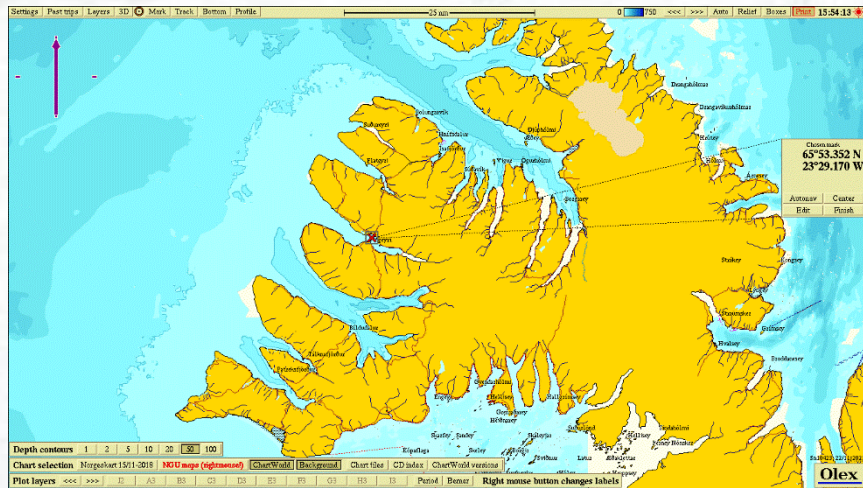


Gemlufall, Arctic Sea Farm B-bottom survey, July 2021 (maximum biomass survey)



Information client			
Title	Gemlufall, Arctic Sea Farm. B-bottom survey, July 2021		
Report number	APN-63341.B01		
Site name	Gemlufall	Coordinates site	65°53.352 N 023°29.170 V
County	Ísafjörður	Municipality	Ísafjörður
MTB-or estimated max biomass	1.306 ton	Site manager/contact	Steinunn G. Einarsdóttir
Client name	Arctic Sea Farm		

Biomass/production/status at date of survey			
Biomass at date of survey	1.298 ton	Feed use	1.413
Fish type	Salmon	Amount produced	
Type/time of survey	Mark with X	Comments	
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 iht. NS 9410:2016 (main results)			
Parameters and indexes		Parameters and site status	
Gr. II. pH/Eh	0,20	Gr. II. pH/Eh	1
Gr. III. Sensory	0,75	Gr. III. Sensory	1
GR. II + III	0,47	GR. II+ III	1
Date field work	07.07 2021	Date report	29.11.21
Site status (NS 9410:2016):			1



Report writing and project leader	Snorri Gunnarsson	Signature	
Quality control	Arnþór Gústavsson	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 as they are defined in NS9410:2016. The estimated max biomass for the current generation farmed salmon at the site Gemlufall is 1.306 ton. There is a requirement of at least 10 sampling stations within the mooring lines of the fish farm. The methods applied in this survey follow guidelines in chapter 5 (NS6410:216) and fulfil the requirements described in ISO 12878. 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 Gemlufall was done 07.07 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 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 29. november 2021



Snorri Gunnarsson
Project manager

1 Introduction

The sampling date for the present site survey was 07.07 2021 and done by Akvaplan-niva AS contracted by Arctic Sea Farm in relation to the company's fish farming activity at the site Gemlufall in Dýrafjörður, Ísafjarðabær 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.

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

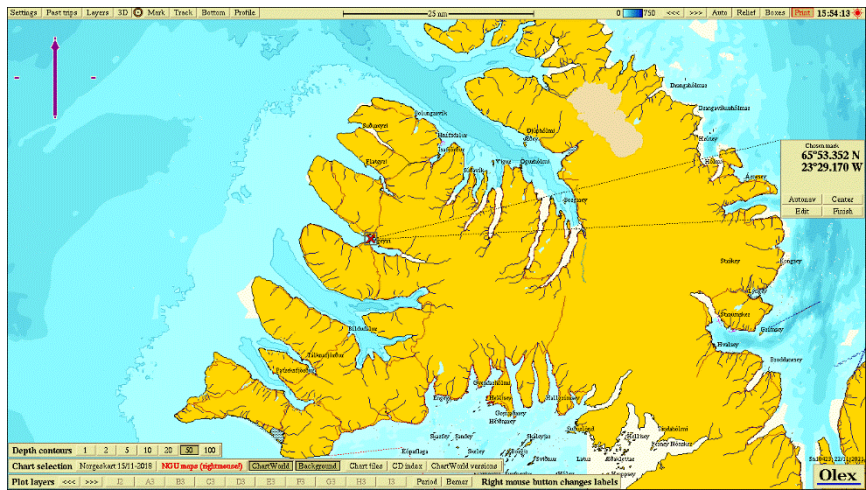


Figure 1. An overview map with the Gemlufall site marked by its name with a red cross.

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 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. 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: <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 Gemlufall site is coming to an end of the second production cycle at the site with current setup and position of farm. The fish farm at the site has a single frame 2x5 mooring system, a total of 10 cages, each with 160 m circumference. The current production cycle was started in summer 2020 and is planned to terminate in July 2021 (all fish to be transferred to another site). The previous production cycle was started in June 2017 and farmed until October 2019.

Table 2 shows the production and feed usage for the present and or past generations.

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

Generation of fish (G)	Production (ton)	Feed usage (ton)
Present generation until sampling date	1.172	1.413
2017-2019	2.914	3.945

3.2 Present and past site surveys

Akvaplan-niva has previously done one B-survey in May 2020 at Gemlufall at fallow period, prior to putting out current generation (Gústavsson, 2020). The results from the B survey at fallow gave overall site condition 1 «very good». In general, there was soft bottom in the whole local impact zone.

For the previous generation farmed salmon there were done survey of type C prior to putting smolt into sea with sampling in July 2017 and around max biomass in November 2018, ref. Gallo 2018; Gallo, 2019).

Table 3. Past site studies for Gemlufall site

Date of sampling	Report number	Survey type	Overall site status
20.05.2020	APN-62175.B01	B survey, fallow period	1

3.3 Dispersing current

Dispersing current was measured at 30 m for Gemlufall site (Gústavsson, 2019). Dominating current (30 m) is in direction south-east (120 degrees) with little counter current. Average current speed is measured to be 5.9 cm/s. Highest current speed is measured to be 25.6 cm/s and 4.0 % of the measurements are < 1 cm/s.

Current at 5- and 15-meter depth at Gemlufall is towards north-by-northwest (345-360°) (Eriksen, 2016).

3.4 Position of sampling stations

Description of the 10 sampling 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. Gemlufall site is close to the center of Dýrafjörður and the site is well sheltered. At the Gemlufall site the typical depth in the local impact zone is in the range from 28 – 32 m, with very little slope and slightly less depth in north part of the farming area. 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 28 to 31 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.

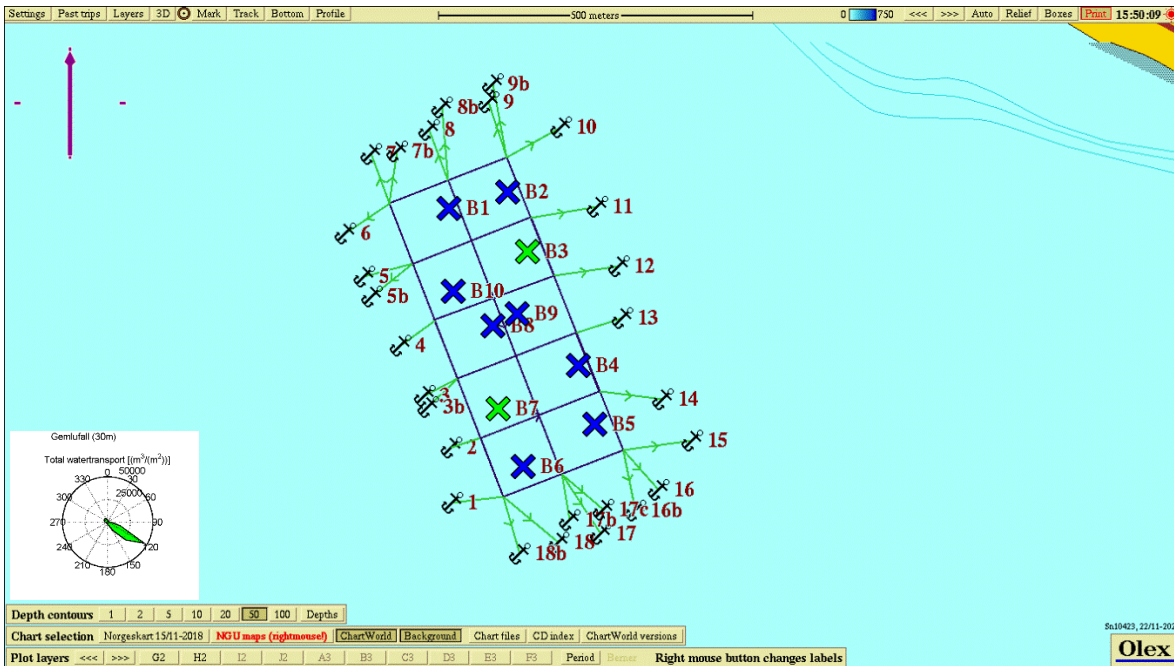


Figure 2. Chart showing depths at the site Gemlufall. Sampling stations st. 1 – 10 are marked with color codes that describe the condition according to NS 9410:2016, chapter 7.11. Color codes: Blue = very good condition, green = good condition, yellow = bad condition, red = very bad condition.

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

Station number	North	Vest	Depth (m)
St 1	65°53.457	23°29.294	29
St 2	65°53.471	23°29.171	28
St 3	65°53.420	23°29.129	29
St 4	65°53.323	23°29.033	30
St 5	65°53.272	23°29.987	30
St 6	65°53.236	23°29.139	31
St 7	65°53.286	23°29.190	30
St 8	65°53.357	23°29.202	30
St 9	65°53.367	23°29.150	29
St 10	65°53.386	23°29.285	30

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 2 «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 ten sampling stations with total of thirteen grabs. This indicates that in general there is soft bottom in the local impact zone. The sediment type consisted mainly of clay in the whole farming area. For the group II parameters (pH/Eh), all ten stations had conditions 1 «very good». For sensory parameters (group III) eight stations had condition 1 «very good» and two stations had condition 2 «good». For combined parameters II and III (pH/redox and sensory) eight stations had condition 1 «very good» and two stations had condition 2 «good» (stations 3 and 7). Feed was visible at three stations (st. 2, 3 and 7). Animals were present in all the ten samples mainly in the form of polychaetes.

5 Conclusion

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 stations were sampled, grabs taken with Van Veen grab (0,1 m²), around the 10 cages that are operated at the Gemlufall site during the present production cycle.

For combined parameters II and III (pH/redox and sensory) eight stations had condition 1 «very good» and two stations had condition 2 «good» (stations 3 and 7). The stations with condition 2 «good» were located at the north-eastern (St. 3) and south-western (St. 7) part of the fish farming area. Highest biomass and feeding during the current generation was in the six cages in the northern part of the farming area so the highest organic load in the local impact zone is coherent with the layout of these and the direction of spread current of the site (to south-east). Animals were present in all soft bottom samples. The previous B bottom survey at fallow before putting smolt into sea gave also overall condition 1 «very good». The current results indicate some slight increase in organic load at the site compared to results from the fallow survey in May 2020. The short production period (about 1 year) at the site for the current generation should however be pointed out (salmon to be moved to another site in July 2021).

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.

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Gústavsson, A., 2020. Gemlufall, Arctic Sea Farm hf. B-bottom survey, May 2020 (post fallow period). Akvaplan-niva AS report nr. 62175.B01.

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:	07.07 2021		
Site:		Gemlufall										Site no.:			
Fieldworker:		Snorri Gunnarsson													
Gr	Parameter	Point	Sample number										Index		
	Bottom type: S (soft) or H (hard)		1	2	3	4	5	6	7	8	9	10	S%	H%	
			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	7,7	7,9	8,7	7,8	7,7	7,8	7,6	7,8	7,8	7,9			
	Eh (mV)	ORP	32	39	-134	12	-13	14	-134	-16	7	18			
		plus ref. value	232	239	66	212	187	214	66	184	207	218			
	pH/Eh	from figure	0	0	1	0	0	0	1	0	0	0	0,20		
	Status station			1	1	1	1	1	1	1	1	1			
	Status group II			1	Buffer temp	5,0 C		Sea temp	9,0 C		Sediment temp	8,9 C			
	pH sea		8,09	ORP sea	184 mV		Eh sea	384 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		
			Brown/black (2)			2					2				
Smell		None (0)		0		0	0			0	0				
		Light (2)	2		2				2	2			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)													
	1/4 < v < 3/4 (1)	1													
	v > 3/4 (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				
	2 < t < 8 cm (1)								1						
	t > 8 cm (2)														
Sum			3,0	2,0	6,0	2,0	2,0	4,0	7,0	2,0	2,0	4,0			
Corrected (*0,22)			0,7	0,4	1,3	0,4	0,4	0,9	1,5	0,4	0,4	0,9	0,75		
Status station			1	1	2	1	1	1	2	1	1	1			
Status group III			1												
Average group II & III			0,3	0,2	1,2	0,2	0,2	0,4	1,3	0,2	0,2	0,4	0,47		
Status station			1	1	2	1	1	1	2	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			
Grabb ID		K-3													
pH / Eh ID		Ysi Professional plus													
page 1 of 2 pages															



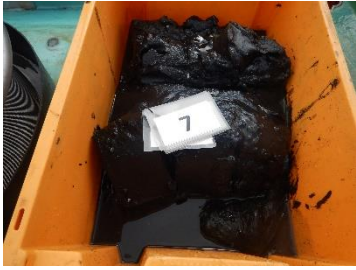







Sample Scheme B.2

Company:		Arctic Sea Farm								
Site:		Gemlufall								
Fieldworker:		Snorri Gunnarsson								
Date:		07.07 2021								
Site no.:		0								

Sample number	1	2	3	4	5	6	7	8	9	10
Depth (m)	29	28	29	30	30	31	30	30	29	30
Number of trials	2	2	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
	Silt									
	Sand									
	Gravel									
	Shellsand									
Reef										
Rocky bottom (cobbles, boulders)										
Echinodermata, count										
Crustaceans, count										
Molluscs, count										
Polychaetes, count	>10	>50	>50	>50	>30	>50	>10	>10	>100	>30
Other animals, count										
<i>Beggiatoa</i>										
Feed										
Faeces		Yes	Yes				Yes			
Comments										
Grab	Area [m ²]						Grab ID			K-3
Signature fieldworker:	Snorri Gunnarsson									

7.2 Pictures of samples at Gemlufall

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

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

7.3 Bottom topography and 3D view

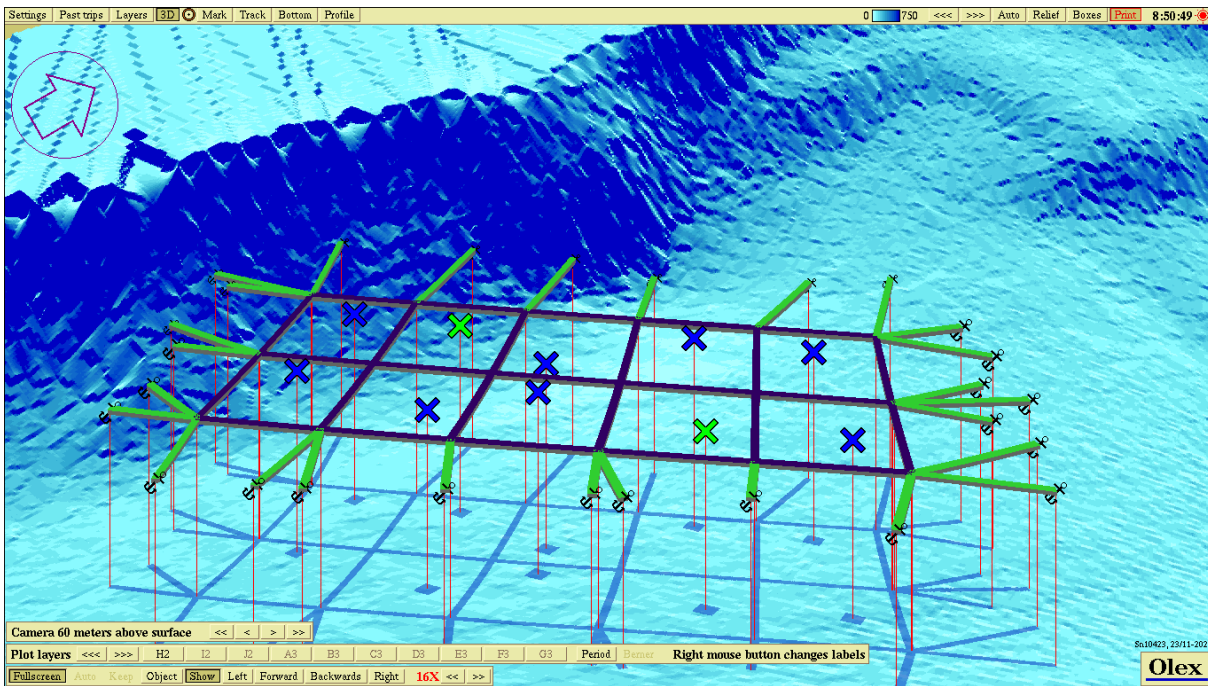


Figure 3. Showing bottom topography 3D at Gemlufall with each sampling station according to info in figure 2 and Table 3.