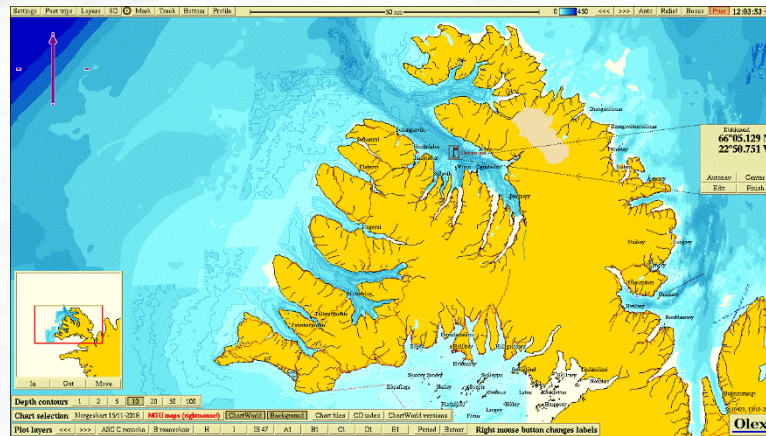


Kirkjusund, Arctic Sea Farm B-bottom survey, September 2021 (pre study)



Akvaplan-niva AS: APN 63466.B01

Information client			
Title	Kirkjusund, Arctic Sea Farm. B-bottom survey (pre study), September 2021		
Report number	APN-63466.B01		
Site name	Kirkjusund	Coordinates site	66°05,129N 022°50,751V
County	Ísafjarðarsýsla	Municipality	Ísafjarðarbær
MTB-or estimated max biomass	5.500 tonnes	Site manager/contact	Steinunn Guðný Einarsdóttir
Client name	Arctic Sea Farm		

Biomass/production/status at date of survey			
Biomass at date of survey	0 ton	Feed use	0
Fish type	Salmon	Amount produced	
Type/time of survey	Mark with X	Comments	
At maximal biomass see kap 7.9	<input type="checkbox"/>		
A follow up survey	<input type="checkbox"/>		
Half maximal biomass	<input type="checkbox"/>		
Survey prior to putting out smolt	<input type="checkbox"/>		
A pre-survey new site	<input checked="" type="checkbox"/>		
Other	<input type="checkbox"/>		
Last following period:			

Results from B-survey according to NS 9410:2016 (main results)			
Parameters and indexes		Parameters and site status	
Gr. II. pH/Eh	0,00	Gr. II. pH/Eh	1
Gr. III. Sensory	0,22	Gr. III. Sensory	1
GR. II + III	0,11	GR. II+ III	1
Date field work	04.08 2021	Date report	05.11.21
Site status (NS 9410:2016):			1



Report writing and project leader	Arnþór Guðstavsson	Signature	
Quality control	Snorri Gunnarsson	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 bottom survey in the local impact zone at fallow period as they are defined in NS9410:2016. Current survey is a pre-survey, undertaken before any operation or fish has been transferred to the site. As a pre-survey type B, a total of 10 sampling stations were sampled within the planned mooring lines of the fish farm. The estimated max biomass for the first generation of salmon, farmed at the Kirkjusund site, is 5.500 ton.

The following have participated in the survey:


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

The sampling at Kirkjusund was done 04.08 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.
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Akvaplan-niva AS thanks Arctic Sea Farm and their personnel for the cooperation during the conductance of this site survey.

Kópavogi 5. November 2021

Arnþór Gústavsson
Project manager

1 Introduction

The sampling date for the present site survey was 04.08 2021 and done by Akvaplan-niva AS contracted by Arctic Sea Farm in relation to the company's fish farming activity at the site Kirkjusund in Ísafjarðardjúp, Ísafjarðarbær 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 impact assessment of the site from any previous activity.

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

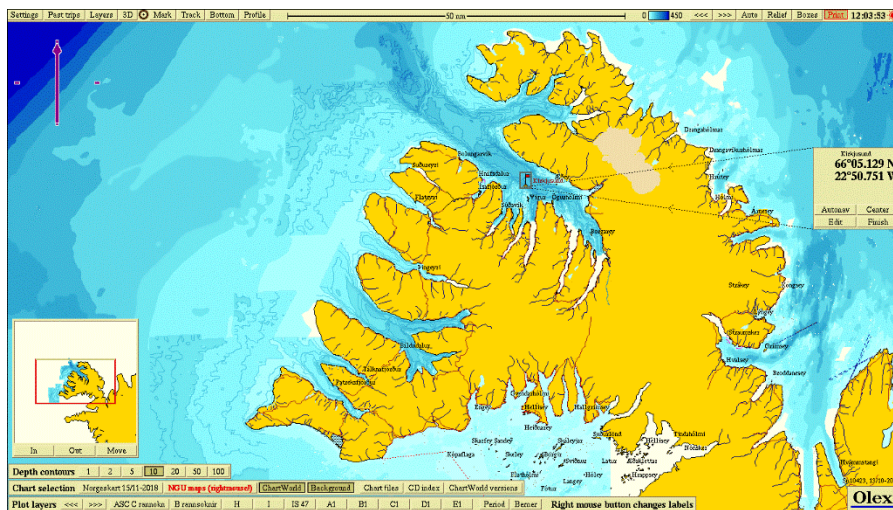


Figure 1. An overview map with the Kirkjusund site marked by its name with a flag.

2 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 proximity, to the fish farming site (local impact zone). Sediment is collected by use of grab (min 250 cm²). 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. Current survey is a pre-survey, undertaken before any operation or fish has been transferred to the site. As a pre-survey type B, a total of 10 sampling stations were sampled within the planned mooring lines of the fish farm.

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: <ul style="list-style-type: none"> - 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 m²)

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 Kirkjusund site is in Ísafjarðardjúp, approximately 1,3 nm off the northern tip of the island Vigur, at the center of Ísafjarðardjúp. Mooring and cages have not been installed. Plans include a 2 x 7 or a 7 + 7 installation, in northeast direction (030 - 60°). The depth underneath planned cages range from about 40 - 100 m.

As this is a pre-survey, no previous generation has been farmed the site. Production licenses will be issued for Kirkjusund along with 2 other sites in Ísafjarðardjúp. These three sites will be put in operation stepwise from 2022 – 2024, plans assume that first smolt transfer to Kirkjusund will be spring 2022.

3.2 Dispersing current

Measurement of dispersing current was done at the site in April – May 2021 measurements at 57 m depth (Gustavsson, 2021). Dominating current at 57 m is in direction south by south-east (125 degrees) with a small counter current in opposite direction (Figure 2). Average current speed is measured to be 6.5 cm/s. Highest current speed is measured to be 28.3 cm/s and 3.5 % of the measurements are < 1 cm/s.

3.3 Position of sampling stations

Position of the 10 stations in the survey is given in Figure 2 and Table 2. Positioning of the stations was chosen based on guidance and criteria described in NS 9410:2016 and spread around the periphery of the cages (as cage setup is planned). At the site the typical depth in the local impact zone is in the range from 40 – 100 m, with an increasing depth on northern part of the mooring frame. 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 87 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.

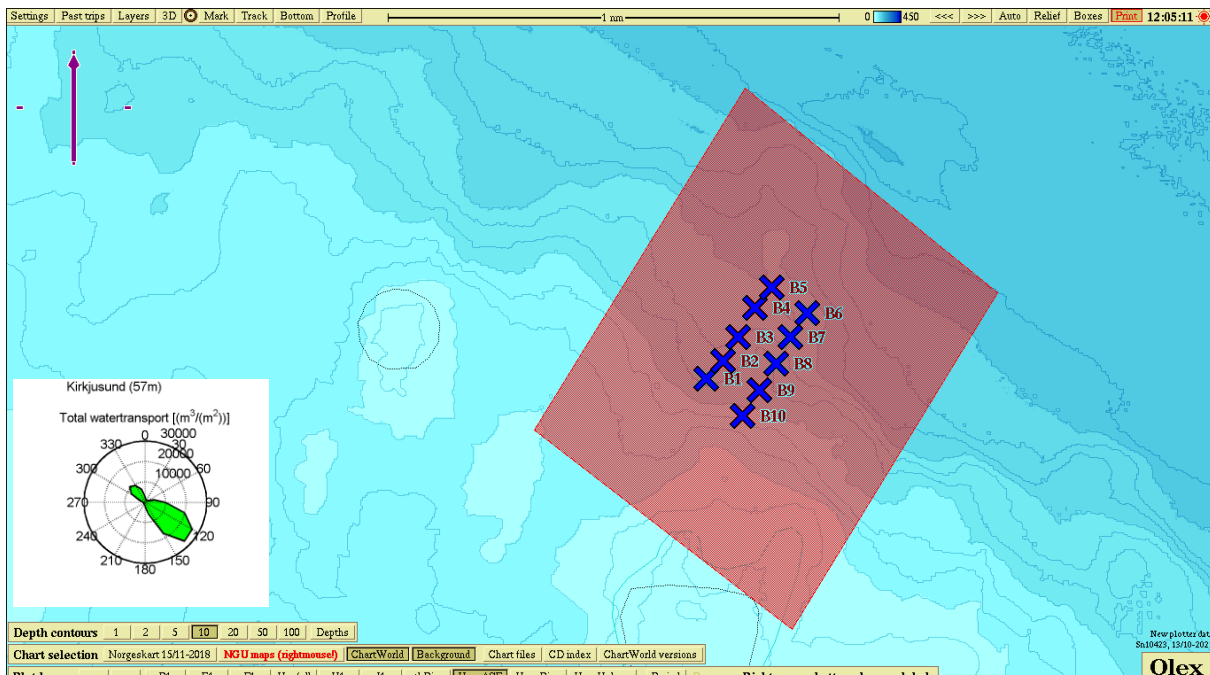


Figure 2. Chart showing Kirkjusund site. Sampling stations st. 1 – 10 are marked with color codes that describe the group II and III condition according to NS 9410:2016, chapter 7.11. Color codes: Blue = very good condition, green = good condition, yellow = bad condition, red = very bad condition.

Table 2. Placement and depth of the sampling stations in the B-survey.

Station number	North	West	Depth (m)
St 1	66°05,079	22°51,032	72
St 2	66°05,119	22°50,943	77
St 3	66°05,171	22°50,857	83
St 4	66°05,236	22°50,769	87
St 5	66°05,281	22°50,675	86
St 6	66°05,224	22°50,483	84
St 7	66°05,170	22°50,572	83
St 8	66°05,112	22°50,653	70
St 9	66°05,052	22°50,741	67
St 10	66°04,997	22°50,835	55

4 Results

Results for the different parameters are given in Table 3. 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 3. 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 ten sampling stations. This indicates that in general there is soft bottom in the local impact zone. The sediment type consisted mainly of clay, sand and gravel.

For the group II parameters (pH/Eh), all stations had conditions 1 «very good». For sensory parameters (group III) all ten stations had condition 1 «very good», see Table 1. For combined parameters II and III (pH/redox and sensory) all ten stations received status 1 «very good», see Figure 2. Animals were present in all the ten samples, polychaetes were most prominent, and molluscs were observed in most samples.

5 Conclusion

Current pre-survey is the first B survey for Kirkjusund site, carried out along with a C survey. Bottom type can be described as muddy mixed with shell-sand and gravel. Clay and shell-sand were prominent in all samples and gravel was present in most samples in different magnitude. Current pre-study indicated good condition of the site and overall site status of 1 and no obvious traces of organic load in the area. Redox potential was positive at all ten sampling stations

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 10 grabs were taken with Van Veen grab (0,1 m²), placed around the planned 14 cages at the Kirkjusund site.

For parameters II and III and II and III combined (pH/redox and sensory) all stations had status 1 «very good». Animals were present in all samples and no indications of substantial organic load at any of the sampling stations.

Results indicate good natural conditions of the site without impact from previous operations or outside pollutants.

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. 2021. Arctic Fish. Arnarnes, Sandeyri og Kirkjusund dreifistraumur. Dispersing current measurement. 49 meters depth.

Akvaplan-niva AS project nr. 63085.

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												
Site:		Kirkjusund												
Fieldworker:		AGU												
Date:		4.8.2021												
Site no.:														
Gr	Parameter	Point	Sample number										Index	
			1	2	3	4	5	6	7	8	9	10	S%	H%
	Bottom type: S (soft) or H (hard)		S	S	S	S	S	S	S	S	S	S	100	0
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0	0	0	0	0		
II	pH	value	7,8	7,8	7,7	7,8	7,8	7,6	7,7	7,5	7,7	7,8		
	Eh (mV)	ORP	72	87	85	64	83	88	91	53	82	78		
		plus ref. value	272	287	285	264	283	288	291	253	282	278		
	pH/Eh	from figure	0	0	0	0	0	0	0	0	0	0	0,00	
Status station			1	1	1	1	1	1	1	1	1	1		
Status group II			1	Buffer temp	C		Sea temp	C		Sediment temp	C			
pH sea			ORP sea			mV		Eh sea		mV		Reference electrode		200 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	0		
		Brown/black (2)												
	Smell	None (0)	0	0	0	0	0	0	0	0	0	0		
		Light (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		0				
1/4 < v < 3/4 (1)		1	1			1		1		1	1			
v > 3/4 (2)				2	2									
Thickness of sludge (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			1,0	1,0	2,0	2,0	1,0	0,0	1,0	0,0	1,0	1,0		
Corrected (*0,22)			0,2	0,2	0,4	0,4	0,2	0,0	0,2	0,0	0,2	0,2	0,22	
Status station			1	1	1	1	1	1	1	1	1	1		
Status group III			1											
Average group II & III			0,1	0,1	0,2	0,2	0,1	0,0	0,1	0,0	0,1	0,1	0,11	
Status station			1	1	1	1	1	1	1	1	1	1		
Status group II & III			1											
pH/Eh		Status												
Corr.sum														
Index														
Average														
< 1,1		1												
1,1 - <2,1		2												
2,1 - <3,1		3												
≥3,1		4												
Status site:												1		
Grabb ID	K-3													
pH / Eh ID	YSi professional plus													

Sample Scheme B.2











Company:	Arctic Sea Farm
Site:	Kirkjusund
Fieldworker:	AGU

Date:	4.8.2021
Site no.:	0

Sample number	1	2	3	4	5	6	7	8	9	10
Depth (m)	72	77	83	87	86	84	83	70	67	55
Number of trials	2	2	2	1	1	2	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
	Silt				X	X				
	Sand						X	X	X	
	Gravel	X	X	X		X	X	X	X	X
	Shellsand	X	X	X	X	X	X	X	X	X
Reef										
Rocky bottom (cobble, boulders)										
Echinodermata, count								3		
Crustaceans, count								1		
Molluscs, count		2	1	1	3	1	4		1	
Polychaetes, count	20+	20+	30+	40+	30+	40+	30+	10	20+	20+
Other animals, count										
<i>Beggiatoa</i>										
Feed										
Faeces										
Comments										
Grab	Area [m ²]							Grab ID	K-3	
Signature fieldworker:										

7.2 Pictures of samples at Kirkjusund

<i>St 1</i>	 A photograph showing a sample of dark, muddy sediment in an orange bucket. A white label with the number '1' is placed next to the sediment.	 A photograph showing the sample from St 1 after being filtered through a sieve. The residue is a mixture of dark sediment and small, light-colored particles. A white label with the number '1' is placed in the center.
<i>St 2</i>	 A photograph showing a sample of dark, muddy sediment in an orange bucket. A white label with the number '2' is placed next to the sediment.	 A photograph showing the sample from St 2 after being filtered through a sieve. The residue is a mixture of dark sediment and small, light-colored particles. A white label with the number '2' is placed in the center.
<i>St 3</i>	 A photograph showing a sample of dark, muddy sediment in an orange bucket. A white label with the number '3' is placed next to the sediment.	 A photograph showing the sample from St 3 after being filtered through a sieve. The residue is a mixture of dark sediment and small, light-colored particles. A white label with the number '3' is placed in the center.
<i>St 4</i>	 A photograph showing a sample of dark, muddy sediment in an orange bucket. A white label with the number '4' is placed next to the sediment.	 A photograph showing the sample from St 4 after being filtered through a sieve. The residue is a mixture of dark sediment and small, light-colored particles. A white label with the number '4' is placed in the center.
<i>St 5</i>	 A photograph showing a sample of dark, muddy sediment in an orange bucket. A white label with the number '5' is placed next to the sediment.	 A photograph showing the sample from St 5 after being filtered through a sieve. The residue is a mixture of dark sediment and small, light-colored particles. A white label with the number '5' is placed in the center.

<p><i>St 6</i></p>		
<p><i>St 7</i></p>		
<p><i>St 8</i></p>		
<p><i>St 9</i></p>		
<p><i>St 10</i></p>		

7.3 Bottom topography and 3D view

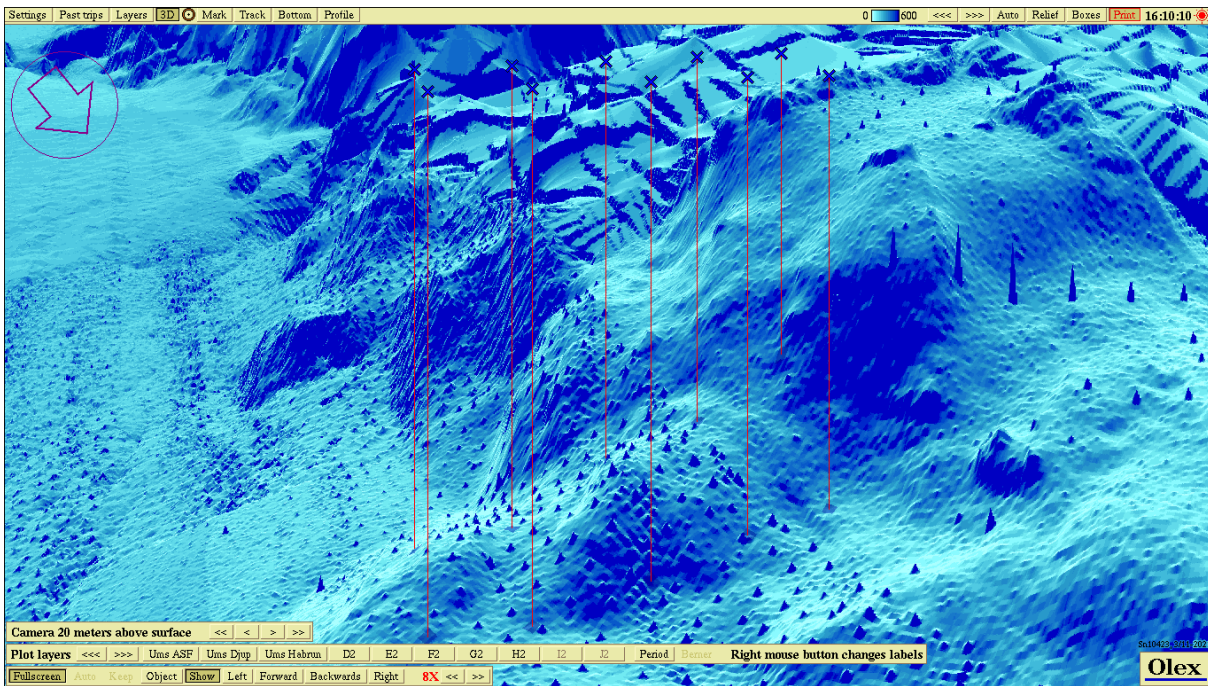


Figure 3. Showing bottom topography 3D at Kirkjusund with each sampling station according to info in Figure 1 and Table 2.