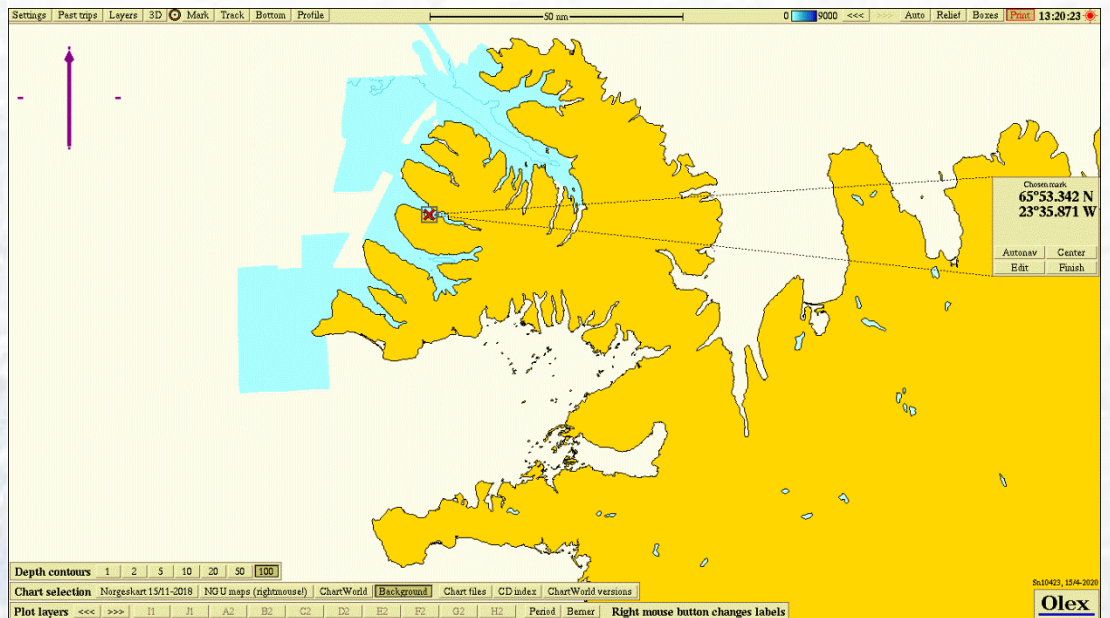


Haukadalsbót, Arctic Sea Farm
B-bottom survey,
August 2021
(maximum biomass survey)



Information client			
Title	Haukadalsbót, Arctic Sea Farm. B-bottom survey, August 2021		
Report number	APN-63315.B01		
Site name	Haukadalsbót	Coordinates site	65°53.342 N 23°35.871 V
County	Ísafjarðabær	Municipality	Pingeyri
MTB-or estimated max biomass	5.000 ton	Site manager/contact	Steinunn Guðný Einarsdóttir
Client name	Arctic Sea Farm		

Biomass/production/status at date of survey			
Biomass at date of survey	3.759 ton	Feed use	4.699
Fish type	Salmon	Amount produced	3.730
Type/time of survey	Mark with X	Comments	
At maximal biomass see kap 7.9	<input checked="" type="checkbox"/>		
A follow up survey	<input type="checkbox"/>		
Half maximal biomass	<input type="checkbox"/>		
Survey prior to putting out smolt	<input 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	0,31	Gr. II. pH/Eh	1
Gr. III. Sensory	0,72	Gr. III. Sensory	1
GR. II + III	0,51	GR. II+ III	1
Date field work	26.08 2021	Date report	16.11.21
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 as they are defined in NS9410:2016. The estimated max biomass for the current generation farmed salmon at the site Haukadalsbót is 5.000 MTB ton. There is a requirement of at least 15 sampling stations within the mooring lines of the fish farm. The methods applied in this survey follow guidelines in chapter 5 (NS6410:216) and fulfil the requirements described in ISO 12878. 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.
Snorri Gunnarsson	Akvaplan-niva AS	Fieldwork and Report. Charts (Olex).
Arnþór Gústavsson	Akvaplan-niva AS	Quality assurance

The sampling at Haukdalsbót was done 26.08 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 16. november 2021



Snorri Gunnarsson
Project manager

1 Introduction

The sampling date for the present site survey was 26.08 2021 and done by Akvaplan-niva AS contracted by Arctic Sea Farm in relation to the company's fish farming activity at the site Haukadalsbót 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 feasibility assessment of the site for fish farming activity.

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

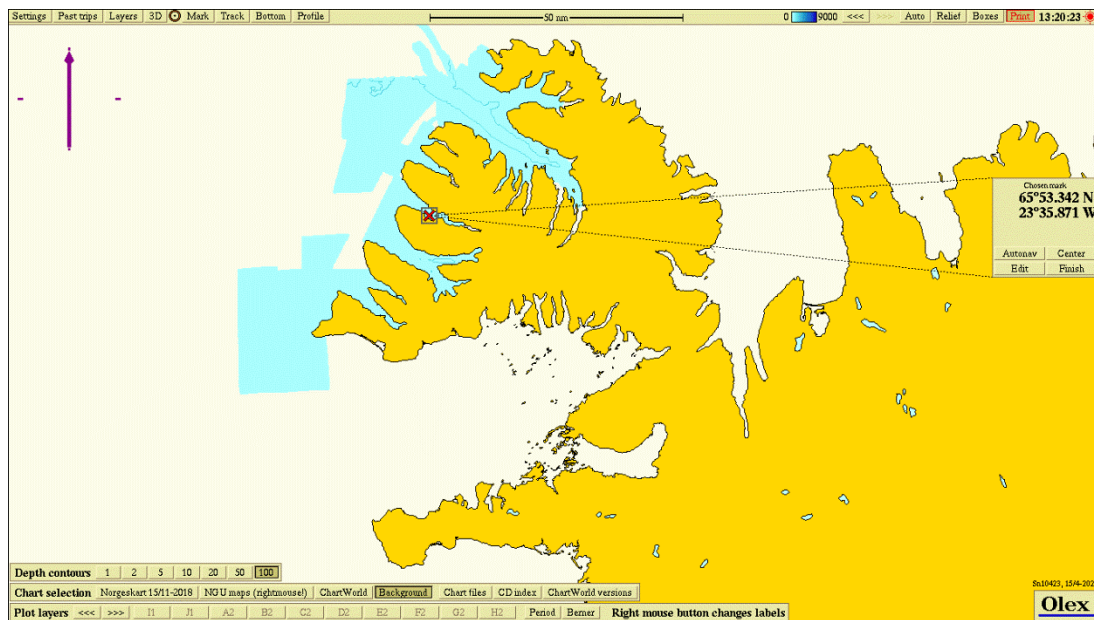


Figure 1. An overview map with the Haukadalsbót site marked by its name with a red cross.

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	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:

Grabb: Van Veen grabb (0,1 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

Haukadalsbót site is coming to an end of the third production cycle at the current location. The first generation of salmon at Haukadalsbót was farmed from August 2012 to late fall 2014. The second generation of rainbow trout was farmed from spring 2015 until late 2016 early year 2017. The current generation of salmon was put into sea in May/June 2020.

The fish farm at the site is a two frame mooring system, each frame having 6 cages (160 m circumference), or a total of 12 cages at the site. The standing biomass on the date of sampling was 3.759 tonnes. Table 2 shows the production and feed usage for the present generation.

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

Generation of fish (G)	Production (ton)	Feed usage (ton)
Generation 2012-2014 A. salmon	1.000 ton (approx.)	1.000 ton (approx.)
Generation 2015-2017 rainbow trout	1.900 ton (approx.)	-
May/June 2020	3.730	4.669

3.2 Present and past site surveys

Akvaplan-niva has previously done one B-survey in March 2020 at Haukadalsbót at fallow period, prior to putting out current generation (Gunnarsson, 2020). The results from the B survey at fallow gave overall site condition 1 «very good». In general, there was soft bottom in the whole local impact zone exceptions for three stations located in the northern part of the local impact zone where only a small sediment sample could be collected.

Table 3. Past site studies for Haukadalsbót site

Date of sampling	Report number	Survey type	Overall site status
25.03.2020	APN-62024.B01	B survey, fallow period	1

3.3 Dispersing current

Measurement of dispersing current has been done at the site at 32 m deep in October and November 2019 (Gustavsson, 2019). Dominating current (28 m) is in direction south-east (160-170 degrees). Average current speed is measured to be 6.0 cm/s. Highest current speed is measured to be 21 cm/s and 3.6 % of the measurements are < 1 cm/s.

3.4 Position of sampling stations

Description of the 16 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 2016 and the bottom topography and planned configuration of the farm. At the Haukadalsbót site the typical depth in the local impact zone is in the range from 25 – 35 m, with the shallowest parts in the

south part (closest to land) and more depth in direction into the middle of the fjord. 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 29 m to 35 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.

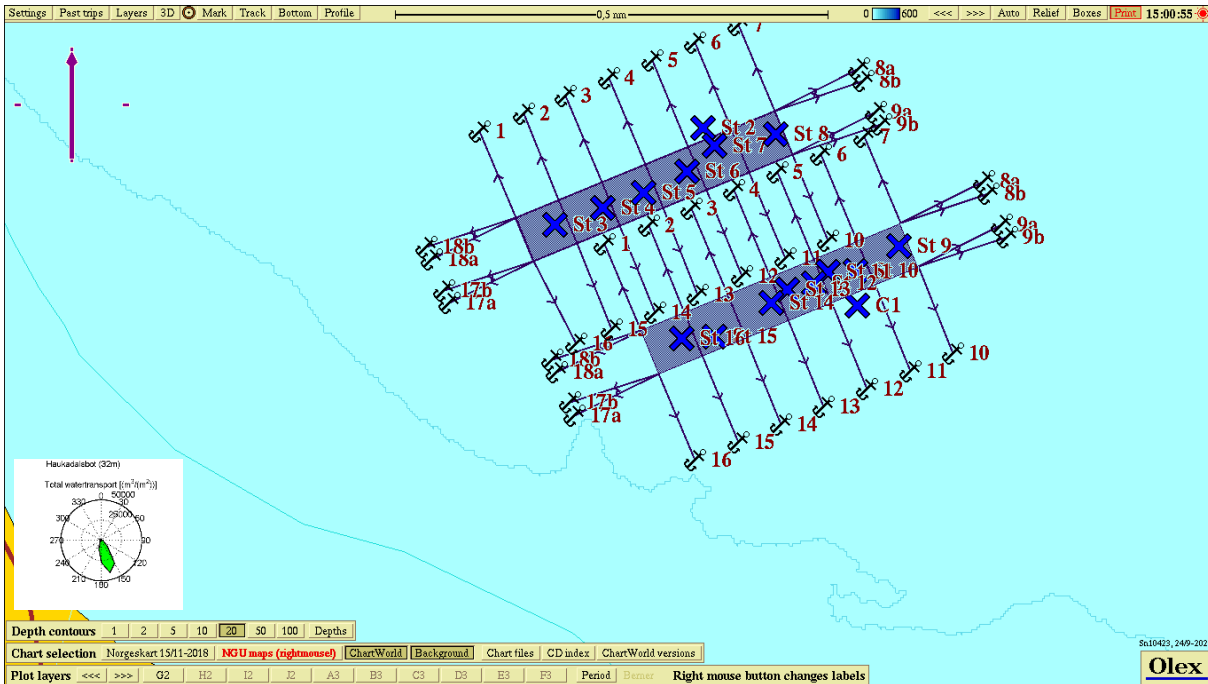


Figure 2. Chart showing depths at the site Haukadalsbót. Sampling stations st. 1 – 16 are marked with color codes that describe the condition according to NS 9410:2016, chapter 7.11. Color codes: Blue = very good condition, green = good condition, yellow = bad condition, red = very bad condition.

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

Station number	North	Vest	Depth (m)
St 1	65°53.279	23°35.446	34
St 2	65°53.483	23°35.884	34
St 3	65°53.372	23°36.302	31
St 4	65°53.391	23°36.166	32
St 5	65°53.409	23°36.051	32
St 6	65°53.433	23°35.928	33
St 7	65°53.463	23°35.850	34
St 8	65°53.476	23°35.678	35
St 9	65°53.347	23°35.329	35
St 10	65°53.319	23°35.451	35
St 11	65°53.318	23°35.529	34
St 12	65°53.304	23°35.570	33
St 13	65°53.297	23°35.649	32
St 14	65°53.282	23°35.691	31
St 15	65°53.243	23°35.851	31
St 16	65°53.241	23°35.943	29

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 sixteen 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), all sixteen stations had conditions 1 «very good». For sensory parameters (group III) fifteen stations had condition 1 «very good» and one station had condition 2 «good». For combined parameters II and III (pH/redox and sensory) all sixteen stations had status 1 «very good». Some faeces were visible at three stations (st. 5, 9, 10 and 12). Animals were present in all the sixteen 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 17 grabs were taken with Van Veen grab (0,1 m²), divided on the 16 stations placed around the 12 cages that are operated at the Haukadalsbót site during the present production cycle.

For combined parameters II and III (pH/redox and sensory) all sixteen stations had status 1 «very good» and animals were present in all soft bottom samples. The sampled sediment at the sixteen stations indicates that there is in general soft bottom in the whole area. Overall, the results indicate relatively little organic load in the local impact zone at Haukadalsbót at max biomass sampling for the current generation farmed at the site. The previous B bottom survey at fallow period before putting the current generation into sea gave overall site condition 1 «very good».

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.

Gunnarsson, S., 2020. Haukadalsbót, Arctic Sea Farm. B-bottom survey fallow period, March 2020. Akvaplan-niva AS report nr. 62024.B01.

Gustavsson, A. 2019. Arctic Sea Farm hf, measurement of spread current at Haudadalsbót 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:		26.08 2021		
Site:		Haukadalsbót						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	7,6	7,7	7,7	7,5	7,8	7,8	7,8	7,7	7,7	7,8
	Eh (mV)	ORP	-52	49	21	-111	-19	-35	-75	-137	-28	-4
		plus ref. verdi	148	249	221	89	181	165	125	63	172	196
	pH/Eh	from figure	0	0	0	1	0	0	0	1	0	0
	Status station		1	1	1	1	1	1	1	1	1	1
	Buffer-temp		C			Sea temp		C		Sediment temp		C
	pH sea		ORP sea		mV		Eh sea		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				
		Light (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)										
		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	2,0	2,0	4,0	2,0	4,0	4,0	4,0	4,0	6,0
	Corrected (*0,22)		0,4	0,4	0,4	0,9	0,4	0,9	0,9	0,9	0,9	1,3
	Status station		1	1	1	1	1	1	1	1	1	2
	Average group II & III		0,2	0,2	0,2	0,9	0,2	0,4	0,4	0,9	0,4	0,7
	Status station		1	1	1	1	1	1	1	1	1	1
Grab ID		K3										
pH / Eh ID		Ysi professional plus										

Sample scheme B.1

Company:	Arctic Sea Farm	Date:	26.08 2021
Site:	Haukadalsbót	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							100	0		
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0										
II	pH	value	7,8	7,6	7,5	7,5	7,7	7,5										
	Eh (mV)	ORP	-26	-109	-135	-58	-116	-90										
		plus ref. verdi	174	91	65	142	84	110										
	pH/Eh	from figure	0	1	1	0	1	0								0,31		
	Status station			1	1	1	1	1	1									
	Status group II			1	Buffer temp	0,0 C		Sea temp	0,0 C		Sediment temp	0,0 C						
	pH sea	0	ORP sea	0	mV	Eh sea	mV		Reference electrode	200 mV								
	III	Gas bubbles	Yes (4) No (0)	0	0	0	0	0	0									
		Colour	Light/grey (0)	0	0	0	0	0	0									
			Brown/black (2)															
Smell		None (0)	0	0	0													
		Light (2)				2	2	2										
		Strong (4)																
Consistency		Solid (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											
Thickness of sludge (t)	t < 2 cm (0)	0	0	0	0	0	0											
	2 < t < 8 cm (1)																	
	t > 8 cm (2)																	
Sum			2,0	2,0	2,0	4,0	4,0	4,0										
Corrected (*0,22)			0,4	0,4	0,4	0,9	0,9	0,9								0,72		
Status station			1	1	1	1	1	1										
Status group III			1															
Average group II & III			0,2	0,7	0,7	0,4	0,9	0,4								0,51		
Status station			1	1	1	1	1	1										
Status group II & III			1															
pH/Eh																		
Corr.sum																		
Index																		
Average																		
< 1,1																		
1,1 - <2,1																		
2,1 - <3,1																		
≥3,1																		
Status site:															1			


Grab ID	K3
pH / Eh ID	Ysi professional plus

Sample scheme B.2

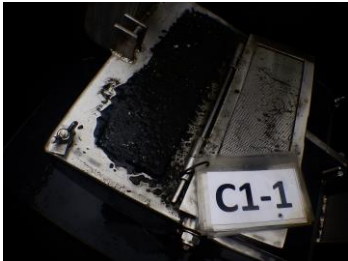
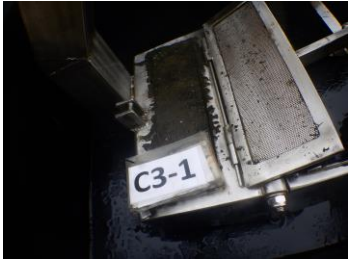







Company:	Arctic Sea Farm	Date:	26.08 2021
Site:	Haukadalsbót	Site no.:	0
Fieldworker:	Snorri Gunnarsson		




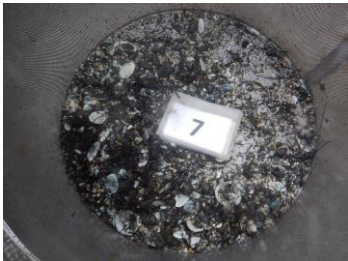





Sample number	1	2	3	4	5	6	7	8	9	10
Depth (m)	34	34	31	32	32	33	34	35	35	35
Number of trials	2	1	1	1	1	1	1	1	1	1
Gas bubbles (in sample)	No	No	No	No	No	No	No	No	No	No
Sediment type	Clay	x	x	x	x	x	x	x	x	x
	Silt									
	Sand									
	Gravel									
	Shellsand									
Reef										
Rocky bottom (cobbles, boulders)										
Echinodermata, count									1	
Crustaceans, count										
Molluscs, count										
Polychaetes, count	>50	>50	>50	>100	>50	>100	>100	>100	>50	>100
Other animals, count										
<i>Beggiatoa</i>										
Feed										
Faeces					x				x	x
Comments										
Grab	Area [m ²]	0,1			Grab ID	K3				










Sample scheme B.2

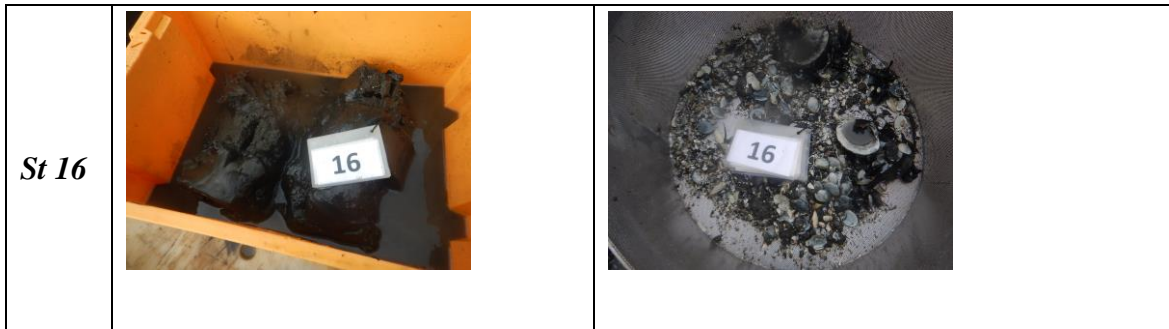
Company:	Arctic Sea Farm					Date:	26.08 2021				
Site:	Haukadalsbót					Site no.:	0				
Fieldworker:	Snorri Gunnarsson										
Sample number	11	12	13	14	15	16	17	18	19	20	
Depth (m)	34	33	32	31	31	29					
Number of trials	1	1	1	1	1	1					
Gas bubbles (in sample)	No	No	No	No	No	No					
Sediment type	Clay	x	x	x	x	x	x				
	Silt										
	Sand										
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count											
Polychaetes, count	>100	>100	>100	>100	>50	>20					
Other animals, count											
Beggiatoa											
Feed											
Faeces		x									
Comments											
Grab	Area [m ²]	0,1			Grab ID	K3					
Signature fieldworker:						page 4 of 4 pages					

7.2 Pictures of samples at Haukadalsbót

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

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

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



7.3 Bottom topography and 3D view

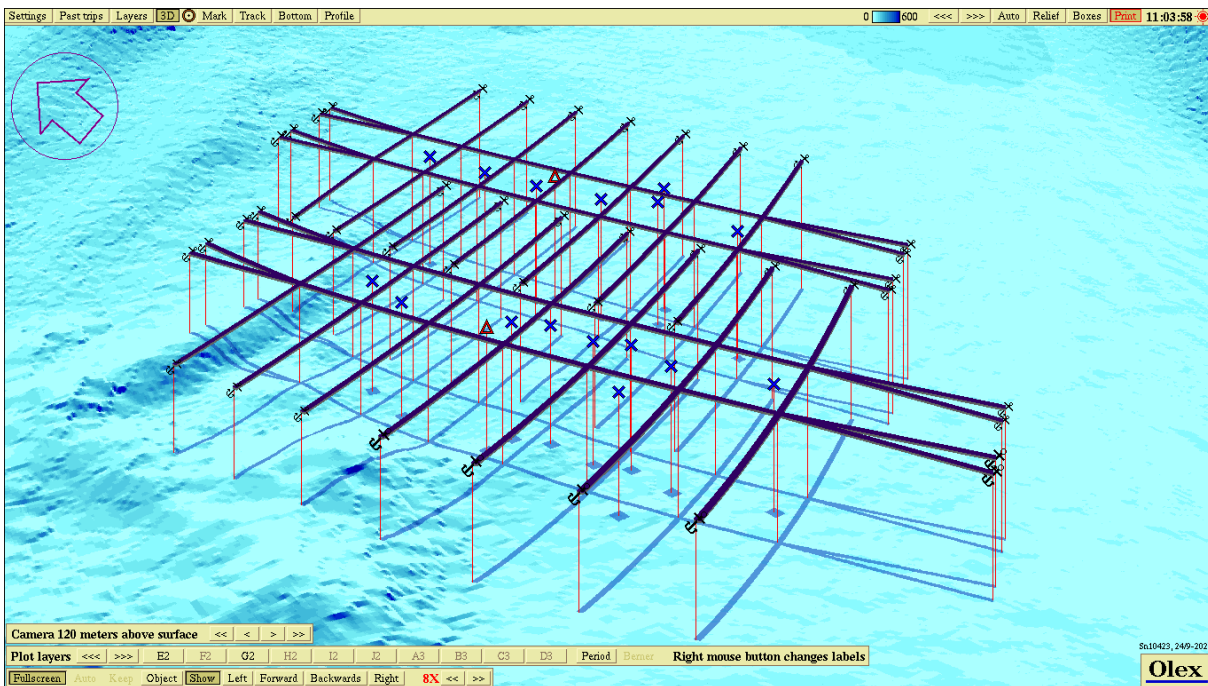


Figure 3. Showing bottom topography 3D at Haukadalsbót with each sampling station according to info in figure 2 and Table 3.