

# B-survey at Kvígingisdalur, May 2024 (fallow period), Arctic Sea Farm ehf

**Akvaplan-niva AS Report:**  
**APN 65930.B01**



# B survey at Kvíndisdalur May 2024 (fallow period), Arctic Sea Farm ehf

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## Summary

Sediment was recovered at all 18 stations (100% soft bottom). The sediments consisted primarily of clay in the deeper areas but mixture of clay and silt or sand in the shallower parts. Fauna was recorded to be present at all stations mainly in the form of polychaetes. No smell of H<sub>2</sub>S was recorded at any of the sampling stations and no signs of out-gassing. The substrate was light/grey colour at all stations. No signs of faeces, feeds or the bacteria *Beggiatoa*.

Based on the classification of sediment chemistry (pH/Eh) and the sensory assessment all eighteen stations received status 1 - "Very good". Overall, the index score for parameter III (sensory parameters) was higher than the index score for the parameter II (pH/Eh), or 0,37 for parameter III but 0,00 for parameter II.

In summary, the site receives the environmental status 1 - "Very good" (average group II-III index =0.18).

## Approval

  
Project Manager

  
Quality Control

## Key information

Site details and license holder information			
Site name	Kvígindisdalur	Site coordinates	65°34.665' N 24°02.222' V
County	Vesturbyggð	Municipality	Patreksfjörður
MTB (Maximum estimated biomass next generation)	6.137 tonnes	Operations Manager / Contact	Guðmundur Ólafsson
License holder / customer	Arctic Sea Farm		

Production status on date of survey			
Biomass at site	0 tonnes	Total feed use	0 tonnes
Farmed species	Salmon	Total biomass produced	0 tonnes
Type/time of survey	Indicated with X	Comments	
Maximum organic load cf. chapter 7.9	<input type="checkbox"/>		
Follow-up survey	<input type="checkbox"/>		
Half maximum load	<input type="checkbox"/>		
Pre-stock	<input checked="" type="checkbox"/>		
Required by the state administrator - baseline survey	<input type="checkbox"/>		
Other	<input type="checkbox"/>		
Last fallowing period:	17.09 2023 - present		

Results from B-survey in accordance with NS 9410:2016 (main results)			
Parameter group and index		Parameter group and status	
Gr. II. pH/Eh	0.00	Gr. II. pH/Eh	1
Gr. III. Sensory	0.37	Gr. III. Sensory	1
GR. II + III	0.18	GR. II+ III	1
Date of fieldwork	30.05 2024	Date of report	24.06 2024
Environmental status (NS 9410:2016):			<b>1</b>

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# 1 Introduction

The present survey was conducted by Akvaplan-niva AS on behalf of Arctic Sea Farm in connection with the company's fish farming activities at the site Kvígindisdalur in Patreksfjörður municipality in Vesturbyggð county.

The purpose of a B-survey is to document the environmental status in the near zone of a fish farm by evaluating sediment condition (chemistry, sensory and presence/absence of fauna) in accordance with NS 9410:2016.

The B-survey is a tool for trend monitoring and allows to assess the status of organic enrichment beneath the net pens at different stages of the production cycle.

Figure 1 shows a map of the fjord Patreksfjörður where Kvígindisdalur is located.

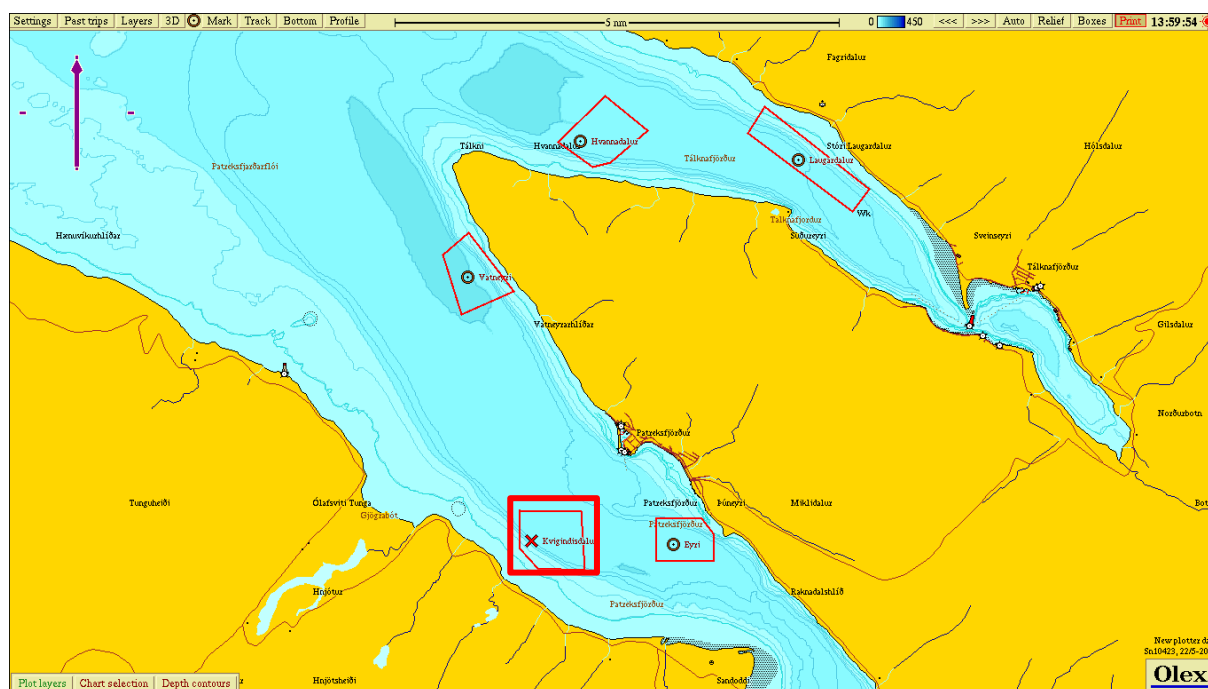


Figure 1. Overview map of Patreksfjörður with Kvígindisdalur marked by red square and an X. Other aquaculture sites are marked with locality name.



## 2 Methods

Monitoring of the environmental impact of fish farming activities on the seabed is standardised and regulated. All fish farming sites that are in use must 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) under and in the immediate vicinity of an aquaculture site. Sediment samples are taken using a grab (min. 250 cm<sup>2</sup>). Sediment condition for each sample is assessed applying three indicators: sediment chemistry (pH and redox potential), sensory evaluation (gas bubbles; smell, texture, colour of substrate and thickness of deposited sludge) and the presence or absence of fauna. The performance of these indicators against predefined thresholds allows to categorise the site into four different environmental statuses (Table 1), which are used to determine subsequent sampling frequency. The number of sampling stations is based on the site's allocated MTB (here the estimated max biomass next generation at the site).

Table 1. Frequency of B-survey based on environmental status at site.

Environmental status at maximum organic load (near zone)	Monitoring frequency for B survey
1-very good	At the next maximum load
2-good	Pre-stock and again at maximum load
3-poor	Pre-stock If the survey prior to restocking / end of following provides: Status 1 – survey should be carried out at next maximum load. Status 2 – survey should be carried out at half the maximum load and at the next maximum load. Status 3 – survey should be carried out at half the maximum load and at maximum load. Implementation of measures to reduce impact should be planned for the next production cycle. If any surveys show the environmental status to be 4 – "very poor", the site's environmental capacity has been exceeded.
4- very poor	Environmental capacity at site is exceeded. The authorities decide further measures.

The following equipment was used in this survey:

Grab: Van Veen grab (0.1 m<sup>2</sup>)

Sieve 1 mm: Akvaplan-niva

pH meter: Electrode, YSI Professional Plus

Redox meter: Electrode, YSI Professional Plus

Position determination – GPS map 62s

Digital camera

## 3 Site, production and survey design

### 3.1 Site characteristics and production

The Kvígindisdalur site is located in fjord Patreksfjörður about 2 km west from the nearest town Patreksfjörður. The cages are lined in a northern direction from land (354 degrees). The depth under cages ranges from about 33-58 m. The fish farm at the site is a two-frame mooring system, each frame having 5 cages total 10 cages each with 200 m circumference. During the last production cycle all 10 cages were used.

There have been farmed two generations farmed salmon at the site. The last generation started with smolt output fall 2021 and finished slaughter on the 17<sup>th</sup> of September.

Table 2 shows production and feed use for the two previous generations.

Table 2. Production and feed use for farm site Kvígindisdalur. Data provided by customer.

Generation of fish (G)	Production (tonnes)	Feed use (tonnes)
Preceding generation (2021-2023)	4.978 tonnes	6.880 tonnes
Preceding generation (2019-2021)	6.556 tonnes	7.953 tonnes

### 3.2 Current and past surveys

Table 3 provides an overview on results and time of sampling for the last B-surveys at site.

Table 3. Present and previously conducted B-surveys at the site.

Date of sampling	Report number	Production status	Location condition
30.05 2024	APN-65930.B01	B survey fallow period	1
21.06 2023	APN-65058.B01	B survey max biomass	2
02.09 2021	APN-63430.B02	B survey fallow period	1
10.02.2021	APN-62868.B01	B survey follow up survey after max biomass	1
10.11.2020	APN-62579.B02	B survey max biomass	2
03.05.2019	APN-61207.B01	B pre survey	1

### 3.3 Hydrodynamic conditions

Measurement of dispersing current was done at the site in 24th of September-30th of October 2020 measurements at 51 m depth (Holen, 2022). Dominating current 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 Survey design

Sampling stations were placed following an assessment of site configuration and local environmental conditions, i.e. bathymetry and hydrodynamics. An overview of sampling stations can be found in Figure 2 with coordinates and depth provided in Table 4. Sampling stations were placed to represent the varied environmental conditions within the near zone and cover thus both the deeper and shallower areas. Samples were collected from depths ranging from 58 metres (St 8, 9, 17, 18), the deepest, to 50 metres (St 11), as the shallowest. The client has stated that all cages at

the site were used during last production cycle (pers. Comm Ísak Óskarsson). The station placement is considered representative for an environmental survey of the farm's near-zone and in accordance with the requirements outlined in NS 9410:2016.

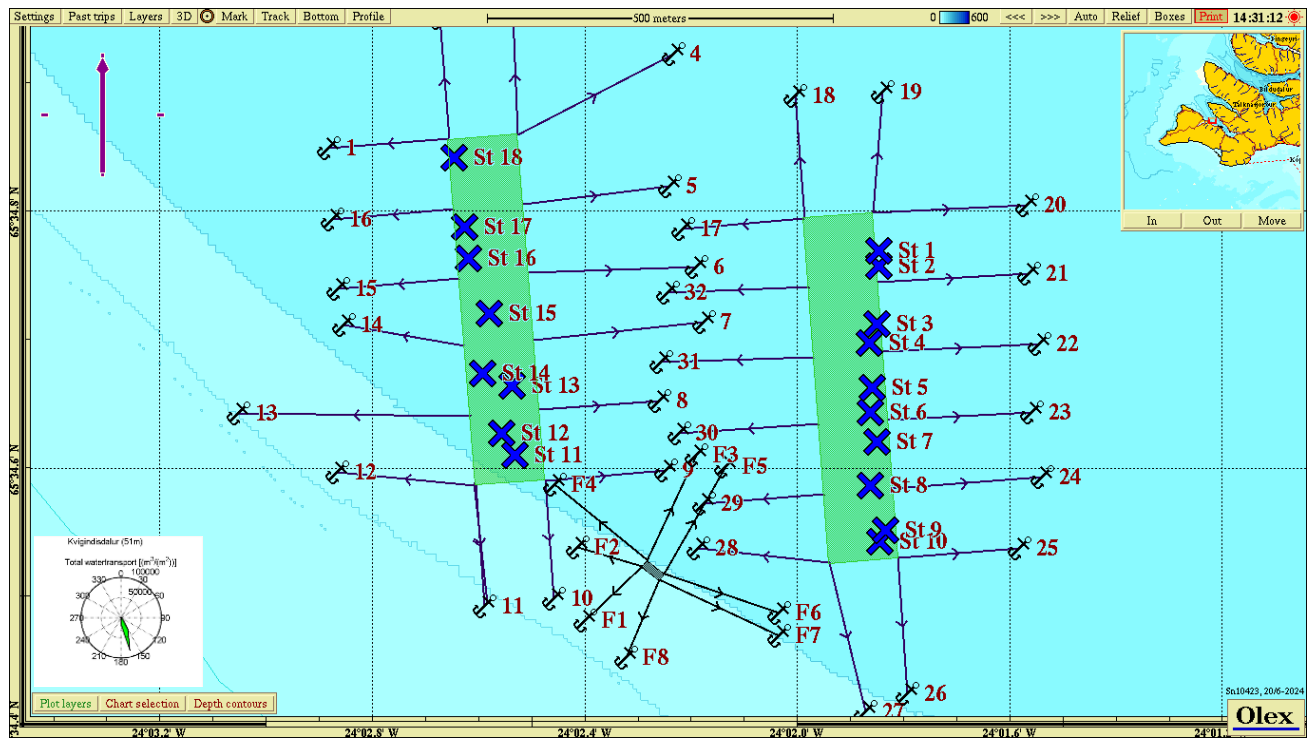


Figure 2. Overview map showing site configuration and local bathymetry at Kvígindisdalur. Sampling stations are marked by crosses and colour coded to visualise the environmental status at the respective station following the classification outlined in NS 9410:2016, chapter 7.11 (1 = blue, 2 = green, 3 = yellow, 4 = red). The current rose in the left corner shows the direction of water transport at dispersal depths at the site (Holen, 2022).



Table 4. Position and depth of the sampling stations of this survey.

Station number	Northing	Westing	Depth [m]
St 1	65°34,769	24°01,846	55
St 2	65°34,757	24°01,846	55
St 3	65°34,712	24°01,851	55
St 4	65°34,637	24°01,865	56
St 5	65°34,662	24°01,859	56
St 6	65°34,643	24°01,863	57
St 7	65°34,620	24°01,850	57
St 8	65°34,536	24°01,662	58
St 9	65°34,551	24°01,834	58
St 10	65°34,542	24°01,845	57
St 11	65°34,610	24°02,531	50
St 12	65°34,627	24°02,577	52
St 13	65°34,664	24°02,537	56
St 14	65°34,679	24°02,593	55
St 15	65°34,720	24°02,580	57
St 16	65°34,763	24°02,620	57
St 17	65°34,787	24°02,626	58
St 18	65°34,841	24°02,646	58

## 4 Results

Classified survey results for the different parameter categories as well as the assigned environmental status of the site are shown in Table 5. The complete survey assessment form with results and classifications for each station can be found in the attachment.

Table 5. Results from the environmental assessment of the near zone of Kvígindisdalur.

Parameter	Status
Group II parameters (pH/Eh)	1
Group III parameters (sensory)	1
Group II + III – parameters (mean)	1
Environmental status (site)	1

Sediment was recovered at all 18 stations (100% soft bottom). The sediments consisted primarily of clay in the deeper areas but mixture of clay and silt or sand in the shallower parts. Fauna was recorded to be present at all stations mainly in the form of polychaetes. No smell of H<sub>2</sub>S was recorded at any of the sampling stations and no signs of out-gassing. The substrate was light/grey colour at all stations. No signs of faeces, feeds or the bacteria *Beggiatoa*.

Based on the classification of sediment chemistry (pH/Eh) and the sensory assessment all eighteen stations received status 1 - "Very good". Overall, the index score for parameter III (sensory parameters) was higher than the index score for the parameter II (pH/Eh), or 0,37 for parameter III but 0,00 for parameter II.

In summary, the site receives the environmental status 1 - "Very good" (average group II-III index =0.18).

## 5 Summary

Applying the indicator thresholds and classification outlined in NS 9410:2016 it is shown that the site Kvígindisdalur receives an environmental status of 1 – Very good at the time of this B survey (fallow period). Samples were collected with a Van Veen grab at 18 stations distributed around the 10 cages in use during the last production cycle. Sediment was successfully collected at all 18 stations, and they all received status 1 – Very good

The survey presented here was undertaken at fallow period and the results indicate relatively little organically enriched conditions in the whole of the near zone.

Previous B surveys carried out close to feeding peak gave the site an environmental status of 2 - Good (Gunnarsson, 2023). In the 2023 survey there were three stations with status 4 – Very bad, four station with status 3 – Bad and three stations with status 2 – Good. The environmental conditions have therefore improved significantly during the fallow period as the current survey results are better than those recorded during the previous B survey with all stations having status 1 – Very good.

**The site is given environmental status 1 - Very good. In accordance with the frequency of B-surveys specified in NS 9410:2016, the site shall have a new survey at the next maximum load.**

## 6 References

Forskrift om drift av akvakulturanlegg (akvakulturdriftsforskriften) §§ 35 og 36.

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

Gunnarsson, S. 2021a. Kvíindisdalur, Arctic Sea Farm. B-bottom survey, November 2020 (max biomass survey). Akvaplan-niva AS report nr. 62579.B02.

Gunnarsson, S. 2021b. Kvíindisdalur, Arctic Sea Farm. B-bottom survey, February 2021 (a follow up survey). Akvaplan-niva AS report nr. 62868.B01.

Gunnarsson, S. 2022. Kvíindisdalur, Arctic Sea Farm. B-bottom survey, September 2021 (fallow period). Akvaplan-niva AS report nr. 63430.B02.

Gunnarsson, S. 2023. Kvíindisdalur, Arctic Sea Farm. B survey, June 2023 (max biomass). Akvaplan-niva AS report nr. 65058.B01.

Holen, V. 2022. Current measurement at Kvíindisdalur. Akvaplan-niva AS report nr. 62459.03

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.

Personal reference. Ísak Óskarsson, Station manager Arctic Sea Farm. 2023

# 7 Attachments

## 7.1 Form (B.1 and B.2) NS 9410:2016

<b>Sample scheme B.1</b>											
Company	Arctic Sea Farm					Date:	30.05 2024				
Site:	Kvígindisdalur (fallow period)					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	7.65	7.56	7.70	7.63	7.45	7.65	7.48	7.76	7.63	7.68				
	Eh (mV)	ORP	63	60	21	-2	10	43	58	23	5	-75				
		plus ref. verdi	263	260	221	198	210	243	258	223	205	125				
	pH/Eh	from figure	0	0	0	0	0	0	0	0	0	0				
	<b>Status station</b>			1	1	1	1	1	1	1	1	1				
	Buffer-temp			21.0 C				Sea temp		6.1 C		Sediment temp		4.6 C		
	pH sea			8.00		ORP sea		177.0 mV		Eh sea		377.0 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	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	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	2	2	2	2	2				
Thickness of sludge (t)	t < 2 cm (0)	0	0	0	0	0	0	0	0	0	0	0				
	2 < t < 8 cm (1)															
	t > 8 cm (2)															
Sum			2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0				
Corrected (*0.22)			0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4				
<b>Status station</b>			1	1	1	1	1	1	1	1	1	1				
<b>Average group II &amp; III</b>			0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2				
<b>Status station</b>			1	1	1	1	1	1	1	1	1	1				

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

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# Sample scheme B.1

Company:	Arctic Sea Farm
Site:	Kvígindisdalur (fallow period)
Fieldworker:	Snorri Gunnarsson

Date:	30.05 2024
Site no.:	0

Gr	Parameter	Point	Sample number										Index		
			11	12	13	14	15	16	17	18	19	20	S%	H%	
	Bottom type: S (soft) or H (hard)		S	S	S	S	S	S	S	S	S			100	0
I	Animals > 1mm	Yes (0) No (1)	0	1	0	0	0	0	0	0	0				
II	pH	value	7.72	7.62	7.51	7.54	7.53	7.51	7.61	7.52					
	Eh (mV)	ORP	23	40	48	25	15	35	34	43					
		plus ref. verdi	223	240	248	225	215	235	234	243					
	pH/Eh	from figure	0	0	0	0	0	0	0	0				0.00	
	Status station			1	1	1	1	1	1	1	1				
	Status group II			1	Buffer temp	21.0 C		Sea temp	6.1 C		Sediment temp	4.6 C			
	pH sea	8.00	ORP sea	177 mV		Eh sea	377 mV		Reference electrode	200 mV					
	Gas bubbles	Yes (4) No (0)	0	0	0	0	0	0	0	0					
	Colour	Light/grey (0)	0	0	0	0	0	0	0	0					
		Brown/black (2)													
Smell	None (0)	0	0	0	0	0	0	0	0						
	Light (2)														
	Strong (4)														
Consistency	Solid (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									
	v > 3/4 (2)						2	2	2						
Thickness of sludge (t)	t < 2 cm (0)	0	0	0	0	0	0	0	0						
	2 < t < 8 cm (1)														
	t > 8 cm (2)														
Sum			0.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0					
Corrected (*0,22)			0.0	0.2	0.2	0.2	0.2	0.4	0.4	0.4				0.37	
Status station			1	1	1	1	1	1	1	1					
Status group III			1												
Average group II & III			0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2				0.18	
Status station			1	1	1	1	1	1	1	1					
Status group II & III			1												
pH/Eh															
Corr.sum															
Index															
Average															
< 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
Site:	Kvígindisdalur (fallow period)
Fieldworker:	Snorri Gunnarsson


Date:	30.05 2024
Site no.:	0

Sample number	1	2	3	4	5	6	7	8	9	10
Depth (m)	55	55	55	56	56	57	57	58	58	57
Number of trials	1	1	1	1	1	3	1	1	2	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									
	Sand									
	Gravel									
	Shellsand									
Reef										
Rocky bottom (cobbles, boulders)										
Echinodermata, count										
Crustaceans, count										
Molluscs, count							2			
Polychaetes, count	>10	>20	>20	>30	>10	>50	5	>10	>10	>20
Beggiatoa										
Feed										
Faeces										
Comments	St 1-7: Mud. St 8 - 10: Mud and some black algae.									
Grab	Area [m <sup>2</sup> ]	0.1			Grab ID	K-3				
	page 3 of 4 pages									



## Sample scheme B.2










Company:	Arctic Sea Farm
Site:	Kvígindisdalur (fallow period)
Fieldworker:	Snorri Gunnarsson

Date:	30.05 2024
Site no.:	0

Sample number	11	12	13	14	15	16	17	18	19	20
Depth (m)	50	52	56	55	57	57	58	58		
Number of trials	1	1	1	1	1	1	1	1		
Gas bubbles (in sample)	No	No	No	No	No	No	No	No		
Sediment type	Clay			X	X	X	X	X		
	Silt			X	X	X				
	Sand	X	X							
	Gravel									
	Shellsand									
Reef										
Rocky bottom (cobbles, boulders)										
Echinodermata, count					2					
Crustaceans, count										
Molluscs, count	1					1				
Polychaetes, count	3		>10	>10	>10	5	>20	>10		
Other animals, count										
Beggiatoa										
Feed										
Faeces										
Comments	St. 11-12: Sand. St. 13. Silt and some black algae. St 14 - 15. Silt and mud and some black algae. St 16 - 18. Mud and some black algae.									
Grab	Area [m <sup>2</sup> ]	0.1				Grab ID	K-3			
Signature fieldworker:										page 4 of 4 pages

## 7.2 Images of samples at Kvígingisdalur

<i>St</i>	<i>Image before sieving</i>	<i>Image after sieving</i>
<i>St 1</i>		
<i>St 2</i>		
<i>St 3</i>		
<i>St 4</i>		
<i>St 5</i>		

<b>St 6</b>		
<b>St 7</b>		
<b>St 8</b>		
<b>St 9</b>	NA	
<b>St 10</b>		



<p><i>St 11</i></p>		
<p><i>St 12</i></p>		
<p><i>St 13</i></p>		
<p><i>St 14</i></p>		
<p><i>St 15</i></p>		

St 16		
St 17		
St 18		

### 7.3 3D-bathymetry

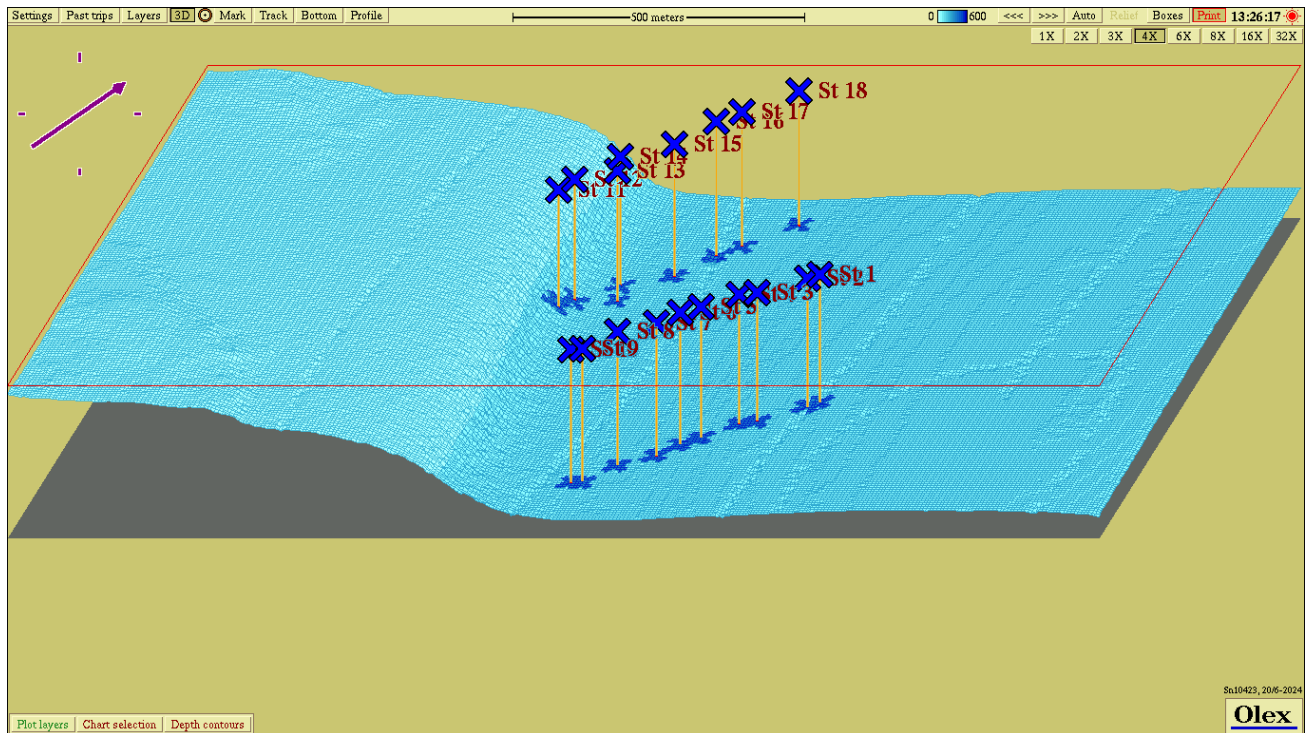


Figure 3. 3D-view of bathymetry at Kvígindisdalur with stations as shown in Figure 2 and Table 4.