Akvaplan niva

Rapport Report

Haukadalsbót, Arctic Sea Farm
B survey,
March 2023
(fallow period)

NORSK
AKKREDITERING
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Akvaplan-niva AS: APN 64837.B01

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Information client			
Title	Haukadalsbót, Arctic Sea Farm. B survey (fallow period), March 2023		
Report number	APN-64837.B01		
Site name	Haukadalsbót	Coordinates site	65°53,342N 23°35,871V
County	Ísafjarðarbær	Municipality	Ísafjarðarbær
MTB-or estimated max biomass	5.000 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	☐		
A follow up survey	☐		
Half maximal biomass	☐		
Survey prior to putting out smolt	☒		
A pre-survey new site	☐		
Other	☐		
Last fallowing period:	28/02 2022- 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	0,13	Gr. II. pH/Eh	1
Gr. III. Sensory	0,70	Gr. III. Sensory	1
GR. II + III	0,41	GR. II+ III	2
Date fieldwork	17.03 2023	**Date report**	23.03 2023
Site status (NS 9410:2016):			**1**

Report writing and project leader	Snorri Gunnarsson	Signature	Snorri Gunnarsson
Quality control	Gyda W. Lorås	Signature	Gyda Wuttudal Lorås Digitally signed by Gyda Wuttudal Lorås Date: 2023.03.23 16:03:05 +01'00'

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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	Prosjektleder.
Snorri Gunnarsson	Akvaplan-niva AS	Fieldwork and Report. Charts (Olex).
Gyda W. Lorås	Akvaplan-niva AS	Quality assurance

The sampling at Haukadalsbót was done 17.03.2023.

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 23.03 2023

Snorri Gunnarsson
Project manager

1 Introduction

Sampling was undertaken on 17.03.2023 by Akvaplan-niva AS, who has been contracted by Arctic Sea farm in relation to the company's fish farming activity at the site Haukadalsbót 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. Haukadalsbót has an estimated max. biomass of 5.000 t for current generation farmed fish (Egill Ólafsson, personal reference) and thus a total of 16 stations were sampled.

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

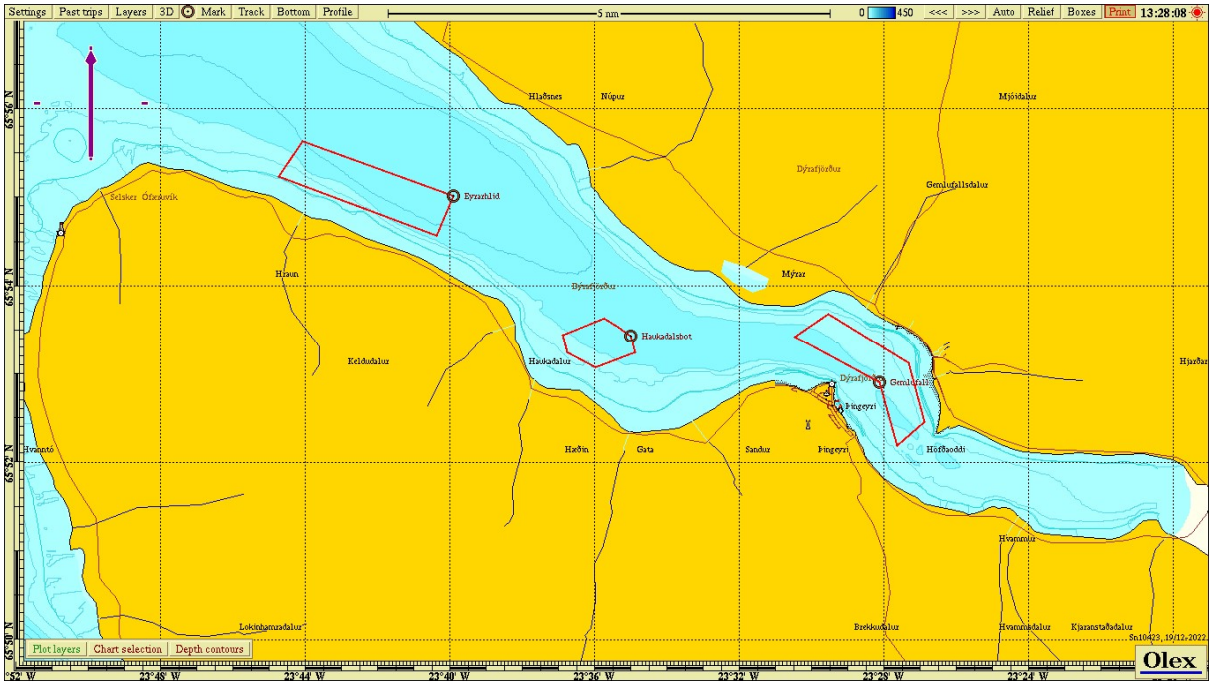

Figure 1. An overview map where Haukadalsbót is marked. Other fish farming areas in the nearest vicinity (Dýraförður) are also shown.

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 cm^2). 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: - 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 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 Study site, production and survey design

3.1 Study site and production

The Haukadalsbót site is in Dýrafjörður about 5,5 km west from Þingeyri town. The cages are lined in a north-eastern direction from land. The depth under cages ranges from about 25 - 35 m. 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.

Previously there have been farmed three generations salmon at the site. The current fallow period started 28th of February 2022 and the plan for putting out smolts is late April 2023 (Egill Ólafsson, personal reference).

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

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

Generation of fish (G)	Production (tonnes)	Feed usage (tonnes)
Generation 2012-2014 A. salmon	1.000 (approx.)	1.000 (approx.)
Generation 2015-2017 rainbow trout	1.900 (approx.)	-
Generation 2020-2022	5.831	7.567

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 Haukadalsbót.

Date of sampling	Report number	Survey type	Overall site status
17.03.2023	APN 64837.B01	B-survey fallow period	1
26.08 2021	APN 63315.B01	B-survey max biomass	1
25.03.2020	APN-62024.B02	B-survey fallow period	1

3.3 Hydrodynamic conditions

Measurement of dispersing current has been done at the site at 32 m deep in October and November 2019 (Gustavsson, 2019). Dominating current (32 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 Survey design

The placement of the 16 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 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. 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 28 to 35 m. The placement of sampling stations is regarded to be in accordance with the requirements outlined in NS 9410:2016.

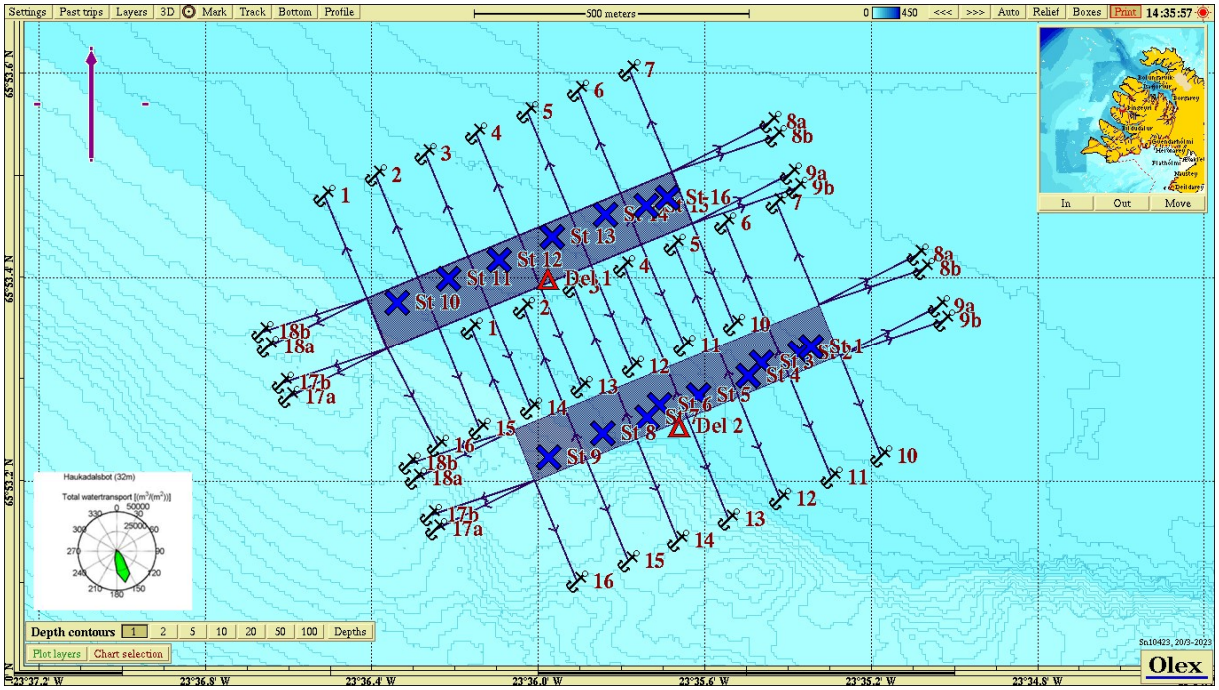

Figure 2. Site specific map of Haukadalsbót showing frame, mooring lines and farming area. Sampling stations st. 1 – 16 are marked with crosses. The color of each cross represents the environmental condition at the respective station following the classification as outlined in NS 9410:2016, chapter 7.11. 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 32 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°53,332	23°35,344	35
St 2	65°53,326	23°35,373	35
St 3	65°53,316	23°35,464	34
St 4	65°53,303	23°35,496	34
St 5	65°53,284	23°35,614	32
St 6	65°53,274	23°35,708	32
St 7	65°53,262	23°35,739	32
St 8	65°53,246	23°35,844	31
St 9	65°53,223	23°35,974	28
St 10	65°53,375	23°36,340	31
St 11	65°53,399	23°36,216	32
St 12	65°53,417	23°36,095	33
St 13	65°53,440	23°35,967	33
St 14	65°53,461	23°35,839	34
St 15	65°53,470	23°35,740	35
St 16	65°53,478	23°35,689	35

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 16 sampling stations (100% soft bottom). Sediment samples consisted mainly of clay in all parts of the local impact zone. Fauna was recorded at all stations with polychaetes being most prominent. The substrate was of brown/black colour at fourteen stations and light grey colour at the resting two stations. No signs of out-gassing were recorded at any of the sampling stations. A slight smell of H_2S was recorded at four stations and no smell at the resting twelve 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 – "good" (average group II-III index =0.41).

5 Conclusion

Applying the indicator thresholds and classification outlined in NS 9410:2016 it is shown that Haukadalsbót receives site status 1 – "very good" at the time of this B survey. Samples were collected with a Van Veen grab (0,025 m^2) at 16 stations distributed around the 12 cages, which are placed in the two frames during last production cycle. All sixteen sampling stations received status 1 – "very good".

The here presented survey was undertaken during the time of fallowing period that started 28th of February 2022 (over 12 months period). The results indicate relative little organic load in the local impact zone. The four stations with light smell were all located in the south-eastern frame in line with the direction of main spread current at the site indicating that this is were there is highest accumulation of organic material.

In two last B-surveys, one at fallow period in 2020 (Gunnarsson, 2020) and the other at max biomass for previous generation in 2021 (Gunnarsson, 2021) the overall site condition was also 1 "very good" in both surveys. Since previous B-survey at max biomass the overall site condition is similar or has improved. For sensory parameter III the index score was 0.72 in 2021 but is 0.70 in 2023. There are more stations with color black/brown in 2023 compared to 2021 survey but fewer stations with light smell in the present survey.

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.

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

Gunnarsson, S., 2021. Haukadalsbót, Arctic Sea Farm. B-bottom survey, August 2021 (maximum biomass survey). Akvaplan-niva AS report nr. 63315.B01.

Gustavsson, A. 2019. Arctic Sea Farm hf, measurement of spread current at Haukadalsbót fall 2019. Akvaplan-niva AS 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 akvakultur-anlegg.

Personal reference. Egill Ólafsson, Operational manager Seawater 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	Date:	17.03 2023
Site:	Haukadalsbót (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	7.72	7.71	7.71	7.72	7.65	7.78	7.42	7.68	7.67	7.35
	Eh (mV)	ORP	-114	58	-25	58	39	-56	-14	58	71	-28
		plus ref. verdi	86	258	175	258	239	144	186	258	271	172
	pH/Eh	from figure	1	0	0	0	0	0	0	0	0	0
	Status station		1	1	1	1	1	1	1	1	1	1
			Buffer-temp	3.0 C		Sea temp	0.8 C		Sediment temp		1.2 C	
		pH sea 8.1	ORP sea	115.0 mV		Eh sea	315.0 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)										
		Brown/black (2)	2	2	2	2	2	2	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)									0	
		1/4 < v < 3/4 (1)	1	1	1	1	1	1	1	1		1
		v > 3/4 (2)										
	Thickness of slidge (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	5.0	5.0	3.0	5.0	3.0	3.0	5.0	3.0	2.0	3.0
		Corrected (*0,22)	1.1	1.1	0.7	1.1	0.7	0.7	1.1	0.7	0.4	0.7
	Status station		2	2	1	2	1	1	2	1	1	1
	Average group II & III		1.1	0.6	0.3	0.6	0.3	0.3	0.6	0.3	0.2	0.3
	Status station		1	1	1	1	1	1	1	1	1	1

Grab ID	K-21
pH / Eh ID	Ysi prof. Plus

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Sample scheme B.1

Company:	Arctic Sea Farm	Date:	17.03 2023
Site:	Haukadalsbót (fallow period)	Site no.:	0
Fieldworker:	Snorri Gunnarsson		

Gr	Parameter	Point	Sample number										Index	
			11	12	13	14	15	16					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	7.6	7.2	7.7	7.8	7.7	7.6						
	Eh (mV)	ORP	-14	17	57	-85	-21	41						
		plus ref. verdi	186	217	257	115	179	241						
	pH/Eh	from figure	0	1	0	0	0	0					0.13	
		Status station	1	1	1	1	1	1						
		Status group II	1	Buffer temp	3.0 C		Sea temp	0.8 C		Sediment temp	1.2 C			
		pH sea 8.1	ORP sea	115 mV		Eh sea	315 mV			Reference electrode	200 mV			
III	Gas bubbles	Yes (4) No (0)	0	0	0	0	0	0						
	Colour	Light/grey (0)					0	0						
		Brown/black (2)	2	2	2	2								
	Smell	None (0)	0	0	0	0	0	0						
		Light (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)	1	1	1	1	1	1						
		v > 3/4 (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	3.0	3.0	3.0	3.0	1.0	1.0						
		Corrected (*0,22)	0.7	0.7	0.7	0.7	0.2	0.2					0.70	
		Status station	1	1	1	1	1	1						
		Status group III	1											
		Average group II & III	0.3	0.8	0.3	0.3	0.1	0.1					0.41	
		Status station	1	1	1	1	1	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-21
pH / Eh ID	Ysi prof. Plus

Sample scheme B.2

Company:	**Arctic Sea Farm**	**Date:**	**17.03 2023**
Site:	**Haukadalsbót (fallow period)**	**Site no.:**	**0**
Fieldworker:	**Snorri Gunnarsson**		

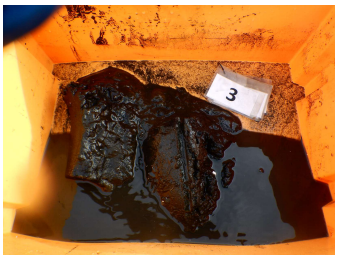
Sample number		1	2	3	4	5	6	7	8	9	10
Depth (m)		35	35	34	34	32	32	32	31	28	31
Number of trials		1	1	1	1	1	1	1	1	1	2
Gas bubbles (in sample)		No	No	No	No	No	No	No	No	No	No
Sediment type	**Clay**	X	X	X	X	X	X	X	X	X	X
	Silt										
	Sand										
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count					1			1			
Crustaceans, count											
Molluscs, count											
Polychaetes, count		>50	>10	>50	6	>100	>100	4	>10	2	9
Other animals, count											
Beggiatoa											
Feed											
Faeces											
Comments		St. 7. 1 x sea cucumber. St. 9. Small amount of sediment but parameter II and III ok.									
Grab		**Area [m^2]**		0.025		**Grab ID**		K-21			

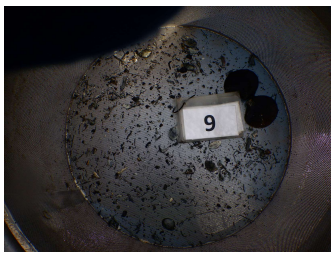
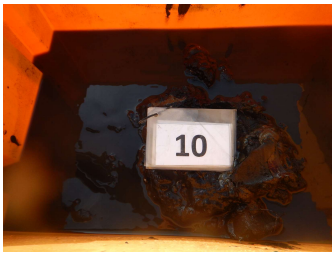
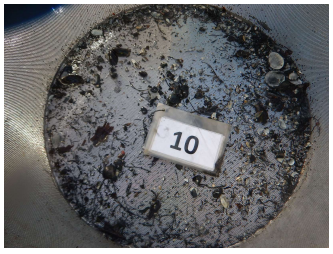
Sample scheme B.2

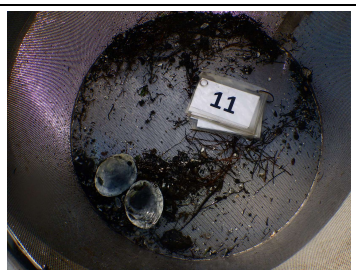
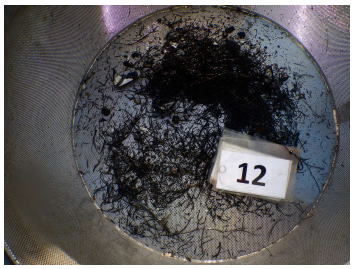
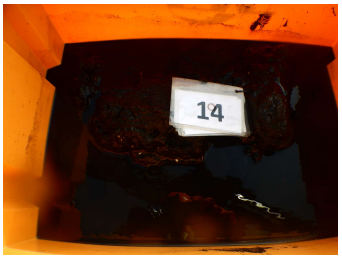
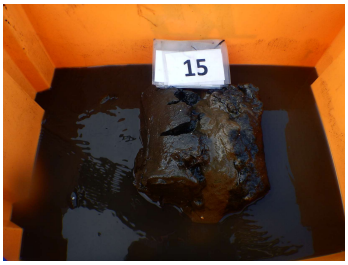
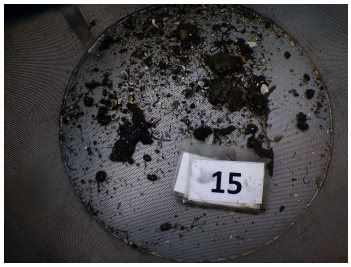
Company:	Arctic Sea Farm	Date:	17.03 2023
Site:	Haukadalsbót (fallow period)	Site no.:	0
Fieldworker:	Snorri Gunnarsson		

Sample number		11	12	13	14	15	16	17	18	19	20
Depth (m)		32	33	33	34	35	35				
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		>10	3	>10	>100	4	6				
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 Pictures of samples at Haukadalsbót.

St 1		
St 2		
St 3		
St 4		
St 5		

St 6		
St 7		
St 8		
St 9		
St 10		

St 11		
St 12	NA	
St 13		
St 14		
St 15		

St 16		

7.3 Bottom topography and 3D view

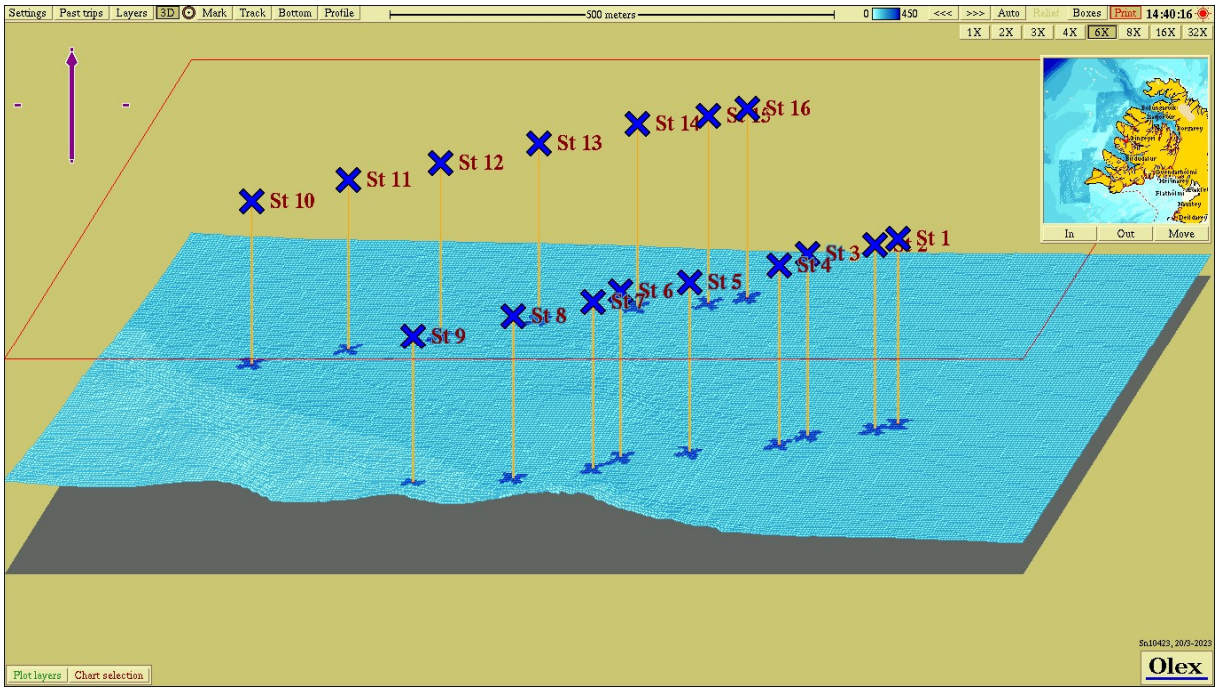


Figure 3. Bottom topography in 3D at Haukadalsbót with each sampling station according to info in Figure 1 and Table 4.