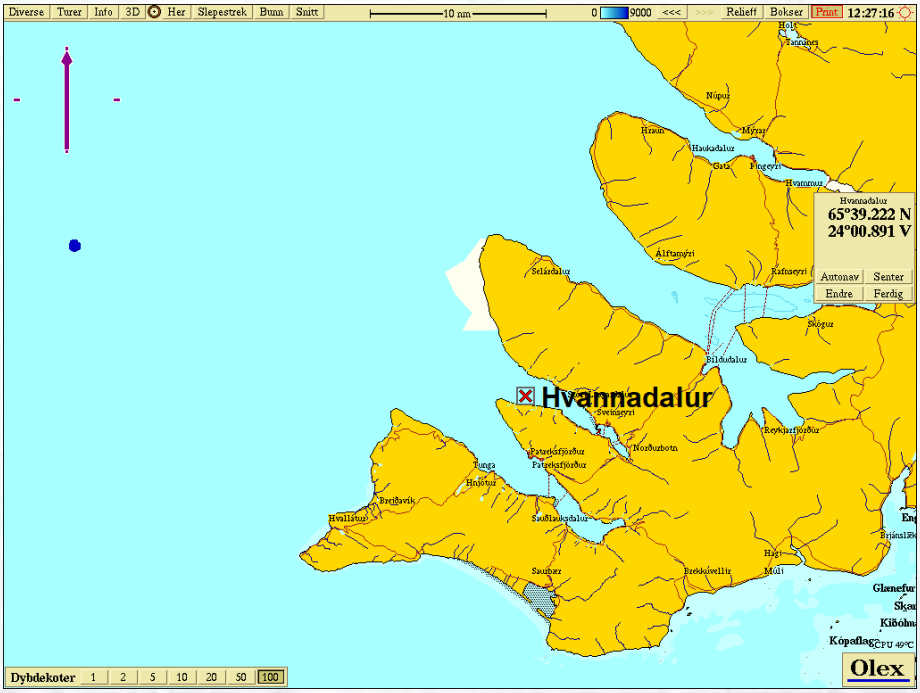
Akvaplan niva

Rapport Report

Hvannadalur, Arctic Sea Farm
B-bottom survey,
April 2021
(maximum biomass survey)



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Akvaplan-niva AS: APN 62907.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	Hvannadalur, Arctic Sea Farm. B-bottom survey, April 2021		
Report number	APN-62907.B01		
Site name	Hvannadalur	Coordinates site	65°39.222 N 024°00.891 V
County	Vesturbyggð	Municipality	Tálknafjörður
MTB-or estimated max biomass	5.104 ton	Site manager/contact	Steinunn G. Einarsdóttir
Client name	Arctic Sea Farm		

Biomass/production/status at date of survey			
Biomass at date of survey	5.104 ton	Feed use	6.698
Fish type	Salmon	Amount produced	

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	1,10	Gr. III. Sensory	2
GR. II + III	1,02	GR. II+ III	1
Date field work	09.04 2021	**Date report**	18.06.21
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 maximum biomass survey (MTB) as they are defined in NS9410:2016. There is a requirement of at least 15 sampling stations within the mooring lines of the fish farm. The estimated max biomass for the current generation farmed salmon at the site Hvannadalur is 5.104 MTB ton. The methods applied in this 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.
Snorri Gunnarsson	Akvaplan-niva AS	Fieldwork and Report. Charts (Olex).
Arnþór Gústavsson	Akvaplan-niva AS	Quality assurance

The sampling at Hvannadalur was done 09.04 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.

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 Arctic Sea Farm and their personnel for the cooperation during the conductance of this site survey.

Kópavogi 18. juni 2021

Snorri Gunnarsson
Project manager

1 Introduction

The sampling date for the present site survey was 09.04 2021 and done by Akvaplan-niva AS contracted by Arctic Sea Farm in relation to the company's fish farming activity at the site Hvannadalur in Tálknafjörður, 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 of southern part of Vestfirðir where the site Hvannadalur is located.

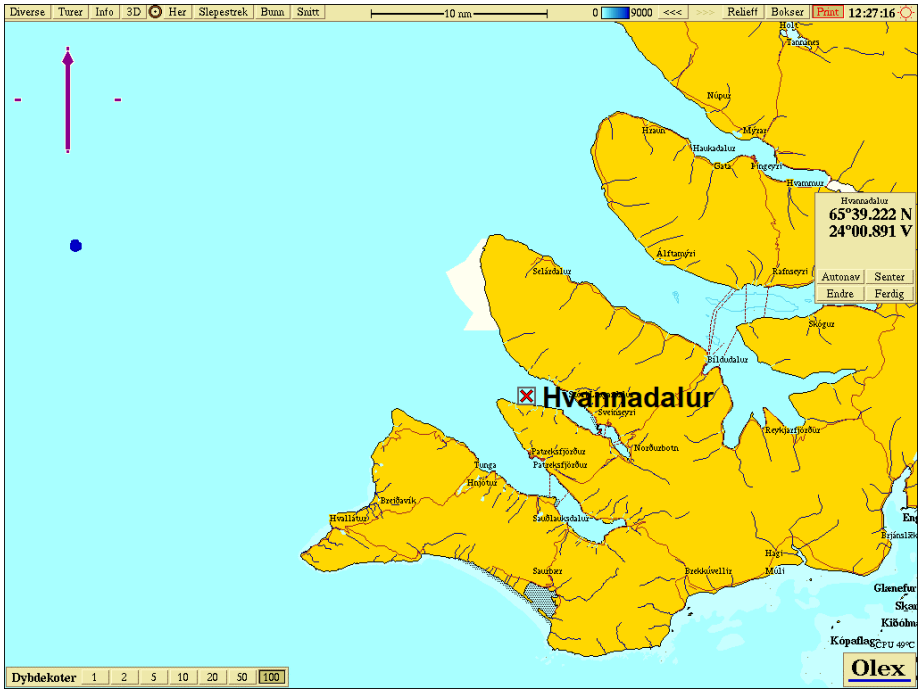

Figure 1. An overview map with the Hvannadalur site market by its name with a red cross.

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 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

The Hvannadalur site is coming to an end of the first production cycle after installing a new frame for cages at the site in 2019. The current generation was started with putting out smolts during late summer/fall 2019. 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 present production cycle 11 cages of the total 12 have been used (Steinunn G. Einarsdóttir, pers. info).

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

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

Generation of fish (G)	Production (ton)	Feed usage (ton)
Present generation until sampling date	5.221	6.698

3.2 Present and past site surveys

There was done a base line study (B-survey) at the site prior to putting fish into sea (Gústavsson, 2019) with sampling date 15.07 2019. Bottom was described as soft bottom with mainly clay and some silt. The site was assigned overall condition 1 (Very good) and and visual and chemical parameters did not show any signs of organic load at the site. Redox potential was positive at all ten sampling stations.

Table 3. Past site studies for Hvannadalur site

Date of sampling	Report number	Survey type	Overall site status
15.07.2019	APN-61376.B01	B survey new site	1

3.3 Dispersing current

Measurement of dispersing current was done at the site in 24th of September – 29th of October 2020 measurements at 48 m depth (Hermansen. 2020). Dominating current (48 m) is in direction southeast (135 degrees). Average current speed was measured to be 6.4 cm/s. Highest current speed is measured to be 26.3 cm/s and 4.2 % of the measurements were < 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 and spread around the periphery of the cages. At the Hvannadalur site the typical depth in the local impact zone is in the range from 53 – 58 m, with the shallowest parts in the south-east part (closest to land) and more depth in direction into the middle of the fjord. 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 56 to 58 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.

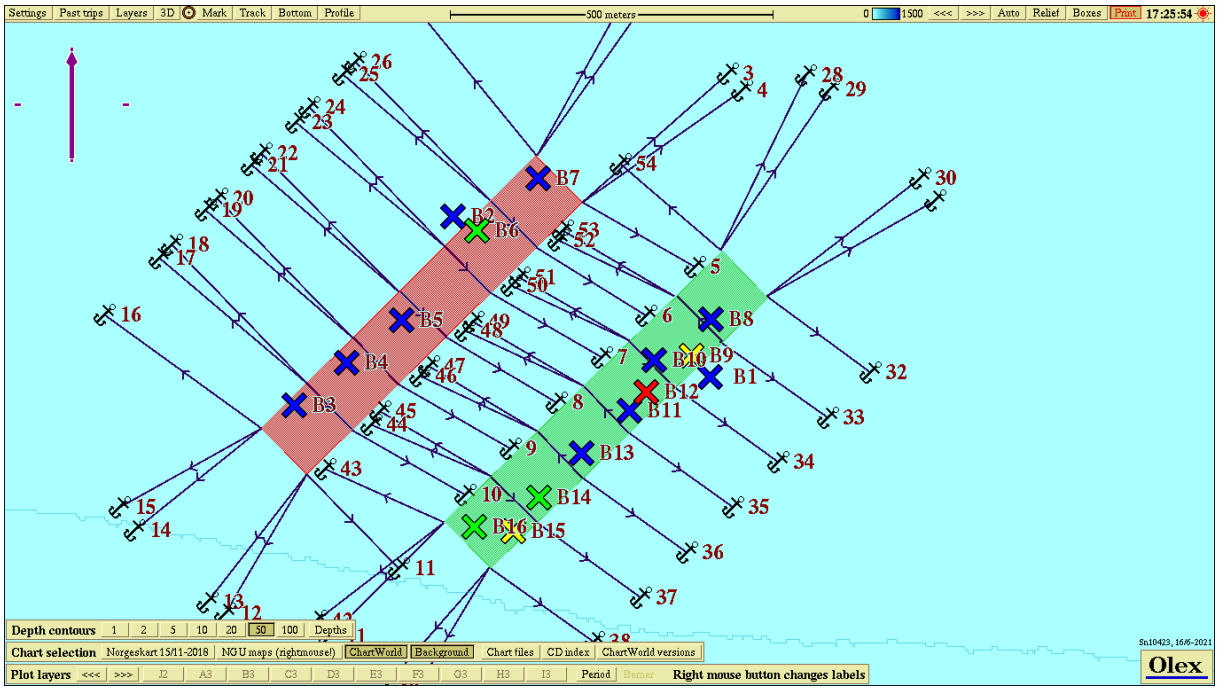

Figure 2. Chart showing depths at the site Hvannadalur. Sampling stations st. 1 – 16 are marked with color codes that describe the condition according to NS 9410:2016, chapter 7.11. Color codes: Blue = very good condition, green = good condition, yellow = bad condition, red = very bad condition.

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

Station number	North	Vest	Depth (m)
St 1	65°39.210	24°00.493	58
St 2	65°39.344	24°01.013	58
St 3	65°39.186	24°01.336	58
St 4	65°39.222	24°01.230	58
St 5	65°39.257	24°01.118	58
St 6	65°39.332	24°00.966	58
St 7	65°39.376	24°00.841	58
St 8	65°39.258	24°00.491	57
St 9	65°39.228	24°00.532	57
St 10	65°39.224	24°00.607	57
St 11	65°39.182	24°00.657	58
St 12	65°39.197	24°00.623	58
St 13	65°39.146	24°00.754	57
St 14	65°39.109	24°00.839	58
St 15	65°39.081	24°00.891	56
St 16	65°39.085	24°00.971	56

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 2 «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)	2
Group II + III – parameters (mean value)	1
Site condition	1

There were collected valid sediment samples at fifteen out of the total 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. One station was defined as hard bottom (station 13) even though it was possible to get some bottom sample for sensory analysis it was not possible to measure pH and redox. For the group II parameters (pH/Eh), eleven stations had conditions 1 «very good», one station had condition 2 «good» , two stations had condition 3 «bad» and one stations had condition 4 «very bad». For sensory parameters (group III) seven stations had condition 1 «very good», eight stations had condition 2 «good» and one station had condition 3 «bad». For combined parameters II and III (pH/redox and sensory) ten stations had status 1 «very good», three stations had condition 2 «good», two stations had condition 3 «bad» and one station had condition 4 «very bad» (st. 12). Some bacteria formations most likely *Beggiatoa* was apparent at two stations (st. 12 and st. 9). Feed were visible at one station (st. 9). Animals where present in all the fifteen 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 (0,025 m^2), divided on 16 stations placed around the 11 cages that are operated at the Hvannadalur site during the present production cycle.

For combined parameters II and III (pH/redox and sensory) ten stations had status 1 «very good», three stations had condition «good», two stations had condition «bad» and one station had condition «very bad». The stations with bad and very bad conditions were mainly located at the eastern part of the fish farming area and overall the condition was better at the western part of the site. The accumulation of organic material seems therefore to a greater extent to accumulate at the eastern part of the fish farming area coherent with the direction of the spread current for the site in SE direction (135 degrees). Animals were present in all soft bottom samples. The previous B bottom pre-survey before putting smolt into sea gave overall condition 1 «very good». The results for the current B-survey at max biomass indicate some moderate organic load at the Hvannadalur site that has accumulated in the local impact zone during the this first production cycle.

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.

Gústavsson, A., 2019. Hvannadalur, Arctic Sea Farm. B-bottom pre-survey, July 2019. Akvaplan-niva AS report nr. 61376.B01.

Hermansen, S., 2020. Arctic Sea Farm hf. Current measurements at Hvannadalur, 2020. Akvaplan-niva AS report nr. 62459.02.

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.

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

www.fiskeridir.no

7 Appendix:

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

Sample scheme B.1

Company	Arctic Sea Farm	Date:	09.04 2021
Site:	Hvannadalur (max biomas)	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		7,9	8,0	7,7	7,7	7,7	7,3	7,8	7,8	6,8	7,7
	Eh (mV)	ORP		82	92	61	-32	31	-265	-27	-17	-240	-61
		plus ref. verdi		282	292	261	168	231	-65	173	183	-40	139
	pH/Eh	from figure		0	0	0	0	0	2	0	0	3	0
		Status station		1	1	1	1	1	2	1	1	3	1
			Buffer-temp	5,0 C			Sea temp	2,3 C		Sediment temp		C	
		pH sea 8,03	ORP sea	129,0 mV			Eh sea	329,0 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								
		Brown/black (2)				2	2	2	2	2	2	2	2
	Smell	None (0)		0	0	0	0	0		0	0		0
		Light (2)											
		Strong (4)							4			4	
	Consistency	Solid (0)		0	0	0	0	0	0	0			
		Soft (2)									2	2	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					2			
	Thickness of slidge (t)	t < 2 cm (0)		0	0	0	0	0	0	0	0		0
		2 < t < 8 cm (1)										1	
		t > 8 cm (2)											
		Sum		2,0	3,0	3,0	3,0	3,0	7,0	4,0	5,0	10,0	5,0
		Corrected (*0,22)		0,4	0,7	0,7	0,7	0,7	1,5	0,9	1,1	2,2	1,1
		Status station		1	1	1	1	1	2	1	2	3	2
		Average group II & III		0,2	0,3	0,3	0,3	0,3	1,8	0,4	0,6	2,6	0,6
		Status station		1	1	1	1	1	2	1	1	3	1

Grab ID	k-22
pH / Eh ID	YSI professional plus

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Sample scheme B.1

Company:	Arctic Sea Farm	Date:	09.04 2021
Site:	Hvannadalur (max biomas)	Site no.:	0
Fieldworker:	Snorri Gunnarsson		

Gr	Parameter	Point	Sample number 11	12	13	14	15	16	17	18	19	20	Index S%	Index H%
	Bottom type: S (soft) or H (hard)		S	S	H	S	S	S					94	6
I	Animals > 1mm	Yes (0) No (1)	0	0		0	0	0						
II	pH	value	7,8	6,7	ut	7,6	6,8	7,3						
	Eh (mV)	ORP	-83	-250	ut	-135	-210	-132						
		plus ref. verdi	117	-50		65	-10	68						
	pH/Eh	from figure	0	5	ut	1	3	1					1,00	
		Status station	1	4	ut	1	3	1						
		Status group II	1	Buffer temp	5,0 C		Sea temp	2,3 C		Sediment temp	0,0 C			
		pH sea 8,03	ORP sea	129 mV		Eh sea	329 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		0									
		Light (2)		2		2	2	2						
		Strong (4)												
	Consistency	Solid (0)			0									
		Soft (2)	2	2		2	2	2						
		Aqueous (4)												
	Grab volume (v)	v < 1/4 (0)			0									
		1/4 < v < 3/4 (1)	1	1		1	1	1						
		v > 3/4 (2)												
	Thickness of slidge (t)	t < 2 cm (0)	0		0	0		0						
		2 < t < 8 cm (1)		1			1							
		t > 8 cm (2)												
		Sum	5,0	8,0	0,0	7,0	8,0	7,0						
		Corrected (*0,22)	1,1	1,8	0,0	1,5	1,8	1,5					1,10	
		Status station	2	2	1	2	2	2						
		Status group III	2											
		Average group II & III	0,6	3,4	0,0	1,3	2,4	1,3					1,02	
		Status station	1	4	1	2	3	2						
		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

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Sample scheme B.2

Company:	**Arctic Sea Farm**	**Date:**	**09.04 2021**
Site:	**Hvannadalur (max biomas)**	**Site no.:**	**0**
Fieldworker:	**Snorri Gunnarsson**		

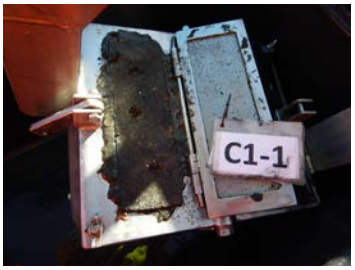
Sample number		1	2	3	4	5	6	7	8	9	10
Depth (m)		58	58	58	58	58	58	58	57	57	57
Number of trials		1	1	2	1	1	1	1	1	1	1
Gas bubbles (in sample)		No	No	No	No	No	No	No	No	No	No
Sediment type	**Clay**	X	X	X	X	X	X	X	X	X	X
	Silt										
	Sand										
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count											
Polychaetes, count		>100	>100	>50	>50	>100	2	>50	>100	2	>100
Other animals, count											
Beggiatoa									X		
Feed									X		
Faeces											
Comments											
Grab	**Area [m^2]**	0,025				**Grab ID**			k-22		

Sample scheme B.2

Company:	**Arctic Sea Farm**	**Date:**	**09.04 2021**
Site:	**Hvannadalur (max biomas)**	**Site no.:**	**0**
Fieldworker:	**Snorri Gunnarsson**		

Sample number		11	12	13	14	15	16	17	18	19	20
Depth (m)		58	58	57	58	56	56				
Number of trials		1	1	3	1	2	1				
Gas bubbles (in sample)		No	No		No	No	No				
Sediment type	**Clay**	X	X		X	X	X				
	Silt										
	Sand										
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count											
Polychaetes, count		>100	3		>50	3	>10				
Other animals, count											
Beggiatoa			X								
Feed											
Faeces											
Comments											
Grab		**Area [m^2]**		0,025		**Grab ID**			k-22		
Signature fieldworker:											

7.2 Pictures of samples at Hvannadalur

St 1		
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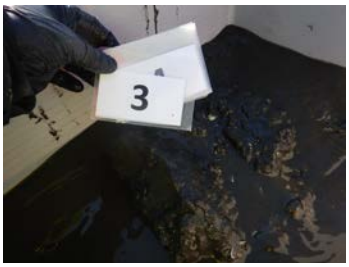
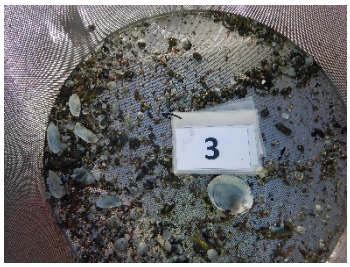
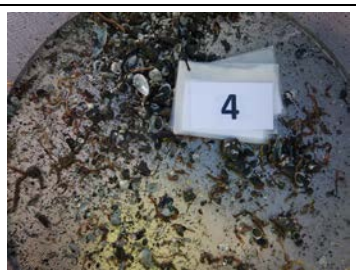
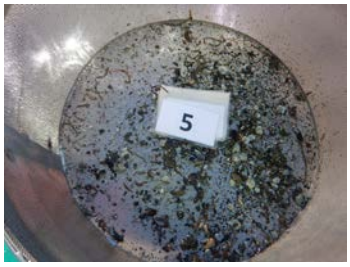
St 3		
St 4		
St 5		

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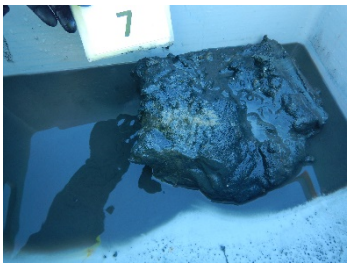
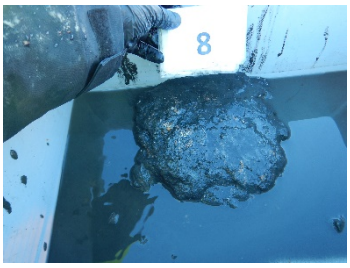
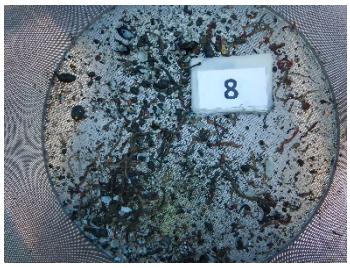
St 7		
St 8		
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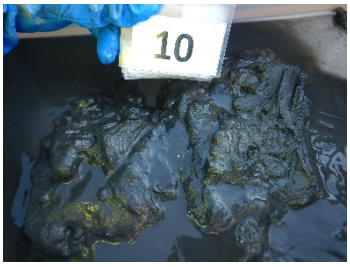
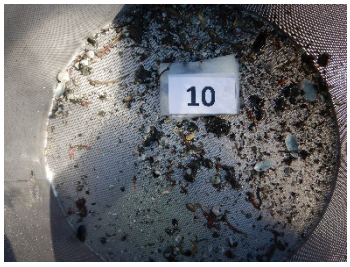
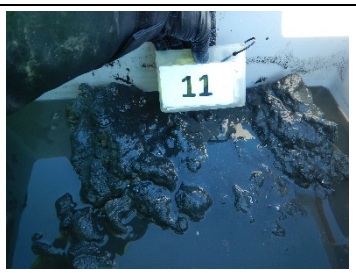
St 10		

St 11		
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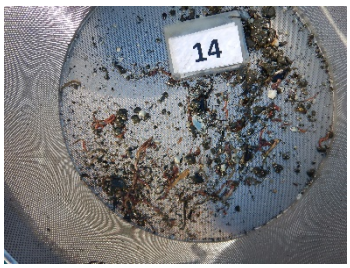
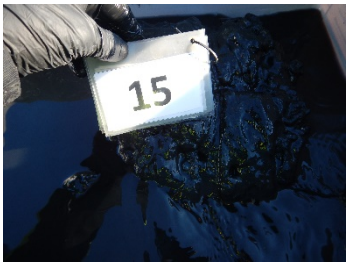
St 13	NA	NA
St 14		
St 15		

St 16		

7.3 Bottom topography and 3D view

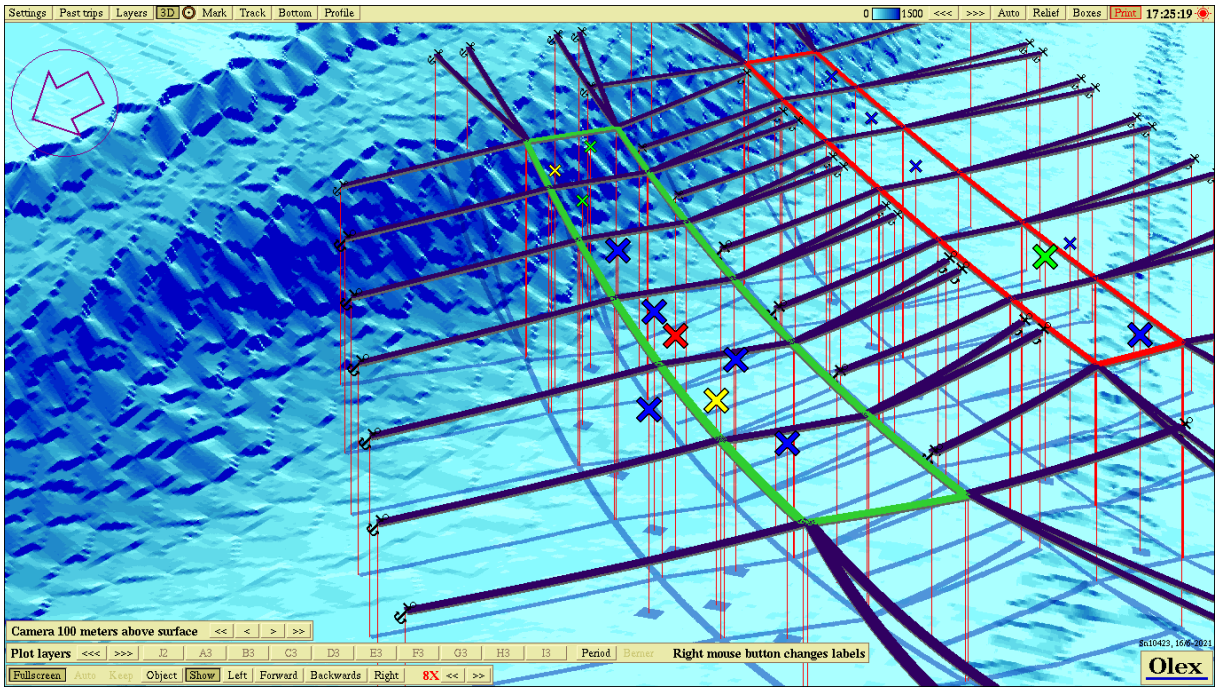


Figure 3. Showing bottom topography 3D at Hvannadalur with each sampling station according to info in figure 2 and Table 3.