.0	4.0	2.0	2.0	2.0				
	Corrected (*0.22)		0.4	0.7	0.4	0.4	0.9	0.4	0.4	0.4			0.50	
	Status station		1	1	1	1	1	1	1	1				
	Status group III		1											
	Average group II & III		0.2	0.3	0.2	0.2	0.4	0.2	0.2	0.2			0.25	
	Status station		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:	Arctic Sea Farm
Site:	Eyrarhlíð I (fallow period)
Fieldworker:	Snorri Gunnarsson

Date:	04.07 2023
Site no.:	0











Sample number	1	2	3	4	5	6	7	8	9	10
Depth (m)	42	41	41	41	41	41	41	41	40	40
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 (cobbles, boulders)										
Echinodermata, count										
Crustaceans, count										
Molluscs, count										
Polychaetes, count	>20	>10	>20	>10	>10	>10	>20	>20	>10	>10
Other animals, count										
<i>Beggiatoa</i>										
Feed										
Faeces										
Comments										
Grab	Area [m ²]	0.025	Grab ID	K-21						











Sample scheme B.2











Company:	Arctic Sea Farm	Date:	04.07 2023
Site:	Eyrarhlíð I (fallow period)	Site no.:	0
Fieldworker:	Snorri Gunnarsson		

Sample number	11	12	13	14	15	16	17	18	19	20
Depth (m)	41	41	41	41	41	42	42	42		
Number of trials	1	1	1	1	1	1	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									
	Sand									
	Gravel									
	Shellsand									
Reef										
Rocky bottom (cobbles, boulders)										
Echinodermata, count										
Crustaceans, count	1									
Molluscs, count										
Polychaetes, count	6	5	7	>10	>10	>10	8	>10		
Other animals, count										
<i>Beggiatoa</i>										
Feed										
Faeces										
Comments										
Grab	Area [m ²]	0.025	Grab ID	K-21						
Signature fieldworker:										

7.2 Pictures of samples at Eyrarhlíð I.

<i>St 1</i>		
<i>St 2</i>		
<i>St 3</i>		
<i>St 4</i>		
<i>St 5</i>		

<p><i>St 6</i></p>		
<p><i>St 7</i></p>		
<p><i>St 8</i></p>		
<p><i>St 9</i></p>		
<p><i>St 10</i></p>		

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

<p><i>St 16</i></p>		
<p><i>St 17</i></p>		
<p><i>St 18</i></p>		

7.3 Bottom topography and 3D view

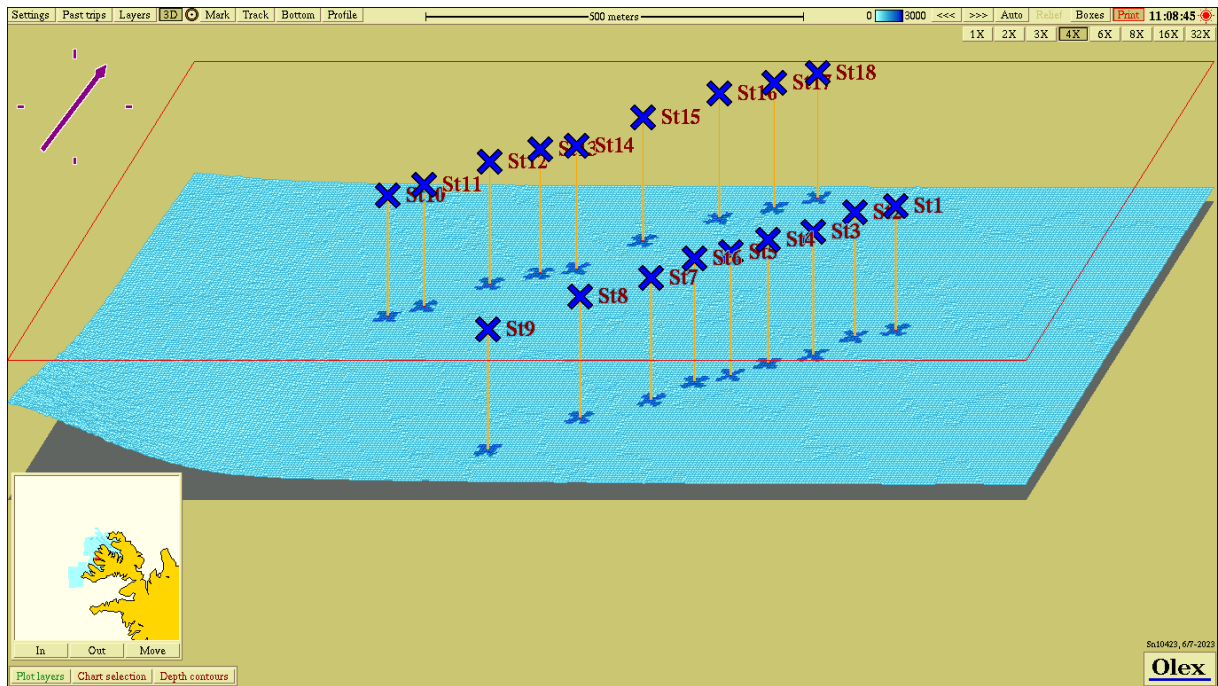


Figure 3. Bottom topography in 3D at Eyrarhlíð I with each sampling station according to info in Figure 1 and Table 4.