

Information client			
Title	Eyrarhlíð, Arctic Sea Farm. B-bottom survey, April 2021		
Report number	APN-63090.B01		
Site name	Eyrarhlíð	Coordinates site	65°54.898 N 023°40.390 V
County	Ísafjarðarbær	Municipality	Ísafjarðarbær
MTB-or estimated max biomass	5.779 ton	Site manager/contact	Steinunn Guðný Einarsdóttir
Client name	Arctic Sea Farm		

Biomass/production/status at date of survey			
Biomass at date of survey	0 ton	Feed use	0
Fish type	Salmon	Amount produced	
Type/time of survey	Mark with X	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 following period:			

Results from B-survey iht. NS 9410:2016 (main results)			
Parameters and indexes		Parameters and site status	
Gr. II. pH/Eh	0,24	Gr. II. pH/Eh	1
Gr. III. Sensory	0,82	Gr. III. Sensory	1
GR. II + III	0,53	GR. II+ III	1
Date field work	15.04 2021	Date report	22.09.21
Site status (NS 9410:2016):			1



Report writing and project leader	Snorri Gunnarsson	Signature	
Quality control	Arnþór Gústavsson	Signature	

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Preface

The survey is carried out according to guidelines in NS 9410:2016 which includes evaluation of sediment, faunal investigation and bottom topography. The environmental survey is regulated by § 35 in the Norwegian «akvakulturdriftsforskriften. The survey also fulfills the requirements regarding bottom surveys in the standard ISO 12878.

The primary objective of a B-survey is to fulfil the requirements regarding bottom survey in the local impact zone at fallow period as they are defined in NS9410:2016. There is a requirement of 17 sampling stations within the mooring lines of the fish farm. The estimated max biomass for the next generation farmed salmon at the site Eyrarhlíð is 5.779 ton.

The following have participated in the survey:


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

The sampling at Eyrarhlíð was done 15.04 2021.

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. It should be pointed out that as Icelandic officials have not set standards regarding different parameters based on samplings at Icelandic conditions so the site characters in this report should be interpreted with that disclaimer in mind.

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

Kópavogi 22. september 2021


Snorri Gunnarsson
Project manager

1 Introduction

The sampling date for the present site survey was 15.04 2021 and done by Akvaplan-niva AS contracted by Arctic Sea Farm in relation to the company's fish farming activity at the site Eyrarhlíð in Dýrafjörður, Ísafjarðabær municipality.

The objective of the B-survey is to document the environmental condition of the local impact zone of the fish farm according to NS 9410:2016 (and ISO 12878) which includes condition of the seabed, faunal evaluation and bottom topography registration.

The survey gives an estimate and evaluation of the site condition regarding organic load and impact assessment of the site from fish farming activity.

Figure 1 shows map of the fjord system of southern part of Vestfirðir where the site Eyrarhlíð is located.

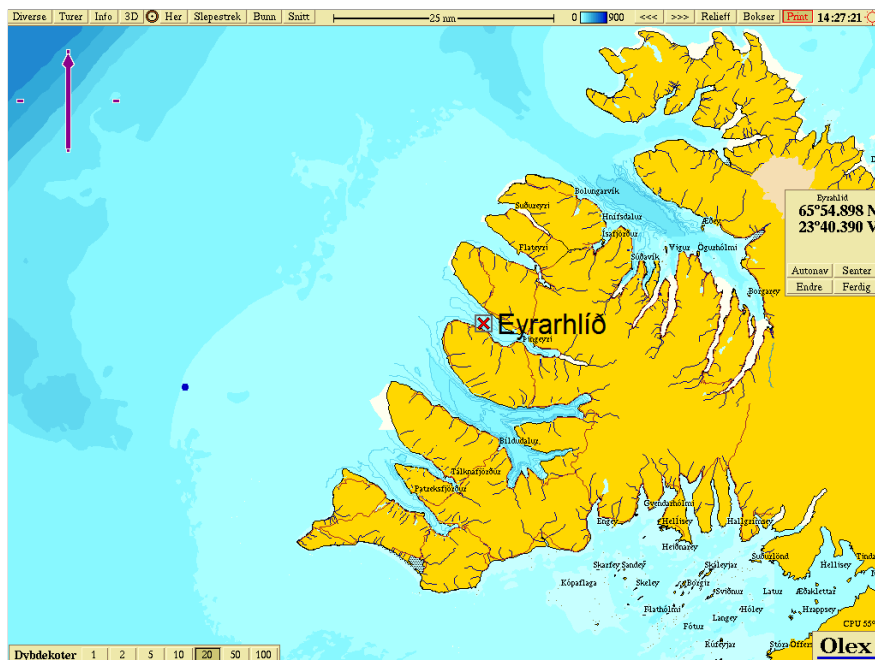


Figure 1. An overview map with the Eyrarhlíð site marked by its name with a red cross.

2 Professional program and methods

Environmental monitoring of the impact from the fish farming activities on the seabed is a standardised system. All fish farming sites in the sea are to be regularly assessed. The methods for monitoring in Iceland, are based on description in the ISO 12878 standard and methodology described in the NS 9410:2016 is followed. The Icelandic Environmental agency (Umhverfisstofnun) can also set forward specific requirements regarding frequency of samplings for different fish farming sites that can overrule the requirements in the above mentioned standards.

The B-survey is a trend study of the benthic conditions at, or in close proximity, to the fish farming site (local impact zone). Sediment is collected by use of grab (min 250 cm²). Each grab sample is investigated with regard to three observation types of benthic characters; faunal parameters, chemical parameters (pH and redox potential) and a sensory evaluation (gas bubbles, smell, texture, colour and the thickness of the precipitated slam layer in the sediment). The different benthic parameters are given a character on the scale from 1 to 4 (see Table 1), according to the scale of the impact on the benthic conditions from organic load, see criteria in table 1 and it is the weighted average for all the sampling stations that gives the sites condition. The number of sampling stations are decided based on the estimated max standing biomass for the given year class for farmed fish at the site.

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	<p>Prior to putting next generation into sea. Based on the site condition prior to putting next generation into sea:</p> <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 <p>If any of the samples result in character 4 it is a sign of overload.</p>
4-very bad	Overload

2.1 Field equipment

The following field equipment was used during the site survey:

Grabb: Van Veen grabb (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 Site description and bottom topography

3.1 Info site operation

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.

Eyrarhlíð has been in a fallow since 16th of November 2020. The previous generation farmed at the site was started with putting out smolts in the period from June to September 2018 and farmed until November 2020. The fish farm at the site is a two-frame mooring system, each frame having 6 cages total 12 cages each with 160 m circumference. During the last production cycle all 12 cages of were used at some point.

Table 2 shows the production and feed usage for the present and or past generations.

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

Generation of fish (G)	Production (ton)	Feed usage (ton)
Generation 2018 - 2020	7.502	8.844

3.2 Present and past site surveys

Previously there have been done two B bottom surveys at the Eyrarhlíð site. One at halv max biomass There was done a base line study (C-survey) at the site prior to putting fish into sea (Gallo, 2019) with sampling date 5.06 2018. Bottom was described as muddy and visual and chemical parameters did not show any signs of organic load at the site. Redox potential was positive at all eight sampling stations.

There was done a B-survey at the time of a half-max biomass, done upon the initiative from Arctic Sea Farm (time of survey was however delayed due to extreme weather conditions). A second B-survey was done late March 2020. In both previous surveys the overall site condition was "Very good".

Table 3. Past site studies for Eyrarhlíð east site

Date of sampling	Report number	Survey type	Overall site status
30.01.2020	APN-61859.B01	B survey half max biomass	1
25.03.2020	APN-62008.B02	B survey max biomass	1

3.3 Dispersing current

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) 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 Position of sampling stations

Description of the 17 stations in the survey is given in figure 2 and table 4. Positioning of the stations was chosen based on guidance and perimeters described in NS 9410:2016 and spread around the periphery of the cages. At the site the typical depth in the local impact zone is in the range from 40 – 42 m, with a slightly deeper area into the fjord (NNV). The placement of sampling stations was chosen to give a good picture of the condition of the whole local impact zone. It is important to evaluate the status in both the deeper and shallower parts of the local impact zone of the fish farm. The sampling stations had a depth varying from 40 to 41 m. The placement of the sampling stations is regarded to be in accordance with the descriptions for survey of local impact zone given in NS 9410:2016.

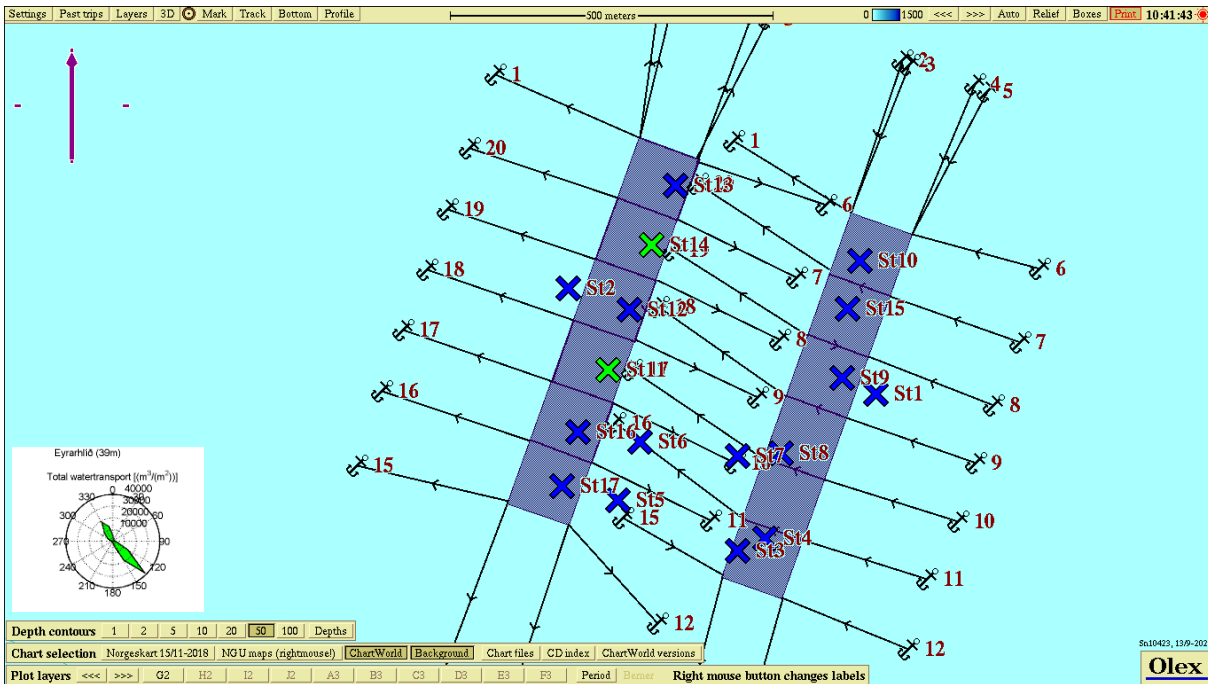


Figure 2. Chart showing depths at the site Eyrarhlíð. Sampling stations st. 1 – 17 are marked with color codes that describe the condition according to NS 9410:2016, chapter 7.11. Color codes: Blue = very good condition, green = good condition, yellow = bad condition, red = very bad condition.

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

Station number	North	West	Depth (m)
St 1	65°54.876	23°40.052	41
St 2	65°54.964	23°40.681	41
St 3	65°54.745	23°40.335	40
St 4	65°54.755	23°40.279	40
St 5	65°54.787	23°40.579	41
St 6	65°54.836	23°40.535	41
St 7	65°54.824	23°40.336	41
St 8	65°54.826	23°40.246	41
St 9	65°54.889	23°40.122	41
St 10	65°54.987	23°40.086	41
St 11	65°54.896	23°40.600	41
St 12	65°54.946	23°40.557	41
St 13	65°55.049	23°40.461	42
St 14	65°55.001	23°40.511	42
St 15	65°54.947	23°40.111	41
St 16	65°54.844	23°40.661	41
St 17	65°54.799	23°40.694	41

4 Results

Results for the different parameters are given in Table 5. The overall site condition is 1 «very good». The status for group II (pH/Eh) was 1 «very good», status group III parameters (sensory) was 1 «very good» and average group II + III parameters is status 1 «very good». A complete filled sampling sheet with calculations for each parameter is attached in appendix.

Table 5. Results from the classifications of the local impact 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

There were collected valid sediment samples at all the seventeen sampling stations. This indicates that in general there is soft bottom in the local impact zone. The sediment type consisted mainly of clay in the whole farming area. For the group II parameters (pH/Eh), seventeen stations had conditions 1 «very good». For sensory parameters (group III) twelve stations had condition 1 «very good» and five stations had condition 2 «good». For combined parameters II and III (pH/redox and sensory) fifteen stations had status 1 «very good» and two stations had condition 2 «good». Animals were present in all the seventeen soft bottom samples mainly in the form of polychaetes.

5 Conclusion

Based on the criteria given in NS 9410:2016 the fish farming site has been assigned a site condition 1 «very good» at the date of sampling. A total of 20 grabs were taken with Van Veen grab (0,1 m²), divided on 17 stations placed around the 12 cages that are operated at the Eyrarhlíð site during the last production cycle.

For combined parameters II and III (pH/redox and sensory) fifteen stations had status 1 «very good» and two stations had condition 2 «good». The stations with status 2 (stations 11 and 14) at the western part of the fish farming area. The accumulation of organic material seems therefore to a greater extent to accumulate at the eastern part of the fish farming area. The dominating current (39 m) is in direction south-east (130 degrees) with a smaller counter current in north-west direction. The apparent higher accumulation of organic material on the western edge i.e. in opposite direction of the spread current could also be associated to that the cages on the western part of the site were the ones that fish for the longest time prior to slaughter. Animals were present in all soft bottom samples. The previous B bottom survey (at halv max and max biomass) gave also overall condition 1 «very good». The results for the current B-survey at fallow indicate some moderate organic load in small part of the site but in general the condition is in line with previous surveys indicating overall very good condition in the local impact zone.

The site is assigned a condition factor 1 "very good" according to calculations based on methodology described in NS 9410:2016 and sample sheet Table B.1 and B.2 (se chapter 7 Appendix).

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.

Gunnarsson, S., 2020. Arctic Sea Farm. B-survey local impact zone, Eyrarhlíð January 2020 Akvaplan-niva AS report nr. 61859.B01.

Gunnarsson, S., 2020. Eyrarhlíð, Arctic Sea Farm. B-bottom survey March 2020 Akvaplan-niva AS report nr. 62008.B01.

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.

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7 Appendix:

7.1 Sheet (B.1 og B.2) NS 9410:2016

Sample scheme B.1													
Company		Arctic Sea Farm						Date:		15.04 2021			
Site:		Eyrarhlíð (fallow)						Site no.:					
Fieldworker:		Snorri Gunnarsson											
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	7,7	7,8	7,6	7,6	7,9	7,7	7,7	7,5	7,7	7,7	
	Eh (mV)	ORP	124	114	91	101	103	99	-74	75	-57	-75	
		plus ref. verdi	324	314	291	301	303	299	126	275	143	125	
	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		2,2 C		Sediment temp		1,6 C	
	pH sea	8,01	ORP sea		139,0 mV		Eh sea		339,0 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					
		Light (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)										0	
		1/4 < v < 3/4 (1)			1	1				1			
		v > 3/4 (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	2,0	3,0	1,0	2,0	2,0	6,0	5,0	6,0	2,0	
	Corrected (*0,22)		0,4	0,4	0,7	0,2	0,4	0,4	1,3	1,1	1,3	0,4	
	Status station		1	1	1	1	1	1	2	2	2	1	
	Average group II & III		0,2	0,2	0,3	0,1	0,2	0,2	0,7	0,6	0,7	0,2	
	Status station		1	1	1	1	1	1	1	1	1	1	
Grab ID		K-3											
pH / Eh ID		YSI professional plus											

Sample scheme B.1

Company:	Arctic Sea Farm	Date:	15.04 2021
Site:	Eyrarhlíð (fallow)	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					100	0
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0	0						
II	pH	value	7,7	7,8	7,7	7,6	7,6	7,5	7,7						
	Eh (mV)	ORP	-104	-86	-94	-116	-159	-135	-94						
		plus ref. verdi	96	114	106	84	41	65	106						
	pH/Eh	from figure	1	0	0	1	1	1	0					0,24	
	Status station			1	1	1	1	1	1	1					
	Status group II			1	Buffer temp	5,0 C		Sea temp	2,2 C		Sediment temp	1,6 C			
	pH sea	8,01	ORP sea	139	mV	Eh sea	339 mV		Reference electrode	200 mV					
	Gas bubbles	Yes (4) No (0)	0	0	0	0	0	0	0						
	Colour	Light/grey (0)		0	0		0	0	0						
		Brown/black (2)	2			2									
Smell	None (0)							0							
	Light (2)	2	2	2		2	2								
	Strong (4)				4										
Consistency	Solid (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												
	v > 3/4 (2)			2	2	2	2	2	2						
Thickness of sledge (t)	t < 2 cm (0)		0	0		0	0	0							
	2 < t < 8 cm (1)	1			1										
	t > 8 cm (2)														
Sum			6,0	3,0	4,0	9,0	4,0	4,0	2,0						
Corrected (*0,22)			1,3	0,7	0,9	2,0	0,9	0,9	0,4					0,82	
Status station			2	1	1	2	1	1	1						
Status group III			1												
Average group II & III			1,2	0,3	0,4	1,5	0,9	0,9	0,2					0,53	
Status station			2	1	1	2	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-3
pH / Eh ID	YSI professional plus

Sample scheme B.2



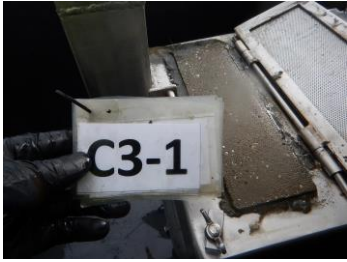







Company:	Arctic Sea Farm	Date:	15.04 2021
Site:	Eyrarhlíð (fallow)	Site no.:	0
Fieldworker:	Snorri Gunnarsson		


Sample number	1	2	3	4	5	6	7	8	9	10
Depth (m)	41	41	40	40	41	41	41	41	41	41
Number of trials	1	1	1	1	2	2	1	2	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			1							
Crustaceans, count										
Molluscs, count				1						
Polychaetes, count	>10	>10	2	>5	5	4	2	1	>10	4
Other animals, count										
<i>Beggiatoa</i>										
Feed										
Faeces										
Comments										
Grab	Area [m ²]	0,01	Grab ID				K-3			
page 3 of 4 pages										










Sample scheme B.2

Company:	Arctic Sea Farm									
Site:	Eyrarhlíð (fallow)									
Fieldworker:	Snorri Gunnarsson									
Date:	15.04 2021									
Site no.:	0									
Sample number	11	12	13	14	15	16	17	18	19	20
Depth (m)	41	41	42	42	41	41	41			
Number of trials	1	1	1	1	1	1	1			
Gas bubbles (in sample)	No	No	No	No	No	No	No			
Sediment type	Clay	X	X	X	X	X	X	X		
	Silt									
	Sand									
	Gravel									
	Shellsand									
Reef										
Rocky bottom (cobbles, boulders)										
Echinodermata, count										
Crustaceans, count										
Molluscs, count										
Polychaetes, count	>50	4	>100	4	6	3	5			
Other animals, count										
<i>Beggiatoa</i>										
Feed										
Faeces										
Comments										
Grab	Area [m ²]	0,01	Grab ID				K-3			
Signature fieldworker:										

7.2 Pictures of samples at Eyrarhlíð

<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>NA</p>	
<p><i>St 8</i></p>		
<p><i>St 9</i></p>		
<p><i>St 10</i></p>		

<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>		



7.3 Bottom topography and 3D view

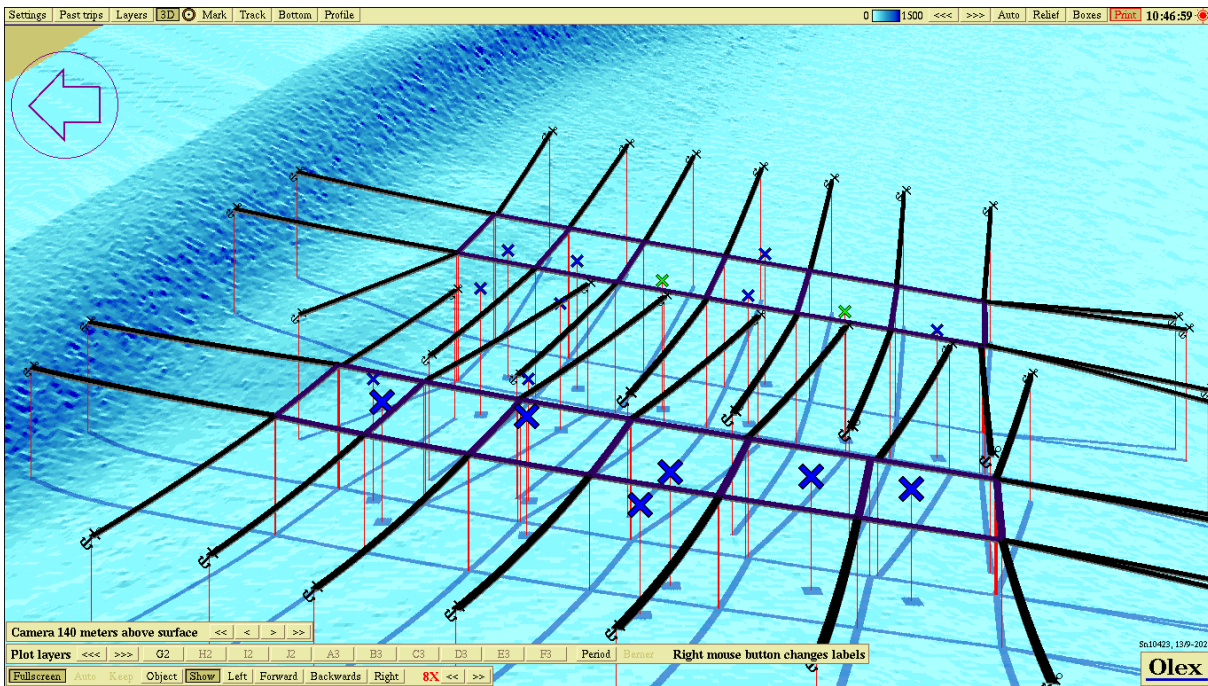


Figure 3. Showing bottom topography 3D at Eyrahlíð with each sampling station according to info in figure 2 and Table 3.