Akvaplan niva

Rapport Report

Hvestudalur, Arctic Sea Farm
B survey,
September 2023
(max biomass)

NORSK
AKKREDITERING
TEST 079

Akvaplan-niva AS: APN 65201.B01

Akvaplan-niva AS
Rådgivning og forskning innen miljø og akvakultur
Org.nr: NO 937 375 158 MVA
Akralind 4, 201 Kópavogi
www.akvaplan.niva.no

Information client			
Title	Hvestudalur, Arctic Sea Farm. B survey (max biomass, September 2023		
Report number	APN-65201.B01		
Site name	Hvestudalur	Coordinates site	65°42,845N 23°38,963V
County	Vesturbyggð	Municipality	Bíldudalur
MTB-or estimated max biomass	3.803 tonnes	Site manager/contact	Maria E. Chiarandini
Client name	Arctic Sea Farm		

Biomass/production/status at date of survey			
Biomass at date of survey	3.803 t	Feed use	4.608 t
Fish type	Salmon	Amount produced	3.681 t
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:	First generation at site		

Results from B-survey according to NS 9410:2016 (main results)			
Parameters and indexes		**Parameters and site status**	
Gr. II. pH/Eh	1,19	Gr. II. pH/Eh	2
Gr. III. Sensory	0,74	Gr. III. Sensory	1
GR. II + III	0,97	GR. II+ III	1
Date fieldwork	13.09 2023	**Date report**	26.09 2023
Site status (NS 9410:2016):			**1**

Report writing and project leader	Snorri Gunnarsson	Signature	
Quality control	Gyda Wuttudal Lorås	Signature	Gyda Wuttudal Lorås Digitally signed by Gyda Wuttudal Lorås Date: 2023.09.26 10:24:10 +02'00'

Table of contents

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 Wuttudal Lorås	Akvaplan-niva AS	Quality assurance

The sampling at Hvestudalur was done 13.09 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 26.09 2023

Snorri Gunnarsson
Project manager

1 Introduction

Sampling was undertaken on 13.09.2023 by Akvaplan-niva AS, who has been contracted by Arctic Sea farm in relation to the company's fish farming activity at the site Hvestudalur in Arnarfjörður, Vesturbyggð 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 max biomass of current production cycle. Sampling stations in this survey are placed within the near zone of the current farm location. Hvestudalur has an estimated max. biomass of 3.803 t for current generation farmed fish (Ísak Óskarsson, personal reference) and thus a total of 16 stations were sampled.

Figure 1 shows a map of the Arnarfjörður in Vestfirðir where Hvestudalur is located.

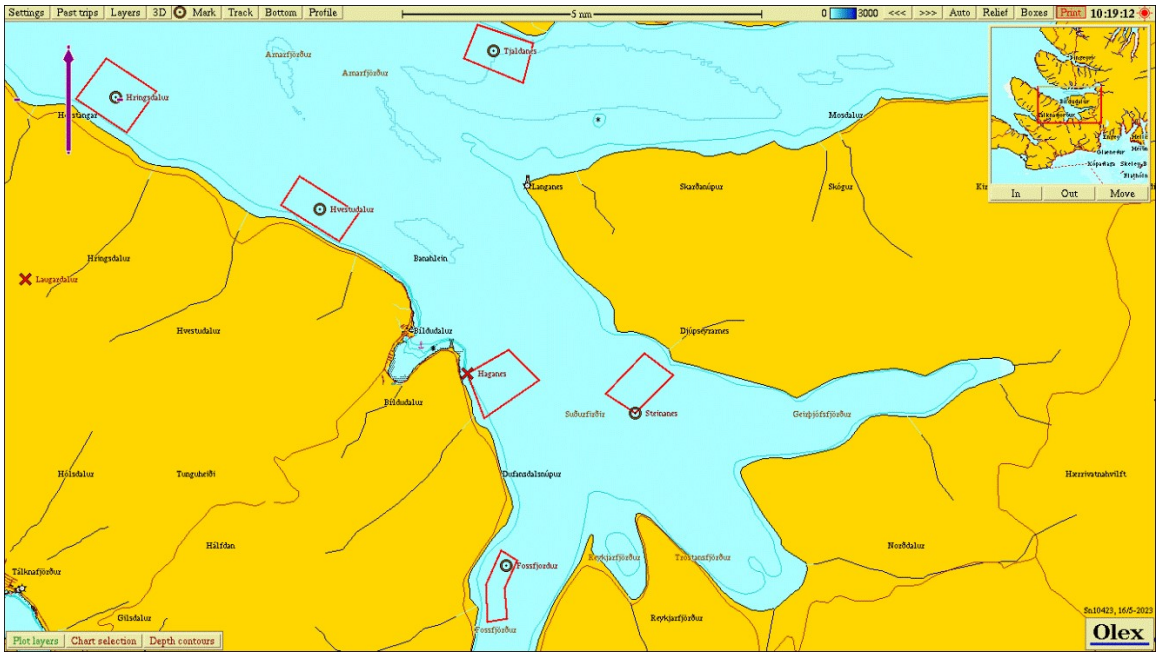


Figure 1. An overview map where Hvestudalur farm is marked. Other fish farming areas in the nearest vicinity (Arnarfjörður) are also shown.

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 0,1 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

Hvestudalur is located in the southern part of Arnarfjörður, approximately 2,5 nm northwest of the town of Bíldudalur. The fish farm at the site is two frame mooring system with a western frame having possibility for 5 cages and an eastern frame with a possibility for 6 cages with 160 - 200 m circumference. The frame is positioned in north-northwesterly direction from land (350°) with depth below the cages ranging from ca. 45 - 78 m.

This is the first-generation farmed fish at the site. The majority of smolts were put into sea in May – July 2022 (mean weight 102-155 g). At the date of the B-survey the standing biomass was 3.803 tons (mean weight about 3.3 kg).

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

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

Generation of fish (G)	Production (tonnes)	Feed usage (tonnes)
Generation 2022- 13.09 2023	3.680	4.608

3.2 Present and past site surveys

Table 3 provides an overview of sampling dates and results of current and historic B-surveys.

Table 3. Current and historic B surveys taken at Hvestudalur.

Date of sampling	Report number	Survey type	Overall site status
13.09 2023	APN-65201.B01	B survey max biomass	1 (very good)
11.05 2022	APN-64085.B01	B pre survey new site	1 (very good)

3.3 Hydrodynamic conditions

Current measurements were undertaken in April-May 2022 at 51 m, which is the dispersing depth for Hvestudalur (Hermansen, 2022). Main current flow at 51 m is in south-easterly direction (150 degrees) (Figure 2). Average current speed is 6,6 cm/s. Highest current speed is 20,6 cm/s and 5.3 % 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 45 – 78 m, with a slightly deeper area into the fjord in northern direction. Sampling stations were placed to represent the varied environmental conditions within the near zone and cover thus both the deeper and shallower areas. During the present production cycle 9 cages were used at the site as only 4 cages were installed at the eastern frame. Therefore, the 16 stations sampled

were distributed around the 9 cages that were used during the current production cycle according to guidance in NS 9410, chapter 7.6. The sampling stations had a depth varying from 47 to 72 m. The placement of sampling stations is regarded to be in accordance with the requirements outlined in NS 9410:2016.

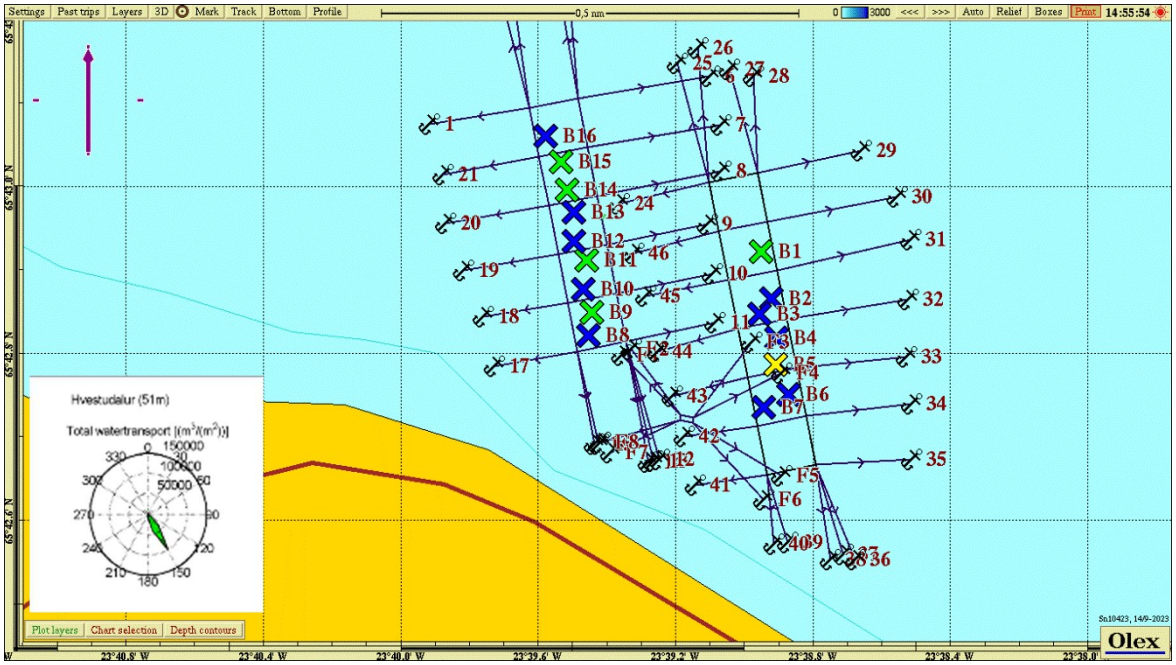


Figure 2. Site specific map of Hvestudalur showing frame, mooring lines and farming area. Sampling stations st. 1 – 16 are marked with crosses. The color of each cross represents the environmental condition at the respective station following the classification as outlined in NS 9410:2016, chapter 7.11. 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 51 m (Hermansen, 2022).

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

Station number	North	West	Depth (m)
St 1	65°42,922	23°38,950	67
St 2	65°42,865	23°38,922	65
St 3	65°42,847	23°38,957	65
St 4	65°42,818	23°38,906	65
St 5	65°42,786	23°38,908	62
St 6	65°42,751	23°38,870	62
St 7	65°42,735	23°38,944	57
St 8	65°42,821	23°39,454	47
St 9	65°42,849	23°39,445	50
St 10	65°42,876	23°39,469	52
St 11	65°42,911	23°39,460	59
St 12	65°42,934	23°39,496	61
St 13	65°42,969	23°39,497	66
St 14	65°42,995	23°39,517	68
St 15	65°43,029	23°39534	70
St 16	65°43,060	23°39,579	72

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)	2
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 sand at stations in the eastern part of the local impact zone and the stations closest to land in the western part and mixture of sand and clay in the middle part of the western frame and clay in deeper areas under the western frame. Fauna was recorded at all stations with polychaetes being most prominent. No signs of out-gassing were observed at any of the sampling stations. The substrate was of brown/black colour at five stations and light grey colour at the resting eleven stations. No smell of H_2S was at eight stations, light smell at six stations and strong smell at two sampling station. Feed particles were observed at three stations and faeces at one station.

Based on the classification of sediment chemistry (ph/Eh) and the sensory assessments ten stations of this survey received status 1 – "very good", five stations received status 2 – "good" and one station status 3– "bad" (Figure 2). Overall, the index score for parameter II (pH/Eh) was lower than the index score for the sensory parameters III, or 1,19 for parameter II but 0,74 for parameter III.

Taken together the site receives the environmental status was 1 – "good" (average group II-III index =0.97).

5 Conclusion

Applying the indicator thresholds and classification outlined in NS 9410:2016 it is shown that Hvestudalur receives overall site status 1 – "very good" at the time of this B survey. Samples were collected with a Van Veen grab (0,1 m^2) at 16 stations distributed around the 9 cages, that were used for farming salmon during present production cycle. Ten stations of this survey received status 1 – "very good", five stations received status 2 – "good" and one station status 3– "bad".

The here presented survey was undertaken during the time of max biomass for the present production cycle. The results indicate that in parts of the local impact zone there is some organic load. Four of the stations with status "good" were found under the western frame and one under the eastern frame. The one stations with status "bad" was found at the eastern frame in direction with the spread current. So, some organic load can be found in all parts of the local impact zone both in deeper and more shallow areas. There was some inconsistency in the score for parameters II (pH/redox) having overall group status 2 (good) and parameters III (sensory) having overall group status 1 (very good). The average group status of II and III resulted in status 1 (very).

In previous B-surveys prior to putting out this first generation farmed fish at the site (pre survey) (Gustavsson, 2022) the overall site condition was 1 "very good" and no signs of organic load contra indications of some build up of organic load during farming of the present generation at the site.

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.

Gustavsson, A. 2022. Hvestudalur, Arctic Sea Farm. B survey (baseline-new site), May 2022. Akvaplan-niva AS report nr. 64085.B01.

Hermansen, A. 2022. Current measuremets at Hvestudalur, 2022. Akvaplan-niva AS report nr. 63924.01.

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. Ísak Óskarsson, Station manager Arctic Sea Farm. 2023

7 Appendix

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

Sample scheme B.1

Company	Arctic Sea Farm	Date:	13.09 2023
Site:	Hvestudalur (max biomasss)	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	7.13	7.71	7.75	7.50	6.91	7.49	7.67	7.43	7.16	7.57
	Eh (mV)	ORP	-251	10	-20	-110	-269	-165	-158	-181	-193	-141
		plus ref. verdi	-51	210	180	90	-69	35	42	19	7	59
	pH/Eh	from figure	2	0	0	1	3	1	1	1	2	1
	Status station		2	1	1	1	3	1	1	1	2	1
			Buffer-temp	11.0 C		Sea temp	10.2 C		Sediment temp		10.4 C	
	pH sea	8.14	ORP sea	178.0 mV		Eh sea	378.0 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	0		
		Light (2)	2									2
		Strong (4)					4				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			
		v > 3/4 (2)				2					2	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	1.0	1.0	2.0	7.0	1.0	1.0	0.0	8.0	4.0
		Corrected (*0,22)	1.1	0.2	0.2	0.4	1.5	0.2	0.2	0.0	1.8	0.9
		Status station	2	1	1	1	2	1	1	1	2	1
		Average group II & III	1.6	0.1	0.1	0.7	2.3	0.6	0.6	0.5	1.9	0.9
		Status station	2	1	1	1	3	1	1	1	2	1

Grab ID	K-3
pH / Eh ID	Ysi prof. Plus

page 1 of 4 pages

Sample scheme B.1

Company:	Arctic Sea Farm	Date:	13.09 2023
Site:	Hvestudalur (max biomasss)	Site no.:	0
Fieldworker:	Snorri Gunnarsson		

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	7.14	7.51	7.39	7.16	7.10	7.73						
	Eh (mV)	ORP	-211	-93	-192	-259	-251	60						
		plus ref. verdi	-11	107	8	-59	-51	260						
	pH/Eh	from figure	2	0	1	2	2	0					1.19	
		Status station	2	1	1	2	2	1						
		Status group II	2	Buffer temp	11.0 C		Sea temp	10.2 C		Sediment temp	10.4 C			
		pH sea 8.14	ORP sea	178 mV		Eh sea	378 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						
		Brown/black (2)	2			2								
	Smell	None (0)		0				0						
		Light (2)	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 slidge (t)	t < 2 cm (0)	0	0	0	0	0	0						
		2 < t < 8 cm (1)												
		t > 8 cm (2)												
		Sum	6.0	2.0	4.0	6.0	4.0	2.0						
		Corrected (*0,22)	1.3	0.4	0.9	1.3	0.9	0.4					0.74	
		Status station	2	1	1	2	1	1						
		Status group III	1											
		Average group II & III	1.7	0.2	0.9	1.7	1.4	0.2					0.97	
		Status station	2	1	1	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-3
pH / Eh ID	Ysi prof. Plus

Sample scheme B.2

Company:	**Arctic Sea Farm**	**Date:**	**13.09 2023**
Site:	**Hvestudalur (max biomasss)**	**Site no.:**	**0**
Fieldworker:	**Snorri Gunnarsson**		

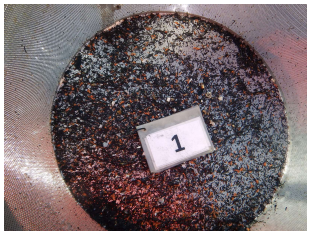
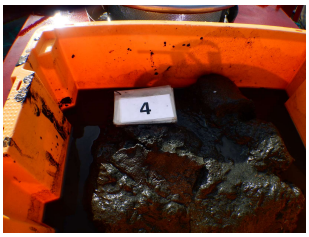
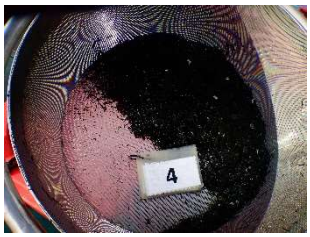
Sample number		1	2	3	4	5	6	7	8	9	10
Depth (m)		67	65	65	65	62	62	57	47	50	52
Number of trials		1	1	1	1	1	1	1	1	1	1
Gas bubbles (in sample)		No	No	No	No	No	No	No	No	No	No
Sediment type	**Clay**									X	X
	Silt										
	Sand	X	X	X	X	X	X	X	X	X	X
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count											
Polychaetes, count		>100	>100	>50	>20	>50	>20	>20	8	>20	>50
Other animals, count											
Beggiatoa											
Feed				x							
Faeces				x							
Comments		St. 1-10. Some black algae. St. 5. Sediment black and oily.									
Grab	**Area [m^2]**	0.1			**Grab ID**		K-3				

Sample scheme B.2

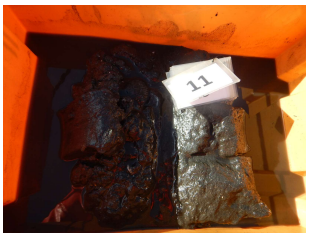
Company:	Arctic Sea Farm	Date:	13.09 2023
Site:	Hvestudalur (max biomasss)	Site no.:	0
Fieldworker:	Snorri Gunnarsson		

Sample number		11	12	13	14	15	16	17	18	19	20
Depth (m)		59	61	66	68	70	72				
Number of trials		1	1	1	1	1	2				
Gas bubbles (in sample)		No	No	No	No	No	No				
Sediment type	Clay	X	X	X	X	X	X				
	Silt						X				
	Sand	X	X								
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count											
Polychaetes, count		>20	>30	>30	>10	>50	>50				
Other animals, count											
Beggiatoa											
Feed			X		X						
Faeces											
Comments		St. 1-6. Some black algae.									
Grab		Area [m^2]		0.1		Grab ID		K-3			
Signature fieldworker:											

7.2 Pictures of samples at Hvestudalur.

St 1		
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		

7.3 Bottom topography and 3D view

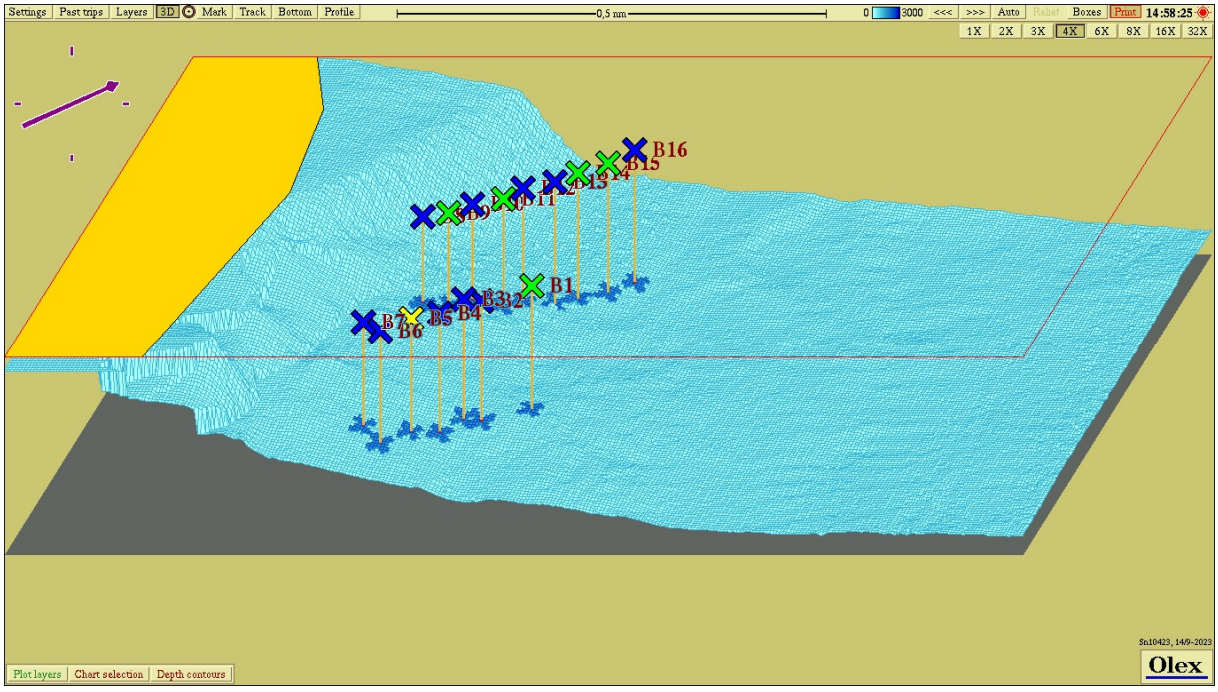


Figure 3. Bottom topography in 3D at Hvestudalur with each sampling station according to info in Figure 1 and Table 4.