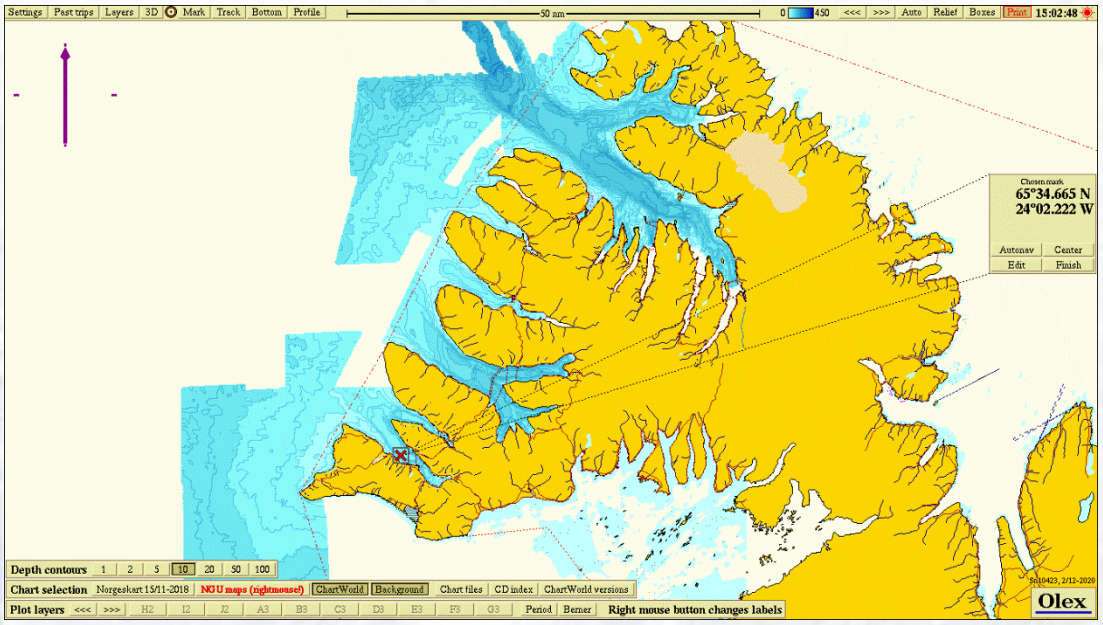
Akvaplan niva

Rapport Report

Kvígindisdalur, Arctic Sea Farm
B-bottom survey,
November 2020
(maximum biomass survey)



NORSK
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Akvaplan-niva AS: APN 62579.B01

Akvaplan-niva AS
Rådgivning og forskning innen miljø og akvakultur
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Information client			
Title	Kvígindisdalur, Arctic Sea Farm. B-bottom survey, November 2020		
Report number	APN-62579.B01		
Site name	Kvígindisdalur	Coordinates site	65°34.665 N 024°02.222 V
County	Vesturbyggð	Municipality	Patreksfjörður
MTB-or estimated max biomass	4.850 ton	Site manager/contact	Steinunn G. Einarsdóttir
Client name	Arctic Sea Farm		

Biomass/production/status at date of survey			
Biomass at date of survey	4.264 ton	Feed use	5.850
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	1,47	Gr. II. pH/Eh	2
Gr. III. Sensory	1,01	Gr. III. Sensory	1
GR. II + III	1,24	GR. II+ III	2
Date field work	10.11 2020	**Date report**	16.12.2020
Site status (NS 9410:2016):			**2**

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

Table of contents

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 Kvígindisdalur is 4.359 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.
Snorri Gunnarsson	Akvaplan-niva AS	Fieldwork and Report. Charts (Olex).
Arnþór Gústavsson	Akvaplan-niva AS	Quality assurance

The sampling at Kvígindisdalur was done 10.11 2020.

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 16. desember 2020

Snorri Gunnarsson
Project manager

1 Introduction

The sampling date for the present site survey was 10.11 2020 and done by Akvaplan-niva AS contracted by Arctic Sea Farm in relation to the company's fish farming activity at the site Kvígindisdalur in Patreksfjörður, 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 Kvígindisdalur is located.

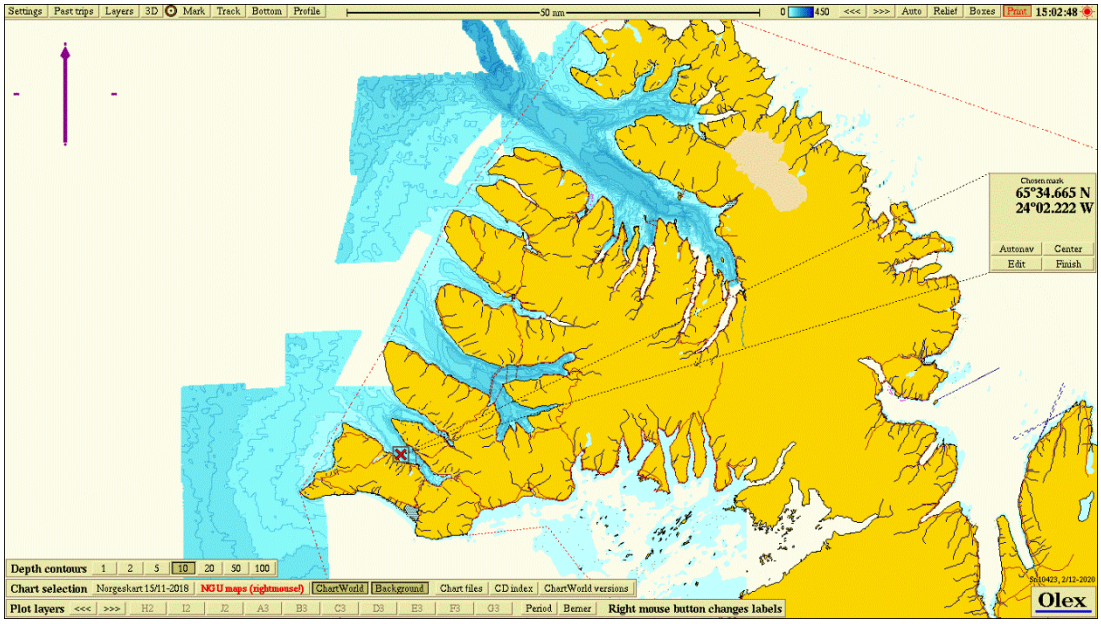

Figure 1. An overview map with the Kvígindisdalur site market by its name with a red cross.

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 (0,1 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 Site description and bottom topography

3.1 Info site operation

The Kvígindisdalur site is coming to an end of the first production cycle after installing a new frame for cages at the site site. The current generation was started with putting out smolts during summer 2019. The fish farm at the site is a two frame mooring system, each frame having 5 cages, total 10 cages each with 160 m circumference. During the present production cycle all 10 cages of 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 Kvígindisdalur, data is based on info given from the fish farmer.

Generation of fish (G)	Production (ton)	Feed usage (ton)
Present generation	4.366	5.850

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 (Gunnarsson, 2019) with sampling date 03.05 2019. Bottom was described as muddy for the most part with some hard bottom closer to shore at less depths and visual and chemical parameters did not show any signs of organic load at the site. Redox potential was positive at all eleven sampling stations.

Table 3. Past site studies for Kvígindisdalur site

Date of sampling	Report number	Survey type	Overall site status
03.05.2019	APN-61207.01	B survey new site	1

3.3 Dispersing current

Measurement of dispersing current was done at the site in 24th of September – 30th of October 2020 measurements at 51 m depth (Akvaplan-niva unpublished data). Dominating current (51 m) is in direction south-southeast (165 degrees). Average current speed was measured to be 6.3 cm/s. Highest current speed is measured to be 19.5 cm/s and 4.3 % of the measurements were < 1 cm/s.

3.4 Position of sampling stations

Description of the 15 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 Kvígindisdalur site the typical depth in the local impact zone is in the range from 35 – 58 m, with the shallowest parts in the south-west 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 55 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.

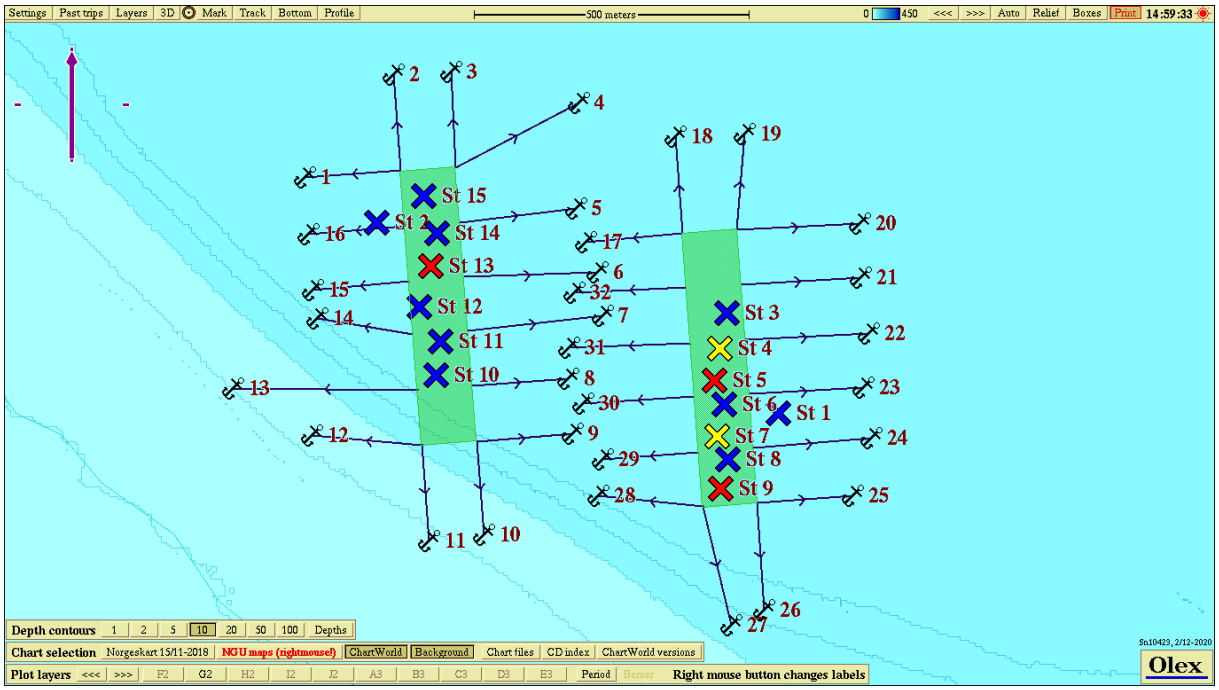

Figure 2. Chart showing depths at the site Kvígindisdalur. Sampling stations st. 1 – 15 are marked with color codes that describe the condition according to NS 9410:2016, chapter 7.11. Color codes: Blue = very good condition, green = good condition, yellow = bad condition, red = very bad condition.

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

Station number	North	Vest	Depth (m)
St 1	65°34.618	24°01.760	57
St 2	65°34.805	24°02.712	58
St 3	65°34.716	24°01.881	56
St 4	65°34.681	24°01.898	56
St 5	65°34.650	24°01.912	57
St 6	65°34.626	24°01.889	57
St 7	65°34.595	24°01.905	58
St 8	65°34.572	24°01.880	58
St 9	65°34.544	24°01.896	57
St 10	65°34.655	24°02.572	55
St 11	65°34.688	24°02.562	56
St 12	65°34.722	24°02.612	57
St 13	65°34.764	24°02.585	57
St 14	65°34.794	24°02.570	58
St 15	65°34.821	24°02.620	58

4 Results

Results for the different parameters are given in Table 5. The overall site condition is 2 « good». The status for group II (pH/Eh) was 2 « good», status group III parameters (sensory) was 1 « very good» and average group II + III parameters is status 2 « 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)	2
Group III – parameters, (sensory)	1
Group II + III – parameters (mean value)	2
Site condition	2

There were collected valid sediment samples at fourteen out of the total fifteen 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 eastern part of the farming area and a mixture of clay and sand in the western part. One station was defined as hard bottom (station 14). For the group II parameters (pH/Eh), ten stations had conditions 1 «very good», two stations had condition 3 «bad» and three stations had condition 4 «very bad». For sensory parameters (group III) eight stations had condition 1 «very good», five stations had condition 2 «good» and two stations had condition 3 «bad». For combined parameters II and III (pH/redox and sensory) ten stations had status 1 «very good», two stations had condition 3 «bad» and three stations had condition 4 «very bad» (stations 5, 9 and 13). Animals where present in all the fourteen 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 2 « good» at the date of sampling. A total of 20 grabs were taken with Van Veen grab (0,1 m^2), divided on 15 stations placed around the cages that are operated at the Kvígindisdalur site during the present production cycle.

For combined parameters II and III (pH/redox and sensory) ten stations had status 1 «very good», two stations had condition «good», three stations had condition «bad» and three station had condition «very bad» (stations 5, 9 and 13). 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 be more accumulated at the eastern part of the fish farming area coherent with the direction of the spread current for the site in SSE direction (165 degrees). Three stations had some gas bubbles noted in the sample (stations 3, 11 and 14). Animals were present in all soft bottom samples. The results indicate some organic load at the Kvígindisdalur site that has accumulated in the local impact zone during the this first production cycle. The previous B survey before putting smolt into sea gave overall condition 1 «very good». In the next B survey close attention should be given to the areas in the eastern part of the local impact zone.

The site is assigned a condition factor 2 "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. 2019. Kvígindisdalur, Arctic Sea Farm. B-bottom pre-survey, May 2019. Akvaplan-niva AS report nr. 61207.01.

Akvaplan-niva unpublished data. Measurement of spread current Kvígindisdalur PS 62459.

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:**	**10.11 2020**
Site:	**Kvígindisdalur**	**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	7,7	7,6	7,3	7,1	6,2	7,4	7,1	7,4	6,7	7,4
	Eh (mV)	ORP	156	202	52	-80	-225	-18	-230	-15	-21	-23
		plus ref. verdi	356	402	252	120	-25	182	-30	185	179	177
	pH/Eh	from figure	0	0	0	3	5	0	3	0	5	0
		Status station	1	1	1	3	4	1	3	1	4	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
		Brown/black (2)			2	2	2	2	2		2	
	Smell	None (0)	0	0						0		2
		Light (2)			2	2		2	2		2	
		Strong (4)					4					
	Consistency	Solid (0)	0	0						0		0
		Soft (2)			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		1	1
		v > 3/4 (2)	2	2								
	Thickness of slidge (t)	t < 2 cm (0)	0	0	0	0		0		0		0
		2 < t < 8 cm (1)					1		1		1	
		t > 8 cm (2)										
		Sum	2,0	2,0	7,0	7,0	10,0	7,0	8,0	0,0	8,0	3,0
		Corrected (*0,22)	0,4	0,4	1,5	1,5	2,2	1,5	1,8	0,0	1,8	0,7
		Status station	1	1	2	2	3	2	2	1	2	1
		Average group II & III	0,2	0,2	0,8	2,3	3,6	0,8	2,4	0,0	3,4	0,3
		Status station	1	1	1	3	4	1	3	1	4	1

Grab ID	k-3
pH / Eh ID	YSI-professional plus

page 1 of 4 pages

Sample scheme B.1

Company:	Arctic Sea Farm	Date:	10.11 2020
Site:	Kvígindisdalur	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	H	S						93	7
I	Animals > 1mm	Yes (0) No (1)	0	0	0		0							
II	pH	value	7,3	7,1	6,7		7,4							
	Eh (mV)	ORP	-85	-88	-194		13							
		plus ref. verdi	115	112	6		213							
	pH/Eh	from figure	0	1	5	0	0						1,47	
		Status station	1	1	4	1	1							
		Status group II	2	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							
	Colour	Light/grey (0)	0	0		0	0							
		Brown/black (2)			2									
	Smell	None (0)	0			0	0							
		Light (2)		2										
		Strong (4)			4									
	Consistency	Solid (0)	0	0		0	0							
		Soft (2)			2									
		Aqueous (4)												
	Grab volume (v)	v < 1/4 (0)				0								
		1/4 < v < 3/4 (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									
		t > 8 cm (2)												
		Sum	1,0	3,0	10,0	0,0	1,0							
		Corrected (*0,22)	0,2	0,7	2,2	0,0	0,2						1,01	
		Status station	1	1	3	1	1							
		Status group III	1											
		Average group II & III	0,1	0,8	3,6	0,0	0,1						1,24	
		Status station	1	1	4	1	1							
		Status group II & III	2											

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: 2

Grab ID	k-3
pH / Eh ID	YSI-professional plus

page 2 of 4 pages

Sample scheme B.2

Company:	**Arctic Sea Farm**	**Date:**	**10.11 2020**
Site:	**Kvígindisdalur**	**Site no.:**	**0**
Fieldworker:	**Snorri Gunnarsson**		

Sample number		1	2	3	4	5	6	7	8	9	10
Depth (m)											
Number of trials		1	1	2	1	1	1	2	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	x	x								x
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count											
Polychaetes, count		>100	>100	>100	>100	4	>100	>10	>100	>50	>10
Other animals, count											
Beggiatoa											
Feed						x		x			
Faeces											
Comments											

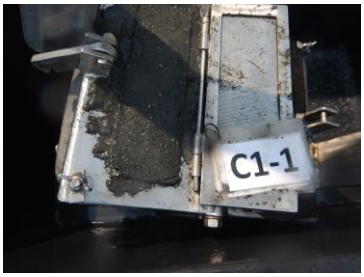
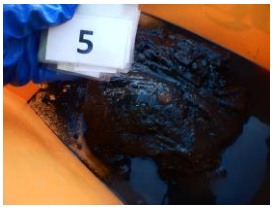
Grab	**Area [m^2]**	0,1	**Grab ID**	k-3

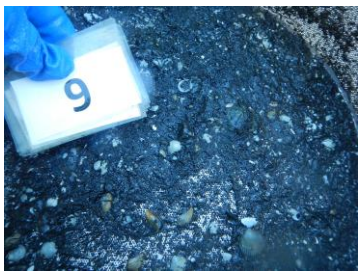
Sample scheme B.2

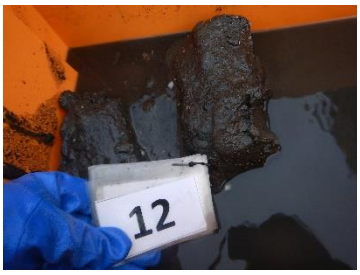
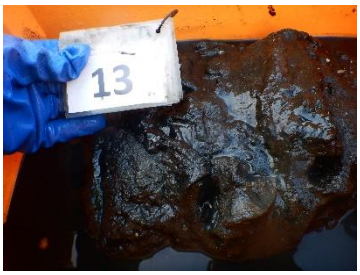
Company:	**Arctic Sea Farm**	**Date:**	**10.11 2020**
Site:	**Kvígindisdalur**	**Site no.:**	**0**
Fieldworker:	**Snorri Gunnarsson**		

Sample number		11	12	13	14	15	16	17	18	19	20
Depth (m)											
Number of trials		1	2	1	3	1					
Gas bubbles (in sample)		No	No	No	No	No					
Sediment type	**Clay**	x	x	x		x					
	Silt										
	Sand	x	x	x		x					
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count											
Polychaetes, count		>50	>100	4		>20					
Other animals, count											
Beggiatoa											
Feed											
Faeces				x							
Comments											
Grab		**Area [m^2]**		0,1		**Grab ID**		k-3			
Signature fieldworker:											

7.2 Pictures of samples at Kvígindisdalur

St 1		NA
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	NA	NA
St 15		

7.3 Bottom topography and 3D view

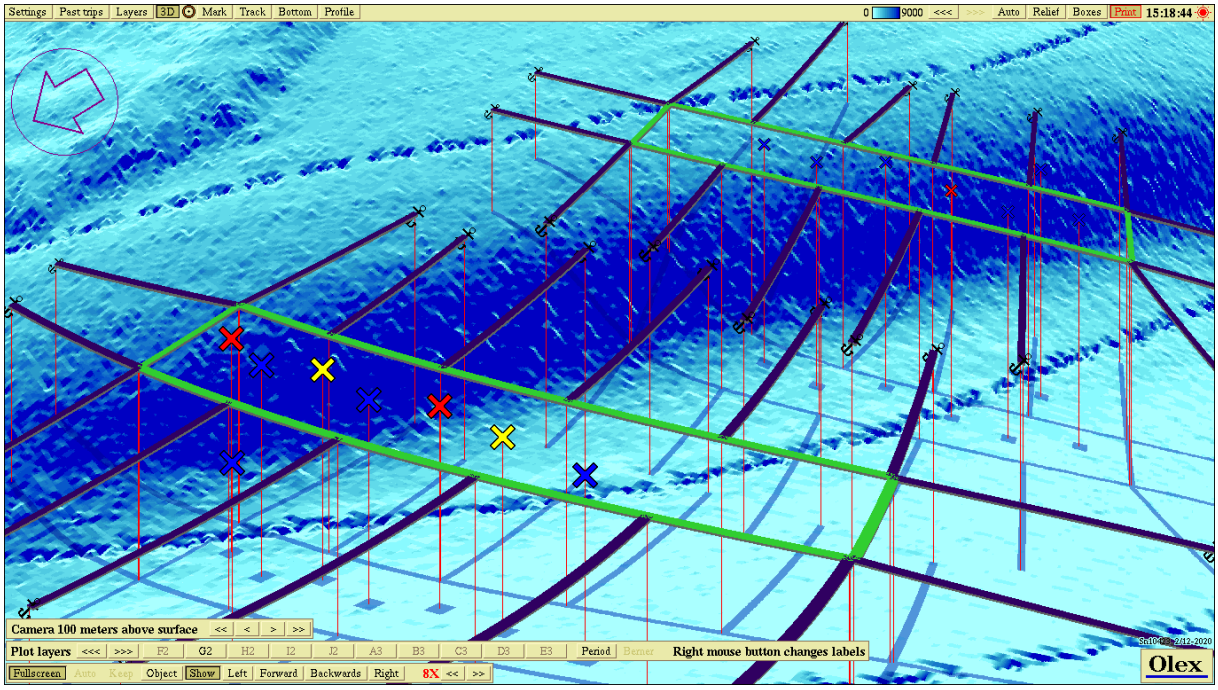


Figure 3. Showing bottom topography 3D at Kvígindisdalur with each sampling station according to info in figure 2 and Table 3.