B-survey at Haganes, October 2024 (max biomass), Arnarlax ehf

Akvaplan-niva AS Report:
APN 66208.B01

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B survey at Haganes October 2024 (max biomass), Arnarlax ehf

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Customer	Arnarlax ehf
Contact person	Silja Baldvinsdóttir

Summary

Substrate was collected at all 16 sampling stations (100% soft bottom). Sediment samples consisted mainly of mud at stations with greater depths and a combination of mud and gravel/sand at shallower parts of the local impact zone. Fauna was recorded at all stations with polychaetes being most prominent, some mussels at two stations and crustacean at one station. Signs of out-gassing were observed at one sampling stations (st. 11). The substrate was of light/grey colour at seven sampling stations and brown/black at nine sampling station. Some light smell of H_2S was observed at twelve stations and four stations had strong smell. Grab volume was higher than ¾ full at eleven stations and (all at deeper area of the local impact zone). Feed was observed at one station (st. 8) and faeces in the grab sample were observed at six stations (st. 2-6 and st. 12). The bacteria *Beggiatoa* was observed in one grab sample (st. 12).

Based on the classification of sediment chemistry (ph/Eh) and the sensory assessments seven stations of this survey received status 1 – "Very good", three stations received status 2 – " Good", five stations of this survey received status 3 – "Bad" and one station received status 4 – "Very bad". Overall, the index score for the parameter II (pH/Eh) was higher (2.0) than the overall score for parameter III (sensory parameters; 1.18).

In summary, the site receives the environmental status was 2 – "Good" (average group II-III index =1.59).

Approval

Project Manager

Quality Control

Key information

Site details and license holder information			
Site name	Haganes	Site coordinates	65°40,469N 23°32,762V
County	Vesturbyggð	Municipality	Vesturbyggð
MTB (Maximum estimated biomass next generation)	5.046 tonnes	Operations Manager / Contact	Silja Baldvinsdóttir
License holder / customer	Arnarlax		

Production status on date of survey			
Biomass at site	5.046 tonnes	Total feed use	5.831 tonnes
Farmed species	Salmon	Total biomass produced	5.045 tonnes
Type/time of survey	Indicated with X	Comments	
Maximum organic load cf. chapter 7.9	☒		
Follow-up survey	☐		
Half maximum load	☐		
Pre-stock	☐		
Required by the state administrator - baseline survey	☐		
Other	☐		
Last fallowing period:	October 2022 - June 2023		

Results from B-survey in accordance with NS 9410:2016 (main results)			
Parameter group and index		Parameter group and status	
Gr. II. pH/Eh	2.00	Gr. II. pH/Eh	2
Gr. III. Sensory	1.18	Gr. III. Sensory	2
GR. II + III	1.59	GR. II+ III	2
Date of fieldwork	31.10 2024	Date of report	14.11 2024
Environmental status (NS 9410:2016):			**2**

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1 Introduction

The present survey was conducted by Akvaplan-niva AS on behalf of Arnarlax in connection with the company's fish farming activities at the site Haganes in Arnarfjörður 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 Arnarfjörður where Haganes site is located.

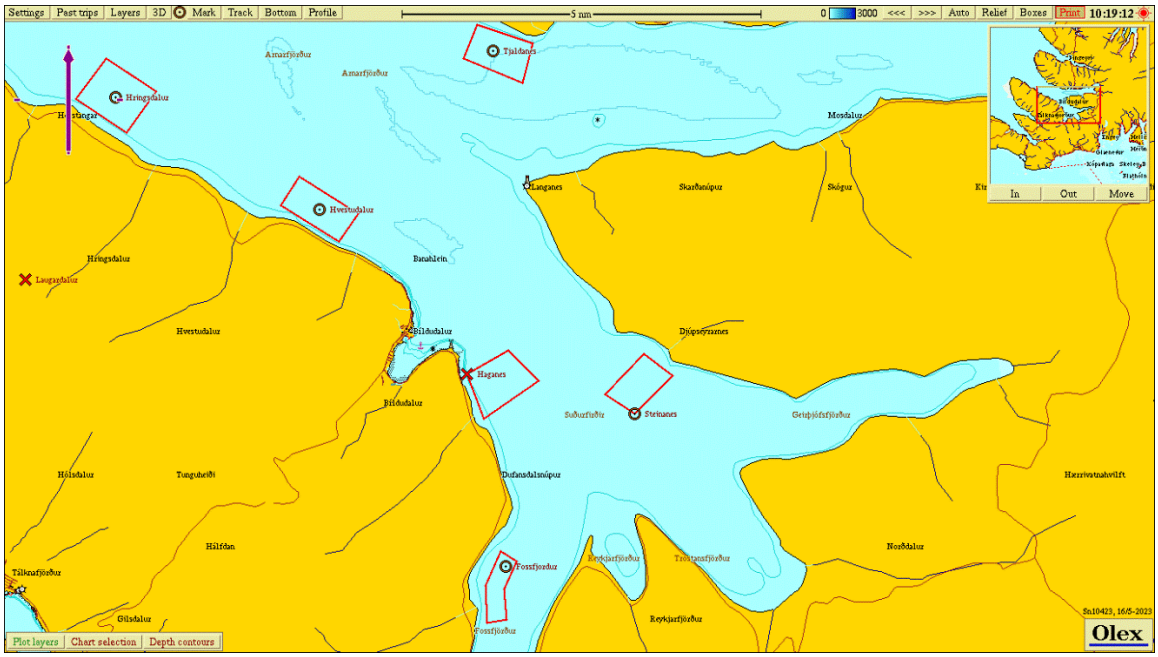

Figure 1. An overview map where Haganes farm is marked with a red cross. Other fish farming areas in the nearest vicinity in Arnarfjörður are also shown.

2 Methods

Monitoring of the environmental impact of fish farming activities on the seabed is standardised and regulated. All fish farming sites 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^2). 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 fallowing 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^2)
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 Haganes site 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 18 net-pens with a circumference of 160 m in a 2 x 9 configuration. The frame is positioned in eastern direction from land (80°) with depth below the cages ranging from 44 to 100 m.
Previously there were farmed three generation at the Haganes site.

The current generation is the fourth being farmed at the Haganes site. At the date of the B-survey the standing biomass was 5.046 tons. Table 2 shows production and feed use for the current and four previous generations.

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

Generation of fish (G)	Production (tonnes)	Feed use (tonnes)
Generation 2014-2016	2.609	3.342
Generation 2017-2019	2.985	3.673
Generation 2020-2022	5.092	6.791
Generation 2023-31.10 2024	5.046	5.831

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
31.10.2024	APN 66208.B01	B survey max biomass	2
26.04.2023	APN 64910.B01	B-survey new site	1
21.06 2022	APN 64106.B01	B-survey max biomass	1
11.06.2020	APN-62253.B01	B-survey fallow period	1
05.09 2018	APN 60258.01	B-survey max biomass	1
22.10.2013	AR131125C	B-survey new site	1

3.3 Hydrodynamic conditions

Current measurements were undertaken in July-August 2020 at 56 m (65°40.728 N and 23°32.780 V), which is the dispersing depth for Hagnes 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 16 sampling stations is shown in Figure 2 with positions listed in Table 4. Stations are distributed within the near zone of the frame position following criteria outlined in NS 9410:2016. The typical depth in the local impact zone is in the range from 44-102 m, with the shallowest parts in the western part (closest to land) and more depth in direction into the middle of the fjord in eastern direction. 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 48 to 102 m. The 16 stations sampled were distributed with emphasis around the cages used during farming of current generation, according to guidance in NS 9410, chapter 7.6. The placement of sampling stations is regarded to be in accordance with the requirements outlined in NS 9410:2016.

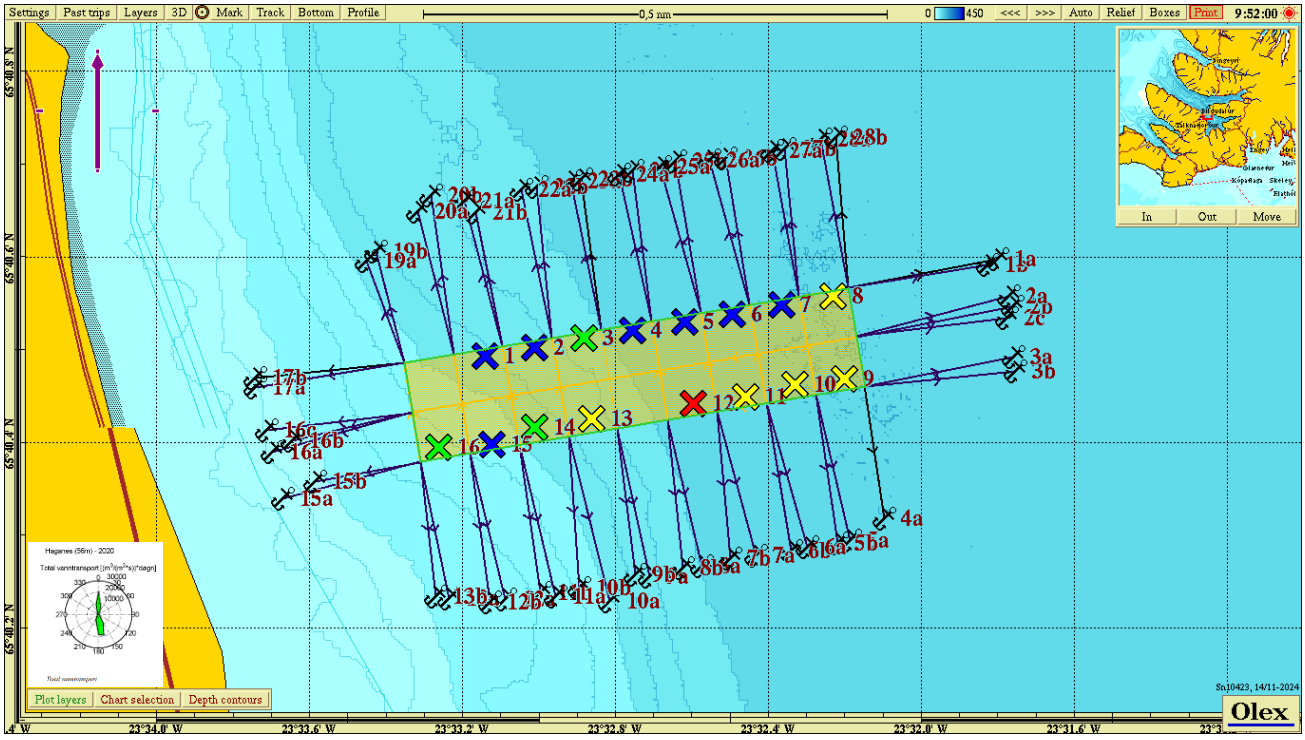

Figure 2. Overview map showing site configuration and local bathymetry at Haganes. Sampling stations are marked by crosses and colour coded to visualise the environmental status at the respective station following the classification outlined in NS 9410:2016, chapter 7.11 (1 = blue, 2 = green, 3 = yellow, 4 = red). The current rose in the lower left corner shows the direction of water transport at dispersal depths at the site (Hermansen, 2020).

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

Station number	Northing	Westing	Depth [m]
St 1	65°40,493	23°33,140	67
St 2	65°40,502	23°33,012	77
St 3	65°40,512	23°32,883	85
St 4	65°40,520	23°32,754	94
St 5	65°40,530	23°32,618	97
St 6	65°40,238	23°32,494	98
St 7	65°40,548	23°32,366	102
St 8	65°40,557	23°32,232	100
St 9	65°40,468	23°32,202	99
St 10	65°40,468	23°32,336	99
St 11	65°40,449	23°32,459	99
St 12	65°40,441	23°32,597	97
St 13	65°40,425	23°32,862	77
St 14	65°40,416	23°33,012	65
St 15	65°40,397	23°33,123	53
St 16	65°40,393	23°33,261	48

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 Haganes.

Parameter	Status
Group II parameters (pH/Eh)	2
Group III parameters (sensory)	2
Group II + III – parameters (mean)	2
Environmental status (site)	2

Substrate was collected at all 16 sampling stations (100% soft bottom). Sediment samples consisted mainly of mud at stations with greater depths and a combination of mud and gravel/sand at shallower parts of the local impact zone. Fauna was recorded at all stations with polychaetes being most prominent, some mussels at two stations and crustacean at one station. Signs of out-gassing were observed at one sampling stations (st. 11). The substrate was of light/grey colour at seven sampling stations and brown/black at nine sampling station. Some light smell of H_2S was observed at twelve stations and four stations had strong smell. Grab volume was higher than ¾ full at eleven stations and (all at deeper area of the local impact zone). Feed was observed at one station (st. 8) and faeces in the grab sample were observed at six stations (st. 2-6 and st. 12). The bacteria *Beggiatoa* was observed in one grab sample (st. 12).

Based on the classification of sediment chemistry (ph/Eh) and the sensory assessments seven stations of this survey received status 1 – "Very good", three stations received status 2 – "Good", five stations of this survey received status 3 – "Bad" and one station received status 4 – "Very bad". Overall, the index score for the parameter II (pH/Eh) was higher (2.0) than the overall score for parameter III (sensory parameters; 1.18).

In summary, the site receives the environmental status was 2 – "Good" (average group II-III index =1.59).

5 Summary

Applying the indicator thresholds and classification outlined in NS 9410:2016 it is shown that Haganes receives overall site status 2 – "Good" at the time of this B survey. Samples were collected with a Van Veen grab (0,1 m^2) at 16 stations distributed around the cages, that were used for farming salmon during present production cycle. Seven stations of this survey received status 1 – "Very good", three stations received status 2 – "Good", five stations of this survey received status 3 – "Bad" and one station received status 4 – "Very bad"

The survey was undertaken during the time of max biomass for the present production cycle which is the fourth farmed at the site. The results indicate that there is some organic load in the local impact zone mainly at the southern part of the farming area in line with main spread current at the site (Hermansen, 2020). Five out of the six stations with condition "Bad" and the one station with condition "Very bad" were all placed at the southern part of the farming area. The index score for parameter II (pH/redox) was somewhat higher than the index score for parameter III (sensory) but both had overall status 2 "Good".

There are six previous B-surveys done at the site Haganes. Two of these were done at max biomass and had overall site status 1 "Very good". The production for the last two generations is higher than for the two first and the results from the current 2024 survey indicates some increase in organic load mainly at the southern part of the local impact zone in the direction ocean flow of spread current at the site. These results will be followed up after next fallowing period at the Haganes site.

Following the criteria outlined in NS 9410:2016 the site receives the status 2 - "Good".

6 References

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

Gunnarsson, S. 2019. Arnarlax ehf, B-undersøkelse, september 2018 Haganes (maksimal belastning). Akvaplan-niva AS rapport nr. 60528.01.

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Gunnarson, S., 2022. Haganes, Arnarlax B- survey, June 2022 (max biomass), APN-64106.B01. Akvaplan-niva AS.

Gunnarson, S., 2023. Haganes, Arnarlax B- survey (pre survey), April 2023, APN-64910.B01. Akvaplan-niva AS.

Hermansen, S., 2020. Arnarlax ehf. 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.

Personal reference. Iona Lucia Nordli, Quality coordinator Arnarlax ehf.

7 Attachments

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

Sample scheme B.1

Company	**Arnarlax**	**Date:**	**31.10 2024**
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	S	S	S	S
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0	0	0	0	0
II	pH	value	7.84	7.36	7.46	7.53	7.71	7.52	7.56	7.02	6.88	7.07
	Eh (mV)	ORP	-173	-183	-179	-127	-65	-173	-127	-227	-231	-228
		plus ref. verdi	27	17	21	73	135	27	73	-27	-31	-28
	pH/Eh	from figure	1	1	1	1	0	1	1	3	3	3
	Status station		1	1	1	1	1	1	1	3	3	3
			Buffer-temp	5.0 C		Sea temp	6.3 C		Sediment temp		4.4 C	
		pH sea 8.05	ORP sea	179.0 mV		Eh sea	379.0 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			
		Brown/black (2)		2	2					2	2	2
	Smell	None (0)										
		Light (2)	2	2	2	2	2	2	2			
		Strong (4)								4	4	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									
		1/4 < v < 3/4 (1)		1								
		v > 3/4 (2)			2	2	2	2	2	2	2	2
	Thickness of slidge (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	2.0	5.0	6.0	4.0	4.0	4.0	4.0	8.0	8.0	8.0
		Corrected (*0,22)	0.4	1.1	1.3	0.9	0.9	0.9	0.9	1.8	1.8	1.8
	Status station		1	2	2	1	1	1	1	2	2	2
	Average group II & III		0.7	1.1	1.2	0.9	0.4	0.9	0.9	2.4	2.4	2.4
	Status station		1	1	2	1	1	1	1	3	3	3

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

page 1 of 4 pages

Sample scheme B.1

Company:	**Arnarlax**	**Date:**	**31.10 2024**
Site:	**Haganes**	**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	S					100	0
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0						
II	pH	value	6.83	6.71	6.95	7.10	7.69	7.08						
	Eh (mV)	ORP	-283	-278	-223	-194	-128	-188						
		plus ref. verdi	-83	-78	-23	6	72	12						
	pH/Eh	from figure	3	5	3	2	1	3					2.00	
	Status station		3	4	3	2	1	3						
	Status group II		2	**Buffer temp**	5.0 C		**Sea temp**	6.3 C		**Sediment temp**	4.4 C			
	pH sea	8.05	**ORP sea**	0 mV		**Eh sea**	mV		**Reference electrode**		200 mV			
III	Gas bubbles	Yes (4) No (0)	4	0	0	0	0	0						
	Colour	Light/grey (0)					0	0						
		Brown/black (2)	2	2	2	2								
	Smell	None (0)												
		Light (2)		2	2	2	2	2						
		Strong (4)	4											
	Consistency	Solid (0)	0	0	0	0	0	0						
		Soft (2)												
		Aqueous (4)												
	Grab volume (v)	v < 1/4 (0)				0	0	0						
		1/4 < v < 3/4 (1)												
		v > 3/4 (2)	2	2	2									
	Thickness of slidge (t)	t < 2 cm (0)		0	0	0	0	0						
		2 < t < 8 cm (1)	1											
		t > 8 cm (2)												
	Sum		13.0	6.0	6.0	4.0	2.0	2.0						
	Corrected (*0,22)		2.9	1.3	1.3	0.9	0.4	0.4					1.18	
	Status station		3	2	2	1	1	1						
	Status group III		2											
	Average group II & III		2.9	3.2	2.2	1.4	0.7	1.7					1.59	
	Status station		3	4	3	2	1	2						
	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 prof. Plus

Sample scheme B.2

Company:	**Arnarlax**	**Date:**	**31.10 2024**
Site:	**Haganes**	**Site no.:**	**0**
Fieldworker:	**Snorri Gunnarsson**		

Sample number		1	2	3	4	5	6	7	8	9	10
Depth (m)		67	77	85	94	97	98	102	100	99	99
Number of trials		2	1	1	1	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			X							
	Sand										
	Gravel	X									
	Shellsand		X	X							
Reef											
Rocky bottom (cobbles, boulders)		X									
Echinodermata, count											
Crustaceans, count											
Molluscs, count						8		1			
Polychaetes, count		>20	>20	>50	>100	>30	>20	>20	>20	>20	>20
Beggiatoa											
Feed									X		
Faeces			X	X	X	X	X				
Comments											

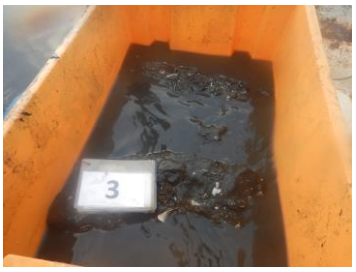
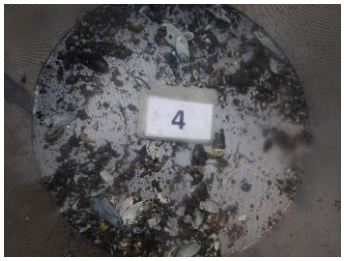
Grab	**Area [m^2]**	0.1	**Grab ID**	K-3

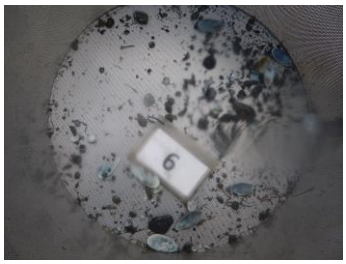
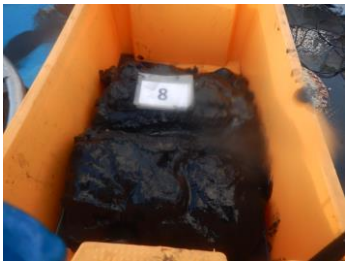
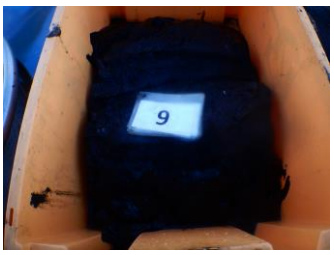
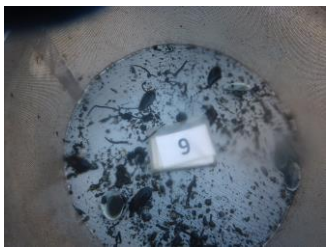
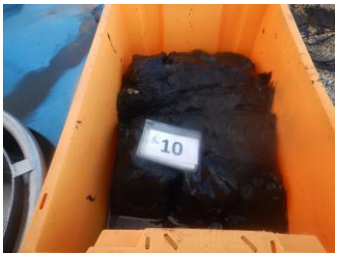
Sample scheme B.2

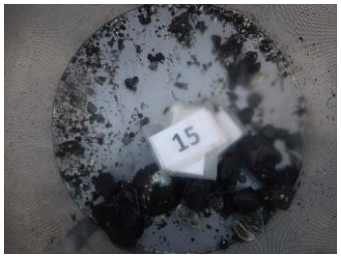
Company:	**Arnarlax**	**Date:**	**31.10 2024**
Site:	**Haganes**	**Site no.:**	**0**
Fieldworker:	**Snorri Gunnarsson**		

Sample number		11	12	13	14	15	16	17	18	19	20
Depth (m)		99	97	77	65	53	48				
Number of trials		1	1	1	1	1	1				
Gas bubbles (in sample)		Yes	No	No	No	No	No				
Sediment type	**Clay**	X	X	X	X	X	X				
	Silt										
	Sand			X			X				
	Gravel			X	X	X	X				
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)						X					
Echinodermata, count											
Crustaceans, count				1							
Molluscs, count											
Polychaetes, count		16	18	3	>20	6	>20				
Other animals, count											
Beggiatoa			X								
Feed											
Faeces			X								
Comments		St. 11 Oily sample.									
Grab		**Area [m^2]**		0.1		**Grab ID**		K-3			
Signature fieldworker:											

7.2 Images of samples at Haganes

St	*Image before sieving*	*Image after sieving*
St 1		
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		
St 15		

St 16		

*picture after sieving at station 12 with wrong label i.e. 13 but was sample 12.

7.3 3D-bathymetry

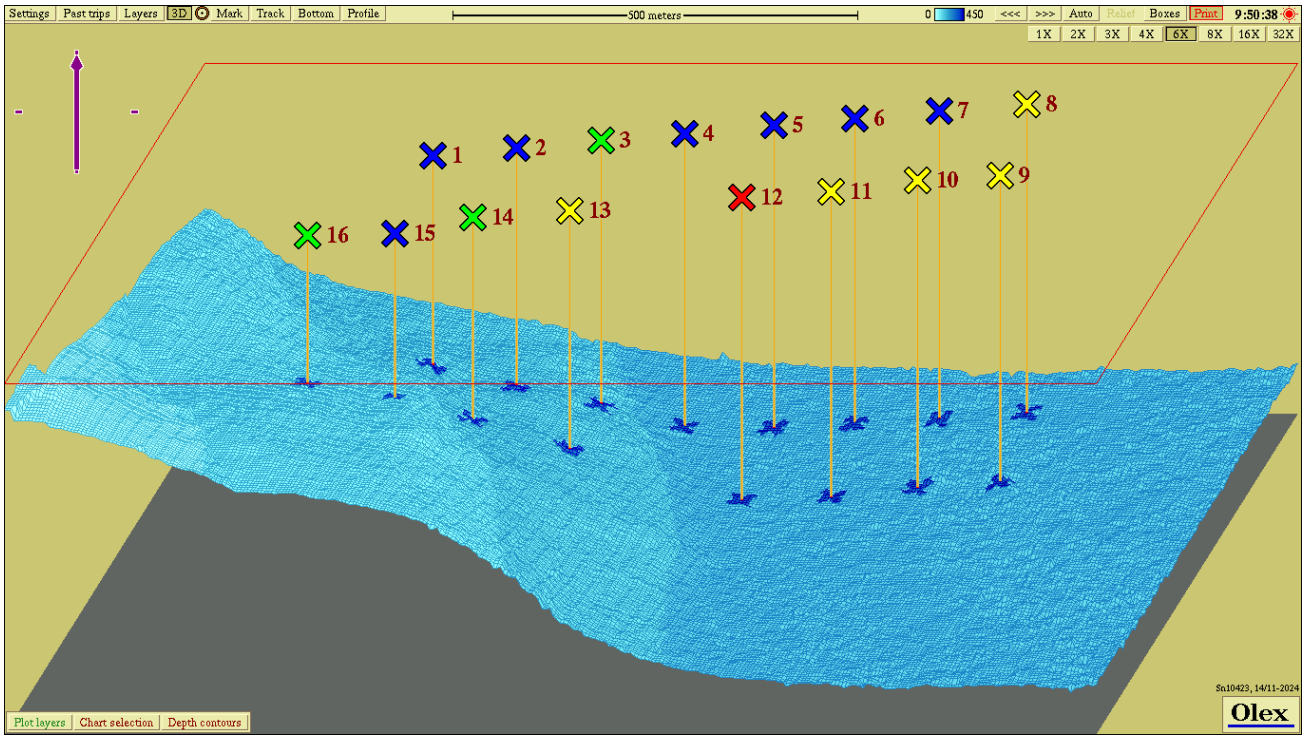


Figure 3. 3D-view of bathymetry at Haganes with stations as shown in Figure 2 and Table 4.