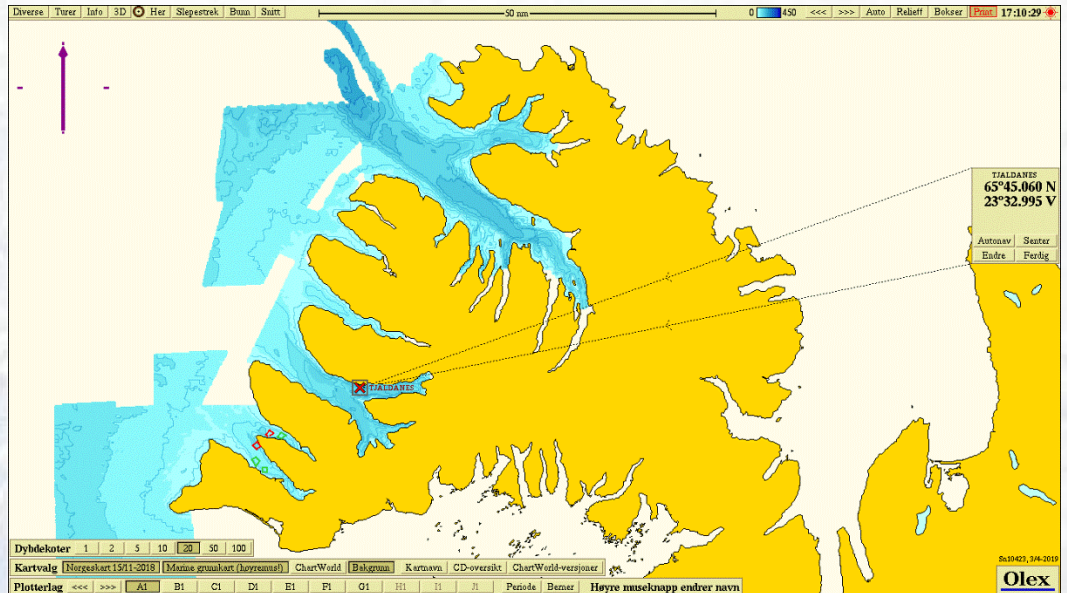




Tjaldanes, Arnarlax  
B-bottom survey,  
July 2020  
(maximum biomass survey)



Information client			
Title	Tjaldanes, Arnarlax. B-bottom survey, July 2020		
Report number	APN-62351.B01		
Site name	Tjaldanes	Coordinates site	65°54.060 N 023°32.995 V
County	Ísafjarðarbær	Municipality	Ísafjarðarbær
MTB-or estimated max biomass	4.850 ton	Site manager/contact	Sija Baldvinsdóttir
Client name	Arnarlax		

Biomass/production/status at date of survey			
Biomass at date of survey	3.700 ton	Feed use	4.478
Fish type	Salmon	Amount produced	
<b>Type/time of survey</b>	<b>Mark with X</b>	<b>Comments</b>	
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	2,00	Gr. II. pH/Eh	2
Gr. III. Sensory	1,46	Gr. III. Sensory	2
GR. II + III	1,73	GR. II+ III	2
<b>Date field work</b>	15.07 2020	<b>Date report</b>	21.10.2020
<b>Site status (NS 9410:2016):</b>			<b>2</b>

Report writing and project leader	Snorri Gunnarsson	Signature	
Quality control	Arnþór Gústavsson	Signature	

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# Preface

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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 maximum biomass survey (MTB) as they are defined in NS9410:2016. There is a requirement of at least 16 sampling stations within the mooring lines of the fish farm. The estimated max biomass for the current generation farmed salmon at the site Tjaldanes is 4.850 MTB ton. The methods applied in this pre-survey follow guidelines in chapter 5 (NS6410:216) and fulfil the requirements described in ISO 12878. The survey deviates though from chapter 7.6 in NS9410:2016 regarding sampling. 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 Tjaldanes was done 15.07 2020.

## Accredited survey:


The following parts of the survey are done in accordance to 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 Arnarlax and their personnel for the cooperation during the conductance of this site survey.

Kópavogi 21. oktober 2020

  
Snorri Gunnarsson  
Project manager

# 1 Introduction

---

The sampling date for the present site survey was 15.07 2020 and done by Akvaplan-niva AS contracted by Arnarlax in relation to the company's fish farming activity at the site Tjaldanes in Arnarfjörður, 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 feasibility assessment of the site for fish farming activity.

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

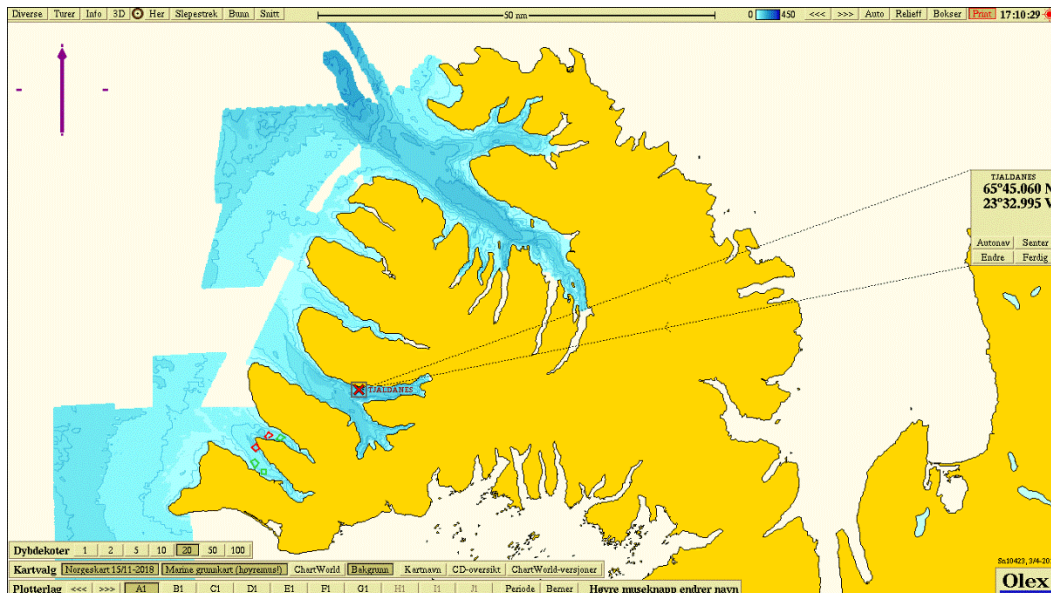


Figure 1. An overview map with the Tjaldanes site marked by its name with a red cross.

## 2 Professional program and methods

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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 cm<sup>2</sup>). 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"><li>- Condition 1 – next site survey at next max biomass</li><li>- Condition 2 – next site survey at next 50% max biomass and at max biomass</li><li>- 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</li></ul> 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 m<sup>2</sup>)

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

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### 3.1 Info site operation

Tjaldanes site is coming to an end of the first production cycle after installing a new frame for cages further to west and into the fjord than the previous site. The current generation was started with putting out smolts during summer/fall 2019. The fish farm at the site is a 2 x 5 cage mooring system, having a total of 10 cages each with 160 m circumference. During the present production cycle all 10 cages of have been used (Silja Baldvinsdóttir, pers. info).

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

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

Generation of fish (G)	Production (ton)*	Feed usage (ton)
Present generation	3.700	4.478

\*standing biomass at date of survey

### 3.2 Present and past site surveys

There was done a base line study (B-survey) at the site prior to putting fish into sea (Gunnarsson, 2019) with sampling date 7.03 2019. Bottom was described as muddy for the most part with some hard bottom closer to shore at less depths and visual and chemical parameters did not show any signs of organic load at the site. Redox potential was positive at all eleven sampling stations.

Table 3. Past site studies for Tjaldanes site

Date of sampling	Report number	Survey type	Overall site status
07.03.2019	APN-60976.01	B survey new site	1

### 3.3 Dispersing current

Measurement of dispersing current was done at the site in November 2013 – January 2014 measurements at 60 m depth (Moe and Ottesen, 2014). Dominating current (60 m) is in direction southeast (130 degrees). Average current speed is measured to be 5.0 cm/s. Highest current speed is measured to be 53 cm/s and 2.7 % of the measurements are < 1 cm/s.

### 3.4 Position of sampling stations

Description of the 16 stations in the survey is given in figure 2 and table 3. Positioning of the stations was chosen based on guidance and perimeters described in NS 9410:2016 and spread around the periphery of the cages. At Tjaldanes site the typical depth in the local impact zone is in the range from 60 – 104 m, with increasing depth into the fjord in southwards direction. 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

66 to 104 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.

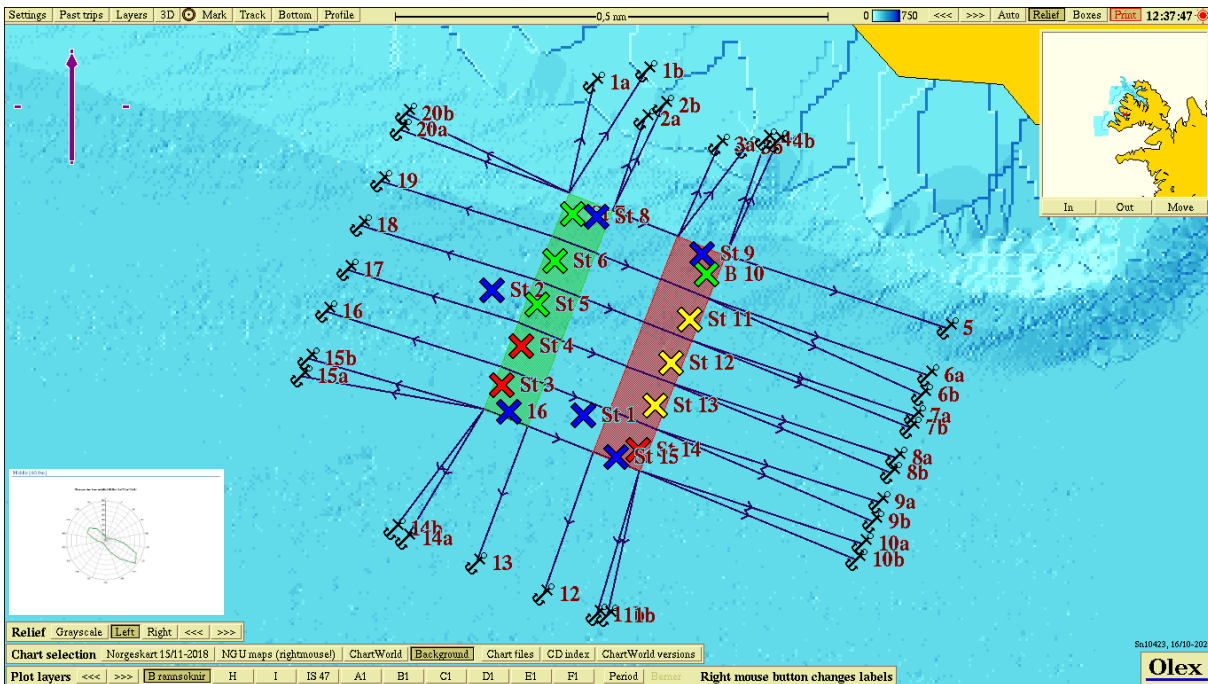


Figure 2. Chart showing depths at the site Tjaldanes. Sampling stations st. 1 – 16 are marked with color codes that describe the condition according to NS 9410:2016, chapter 7.11. Color codes: Blue = very good condition, green = good condition, yellow = bad condition, red = very bad condition.

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

Station number	North	Vest	Depth (m)
St 1	65°44.987	23°32.983	101
St 2	65°45.131	23°33.240	88
St 3	65°45.021	23°33.211	97
St 4	65°45.067	23°33.157	96
St 5	65°45.115	23°33.111	89
St 6	65°45.165	23°33.061	78
St 7	65°45.219	23°33.013	67
St 8	65°45.216	23°32.945	66
St 9	65°45.173	23°32.649	76
St 10	65°45.150	23°32.636	83
St 11	65°45.098	23°32.684	93
St 12	65°45.047	23°32.734	100
St 13	65°44.998	23°32.781	102
St 14	65°44.947	23°32.829	104
St 15	65°44.939	23°32.890	104
St 16	65°44.991	23°33.193	96



## 4 Results

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Results for the different parameters are given in Table 5. The overall site condition is 2 «good». The status for group II (pH/Eh), group III (sensory) and average group II + III parameters is status 2 «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)	2
Group III – parameters, (sensory)	2
Group II + III – parameters (mean value)	2
Site condition	2

There were collected valid sediment samples at fifteen out of the total sixteen sampling stations. This indicates that in general there is soft bottom in the local impact zone. The sediment type consisted mainly of clay and at two stations mixture of clay and gravel and one station defined as hard bottom (station 8). For the group II parameters (pH/Eh), eight stations had conditions 1 «very good», one station had condition «good», four stations had condition «bad» and three stations had condition «very bad». For sensory parameters (group III) six stations had condition 1 «very good» seven stations had condition 2 «good», two stations had condition 3 «bad» and one station had condition «very bad». For combined parameters II and III (pH/redox and sensory) six stations had status 1 «very good», four stations had condition «good», three stations had condition «bad» and three station had condition «very bad» (stations 3, 4 and 14). Animals where present in all the fifteen soft bottom samples mainly in the form of polychaetes

## 5 Conclusion

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Based on the criteria given in NS 9410:2016 the fish farming site has been assigned a site condition 2 « good» at the date of sampling. A total of 22 grabs were taken with Van Veen grab (0,1 m<sup>2</sup>), divided on 16 stations placed around the cages that are operated at the Tjaldanes site during the present production cycle. For combined parameters II and III (pH/redox and sensory) six stations had status 1 «very good», four stations had condition «good», three stations had condition «bad» and three station had condition «very bad» (stations 3, 4 and 14). The three stations with bad condition are placed in the deeper end of the site (south) and the three stations with bad condition at the eastern part of the site so the accumulation of organic load seems to occur more at the direction southeast which is the same direction as the spread current for the site. Three stations had some gas bubbles noted in the sample (stations 3, 11 and 14). Animals were present in all samples. This indicates some organic load at the Tjaldanes site that has accumulated in the local impact zone during the current production cycle but the previous B survey before putting smolt into sea gave overall condition 1 «very good». In the next B survey close attention should be given to the areas in the south and east part of the local impact zone.

**The site is assigned a condition factor 2 "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

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

Gunnarsson, S. 2019. Tjaldaneseyrar, Arnarlax hf, Forundersøkelse (B-undersøkelse) mars 2019. Akvaplan-niva AS report nr. 660976.01.

Moe, A.A. and Ottesen, K. 2014. Current investigation at finfish farm site Tjaldaneseyrar November 2013. Helgeland Havbruksstasjon AS. 30 s.

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.

[www.fiskeridir.no](http://www.fiskeridir.no)

# 7 Appendix:

## 7.1 Sheet (B.1 og B.2) NS 9410:2016

Sample scheme B.1															
Company		Arnarlax													
Site:		Tjaldanes, max biomass													
Fieldworker:		Snorri Gunnarson (SGU)													
Date:		15.07 2020													
Site no.:															
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	H	S	S			
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0	0	0	0	0			
II	pH	value	7,7	7,6	6,6	6,6	7,2	7,4	7,2		7,4	7,1			
	Eh (mV)	ORP	243	191	-210	-291	-142	-160	-250		-15	-295			
		plus ref. verdi	443	391	-10	-91	58	40	-50		185	-95			
	pH/Eh	from figure	0	0	5	5	1	1	2	0	0	3			
	Status station			1	1	4	4	1	1	2	1	1	3		
	Buffer-temp			C			Sea temp			C					
	Sediment temp			C			Reference electrode			200,0 mV					
	pH sea			ORP sea			mV			Eh sea			mV		
	Reference electrode			200,0 mV											
	III	Gas bubbles	Yes (4) No (0)	0	0	4	0	0	0	0	0	0	0		
Colour		Light/grey (0)	0	0						0					
		Brown/black (2)			2	2	2	2	2		2	2			
Smell		None (0)	0	0						0		0			
		Light (2)			2	2	2	2	2		2				
		Strong (4)													
Consistency		Solid (0)	0	0						0		0			
		Soft (2)			2	2	2	2	2		2				
		Aqueous (4)													
Grab volume (v)		v < 1/4 (0)					0	0	0	0	0				
	1/4 < v < 3/4 (1)										1				
	v > 3/4 (2)	2	2	2	2										
Thickness of sludge (t)	t < 2 cm (0)	0	0			0	0		0	0					
	2 < t < 8 cm (1)			1	1			1			1				
	t > 8 cm (2)														
Sum			2,0	2,0	13,0	9,0	6,0	6,0	7,0	0,0	6,0	4,0			
Corrected (*0,22)			0,4	0,4	2,9	2,0	1,3	1,3	1,5	0,0	1,3	0,9			
Status station			1	1	3	2	2	2	2	1	2	1			
Average group II & III			0,2	0,2	3,9	3,5	1,2	1,2	1,8	0,0	0,7	1,9			
Status station			1	1	4	4	2	2	2	1	1	2			
Grab ID	Kyst K-3														
pH/ Eh ID	Ysi professional plus														

## Sample scheme B.1

Company:	Arnarlax
Site:	Tjaldanes, max biomass
Fieldworker:	Snorri Gunnarson (SGU)

Date:	15.07 2020
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							94	6	
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0									
II	pH	value	6,9	7,0	7,0	6,7	7,5	7,2									
	Eh (mV)	ORP	-45	-220	-269	-211	-45	-133									
		plus ref. verdi	155	-20	-69	-11	155	67									
	pH/Eh	from figure	3	3	3	5	0	1								2,00	
	Status station			3	3	3	4	1									
	Status group II			2	Buffer temp		0,0 C		Sea temp		0,0 C		Sediment temp		0,0 C		
	pH sea		0	ORP sea		0 mV		Eh sea		mV		Reference electrode		200 mV			
	III	Gas bubbles	Yes (4) No (0)	4	0	0	4	0	0								
		Colour	Light/grey (0)					0									
			Brown/black (2)	2	2	2	2		2								
Smell		None (0)						0									
		Light (2)	2	2	2		2										
		Strong (4)					4										
Consistency		Solid (0)					0	0									
		Soft (2)	2	2	2	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										
Thickness of sledge (t)		t < 2 cm (0)					0	0									
		2 < t < 8 cm (1)	1	1	1	1											
		t > 8 cm (2)															
Sum			12,0	9,0	9,0	15,0	4,0	2,0									
Corrected (*0,22)			2,6	2,0	2,0	3,3	0,9	0,4							1,46		
Status station			3	2	2	4	1	1									
Status group III			2														
Average group II & III			2,8	2,5	2,5	4,2	0,4	0,7							1,73		
Status station			3	3	3	4	1	1									
Status group II & III			2														
pH/Eh																	
Corr.sum																	
Index																	
Average																	
< 1,1			1														
1,1 - <2,1			2														
2,1 - <3,1			3														
≥3,1			4														
Status site:			2														

Grab ID	Kyst K-3
pH / Eh ID	Ysi professional plus

## Sample scheme B.2

Company:	Arnarlax	Date:	15.07 2020
Site:	Tjaldanes, max biomass	Site no.:	0
Fieldworker:	Snorri Gunnarson (SGU)		

Sample number	1	2	3	4	5	6	7	8	9	10
Depth (m)										
Number of trials	1	1	1	1	2	3	1	4	1	1
Gas bubbles (in sample)	No	No	Yes	No	No	No	No		No	No
Sediment type	Clay	X	X	X	X	X	X	X	X	X
	Silt									
	Sand									
	Gravel								X	
	Shellsand									
Reef										
Rocky bottom (cobble, boulders)										
Echinodermata, count									1	
Crustaceans, count										
Molluscs, count	>50	>50	>5	>40	>10	>50	>20		>20	>100
Polychaetes, count										
Other animals, count										
<i>Beggiatoa</i>										
Feed			X	X			X			X
Faeces										
Comments										
Grab	Area [m <sup>2</sup> ]	0,1			Grab ID	Kyst K-3				











## Sample scheme B.2

Company:		Arnarlax					Date:		15.07 2020		
Site:		Tjaldanes, max biomass					Site no.:		0		
Fieldworker:		Snorri Gunnarson (SGU)									









  





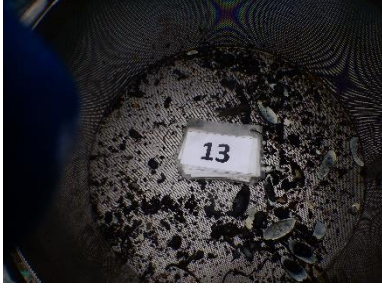


Sample number	11	12	13	14	15	16	17	18	19	20
Depth (m)										
Number of trials	1	1	1	1	1	1				
Gas bubbles (in sample)	Yes	No	No	Yes	No	No				
Sediment type	Clay	X	X	X	X	X	X			
	Silt									
	Sand									
	Gravel						X			
	Shellsand									
Reef										
Rocky bottom (cobble, boulders)										
Echinodermata, count										
Crustaceans, count										
Molluscs, count										
Polychaetes, count										
Other animals, count	>50	>10	>5	>5	>50	>100				
<i>Beggiatoa</i>										
Feed										
Faeces	X	X		X						
Comments										
Grab	Area [m <sup>2</sup> ]	0,1	Grab ID		Kyst K-3					
Signature fieldworker:										

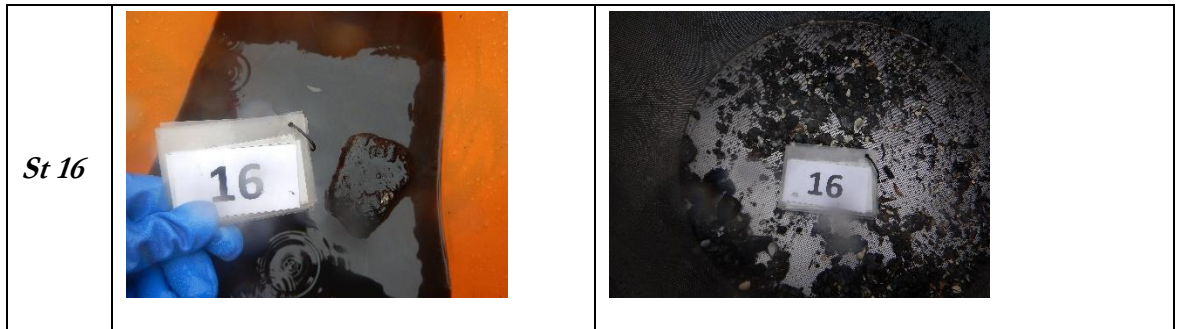
## 7.2 Pictures of samples at Tjaldanes

<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>	NA	NA
<i>St 9</i>		
<i>St 10</i>		

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



### 7.3 Bottom topography and 3D view

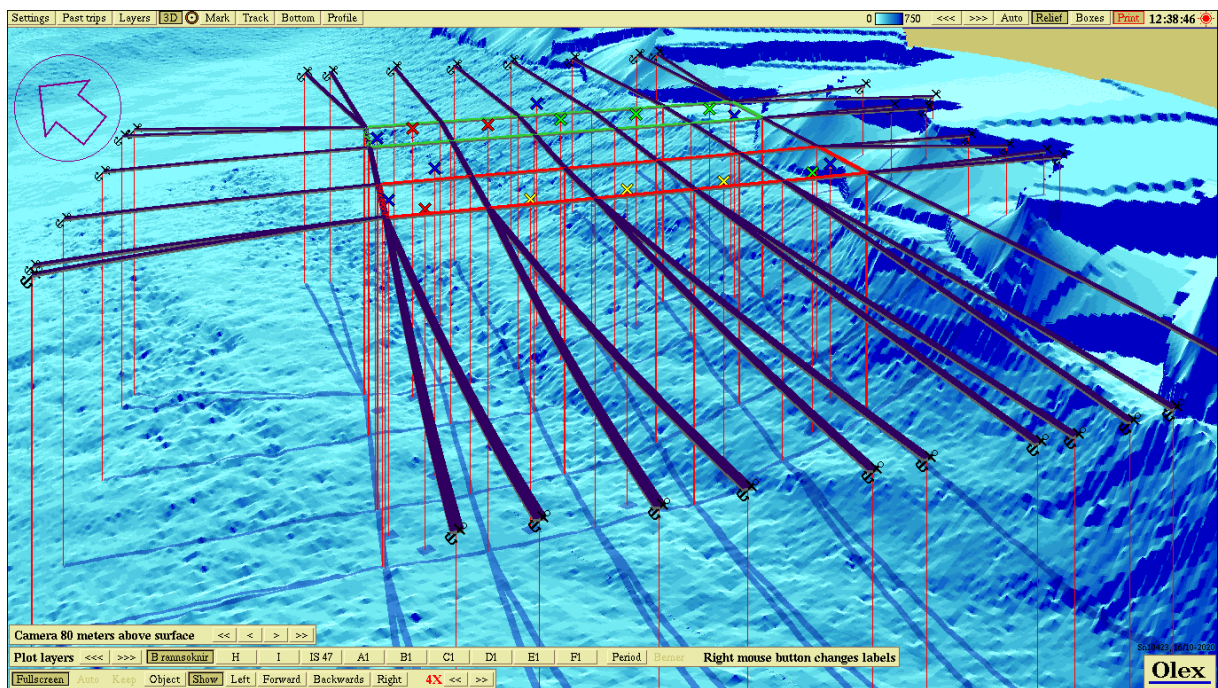


Figure 3. Showing bottom topography 3D at Tjaldanes with each sampling station according to info in figure 2 and Table 3.