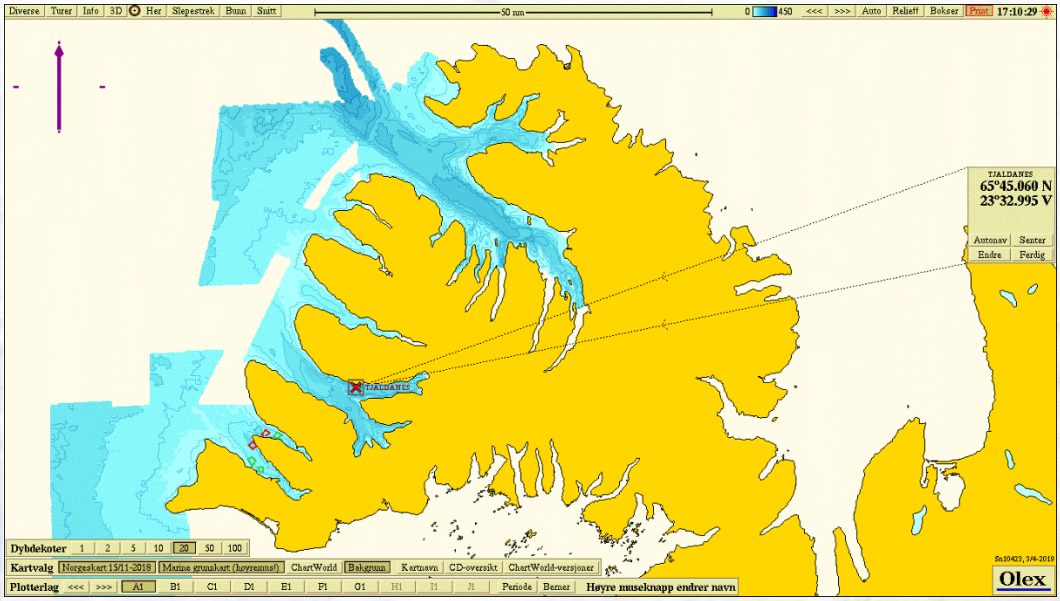
Akvaplan niva

Rapport Report

Tjaldanes, Arnarlax
B-bottom survey (fallow period),
June 2021



NORSK AKKREDITERING
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Akvaplan-niva AS: APN 63266.B01

Akvaplan-niva AS
Rådgivning og forskning innen miljø og akvakultur
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Information client			
Title	Tjaldanes, Arnarlax. B-bottom survey (fallow period), June 2021		
Report number	APN-63266.B01		
Site name	Tjaldanes	Coordinates site	65°54.060 N 023°32.995 V
County	Ísafjarðarbær	Municipality	Ísafjarðarbær
MTB-or estimated max biomass	5.681 ton	Site manager/contact	Silja Baldvinsdóttir
Client name	Arnarlax		

Biomass/production/status at date of survey			
Biomass at date of survey	0 ton	Feed use	0
Fish type	Salmon	Amount produced	

Type/time of survey	Mark with X	Comments
At maximal biomass see kap 7.9	☐	
A follow up survey	☐	
Half maximal biomass	☐	
Survey prior to putting out smolt	☒	
A pre-survey new site	☐	
Other	☐	
Last fallowing period:		

Results from B-survey iht. NS 9410:2016 (main results)			
Parameters and indexes		**Parameters and site status**	
Gr. II. pH/Eh	0,94	Gr. II. pH/Eh	1
Gr. III. Sensory	1,16	Gr. III. Sensory	2
GR. II + III	1,09	GR. II+ III	1
Date field work	04.06 2021	**Date report**	22.09.21
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 in the local impact zone. 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 current study is carried out during the fallow period at Tjaldanes. 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. There is a requirement of 17 sampling stations within the mooring lines of the fish farm. The estimated max biomass for the next generation farmed salmon at the site Tjaldanes is 5.681 ton.

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 04.06 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 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.

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Akvaplan-niva AS thanks Arnarlax and their personnel for the cooperation during the conductance of this site survey.

Kópavogi 22. september 2021

Snorri Gunnarsson
Project manager

1 Introduction

The sampling date for the present site survey was 04.06 2021 and done by Akvaplan-niva AS contracted by Arnarlax in relation to the company's fish farming activity at the site Tjaldanes in Arnarfjörður, Ísafjarðabær municipality. The current study is carried out during the fallow period at Tjaldanes.

The objective of this 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 impact assessment of the site from fish farming activity.

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

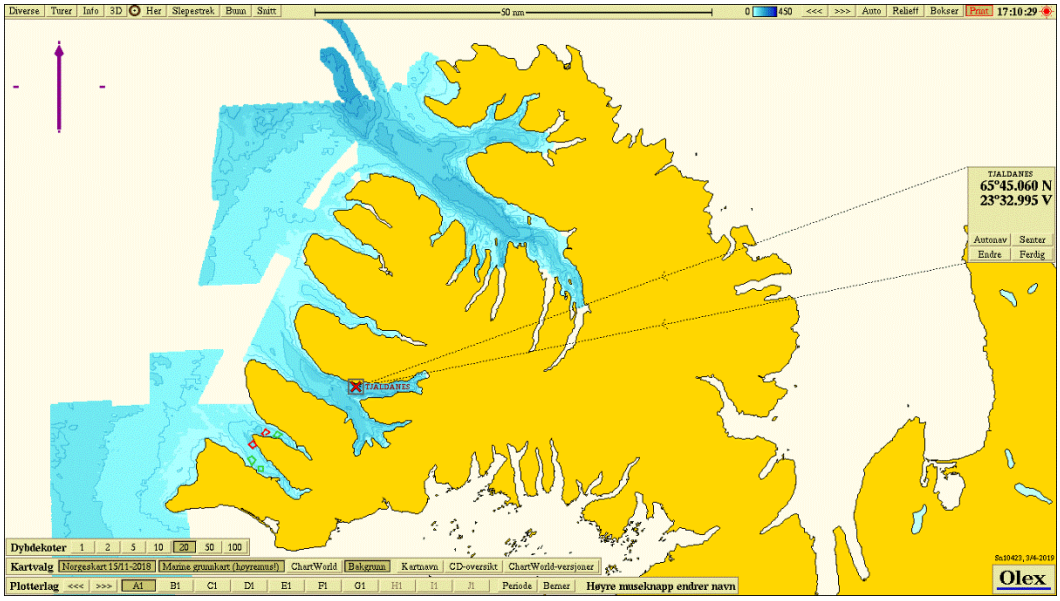

Figure 1. An overview map with the Tjaldanes site market by its name with a red cross.

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 cm^2). 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: - 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 m^2)
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 Tjaldanes site is located in Arnarfjörður about 7.5 km north from Bíldudalur. The cages are lined in a southern direction from land (201 degrees). The depth under cages ranges from about 60 - 104 m.

Tjaldanes has been in a fallow since 21st of March 2021. The previous generation at the Tjaldanes site was the first production cycle after installing a new frame for cages further to west and into the fjord than the previous site. The previous generation farmed at the site was started with putting out smolts in the period summer/fall 2019 and ended in March 2021. 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 or 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)
Generation 2019 - 2021	7.090	8.378

3.2 Present and past site surveys

Previously 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 and a B survey at max biomass (Gunnarsson, 2020) with sampling date 15.07 2020 (Table 3). In the pre-survey 2019 the 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.

The results from the from the survey at max biomass in 2020 indicated some organic load mainly at the deeper (southern part of the site). Of the total of 16 stations, three stations had condition «very bad» and three stations had condition «bad» for the combined parameters II and III (pH/redox and sensory) and overall site condition was 2 «good».

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
15.07 2020	APN-62351.B01	B survey max biomass	2

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 17 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. At the site the typical depth in the local impact zone is in the range from 60 – 104 m, with a deeper area into the fjord (SSV). 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 71 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.

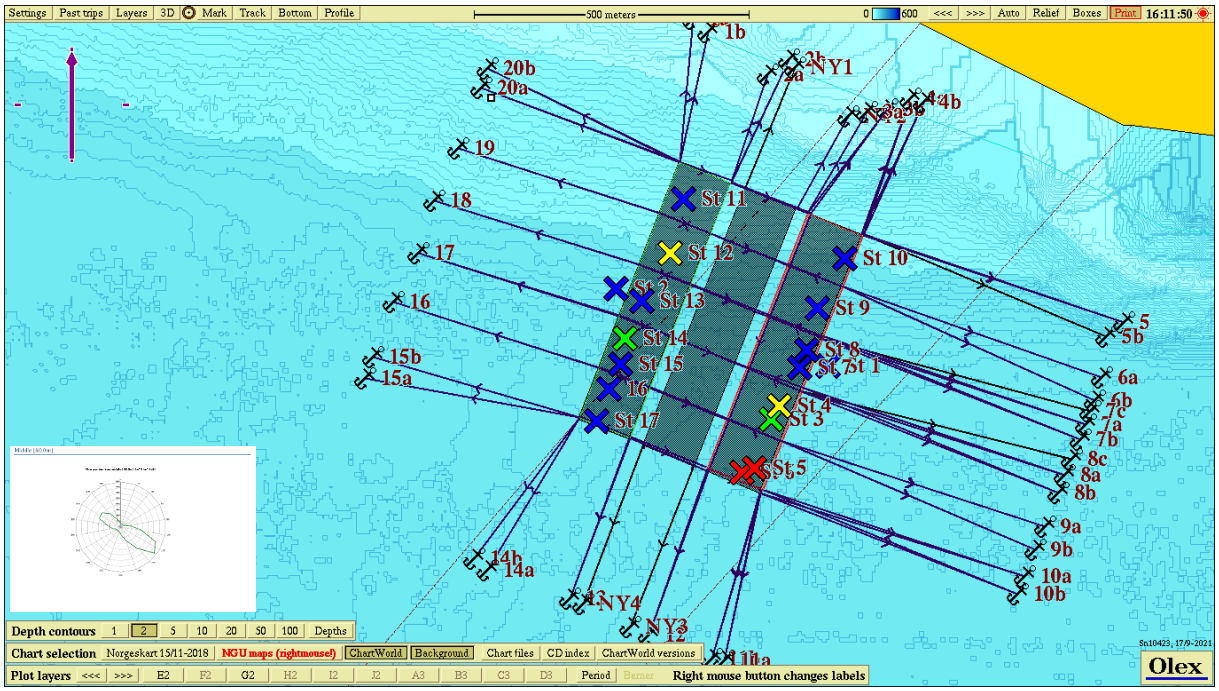

Figure 2. Chart showing depths at the site Tjaldanes. Sampling stations st. 1 – 17 are marked with color codes that describe the condition according to NS 9410:2016, chapter 7.11. Color codes: Blue = very good condition, green = good condition, yellow = bad condition, red = very bad condition.

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

Station number	North	West	Depth (m)
St 1	65°45.044	23°32.668	99
St 2	65°44.044	23°32.081	90
St 3	65°44.044	23°32.803	102
St 4	65°45.044	23°32.784	102
St 5	65°44.044	23°32.844	104
St 6	65°44.044	23°32.873	104
St 7	65°45.044	23°32.734	99
St 8	65°45.044	23°32.719	98
St 9	65°45.044	23°32.693	92
St 10	65°45.044	23°32.628	83
St 11	65°45.044	23°33.012	71
St 12	65°45.044	23°33.044	81
St 13	65°45.044	23°33.113	91
St 14	65°45.044	23°33.153	96
St 15	65°45.044	23°33.163	97
St 16	65°45.044	23°33.191	98
St 17	65°44.044	23°33.220	96

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)	2
Group II + III – parameters (mean value)	1
Site condition	1

There were collected valid sediment samples at all the seventeen sampling stations. 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 and mixture of clay and gravel on the western side of the farming area. At one sampling station (12) it was not possible to measure pH/redoks values due to aqueous state of the sample. Some feed was detected at stations 5 and 12 and gas was detected at two stations (4 and 5) both at the southeast corner of the fish-farming area. For the group II parameters (pH/Eh), eleven stations had conditions 1 «very good», two stations had condition 2 «good», two stations had condition 3 «bad » and one station had condition 4 «very bad». For sensory parameters (group III) nine stations had conditions 1 «very good», five stations had condition 2 «good», one station had condition 3 «bad » and two stations had condition 4 «very bad». For combined parameters II and III (pH/redox and sensory) eleven stations had conditions 1 «very good», two stations had condition 2 «good», two stations had condition 3 «bad » and two stations had condition 4 «very bad». Animals where present in all but one sample (station 5) 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 20 grabs were taken with Van Veen grab (0,1 m^2), divided on 17 stations placed around the 10 cages that are operated at the Tjaldanes site during the last production cycle.

For combined parameters II and III (pH/redox and sensory) eleven stations had conditions 1 «very good», two stations had condition 2 «good», two stations had condition 3 «bad » and two stations had condition 4 «very bad». The stations status 4 (stations 5 and 6) are both located at the southeast site of the fish farming area where most organic load seems to be. The dominating current (39 m) is in direction south-east (130 degrees) with a smaller counter current in north-west direction. The apparent higher accumulation of organic material on the eastern and southern edge is therefore coherent with the main directions of spread current. Animals were present in all but one soft bottom samples and some gas was detected at two sampling station at the southeast side of the farming area.

The previous B bottom survey at max biomass in 2020 gave an overall condition 2 «good» and the results indicated some organic load mainly at the deeper (southern part of the site). Of the total of 16 stations, three stations had condition «bad» and three stations had condition «very bad» for the combined parameters II and III (pH/redox and sensory) and overall site condition was 2 «good». Overall, the condition at Tjaldanes has improved since the previous B-survey as the overall site condition has improved and there are fewer stations with status 3 and 4 for the combined parameters II and III (pH/redox and sensory). Taken together the results from both surveys indicate greatest organic load in the deeper areas of the fish farm and to greater extent in the southeast part coherent with the direction of the spread current at the site.

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.

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

Gunnarsson, S. 2019. Tjaldanes, Arnarlax, B bottom survye, July 2020 (maximum biomass survey). APN report nr. 62351.01.

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 akvakultur-anlegg.

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7 Appendix:

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

Sample scheme B.1

Company	Arnarlax	Date:	04.06 2021
Site:	Tjaldanes at fallow	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	1	0	0	0	0	0
II	pH	value	7,8	7,4	7,1	7,0	6,4	6,9	7,6	7,8	7,6	7,4
	Eh (mV)	ORP	129	115	-214	-231	-25	-289	-7	-85	-26	-65
		plus ref. verdi	329	315	-14	-31	175	-89	193	115	174	135
	pH/Eh	from figure	0	0	2	3	5	3	0	0	0	0
	Status station		1	1	2	3	4	3	1	1	1	1
			Buffer-temp	5,0 C		Sea temp	6,1 C		Sediment temp		2,0 C	
		pH sea 8,12	ORP sea	184,0 mV		Eh sea	384,0 mV		Reference electrode		200,0 mV	
III	Gas bubbles	Yes (4) No (0)	0	0	0	0	4	4	0	0	0	0
	Colour	Light/grey (0)	0	0	2	2	2	2	2	0	0	0
		Brown/black (2)										
	Smell	None (0)	0	0						0		0
		Light (2)			2	2			2		2	
		Strong (4)					4	4				
	Consistency	Solid (0)	0	0	0	0			0	0	0	0
		Soft (2)					2	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 slidge (t)	t < 2 cm (0)	0	0						0	0	0
		2 < t < 8 cm (1)			1	1	1	1	1			
		t > 8 cm (2)										
		Sum	2,0	2,0	7,0	7,0	15,0	15,0	7,0	2,0	4,0	1,0
		Corrected (*0,22)	0,4	0,4	1,5	1,5	3,3	3,3	1,5	0,4	0,9	0,2
	Status station		1	1	2	2	4	4	2	1	1	1
	Average group II & III		0,2	0,2	1,8	2,3	4,2	3,2	0,8	0,2	0,4	0,1
	Status station		1	1	2	3	4	4	1	1	1	1

Grab ID	K-3
pH / Eh ID	YSI-professional plus

page 1 of 4 pages

Sample scheme B.1

Company:	Arnarlax	Date:	04.06 2021
Site:	Tjaldanes at fallow	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	S				100	0
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0	0					
II	pH	value	7,7	ut	7,4	7,3	7,6	7,9	7,7					
	Eh (mV)	ORP	-7	ut	-50	-240	-29	42	-96					
		plus ref. verdi	193		150	-40	171	242	104					
	pH/Eh	from figure	0	ut	0	2	0	0	0				0,94	
		Status station	1	ut	1	2	1	1	1					
		Status group II	1	Buffer temp	5,0 C		Sea temp	6,1 C		Sediment temp	2,0 C			
		pH sea 8,12	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					
	Colour	Light/grey (0)	0	2	2	2	0	0	0					
		Brown/black (2)												
	Smell	None (0)	0				0	0	0					
		Light (2)		2	2	2								
		Strong (4)												
	Consistency	Solid (0)	0			0	0	0	0					
		Soft (2)			2									
		Aqueous (4)		4										
	Grab volume (v)	v < 1/4 (0)	0		0									
		1/4 < v < 3/4 (1)		1					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	1									
		t > 8 cm (2)												
		Sum	0,0	10,0	7,0	6,0	2,0	2,0	1,0					
		Corrected (*0,22)	0,0	2,2	1,5	1,3	0,4	0,4	0,2				1,16	
		Status station	1	3	2	2	1	1	1					
		Status group III	2											
		Average group II & III	0,0	2,2	0,8	1,7	0,2	0,2	0,1				1,09	
		Status station	1	3	1	2	1	1	1					
		Status group II & III	1											

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: 1

Grab ID	K-3
pH / Eh ID	YSI-professional plus

Sample scheme B.2

Company:	**Arnarlax**	**Date:**	**04.06 2021**
Site:	**Tjaldanes at fallow**	**Site no.:**	**0**
Fieldworker:	**Snorri Gunnarsson**		

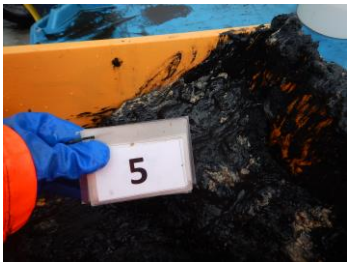
Sample number		1	2	3	4	5	6	7	8	9	10
Depth (m)		100	89	102	102	104	104	99	98	92	83
Number of trials		1	1	1	1	1	1	1	1	1	1
Gas bubbles (in sample)		No	No	No	No	Yes	Yes	No	No	No	No
Sediment type	**Clay**	X	X	X	X	X	X	X	X	X	X
	Silt										
	Sand										
	Gravel									X	
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count				1			1				
Molluscs, count											
Polychaetes, count		<50	<50	3	2		2	<50	<100	<20	<100
Other animals, count											
Beggiatoa											
Feed						X					
Faeces											
Comments		Lots of feed in grab sample at station 5									
Grab		**Area [m^2]**		0,1		**Grab ID**			K-3		

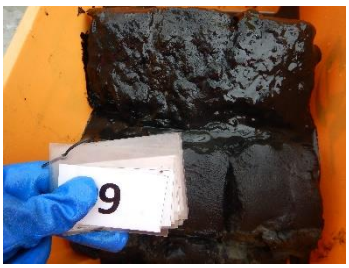
Sample scheme B.2

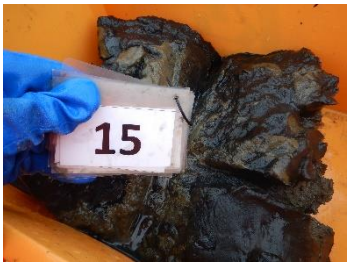
Company:	**Arnarlax**	**Date:**	**04.06 2021**
Site:	**Tjaldanes at fallow**	**Site no.:**	**0**
Fieldworker:	**Snorri Gunnarsson**		

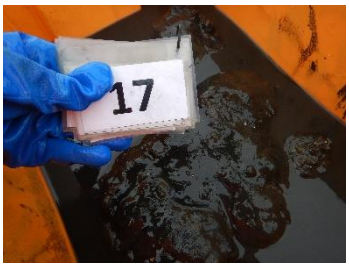
Sample number		11	12	13	14	15	16	17	18	19	20
Depth (m)		71	81	91	96	97	98	96			
Number of trials		1	3	1	2	1	1	1			
Gas bubbles (in sample)		No	No	No	No	No	No	No			
Sediment type	**Clay**	X	X	X	X	X	X	X			
	Silt										
	Sand	X	X	X				X			
	Gravel					X		X			
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count											
Polychaetes, count		<50	<20	15	<10	<50	<50	<50			
Other animals, count											
Beggiatoa											
Feed			X								
Faeces			X								
Comments		Grab sample station 12 watery/loose therefore no pH and redox measurement. Some feed/feces in sample.									
Grab		**Area [m^2]**		0,1		**Grab ID**			K-3		
Signature fieldworker:											

7.2 Pictures of samples at Tjaldanes

St 1		
St 2		
St 3		
St 4		
St 5		

St 6		
St 7		
St 8		
St 9		
St 10		

St 11	NA	
St 12		
St 13	NA	
St 14		
St 15		

St 16		
St 17		

7.3 Bottom topography and 3D view

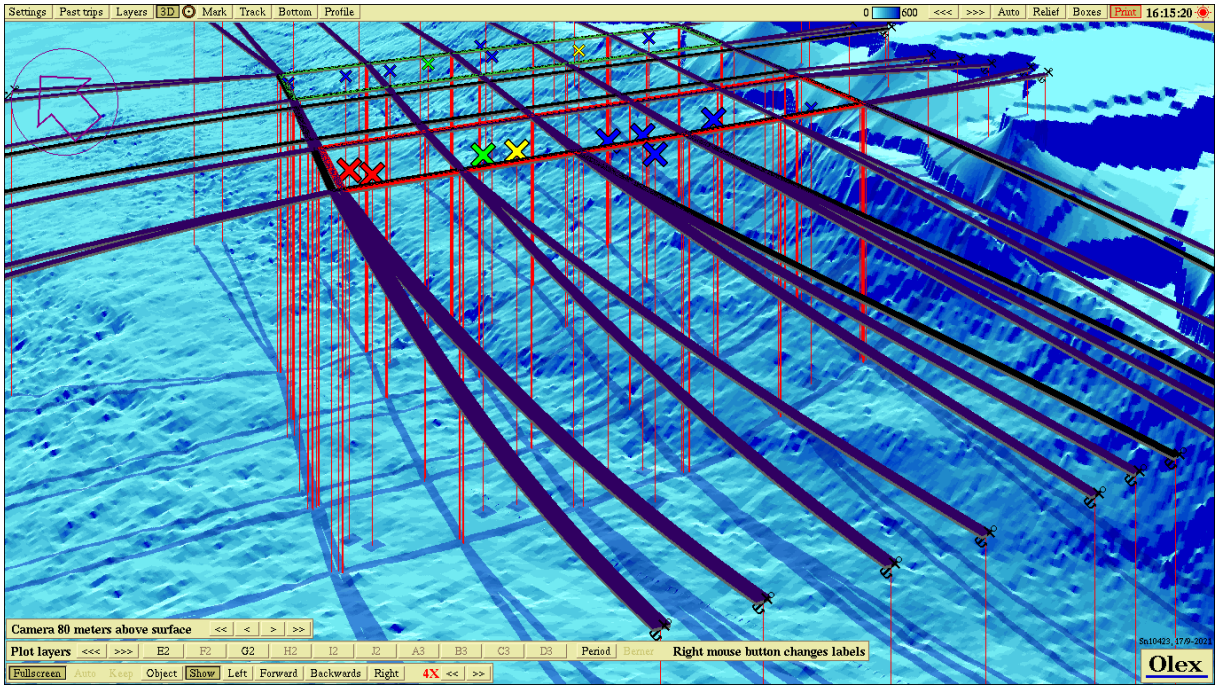


Figure 3. Showing bottom topography 3D at Tjaldanes with each sampling station according to info in figure 2 and Table 3.