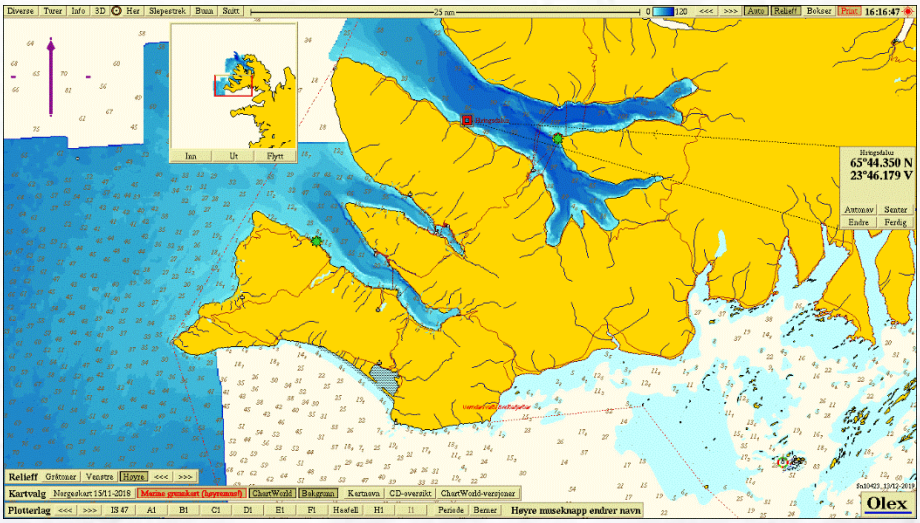
Akvaplan niva

Rapport Report

Hringsdalur, Arnarlax hf.
B-bottom survey,
November 2019
(maximum biomass survey)



NORSK
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Akvaplan-niva AS: APN 61656.B01

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Information client			
Titel	Hringsdalur, Arnarlax hf. B-bottom pre-survey, November 2019		
Report number	APN-61656.B01		
Site name	Hringsdalur	Coordinates site	65°44.350 N 023°46.179 V
County	Vestur Barðastrandasýsla	Municipality	Vesturbyggð
MTB-or estimated max biomass	4981 tonn	Site manager/contact	Silja Baldvinsdóttir
Client name	Arnarlax hf.		

Biomass/production/status at date of survey			
Biomass at date of survey	4.981 ton	Feed use	6.436 ton
Fish type	Salmon	Amount produced	4.789 ton

Type/time of survey	Mark with X	Comments
At maximal biomass see kap 7.9	☒	
A follow up survey	☐	
Half maximal biomass	☐	
Survey prior to putting out smolt	☐	
A pre-survey new site	☐	
Other	☐	
Last fallowing period:		

Results from B-survey iht. NS 9410:2016 (main results)			
Parameters and indexes		**Parameters and site status**	
Gr. II. pH/Eh	1,00	Gr. II. pH/Eh	1
Gr. III. Sensory	0,81	Gr. III. Sensory	1
GR. II + III	0,91	GR. II+ III	1
Date field work	19.11 2019	**Date report**	03.01.20
Site status (NS 9410:2016):			**1**

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

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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 maximum biomass survey (MTB) as they are defined in NS9410:2016. There is a requirement of at least 16 sampling stations within the mooring lines of the fish farm. The estimated max biomass for the current generation farmed salmon at the site Hringsdalur is 4.980 MTB ton. The methods applied in this pre-survey follow guidelines in chapter 5 (NS6410:216) and fulfil the requirements described in ISO 12878. The survey deviates though from chapter 7.6 in NS9410:2016 regarding sampling. Requirements that samplings stations should be placed just beside the cages or under cages that have been used is fulfilled.

The following have participated in the survey:

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

The sampling at Hringsdalur was done 19.11 2019.

Accredited survey:

The following parts of the survey are done in accordance to 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.

NORSK AKKREDITERING TEST 079	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 Arnarlax hf. and their personnel for the cooperation during the conductance of this site survey.

Kópavogi 3. januar 2020

Snorri Gunnarsson
Project manager

1 Introduction

The sampling date for the present site survey was 19.11 2019 and done by Akvaplan-niva AS contracted by Arnarlax hf. in relation to the company's fish farming activity at the site Hringsdalur in Arnarfjörður, Vesturbyggð 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 feasibility assessment of the site for fish farming activity.

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

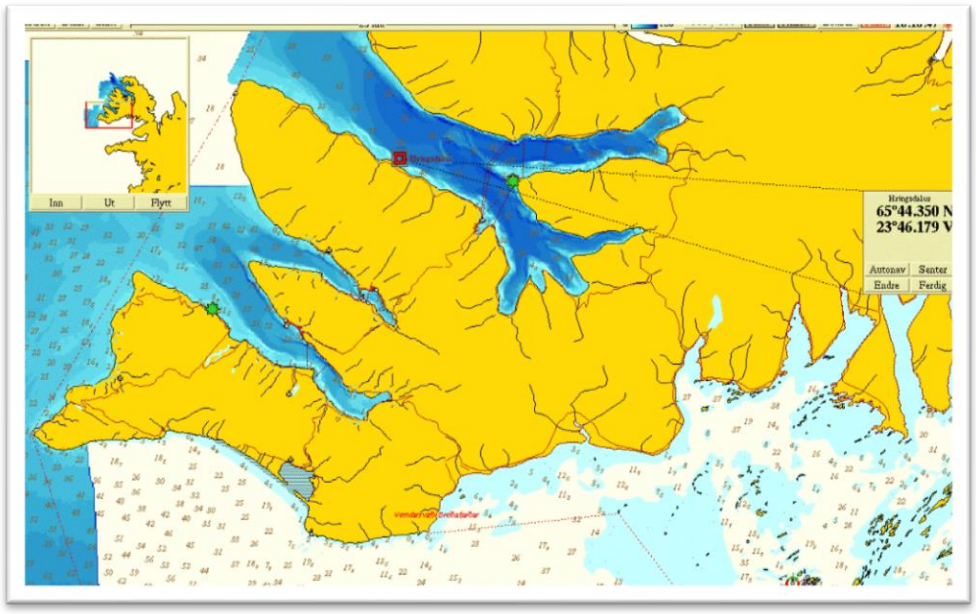

Figure 1. An overview map with the Hringsdalur site market by its name.

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 cm^2). 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	Prior to putting next generation into sea. Based on the site condition prior to putting next generation into sea: - 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:
Grabb: Van Veen grabb (0,025 m^2)
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

Hringsdalur site is coming to an end of the second production cycle. First production cycle was started in June 2016. The fish farm at the site has a single frame 2x3 mooring system, a total of 6 cages, each with 160 m circumference.

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

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

Generation of fish (G)	Production (ton)	Feed usage (ton)
Present generation	4.789	6.436
Previous generation	3.613	3.914

3.2 Present and past site surveys

Table 3. Past site studies for Hringsdalur site

Date of sampling	Report number	Survey type	Overall site status
1.11.2017	APN-9187.02	Maximum biomass	1
16.05.2018	APN-60320.01	Fallow period	1

3.3 Dispersing current

Dispersing current, measured at 60 m for Hringsdalur site, was used as a basis for sampling stations. Dominating current (60 m) is in direction south-east (135 - 150 degrees) with strong counter current (300-345 degrees). Average current speed is measured to be 8 cm/s. Highest current speed is measured to be 30 cm/s and 1.65 % of the measurements are < 1 cm/s (Moe, 2013).

3.4 Position of sampling stations

Description of the stations in the survey is given in Figure 2 and Table 4. Positioning of the stations was chosen based guidance and perimeters described in NS 9410:2016 and the bottom topography and planned configuration of the farm. Hringsdalur site is on the outskirt of Arnarfjörður fjord and the site is open and exposed. Depth at the site is mostly 50 - 70 meters with the south and east part of the farm at up to 75 meters depth. The placement of sampling stations were chosen to give a good picture 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 59 m (St 4) to 75 m (St 16). 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.

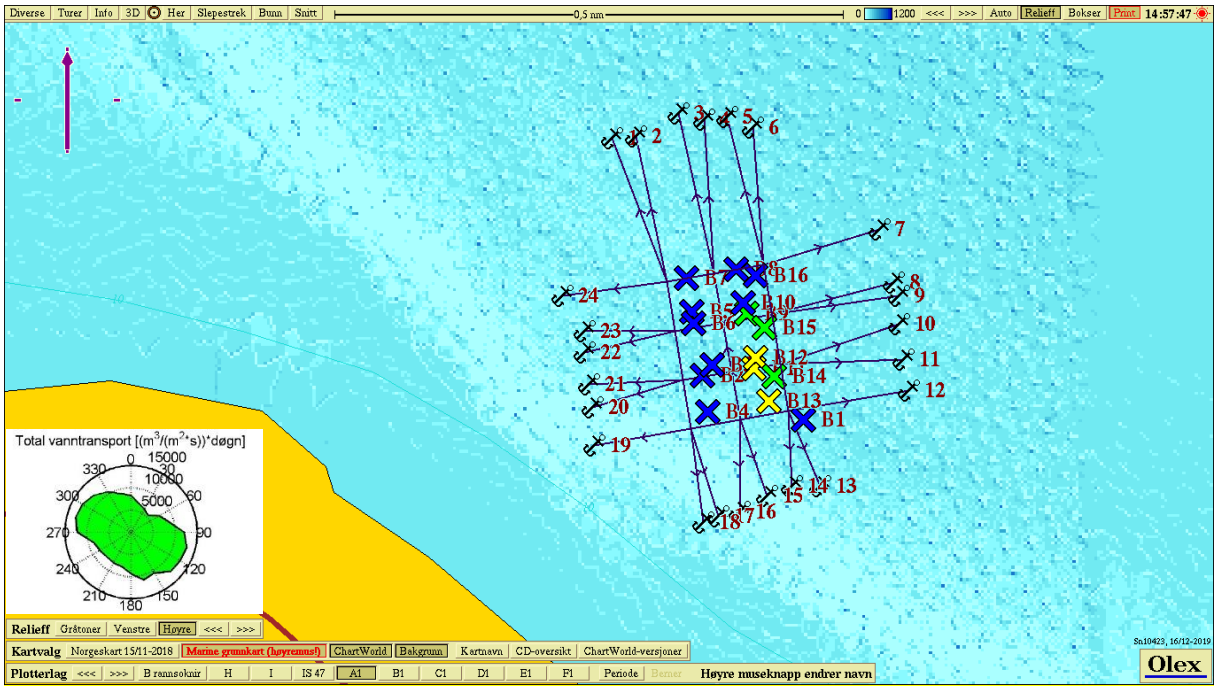

Figure 2. Chart showing depths at the site Hringsdalur. Sampling stations st. 1 – 16 are marked with color codes that describe the condition according to NS 9410:2016, chapter 7.11. Color codes: Blue =very good condition, green = good condition, yellow = bad condition, red = very bad condition.

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

Station number	North	Vest	Depth (m)
St 1	65°44.285	023°46.003	67
St 2	65°44.329	023°46.244	63
St 3	65°44.339	023°46.220	65
St 4	65°44.293	023°46.232	59
St 5	65°44.391	023°46.269	66
St 6	65°44.380	023°46.265	65
St 7	65°44.380	023°46.282	68
St 8	65°44.433	023°46.163	74
St 9	65°44.390	023°46.139	71
St 10	65°44.400	023°46.147	72
St 11	65°44.336	023°46.121	68
St 12	65°44.346	023°46.117	69
St 13	65°44.303	023°46.086	67
St 14	65°44.328	023°46.072	70
St 15	65°44.376	023°46.095	71
St 16	65°44.427	023°46.116	75

4 Results

Results for the different parameters are given in Table 5. 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 stations in the first grab taken. This indicates that in general there is soft bottom in the whole local impact zone. The sediment type consisted mainly of clay, silt and occasionally sand. For the group II parameters, twelve out of sixteen station had conditions 1 «very good». For sensory parameters (group III) eight out of sixteen stations had condition 1 «very good». For combined parameters I, II and III (animals, pH/redox and sensory) ten out of sixteen stations had condition 1 «very good». Animals where present in all samples.

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 16 samples were taken with Van Veen grab (0,025 m^2), divided on 16 stations placed around the six cages that are operated at Hringsdalur site. Ten out of sixteen stations were assigned condition 1 «very good» while three were assigned condition 2 «good» and three condition 3 «bad». Sampling stations assigned condition 3, are on the center and southern part of the site where organic load would be expected to be highest.

Previous maximum biomass sampling was carried out in November 2017 (Gunnarsson, S. 2017). Results from current study are in line with previous results at maximum biomass. Results from current and previous study indicate that the environmental load at the site is stable and is not developing towards a worse condition.

Results are in line with what can be expected in terms of dispersing current. Sampling stations with lower assigned condition factor are concurrent with current measurements. Dominant dispersing current (at 60 meters) was measured 135 – 150° (Southeast) with average current speed of 8 cm/sec. Sampling stations assigned condition factor 2 and 3 are located central to southeast corner of the site. Dominating current (15 m) is in direction south-east (120 degrees).

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.

Erikssen, S.E. 2016. Arnarlax hf, lokalitetsrapport Hringsdalur. Akvaplan-niva AS rapport nr. 8639.01.

Gunnarsson, S. 2017. Arnarlax hf, B-undersøkelse, november 2017 Hringsdalur (maksimal organisk belastning). Akvaplan-niva AS rapport nr. 9187.02.

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.

Moe, A. A. 2013. Current investigation at finfish farm site Hringsdalur February 2013. Helgeland Havbruksstasjon AS - 20.02.2014.

Norsk Standard NS 9410:2016. Miljøovervåking av bunnpåvirkning fra marine akvakultur-anlegg.

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7 Appendix:

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

Sample scheme B.1

Company	Arnarlax hf.	Date:	19.11.2019
Site:	Hringsdalur	Site no.:	
Fieldworker:	Arnþór Gústavsson		

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	7,63	7,63	7,60	7,55	7,37	7,17	7,62	7,53	7,15	7,37
	Eh (mV)	ORP	-55	-8	-13	-50	-120	-141	-30	-85	-234	-130
		plus ref. verdi	145	192	187	150	80	59	110	115	-34	70
	pH/Eh	from figure	0	0	0	0	1	1	0	0	2	1
	Status station		1	1	1	1	1	1	1	1	2	1
			Buffer-kap	7,2 C		Sea kap	6,2 C		Sediment kap		6,0 C	
	pH-sen	7,88	ORP-sen	158,0 mV		Eh-sen	358,0 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		
		Brown/black (2)					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	0
		Soft (2)										
		Aqueous (4)										
	Grab volume (v)	v < 1/4 (0)										
		1/4 < v < 3/4 (1)		1	1	1	1	1	1	1		1
		v > 3/4 (2)	2								2	
	Thickness of sludge (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	1,0	1,0	1,0	5,0	5,0	1,0	1,0	6,0	3,0
		Corrected (*0,22)	0,4	0,2	0,2	0,2	1,1	1,1	0,2	0,2	1,3	0,7
	Status station		1	1	1	1	2	2	1	1	2	1
	Average group II & III		0,2	0,1	0,1	0,1	1,1	1,1	0,1	0,1	1,7	0,8
	Status station		1	1	1	1	1	1	1	1	2	1

Grab ID	K-22
pH / Eh ID	Ysi professional plus

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Sample scheme B.1

Company:	Arnarlax hf.	Date:	19.11.2019
Site:	Hringsdalur	Site no.:	0
Fieldworker:	Arnþór Gústavsson		

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	S	S	S					100	0
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0						
II	pH	value	6,91	6,92	7,04	7,30	7,33	7,65						
	Eh (mV)	ORP	-240	-230	-200	-180	-170	-30						
		plus ref. verdi	-40	-30	0	20	30	170						
	pH/Eh	from figure	3	3	3	1	1	0					1,00	
	Status station		3	3	3	1	1	1						
	Status group II		1	Buffer temp	7,2 C		Sea temp	6,2 C		Sediment temp	6,0 C			
	pH ave.	7,88	ORP ave.	158 mV		Eh ave.	358 mV			Reference electrode	200 mV			
III	Gas bubbles	Yes (4) No (0)	0	0	0	0	0	0						
	Colour	Light/grey (0)						0						
		Brown/black (2)	2	2	2	2	2							
	Smell	None (0)						0						
		Light (2)	2	2	2	2	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)						1						
		v > 3/4 (2)	2	2	2	2	2							
	Thickness of sludge (t)	t < 2 cm (0)	0	0	0	0	0	0						
		2 < t < 8 cm (1)												
		t > 8 cm (2)												
		Sum	6,0	6,0	8,0	6,0	6,0	1,0						
		Corrected (*0,22)	1,3	1,3	1,8	1,3	1,3	0,2					0,81	
		Status station	2	2	2	2	2	1						
		Status group III	1											
		Average group II & III	2,2	2,2	2,4	1,2	1,2	0,1					0,91	
		Status station	3	3	3	2	2	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-22
pH / Eh ID	Ysi professional plus

page 2 of 4 pages

Sample scheme B.2

Company:	Arnarlax hf.	Date:	19.11.2019
Site:	Hringsdalur	Site no.:	0
Fieldworker:	Arnþór Gústavsson		

Sample number		1	2	3	4	5	6	7	8	9	10
Depth (m)											
Number of trials		1	1	2	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	X
	Silt	X	X	X	X	X	X	X	X	X	X
	Sand				X						
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count				1	1		1			1	
Polychaetes, count		>50	>20	>30	>20	>40	>20	>20	>20	>50	>50
Other animals, count											
Beggiatoa											
Feed											
Faeces											
Comments											

Grab	Area [m²]	0,01	Grab ID	K-3

Sample scheme B.2

Compang:	Arnarlax hf.		Date:	19.11.2019
Site:	Hringsdalur		Site no.:	0
Fieldworker:	Arnþór Gústavsson			

Sample number		11	12	13	14	15	16	17	18	19	20
Depth (m)											
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	X	X	X	X	X	X				
	Sand										
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count											
Polychaetes, count		>20	>20	>20	>20	>100	>50				
Other animals, count											
Beggiatoa											
Feed											
Faeces											
Comments											
Grab	Area [m²]	0,01			Grab ID		K-22				
Signature fieldworker:	Arnþór Gústavsson										

7.2 Pictures of samples at Hringsdalur

St 1		N/A
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		N/A

7.3 Bottom topography and 3D view

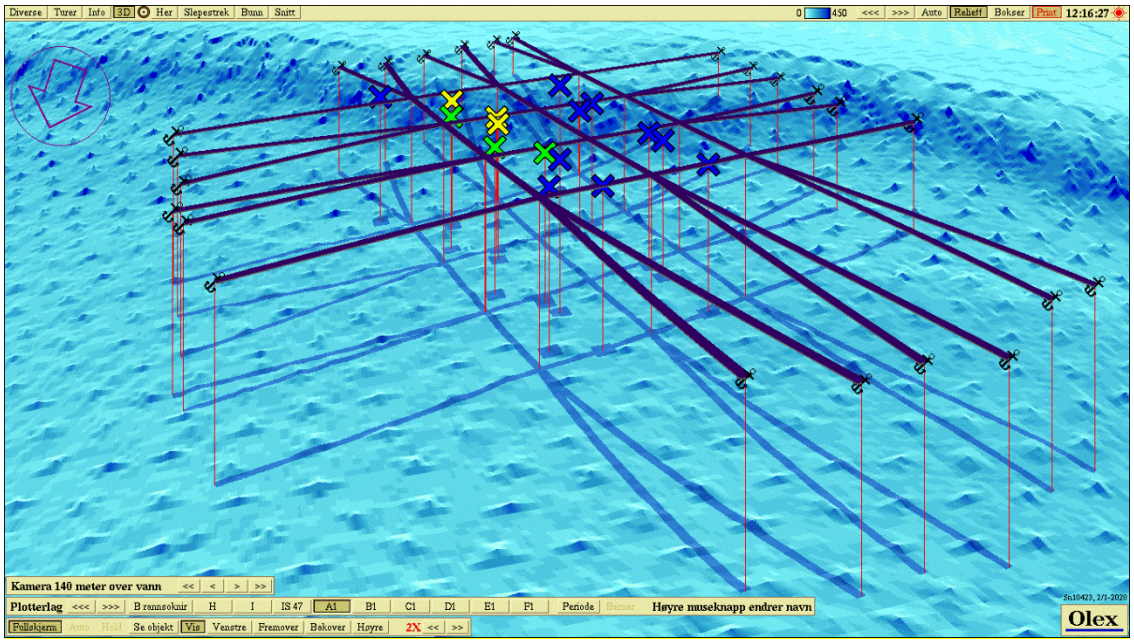

Figure 3. Showing bottom topography 3D at Hringsdalur with each sampling station according to info in figure 2 and Table 3.