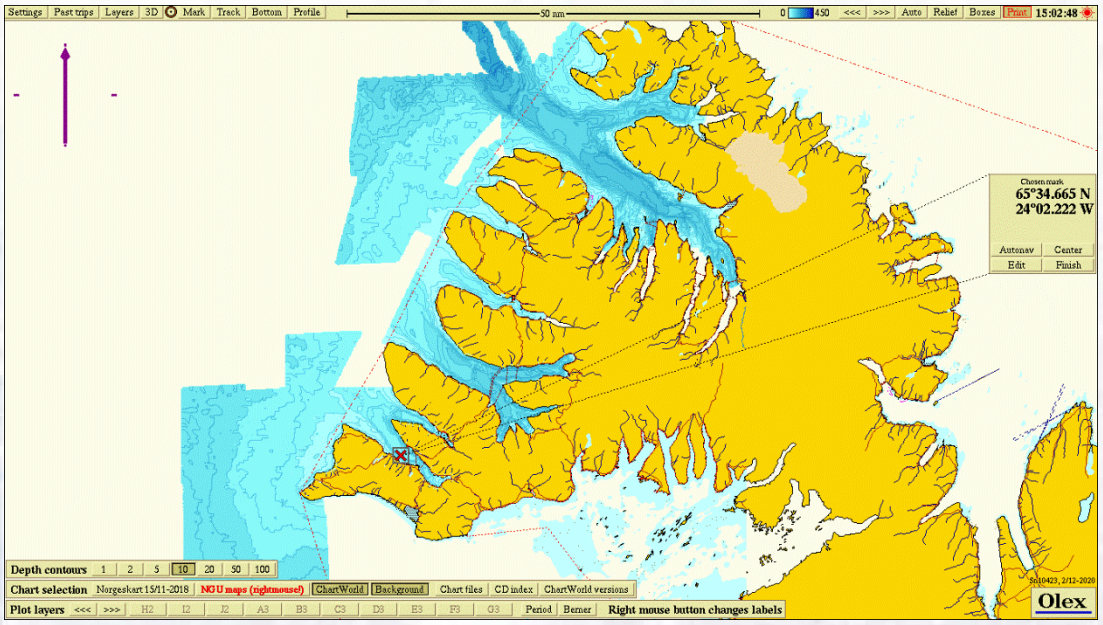
Akvaplan niva

Rapport Report

Kvígindisdalur, Arctic Sea Farm
B-bottom survey,
February 2021
(a follow up survey)



NORSK
AKKREDITERING
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Akvaplan-niva AS: APN 62868.B01

Akvaplan-niva AS
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Information client			
Title	Kvígindisdalur, Arctic Sea Farm. B-bottom survey, February 2021		
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	4.690 ton	Site manager/contact	Steinunn G. Einarsdóttir
Client name	Arctic Sea Farm		

Biomass/production/status at date of survey			
Biomass at date of survey	2.129 ton	Feed use	7.921
Fish type	Salmon	Amount produced	

Type/time of survey	Mark with X	Comments
At maximal biomass see kap 7.9	☐	A follow up study upon request from Arctic Sea Farm
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	0,53	Gr. II. pH/Eh	1
Gr. III. Sensory	0,89	Gr. III. Sensory	1
GR. II + III	0,71	GR. II+ III	1
Date field work	10.02 2021	**Date report**	17.02 2021
Site status (NS 9410:2016):			**1**

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 max biomass for the current generation farmed salmon at the site Kvígindisdalur was 4.690 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 10.02 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.

Akvaplan-niva AS thanks Arctic Sea Farm and their personnel for the cooperation during the conductance of this site survey.

Kópavogi 19. februar 2021

Snorri Gunnarsson
Project manager

1 Introduction

The sampling date for the present site survey was 10.02 2021 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. The current B-survey was done upon request from Arctic Sea Farm as a follow up study after previous B survey around max biomass at the site in November 2020.

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

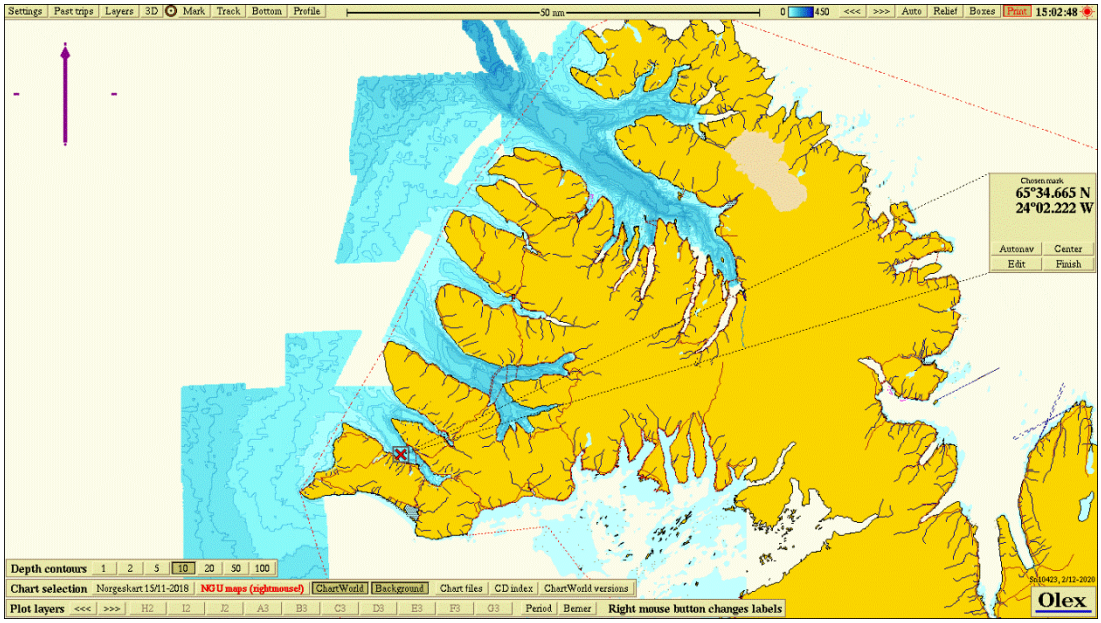

Figure 1. An overview map with the Kvígindisdalur site market by its name with a red cross.

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 (0,025 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 Kvígindisdalur site is coming to an end of the first production cycle after installing a new frame for cages at the 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 8 cages of have been used stations were placed at arrays of these.

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	6.013	7.921

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. Overall condition of the site was 1 (Very good)

Another B-survey was done in November 2020 around max biomass (Gunnarsson, 2020). The results indicated some organic load at the Kvígindisdalur site that had accumulated during farming of the current generation. 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 overall site condition was 2 (Good).

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 (Very good)
10.11 2020	APN-62579.B01	B survey max biomass	2 (Good)

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. This was a follow up study to the November sampling the previous year so special emphasis, with placement of stations, was on sampling around areas that had indications of higher organic load i.e. eastern part of the site. Five sampling station were therefore placed at the array of cages in the western frame and 10 station at the array of cages in the eastern frame. The sampling stations had a depth varying from 55 to 58 m.

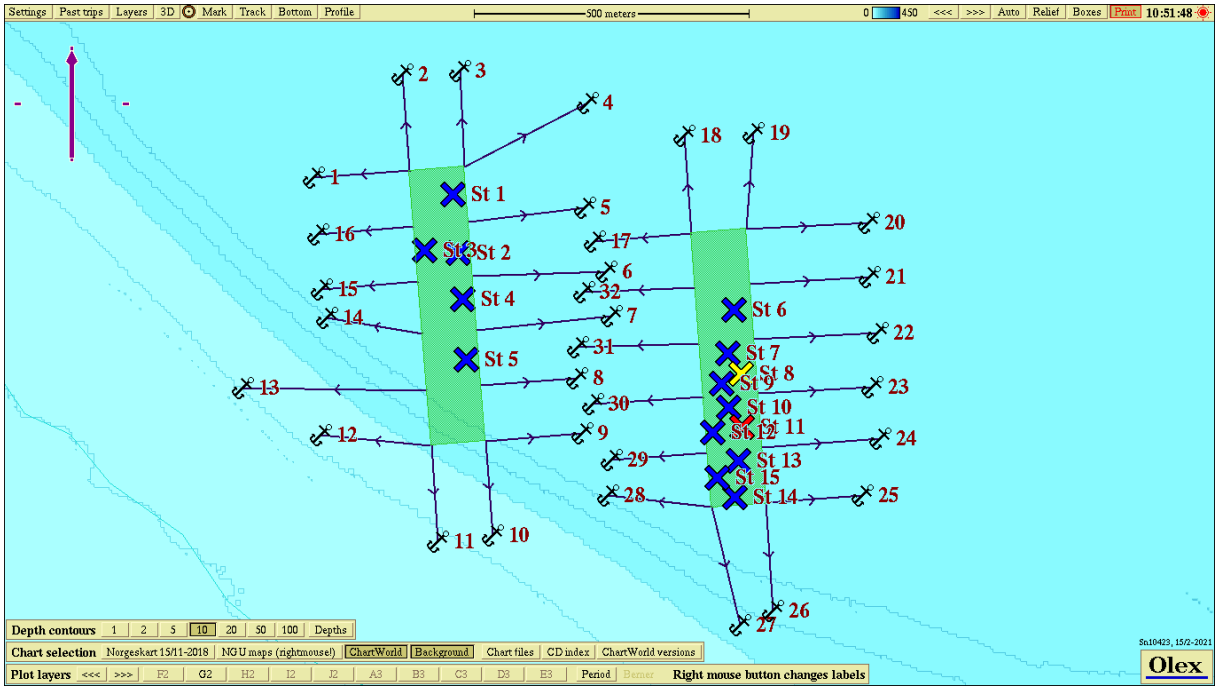

Figure 2. Chart showing depths at the site Kvígindisdalur. Sampling stations st. 1 – 15 are marked with color codes that describe the condition according to NS 9410:2016, chapter 7.11. Color codes: Blue = very good condition, green = good condition, yellow = bad condition, red = very bad condition.

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

Station number	North	Vest	Depth (m)
St 1	65°34.832	24°02.554	58
St 2	65°34.775	24°02.540	58
St 3	65°34.777	24°02.620	58
St 4	65°34.729	24°02.531	57
St 5	65°34.670	24°02.523	56
St 6	65°34.719	24°01.886	55
St 7	65°34.676	24°01.902	57
St 8	65°34.656	24°01.869	57
St 9	65°34.647	24°01.915	57
St 10	65°34.623	24°01.898	57
St 11	65°34.604	24°01.868	58
St 12	65°34.599	24°01.936	58
St 13	65°34.571	24°01.876	58
St 14	65°34.535	24°01.885	57
St 15	65°34.554	24°01.926	57

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 fifteen sampling stations. This indicates that in general there is soft bottom in the local impact zone. The sediment type consisted mainly of clay both in the eastern and western part of the local impact zone. For the group II parameters (pH/Eh), thirteen stations had conditions 1 «very good» and two stations had condition 3 «bad» (stations 8 and 11). For sensory parameters (group III) ten stations had condition 1 «very good», two stations had condition 2 «good», three stations had condition 3 «bad» and one stations had condition 4 «very bad». For combined parameters II and III (pH/redox and sensory) thirteen stations had status 1 «very good», one station had condition 3 «bad» (station 8) and one station had condition 4 «very bad» (station 11). Some gas bobbles were detected in the sample at station 11. Animals where not present at two station (nr. 8 and 11) out of the fifteen sampling stations. Redox value was negative at stations 8 and 11 but positive at other stations.

5 Conclusion

Based on the criteria given in NS 9410:2016 the fish farming site has been assigned an overall site condition 1 « very good» at the date of sampling. A total of 17 grabs were taken with Van Veen grab (0,025 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) thirteen stations had status 1 «very good», one station had condition 3 «bad» (station 8) and one station had condition 4 «very bad» (station 11). The two stations with bad and very bad conditions are located at the eastern part of the local impact zone and coherent with direction of the spread current at Kvígindisdalur.

This is a follow up study on a previous B survey done in November 2020 around the time of max biomass that indicated some organic load mainly in the eastern part of the local impact zone. The overall results from the current survey in February 2021 (about three months after the previous B survey November 2020) indicate some improvements in the environmental status at the site. The overall condition improves from being 2 «good» to 1 «very good». In the November 2020 survey for combined parameters II and III (pH/redox and sensory) two station had condition 3 «bad» and three stations had condition 4 «very bad» contra one stations in each category in the current survey.

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. 2019. Kvígindisdalur, Arctic Sea Farm. B-bottom pre-survey, May 2019. Akvaplan-niva AS report nr. 61207.01.

Gunnarsson, S. 2020. Kvígindisdalur, Arctic Sea Farm B-bottom survey, November 2020 (maximum biomass survey). Akvaplan-niva AS report nr. 62579.B02.

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:	10.02 2021
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	1	0	0
II	pH	value	7,8	7,8	7,9	7,7	7,8	7,5	7,6	6,9	7,6	7,7
	Eh (mV)	ORP	-45	10	53	-79	10	-151	-171	-318	-92	-10
		plus ref. verdi	155	210	253	121	210	49	29	-118	108	190
	pH/Eh	from figure	0	0	0	0	0	1	1	3	0	0
	Status station		1	1	1	1	1	1	1	3	1	1
			Buffer-temp	5,0 C		Sea temp	0,9 C		Sediment temp		NA C	
		pH sea 7,95	ORP sea	46,0 mV		Eh sea	246,0 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		0	0
		Brown/black (2)								2		
	Smell	None (0)		0	0		0	0				0
		Light (2)	2			2			2		2	
		Strong (4)								4		
	Consistency	Solid (0)	0	0	0	0	0				2	2
		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	1	1
		v > 3/4 (2)										
	Thickness of slidge (t)	t < 2 cm (0)	0	0	0	0	0	0	0		0	0
		2 < t < 8 cm (1)								2		
		t > 8 cm (2)										
		Sum	3,0	1,0	1,0	3,0	1,0	3,0	5,0	11,0	5,0	3,0
		Corrected (*0,22)	0,7	0,2	0,2	0,7	0,2	0,7	1,1	2,4	1,1	0,7
		Status station	1	1	1	1	1	1	2	3	2	1
		Average group II & III	0,3	0,1	0,1	0,3	0,1	0,8	1,1	2,7	0,6	0,3
		Status station	1	1	1	1	1	1	1	3	1	1

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

page 1 of 4 pages

Sample scheme B.1

Company:	Arctic Sea Farm	Date:	10.02 2021
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%	Index H%
	Bottom type: S (soft) or H (hard)		S	S	S	S	S						100	0
I	Animals > 1mm	Yes (0) No (1)	1	0	0	0	0							
II	pH	value	7,0	7,7	7,8	7,8	7,8							
	Eh (mV)	ORP	-253	-30	21	-53	-20							
		plus ref. verdi	-53	170	221	147	180							
	pH/Eh	from figure	3	0	0	0	0						0,53	
		Status station	3	1	1	1	1							
		Status group II	1	Buffer temp	5,0 C		Sea temp	0,9 C		Sediment temp	NA C			
		pH sea 7,95	ORP sea	46 mV		Eh sea	246 mV		Reference electrode		200 mV			
III	Gas bubbles	Yes (4) No (0)	4	0	0	0	0							
	Colour	Light/grey (0)		0	0	0	0							
		Brown/black (2)	2											
	Smell	None (0)			0		0							
		Light (2)		2		2								
		Strong (4)	4											
	Consistency	Solid (0)		0	0		0							
		Soft (2)	2			2								
		Aqueous (4)												
	Grab volume (v)	v < 1/4 (0)												
		1/4 < v < 3/4 (1)		1	1	1	1							
		v > 3/4 (2)	2											
	Thickness of slidge (t)	t < 2 cm (0)		0	0	0	0							
		2 < t < 8 cm (1)	1											
		t > 8 cm (2)												
		Sum	15,0	3,0	1,0	5,0	1,0							
		Corrected (*0,22)	3,3	0,7	0,2	1,1	0,2						0,89	
		Status station	4	1	1	2	1							
		Status group III	1											
		Average group II & III	3,2	0,3	0,1	0,6	0,1						0,71	
		Status station	4	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-22
pH / Eh ID	YSI-professional plus

Sample scheme B.2

Company:	**Arctic Sea Farm**	**Date:**	**10.02 2021**
Site:	**Kvígindisdalur**	**Site no.:**	**0**
Fieldworker:	**Snorri Gunnarsson**		

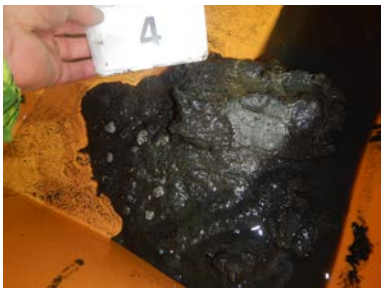
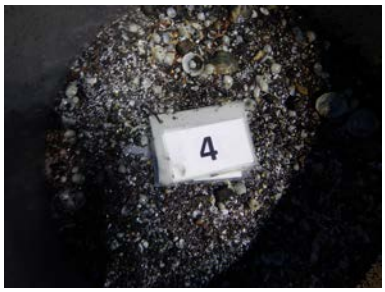
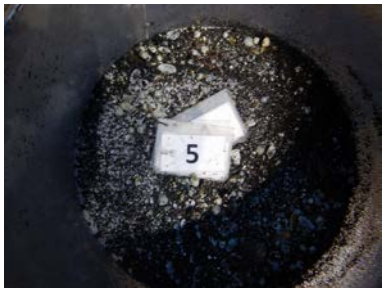
Sample number		1	2	3	4	5	6	7	8	9	10
Depth (m)		61	61	61	61	60	60	60	60	60	60
Number of trials		2	1	1	2	1	1	1	1	1	1
Gas bubbles (in sample)		No	No	No	No	No	No	No	No	No	No
Sediment type	**Clay**	X	X	X	X	X	X	X	X	X	X
	Silt										
	Sand	X									
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count											
Polychaetes, count		>50	>50	>50	>100	>50	>50	>100		>100	>50
Other animals, count											
Beggiatoa											
Feed											
Faeces								X			
Comments		Some dead algae (black) in some samples (1,4,6) and some dead shells (samples 3, 4 and 6)									
Grab		**Area [m^2]**		0,025		**Grab ID**			K-22		

Sample scheme B.2

Company:	**Arctic Sea Farm**		**Date:**	**10.02 2021**	
Site:	**Kvígindisdalur**		**Site no.:**	**0**	
Fieldworker:	**Snorri Gunnarsson**				

Sample number		11	12	13	14	15	16	17	18	19	20
Depth (m)		61	61	60	60	60					
Number of trials		1	1	1	1	1					
Gas bubbles (in sample)		Yes	No	No	No	No					
Sediment type	**Clay**	X	X	X	X	X					
	Silt										
	Sand				X						
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count											
Polychaetes, count			4	>50	>30	>50					
Other animals, count											
Beggiatoa											
Feed											
Faeces											
Comments		Some dead algae (black) in some samples (12,13 and 14)									
Grab		**Area [m^2]**		0,025		**Grab ID**			K-22		
Signature fieldworker:									page 4 of 4 pages		

7.2 Pictures of samples at Kvígindisdalur

St 1		
St 2		
St 3		
St 4		
St 5		

St 6	NA	
St 7		
St 8		NA
St 9		
St 10		

St 11		NA
St 12		
St 13		
St 14		
St 15		

7.3 Bottom topography and 3D view

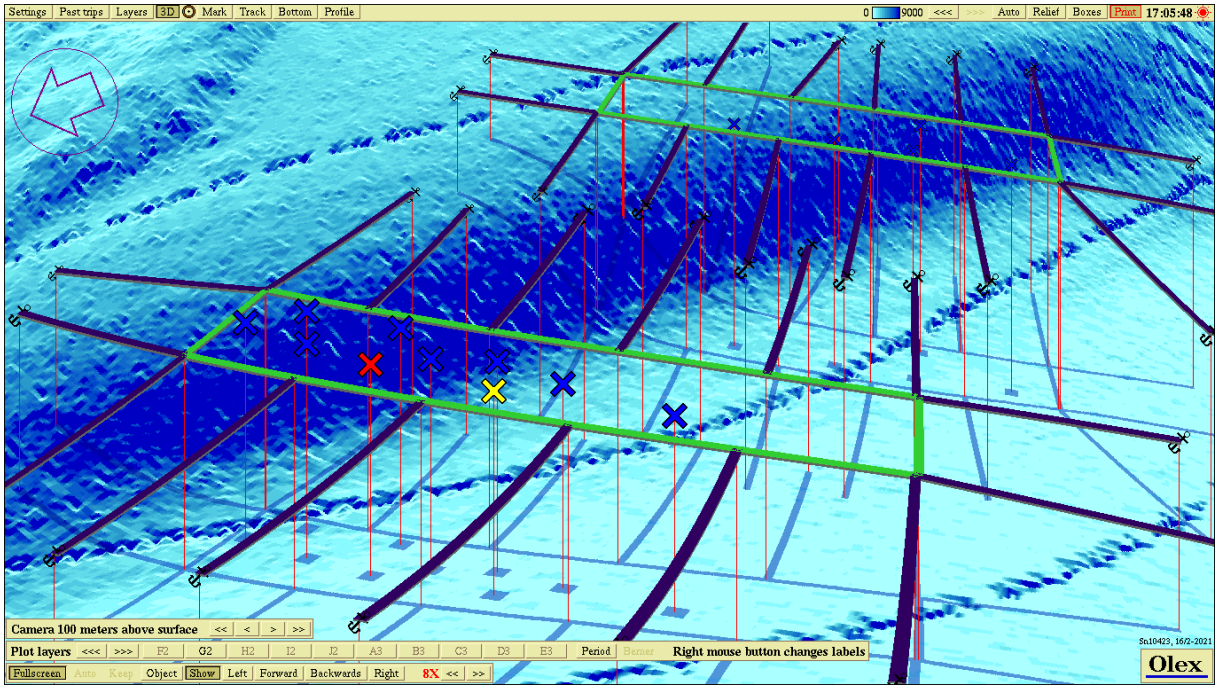


Figure 3. Showing bottom topography 3D at Kvígindisdalur with each sampling station according to info in figure 2 and Table 3.