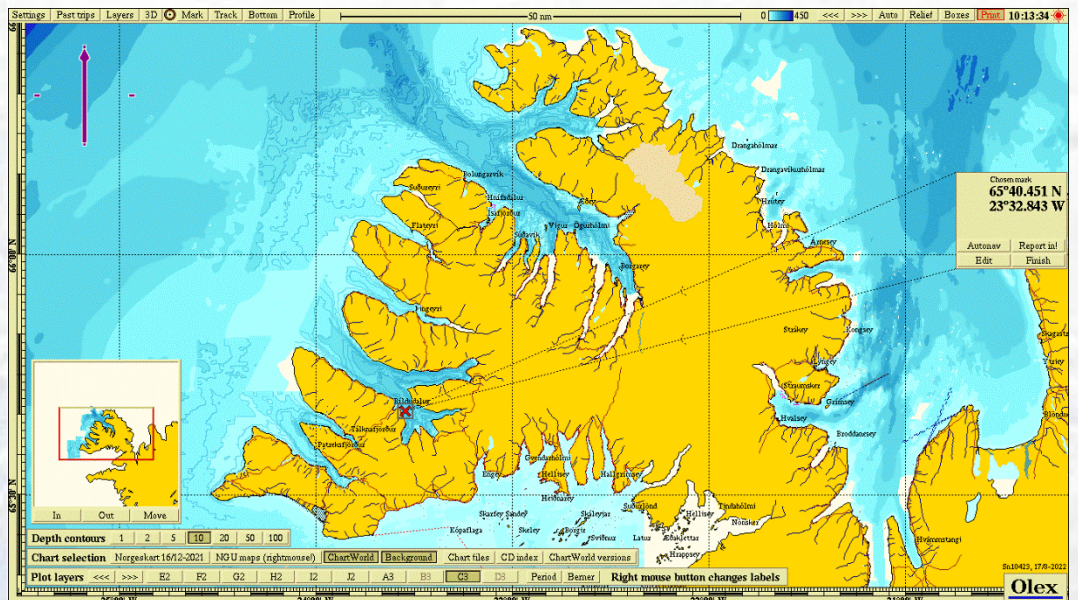


Haganes, Arnarlax
B survey,
June 2022
(max biomass)



Information client			
Title	Haganes, Arnarlax. B survey (max biomass, June 2022)		
Report number	APN-64106.B01		
Site name	Haganes	Coordinates site	65°40,451N 023°32,843V
County	Vesturbyggð	Municipality	Vesturbyggð
MTB-or estimated max biomass	3.866 tonnes	Site manager/contact	Silja Baldvinsdóttir
Client name	Arnarlax		

Biomass/production/status at date of survey			
Biomass at date of survey	3.866 t	Feed use	4.824 t
Fish type	Salmon	Amount produced	3.910 t
Type/time of survey	Mark with X	Comments The farm has been expanded and moved since the farming previous generations.	
At maximal biomass see kap 7.9	<input checked="" 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 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	0,83	Gr. II. pH/Eh	1
Gr. III. Sensory	0,85	Gr. III. Sensory	1
GR. II + III	0,78	GR. II+ III	1
Date fieldwork	21.06 2022	Date report	11.10.22
Site status (NS 9410:2016):			1



Report writing and project leader	Snorri Gunnarsson	Signature	
Quality control	Steinar D Eriksen	Signature	

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Preface

The survey is carried out in accordance to the Norwegian standard NS 9410:2016 - "Environmental monitoring of benthic impact from marine fish farms". Impact assessment is based on sediment condition (chemistry, sensory & presence/absence of fauna). The environmental survey is regulated by § 35 in the Norwegian "akvakulturdriftsforskriften". The survey also fulfills the requirements regarding seabed surveys outlined in the standard ISO 12878.

The primary objective of a B-survey is to assess the benthic impact beneath and in the close vicinity (near zone) of a marine fish farm by applying methods, thresholds and classifications as defined in NS9410:2016. The current survey was undertaken during the period at max biomass for current generation farmed fish. Prior to putting out current generation at the site the farm was expanded and moved within the defined farming area. Sampling stations in this survey are placed within the near zone of the current farm location. Haganes has an estimated max biomass of 3.866 t and thus a total of 14 stations were sampled.

The following have participated in the survey:


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

The sampling at Haganes was done 21.06 2022.

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. Thresholds and classifications of assessment criteria applied in this report are based on Norwegian environmental conditions as Iceland specific criteria have yet not been developed. This should be taken into consideration when reviewing site status.

	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 Arnarlax and their personnel for the cooperation during the conductance of this site survey.

Kópavogi 11. October 2022

Snorri Gunnarsson
Project manager

1 Introduction

Sampling was undertaken on 21.06 2022 by Akvaplan-niva AS, who has been contracted by Arnarlax in relation to the company's fish farming activity at the site Haganes in Arnarfjörður, Vesturbyggð municipality.

The objective of the B-survey is to document the environmental condition in the near zone of a fish farm by evaluating sediment condition (chemistry, sensory & presence/absence of fauna) as defined in NS 9410:2016 (and ISO 12878). The B-survey is a tool for trend monitoring and allows to assess the status of organic enrichment beneath the net pens at various stages of the production cycle.

The here presented survey was undertaken at the time of max biomass of current production cycle. Prior to putting out current generation fish at the site the farm was expanded and moved to a new position within the defined farming area. Sampling stations in this survey are placed within the near zone of the current farm location. Haganes has an estimated max. biomass of 3.866 t and thus a total of 14 stations were sampled.

Figure 1 shows a map of the southern part of Vestfirðir where Haganes is located in the fjord Arnarfjörður.

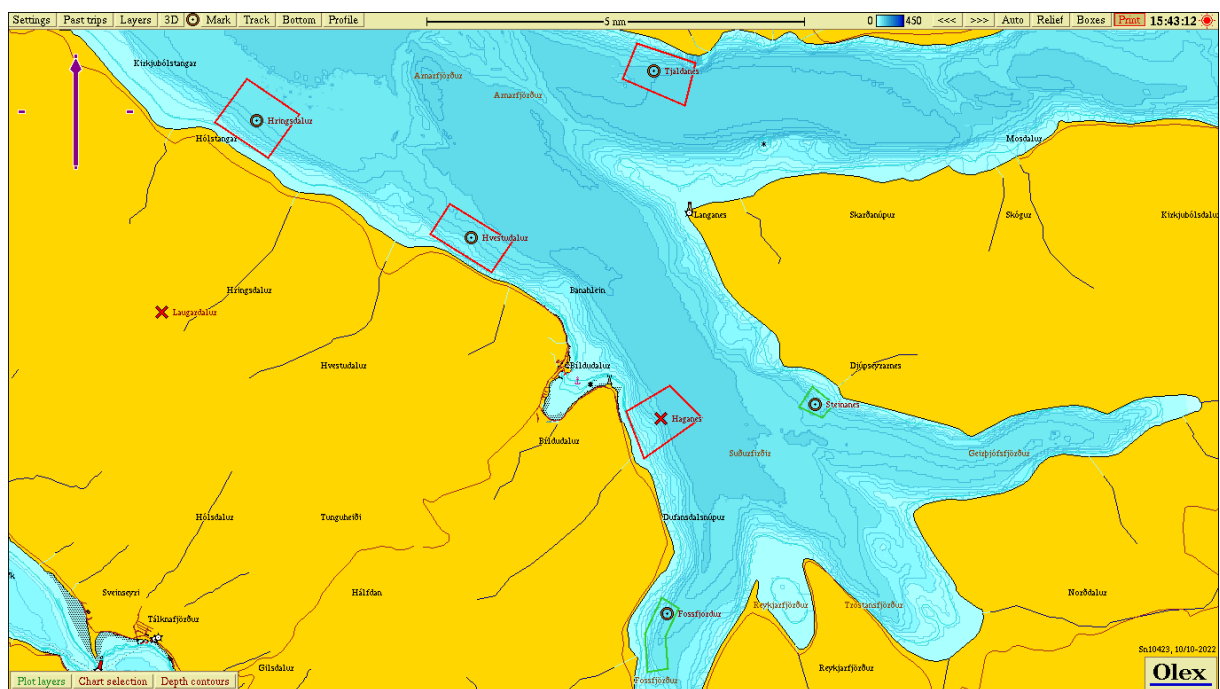


Figure 1. An overview map where Haganes is marked with a red cross. Other fish farming areas in the nearest vicinity (Arnarfjörður) are also shown.

2 Methods

Monitoring of the environmental impact of fish farming activities on the seabed is standardised and regulated. All fish farming sites in the sea are to be regularly assessed. Environmental monitoring in Iceland is following 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) beneath and in the close vicinity of the fish cages (near zone). Sediment is collected using a grab (min 250 cm²). Sediment condition for each sample is assessed using three indicators: sediment chemistry (pH and redox potential), sensory evaluation (gas bubbles, smell, texture, colour and thickness of sludge) and the presence or absence of fauna. The performance of these indicators against predefined thresholds categorizes the farming locations into four different site conditions (see Table 1), which are used to determine the sampling frequency.

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:

Grab: Van Veen grab 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 Study site, production and survey design

3.1 Study site and production

Haganes is located in the southern part of Arnarfjörður, approximately 1,4 nm southeast of the town of Bíldudalur. The installed frame is suited for up to 10 net-pens with a circumference of 160 m. The frame is positioned in northeast direction from land (40°) with depth below the cages ranging from 50 to 99 m.

The current generation is the third generation farmed fish at the site. Current generation was put into sea during summer 2020. For the current production cycle the frame was extended from 6 to 10 net-pens the farm moved approximately 300 m northeastwards.

Table 2 shows the production and feed usage for previous and current generation to sampling date.

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

Generation of fish (G)	Production (tonnes)	Feed usage (tonnes)
Generation 2014-2016	2.609	3.673
Generation 2017 – 2019	2.484	3.342
Generation 2020-present	3.910	4.824

3.2 Present and past site surveys

Table 3 provides an overview of sampling dates and results of current and historic B surveys undertaken at the site following NS 9410:2016.

Table 3. Current and historic B surveys taken at Haganes.

Date of sampling	Report number	Survey type	Overall site status
21.06.2022	APN 64106.B01 (Gunnarsson, 2022)	B survey max biomass	1
11.06.2020	APN-62253.B01 (Gunnarsson, 2020)	B survey fallow period	1
05.09.2018	APN-60528.01 (Gunnarsson, 2019)	B survey max biomass	1
22.10.2013	AR131125C (Moe, 2013)	B survey new site	1

3.3 Hydrodynamic conditions

Current measurements were undertaken in july-august 2020 at 56 m, which is the dispersing depth for Haganes site (Hermansen, 2020). The dominating current at 56 m is in north direction (0 degrees) with a just as strong counter current in opposite direction (165-180 degrees) (Figure 2). Average current speed is 6 cm/s. Highest current speed is measured to be 24.6 cm/s and 4.1 % of the measurements are zero current.

3.4 Survey design

The placement of the 14 sampling stations is shown in Figure 2 with positions listed in Table 4. Stations are distributed within the near zone of the new frame position following criteria outlined in NS 9410:2016. Depth beneath and in the close vicinity of the cage varies between 50– 99 m, with the deepest waters being located in the northeastern part of the frame. Sampling

stations were placed to represent the varied environmental conditions within the near zone and cover thus both the deeper and shallower areas. The sampling stations had a depth varying from 57 to 98 m. The placement of sampling stations is regarded to be in accordance with the requirements outlined in NS 9410:2016.

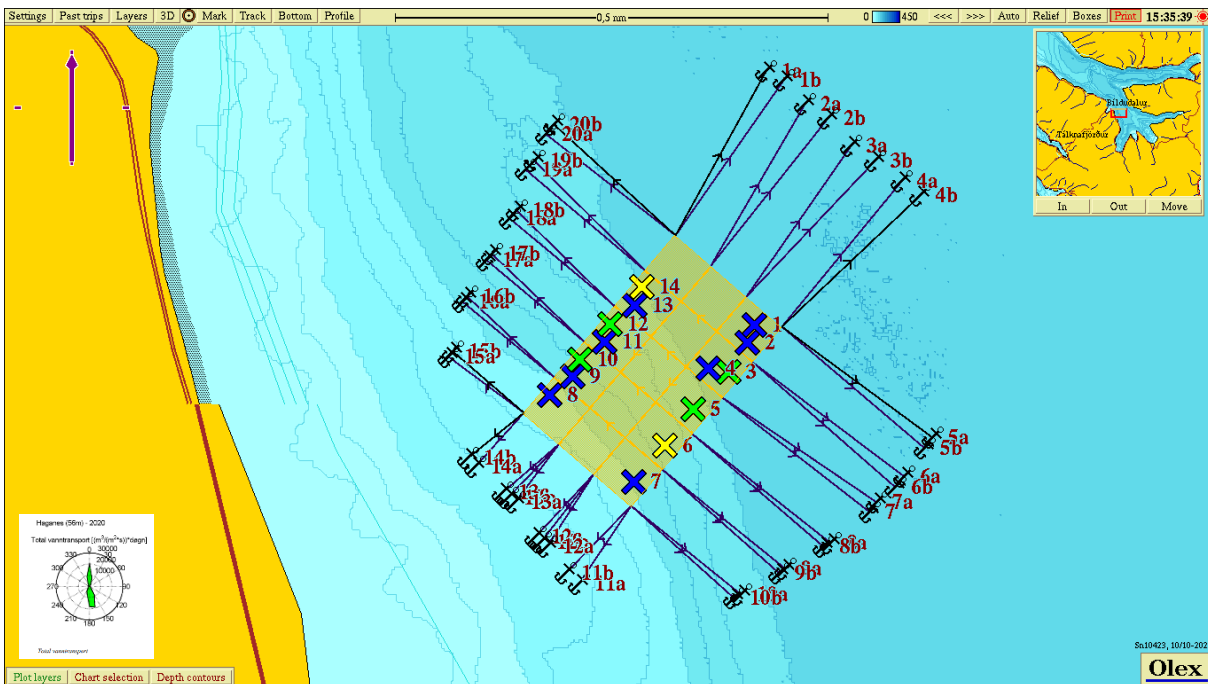


Figure 2. Site specific map of Haganes showing frame, mooring lines and farming area. Sampling stations st. 1 – 14 are marked with crosses. The color of each cross represents the environmental condition at the respective station following the classification as outlined in NS 9410:2016, chapter 7.11. Colour codes: Blue = very good, green = good, yellow = bad, red = very bad. Current rose placed in the lower left corner shows main current direction at 56 m (Hermansen, 2020).

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

Station number	North	West	Depth (m)
St 1	65°40,507	023°32,558	98
St 2	65°40,487	023°32,578	98
St 3	65°40,453	023°32,639	96
St 4	65°40,457	023°32,688	94
St 5	65°40,410	023°32,730	85
St 6	65°40,368	023°32,810	74
St 7	65°40,326	023°32,897	62
St 8	65°40,426	023°33,134	57
St 9	65°40,448	023°33,069	65
St 10	65°40,467	023°33,048	70
St 11	65°40,488	023°32,979	76
St 12	65°40,508	023°32,964	80
St 13	65°40,530	023°32,894	86
St 14	65°40,551	023°32,876	90

4 Results

Results for the different parameters are given in Table 5. The completed fieldwork sampling sheet with calculations for each parameter is attached in appendix.

Table 5. Results from the parameter classifications in the near 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

Substrate was collected at 13 out of the total 14 sampling stations (93% soft bottom). Sediment samples consisted mainly of clay at the stations with more depth whereas mixture of sand and gravel were more apparent at stations with less depth. Fauna was recorded at all 13 stations with valid substrate sample with polychaetes being most prominent. The substrate was of light grey colour at half of the stations and brown/dark at the resting stations. Signs of out-gassing were not observed. A slight smell of H₂S was recorded at four stations and strong smell at two stations (st. 5 and st. 14).

Based on the classification of sediment chemistry (pH/Eh) and the sensory assessments eight stations of this survey received status 1 – "very good", four stations received status 2 – "good" and two stations received status 3 – "bad" (Figure 2). Taken together the site receives as a whole the environmental status 1 – "very good" (average group II-III index =0,78).

5 Conclusion

Applying the indicator thresholds and classification outlined in NS 9410:2016 it is shown that Haganes receives site status 1 – "very good" at the time of this B survey. Samples were collected with a Van Veen grab (0,1 m²) at 14 stations distributed around the 10 cages, which are placed in the frame during current production cycle. Sediment was successfully collected at thirteen out of the total fourteen stations. Eight stations of this survey received status 1 – "very good", four stations received status 2 – "good" and two stations received status 3 – "bad"

The here presented survey was undertaken during the time of max biomass for the present production cycle. The farm has been expanded and moved to a new position within the defined farming area. Sampling stations in this survey are placed within the near zone of the current farm location and thus are not located where organic load was highest during the last production cycle. The north-eastern part of the current frame is being used for the first time whereas for the southwestern part of the farming area it is being used for the third time. A direct comparison with the results of previous B surveys is therefore only suitable for the southwestern part of the fish farm. In the previous survey all sampling stations had condition 1 – "very good" whereas in the current survey one station has condition "good" (st. 9) and one station has condition "bad" (st. 6). Also in the "new" part of the farming area three stations have condition 2 – " good" and one station has condition 3 – "bad". This indicates some organic enrichment within the footprint of the farm location during the current production cycle.

Following the criteria outlined in NS 9410:2016 the site receives the status 1 - "very good".

6 References

- Forskrift om drift av akvakulturanlegg (akvakulturdriftsforskriften) §§ 35 og 36.
- Gunnarsson, S. 2019. Arnarlax hf, B-undersøkelse, september 2018 Haganes (maksimal belastning). Akvaplan-niva AS rapport nr. 60528.01.
- Gunnarson, S., 2020. Haganes, Arnarlax hf B-bottom survey, June 2020 (fallow period), APN-62253.B01. Akvaplan-niva AS.
- Hermansen, S., 2020. Arnarlax hf. Strømmålinger Haganes 5 meter, 15 meter og spredningsstrøm 56 meter. APN-62191.01. Akvaplan-niva AS
- 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.
- Moe A.A. 2013. Environmental monitoring (MOM B) at finfish farm site Haganes. October 2013. Helgeland Havbruk report nr. AR131125C. 28 p.
- Norsk Standard NS 9410:2016. Miljøovervåking av bunnpåvirkning fra marine akvakulturanlegg.

7 Appendix

7.1 Survey data sheet (B.1 & B.2), NS 9410:2016.

Sample scheme B.1														
Company		Arnarlax						Date:		21.06 2022				
Site:		Haganes						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	H	S	S	S		
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0		0	0	0		
II	pH	value	7,8	7,8	7,4	7,8	7,5	7,1	Ut	7,5	7,7	7,7		
	Eh (mV)	ORP	73	6	-138	-32	-162	-158	Ut	-83	5	-110		
		plus ref. verdi	273	206	62	168	38	42		117	205	90		
	pH/Eh	from figure	0	0	1	0	1	3	ut	0	0	1		
	Status station			1	1	1	1	1	3	ut	1	1	1	
	Buffer-temp			5,0 C			Sea temp		1,1 C		Sediment temp		1,1 C	
	pH sea		8,01	ORP sea		186,5 mV		Eh sea		386,5 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		
			Brown/black (2)			2		2	2		2		2	
Smell		None (0)	0	0		0			0	0	0			
		Light (2)			2			2				2		
		Strong (4)					4							
Consistency		Solid (0)	0	0	0	0			0		0			
		Soft (2)					2	2		2		2		
		Aqueous (4)												
Grab volume (v)		v < 1/4 (0)					0	0	0	0	0	0		
	1/4 < v < 3/4 (1)													
	v > 3/4 (2)	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)			1			1							
	t > 8 cm (2)													
Sum			2,0	2,0	7,0	2,0	8,0	7,0	0,0	4,0	0,0	6,0		
Corrected (*0,22)			0,4	0,4	1,5	0,4	1,8	1,5	0,0	0,9	0,0	1,3		
Status station			1	1	2	1	2	2	1	1	1	2		
Average group II & III			0,2	0,2	1,3	0,2	1,4	2,3	0,0	0,4	0,0	1,2		
Status station			1	1	2	1	2	3	1	1	1	2		
Grab ID	K-3													
pH / Eh ID	Ysi professional plus													

Sample scheme B.1

Company:	Arnarlax
Site:	Haganes
Fieldworker:	Snorri Gunnarsson

Date:	21.06 2022
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							93	7
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0								
II	pH	value	Ut	7,4	7,6	6,8								
	Eh (mV)	ORP	Ut	-184	-71	-232								
		plus ref. verdi		16	129	-32								
	pH/Eh	from figure	ut	1	0	3							0,83	
	Status station		ut	1	1	3								
	Status group II		1	Buffer temp	5,0 C		Sea temp	1,1 C		Sediment temp	1,1 C			
	pH sea	8,01	ORP sea	187 mV		Eh sea	387 mV		Reference electrode	200 mV				
	III	Gas bubbles	Yes (4) No (0)	0	0	0	0							
		Colour	Light/grey (0)	0		0								
			Brown/black (2)		2		2							
Smell		None (0)	0		0									
		Light (2)		2										
		Strong (4)				4								
Consistency		Solid (0)	0		0	0								
		Soft (2)		2										
		Aqueous (4)												
Grab volume (v)		v < 1/4 (0)	0	0										
		1/4 < v < 3/4 (1)			1									
		v > 3/4 (2)				2								
Thickness of sledge (t)		t < 2 cm (0)	0	0	0									
	2 < t < 8 cm (1)				1									
	t > 8 cm (2)													
Sum			0,0	6,0	1,0	9,0								
Corrected (*0,22)			0,0	1,3	0,2	2,0						0,85		
Status station			1	2	1	2								
Status group III			1											
Average group II & III			0,0	1,2	0,1	2,5						0,78		
Status station			1	2	1	3								
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 professional plus													


Sample scheme B.2

Company:	Arnarlax	Date:	21.06 2022
Site:	Haganes	Site no.:	0
Fieldworker:	Snorri Gunnarsson		










Sample number	1	2	3	4	5	6	7	8	9	10
Depth (m)	98	98	96	94	85	74	62	57	65	70
Number of trials	1	1	1	1	1	1	3	1	2	1
Gas bubbles (in sample)	No	No	No	No	No	No		No	No	No
Sediment type	Clay	x	x	x	x	x			x	
	Silt									
	Sand						x	x	x	x
	Gravel					x	x	x	x	x
	Shellsand									
Reef										
Rocky bottom (cobbles, boulders)										
Echinodermata, count								2		
Crustaceans, count										
Molluscs, count										
Polychaetes, count	>100	>10	>50	>50	>20	>100		>100	5	>100
Other animals, count										
<i>Beggiatoa</i>										
Feed	x	x								x
Faeces			x			x				
Comments	St. 5 small sample some stones, slightly washed. St. 7 Hardbottom 3 attempts empty grab.									
Grab	Area [m ²]	0,025	Grab ID				K-3			
	page 3 of 4 pages									









Sample scheme B.2









Company:	Arnarlax	Date:	21.06 2022
Site:	Haganes	Site no.:	0
Fieldworker:	Snorri Gunnarsson		

Sample number	11	12	13	14	15	16	17	18	19	20
Depth (m)	76	80	86	90						
Number of trials	2	2	2	1						
Gas bubbles (in sample)	No	No	No	No						
Sediment type	Clay			x	x					
	Silt									
	Sand	x	x	x						
	Gravel									
	Shellsand									
Reef										
Rocky bottom (cobbles, boulders)	x	x								
Echinodermata, count										
Crustaceans, count										
Molluscs, count										
Polychaetes, count	>20	>50	>50	>50						
Other animals, count										
<i>Beggiatoa</i>										
Feed										
Faeces		x		x						
Comments	St.11. Not enough sample to measure pH/orp. St. 12. washed sample. St. 13. Washed									
Grab	Area [m ²]	0,025	Grab ID	K-3						
Signature fieldworker:										page 4 of 4 pages

7.2 Pictures of samples at Haganes.

<p><i>St 1</i></p>		
<p><i>St 2</i></p>		
<p><i>St 3</i></p>		
<p><i>St 4</i></p>		
<p><i>St 5</i></p>		

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

<i>St 11</i>	 <p>A yellow bucket containing a dark, clumpy sediment sample. A small white label with the number '11' is placed on top of the sample.</p>	 <p>A sieve containing the filtered sediment from sample St 11. The material is dark and granular. A small white label with the number '11' is placed in the center.</p>
<i>St 12</i>	 <p>A yellow bucket containing a dark, clumpy sediment sample. A small white label with the number '12' is placed on top of the sample.</p>	 <p>A sieve containing the filtered sediment from sample St 12. The material is dark and granular. A small white label with the number '12' is placed in the center.</p>
<i>St 13</i>	 <p>A yellow bucket containing a dark, clumpy sediment sample. A small white label with the number '13' is placed on top of the sample.</p>	 <p>A sieve containing the filtered sediment from sample St 13. The material is dark and granular. A small white label with the number '13' is placed in the center.</p>
<i>St 14</i>	 <p>A yellow bucket containing a dark, clumpy sediment sample. A small white label with the number '14' is placed on top of the sample.</p>	 <p>A sieve containing the filtered sediment from sample St 14. The material is dark and granular. A small white label with the number '14' is placed in the center.</p>

7.3 Bottom topography and 3D view

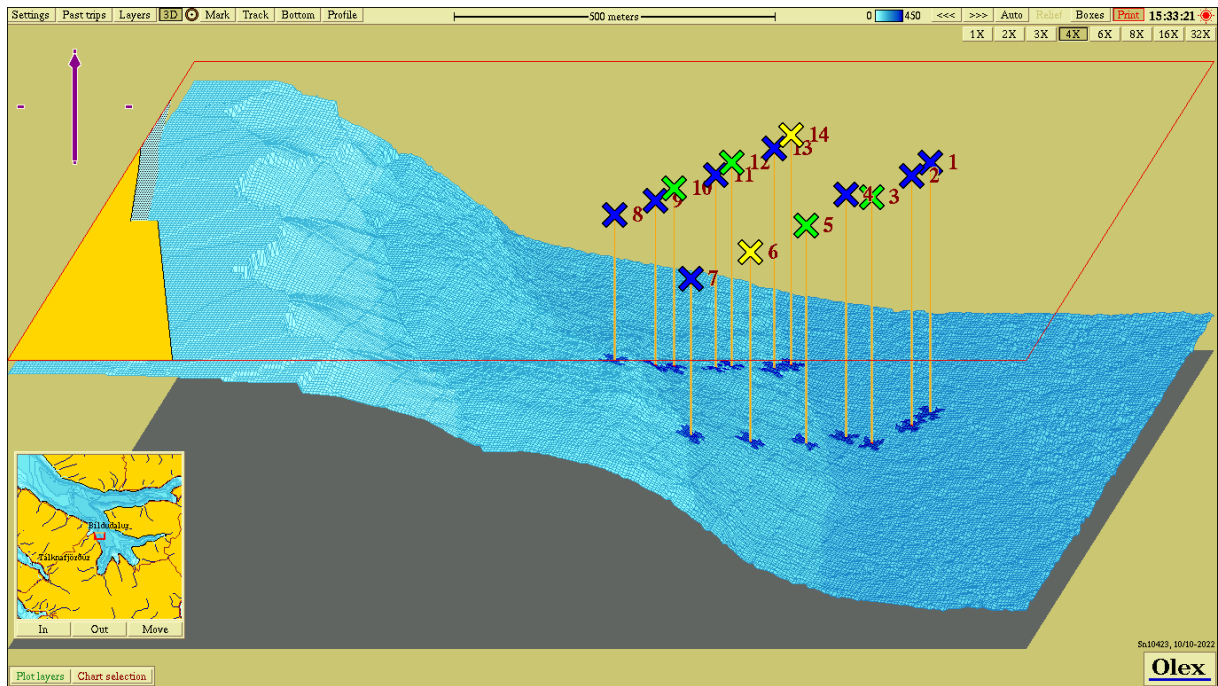


Figure 3. Bottom topography in 3D at Haganes with each sampling station according to info in Figure 1 and Table 4.