Arnarlax, C-survey at Tjaldanes (fallow period), June 2021.

Akvaplan-niva AS Report: 2021 63266.01

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Summary

The results from the monitoring at the farming site Tjaldanes in June 2021 showed that the sediment was somewhat loaded with organic carbon however the copper concentrations were within the natural levels for bottom sediment recorded around Iceland (Egilsson *et al.*, 1999). There was a load effect recorded in the fauna and faunal index, nEQR, which showed moderate to bad conditions at all stations (<0.6). The diversity index H' was below 3 at all stations. The NS 9410:2016-assessment of the community in the local impact zone (C1) showed environmental condition 1 (Very good). The pollution indicator species *Capitella capitata* was recorded among the top-10 species at stations C1, C3, C4 and C5. The redox measurements (pH/Eh) gave point 0 acc., Appendix D in NS 9410:2016, for all the stations. The oxygen saturation in June was good throughout the whole water column with 83 % saturation in the bottom water.

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Preface

Akvaplan-niva carried out an environmental survey of type C (NS 9410:2016) at the Tjaldanes site. It included pH/redox measurements (Eh), hydrography, geochemical analyses and analyses of the bottom fauna from five stations at the fish farming site. The following personnel contributed to this work:

Snorri Gunnarsson	Akvaplan-niva	Field work, report, project leader.
Kamila Sztybor	Akvaplan-niva	Report, professional assessments, and interpretations.
Hans-Petter Mannvik	Akvaplan-niva	Identification of bottom fauna (Echinodermata). KS report, professional assessments, and interpretations.
Rune Palerud	Akvaplan-niva	Identification of bottom fauna (Crustacea). Statistics.
Thomas Hansen	Akvaplan-niva	Identification of bottom fauna (Various).
Jesper Hansen	Akvaplan-niva	Identification of bottom fauna (Mollusca).
Andrey Sikorski	Akvaplan-niva	Identification of bottom fauna (Polychaeta).
Stine Hermansen	Akvaplan-niva	Hydrographical vertical profiles
Kristine H Sperre	Akvaplan-niva	Coordination of sorting of bottom fauna.
Ingar H. Wasbotten	Akvaplan-niva	Coordination of geo-chemical analyses.

Akvaplan-niva would like to thank Arnarlax hf. and Silja Baldvinsdóttir for good cooperation

Accreditation information:

The survey was carried out by Akvaplan-niva AS with ALS Laboratory Group (Czech Republic) as a sub-contractor.

NORSK AKKREDITERING TEST 079

Akvaplan-niva AS is accredited under NS-EN ISO/IEC 17025 by Norwegian Accreditation for field sampling of sediments and fauna, analyses of TOC, TOM, TN, particle size and macrofauna, and for professional evaluations and interpretations. Our Accreditation number is TEST 079.

Czech Accreditation Institute (Lab nr 1163)

ALS Laboratory Group is accredited by the Czech Accreditation Institute (Lab nr 1163) for copper analyses.

Non-accredited services: Hydrographical measurements and mapping of bottom topography (Olex).

Tromsø, 14.09 2021

Snorri Gunnarsson (Project Manager)

1 Data Summary

Client information			
Report title:	Arnarlax, C-survey at Tjaldanes (fallow period), June 2021.		
Report nr.	2021 63266.01	Site:	Tjaldanes
Municipality:		Map Coordinates (construction):	65°45,080 N 23°32,930 W
MTB permitted:	Site MTB	Operations manager:	Rolf Ørjan Nordli
Client:	Arnarlax hf		

Biomass/production status at time of survey (04.06 2021)			
Fish group:	Salmon	Biomass on examination:	0
Feed input:	0	Amount of produced fish:	0
Type/time of survey			
Maximum biomass:		Follow up study:	
Fallow (resting period):	X	New location:	

Results from the C study /NS 9410 (2016) – Main results from soft bottom fauna			
Faunal index nEQR (Veileder 02:2018)		**Diversity index H' (Shannon-Wiener)**	
Fauna C1 (impact zone)	0,419	Fauna C1 (impact zone)	2,28
Fauna C2	0,558	Fauna C2	2,43
Fauna C3	0,436	Fauna C3	2,55
Fauna C4 (deep area)	0,495	Fauna C4 (deep area)	2,74
Fauna C5	0,258	Fauna C5	1,41
Date fieldwork:	04.06.2021	**Date of report:**	17.09 2021
Notes to other results (sediment, pH/Eh, oxygen)			nTOC from 31 to 37 mg/g DW. Copper 48,1 mg/kg at C1 Eh positive at all stations O_2-conditions were good throughout the water column.
Responsible for field work: Snorri Gunnarsson	Signature:	Project manager Snorri Gunnarsson	Signature:

2 Introduction

2.1 Background and aim of the study

On behalf of Arnarlax, Akvaplan-niva completed a C-survey during the fallow period for the fish farming site at Tjaldanes in Arnarfjörður, Iceland (Figure 1). The survey fulfils the requirements from the Icelandic authorities for bottom surveys according to ISO 12878 and the requirements for environmental bottom surveys (according to Vöktunaráætlun). An environmental study was simultaneously undertaken, with reference to chapter 5.0 in NS 9410:2016, which follows the methodology for a C- study. A C-survey is aimed at studying the environmental conditions of the bottom sediments along a transect sector from the fish farm that extends from the local, to the intermediate and finally to the regional impact zones. The main emphasis for the study is the soft bottom fauna and it is conducted according to standards ISO 5567-19:2004 and ISO 16665:2014. The parameters that are obligatory to include in the survey are described in NS 9410:2016.

Neither a classification or threshold values for this type of survey have been developed by Icelandic officials and it is not strictly possible to apply the classification based on Norwegian threshold values to Icelandic conditions. However, we do report the results with these same indexes with reference to Norwegian threshold values but as mentioned above it should be emphasized that some of these (such as NSI) are developed according to Norwegian conditions. For further descriptions of the indexes see details in Appendix 1 and Miljødirektoratets Veileder 02:2018.

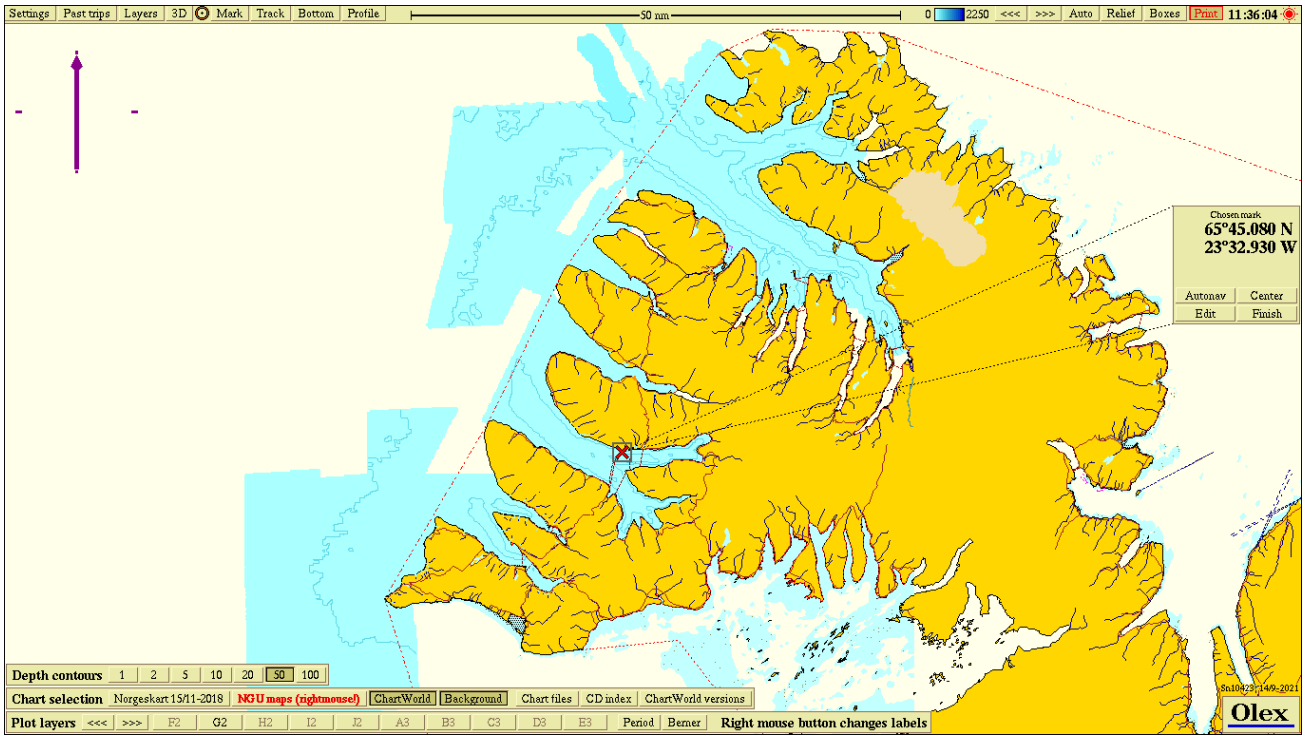

Figure 1 Overview of Arnarfjörður with the farming site Tjaldanes (red cross). The map coordinates for the midpoint of the farming site are given to the right.

2.2 Site operation and feed use

The Tjaldanes site has been in a fallow state since 21 March 2021. Previously two generations of salmon had been farmed at the site. The plant is a frame mooring with a total of ten 160 meters circumference cages in a 2 x 5 configuration. The planned time for setting out the next generation at the site is late June 2021. The previous generations of salmon were farmed at the site from summer 2019 to March 2021.

In Iceland, the MTB (maximum allowed biomass) limit is not given at the site level, as in Norway. The MTB limit determines how much live fish the holder of the permit can have standing in the sea at any time. In Iceland the allowed production is regulated at two levels, site level and company level. For this site the estimated maximal standing biomass for the next generation is 5681 tonnes, used as MTB here (Baldvinsdóttir, pers reference).

2.3 Previous surveys

An overview of previous surveys carried out at Tjaldanes is shown in Table 1.

Akvaplan-niva AS has carried out two previous environmental type C (NS 9410) surveys at the site Tjaldanes during fallow period in March 2019 (Mannvik & Gunnarsson, 2019) and at maximum biomass in October 2020 (Mannvik & Gunnarsson, 2020). The results from the previous fallow study at Tjaldanes indicated that the sediment was somewhat loaded with organic matter. No load effect was recorded in the fauna and fauna index nEQR which showed moderate impact for all stations (< 0.6). The Diversity index H ' was just over 3 at C5 and under 3 at the other stations where it ranged from 1.4 to 2.1. The NS 9410:2016-assessment of the fauna community in the local impact zone (C1) was rated with environmental condition 2 (good). No pollution indicators were recorded among the top-10 taxa at any of the stations.

The results from the max biomass survey at Tjaldanes in October 2020 were similar to those from the previous study. The results indicated that the fauna might be considered as moderately disturbed at all stations with the nEQR between 0.4 and 0.6. The pollution indicator species *Capitella capitata* (polychaete) was the second most dominant at C1, but it was not registered among the top-10 species at the other stations. The sediment had somewhat high levels of organic carbon at the stations (nTOC 22.7 – 29.2 mg/kg).

Table 1: Previous surveys at Tjaldanes.

Survey date	Report reference (author, year)	Production (tonnes)	Type of survey
07.03 2019	APN 60976.01, Mannvik and Gunnarsson (2019)	0	C survey at fallow
08.10 2020	APN 62333.01, Mannvik and Gunnarsson (2020)	5.807	ASC/C survey at max biomass

3 Materials and methods

3.1 Survey program

The choice of study parameters, the placement of sampling stations and other criteria for the study are based on descriptions in NS 9410 (C-surveys). An overview of the planned professional program is given in Table 2.

Akvaplan-niva is accredited for field work, analyses of samples and professional evaluation of results in accordance with applicable standards and guidelines ("Veiledere"). For implementation and follow through, the following standards and quality assurance systems were used:

- ISO 5667-19:2004: *Guidance on sampling of marine sediments.*
- ISO 16665:2014. *Water quality – Guidelines for quantitative sampling and sample processing of marine soft-bottom macro fauna.*
- NS 9410:2016. *Miljøovervåking av bunnpåvirkning fra marine oppdrettsanlegg.*
- Internal procedures. *Quality Manual for Akvaplan-niva.*
- Veileder 02:2018. *Klassifisering av miljøtilstand i vann*. Norsk klassifiseringssystem for vann i henhold til Vannforskriften. Veileder fra Direktoratgruppen.

Table 2: Survey program for the C-survey at Tjaldanes, 2021. TOC = total organic carbon. Korn = grain size in sediment. TOM = total organic material. TN = total nitrogen. Cu = Copper. pH/Eh = acidity and redox potential.

Station	**Type analyses/parameters**
C1 (local impact zone downstream)	Quantitative analyses of bottom fauna. TOC. Korn. TOM. TN. Cu. pH/Eh.
C2 (transect zone outer)	Quantitative analyses of bottom fauna. TOC. Korn. TOM. TN. pH/Eh.
C3 (transect zone)	Quantitative analyses of bottom fauna. TOC. Korn. TOM. TN. pH/Eh.
C4 (transect zone, deep area)	Quantitative analyses of bottom fauna. TOC. Korn. TOM. TN. Hydrography/O_2. pH/Eh.
C5 (local impact zone upstream)	Quantitative analyses of bottom fauna. TOC. Korn. TOM. TN. pH/Eh.

Field work was completed on 04.06 2021.

Placement of stations and local conditions

The number of stations was calculated with reference to the estimated maximal standing biomass of the site for the next farmed generation which is 5.681 tonnes (used as MTB here). According to the standard, five sampling stations should be examined. Depth and position of the stations are given

in Table 3 and shown in Figure 2. The stations were placed in accordance with the direction of the main oceanic current at 60 m depth (distribution current) at the site (Helgeland Havbruk, 2013).

Table 3: Depth, distance between the nearest frame of the fish farm and sampling stations and coordinates for C-stations at Tjaldanes, 2021.

Station	Depth, m	Distance from frame, m	Position N	W
C1	99	25	65°45.044	23°32.668
C2	103	500	65°44.953	23°32.081
C3	102	155	65°45.019	23°32.507
C4	103	195	65°45.011	23°32.457
C5	90	25	65°45.173	23°32.173

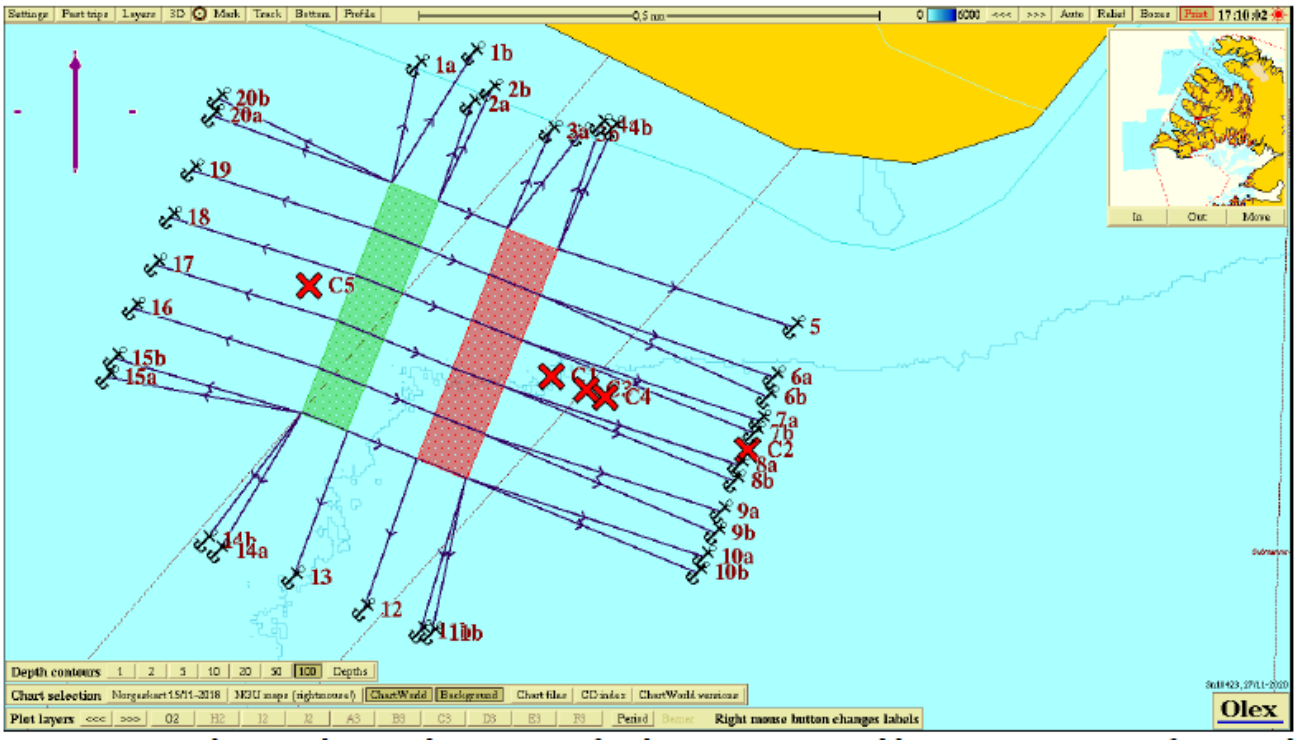

Figure 2. Map showing the sampling stations for the C-survey at Tjaldanes, 2021. Current measurements used were from 60 m depth (Helgeland Havbruk, 2013).

3.2 Hydrography and oxygen

At station C4, hydrographic measurements, salinity, temperature, density, and oxygen saturation were carried out for vertical, surface to bottom profile, using a Sensordata CTDO 204 probe.

3.3 Soft bottom sampling and analyses

3.3.1 Fieldwork

Sediment samples were collected with a 0.1 m^2 bottom grab (van Veen). The sample material was collected through inspection openings. Samples for TOC, TN and Cu were taken from the top 1 cm layer of the sediment and for TOM and grain size analyses from the top 5 cm using a hollow pipe. Only samples with an undisturbed surface were used. The samples were frozen for further processing in the laboratory.

3.3.2 Total organic material (TOM)

The amount of TOM in the sediment was determined by weight loss after combustion at 495 °C. The percent weight loss was calculated. The reproducibility of the TOM analyses is checked during the analyses by using a standard sediment that contains TOM with a known level. Standard calcium carbonate was burned together with the samples as a control of the amount of carbonate that was not burned in the analyses process.

3.3.3 Total nitrogen (TN)

After drying the samples at 40°C, the amount of total nitrogen (TN) was quantified by electrochemical determination using an internal method that is based on NS-EN 12260:2003 (Vannundersøkelse – Bestemmelse av bundet nitrogen (TNb) etter oksidasjon til nitrogenoksider).

3.3.4 Total organic carbon (TOC) and grain size

The proportion of fine material, the fraction less than 63 µm, was determined gravimetrically after wet sieving of the samples. The results are presented as proportion of fine material on a dry weight basis.

After drying the samples at 40 °C, the total organic carbon (TOC) content was determined by NDIR-detection in accordance with DIN19539:2016 (Investigation of solids – Temperature-dependent differentiation of total carbon (TOC_{400}, ROC, TIC_{900})). To classify the environmental conditions based on the content of TOC, the measured concentrations are normalized for proportion of fine sediments (nTOC) using the equation: nTOC = TOC + 18 (1 – F), where TOC and F represent a measured TOC value and the proportion of fine substance (%) in the sample (Aure *et al.,* 1993).

3.3.5 Metal analysis - copper (Cu)

The samples for metal analysis were freeze-dried before being placed in a microwave oven in a sealed Teflon container with concentrated ultrapure nitric acid and hydrogen peroxide. The concentration of copper (Cu) was determined by means of ICP-SFMS.

3.3.6 Redox- and pH measurements

At all the stations, a quantitative chemical examination of the sediment was carried out. Acidity (pH) and redox potential (Eh) were measured using electrodes and the YSI Professional Plus instrument. In accordance with the manual of the instrument, 200 mV was added to the measured ORP (the Oxidation Reduction Potential) value.

3.4 Soft bottom fauna investigation

3.4.1 About effect of organic material on bottom fauna

The emission of organic material from fish farms can contribute to the deterioration of conditions for many of the organisms living in the bottom sediment. Negative effects in the bottom fauna can best be assessed through quantitative bottom fauna analyses. Many soft bottom species have low mobility and the faunal composition will largely reflect the local environmental conditions. Changes in the bottom fauna communities are a good indication of unwanted organic loads. Under natural conditions, the communities typically consist of many species. High number of species (diversity) is, amongst other things, dependent on favourable conditions for the fauna. However, moderate increases in organic load can stimulate the fauna and result in an increased number of species. Larger organic loads can result in less favourable conditions where opportunistic species increase their individual numbers, while the species not suited are knocked out resulting in a reduced diversity of species. Changes in species diversity near emission points of feed and faecal matter can, to a large degree, be attributed to changes in organic content (from the feed and faecal matter) in the sediment.

3.4.2 Sampling and fixation

All the bottom fauna samples were taken with a 0.1 m^2 van Veen grab. Only grab samples, where the grab was completely closed and the surface undisturbed, were approved. After approval, the contents were washed through a 1 mm sieve and the remaining material fixed with 4 % formalin with Bengal Rose dye added and neutralized with borax. In the laboratory, the animals were sorted from the remaining sediment.

3.4.3 Quantitative bottom fauna analysis

At all stations, two samples (replicates) were collected in accordance with guidelines in NS 9410 (2016). After sorting the sample material was processed quantitatively. The bottom fauna was identified to the lowest level possible and quantified by specialists (taxonomists). The quantitative lists of species were analysed statistically. The following statistical methods were used to describe community structure and to assess the similarity between different communities. See Appendix 1 for the description of analysis methods.

- Shannon-Wiener diversity index (H')
- Hurlberts diversity index (ES_{100}) – expected number of species pr. 100 individuals
- Pielou's evenness index (J)
- Sensitivities index (Ømfintlighet) (ISI_{2012}), unsuitable at low individual/species number
- Sensitivity index (NSI)
- Composite index for diversity of species and sensitivity (NQI1)
- Sensitivities index which is included in NQI1 (AMBI)
- Normalized EQR (nEQR)
- Number of species plotted against the number of individuals in geometric arts classes
- Cluster analyses
- The ten most dominant taxa per station (top-ten)

4 Results

4.1 Hydrography and oxygen

The hydrographical profile for the deep station C4 in June 2021 is presented in Figure 3.

The temperature dropped from about 6 ^{0}C at the surface to 2 ^{0}C at the bottom, and oxygen saturation from 106 % in the upper layer to 83 % in the bottom layer.

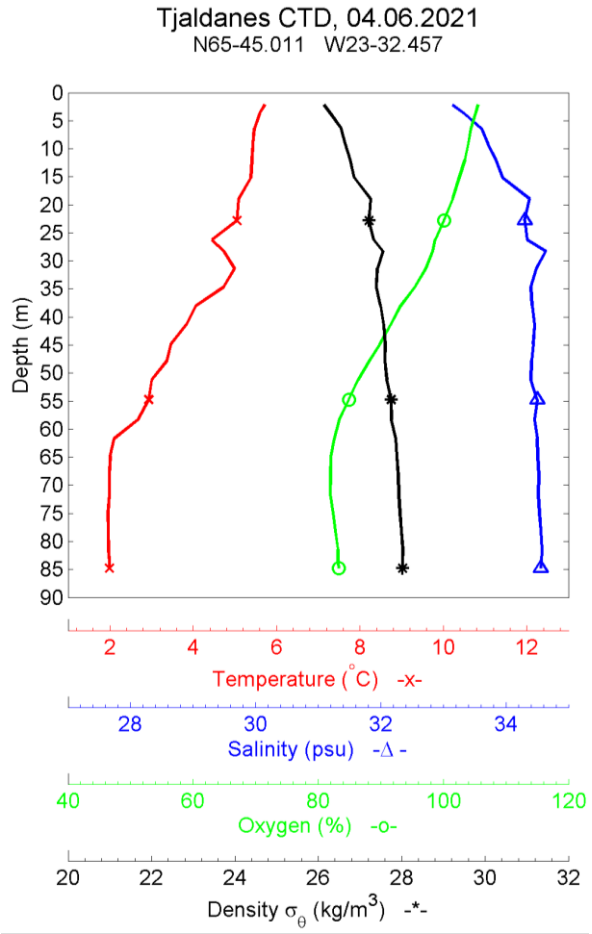

Figure 3. Vertical profiles. Temperature, salinity, density, and oxygen at C4 at Tjaldanes, 2021.

4.2 Sediment

4.2.1 TOC, TOM, TN, C/N, grain size and pH/Eh

Levels of total organic material (TOM), total organic carbon (TN), C/N-relationship, grain size distribution in sediment (Pelite) and pH/Eh in the sediment are presented in Table 4.

TOM-levels varied from 9.1 to 12.6 %. TN-levels were low (2.9 – 4.9 mg/g) as was the C/N-ratio. TOC was rather high at all stations and nTOC varied from 30.8 to 37.2 mg/g DW. The bottom sediments grain size varied from moderately coarse to fine with a pelite ratio ranging from 38.5 to 81.5 %.

Redox measurements (pH/Eh) gave a point of 0 for all the sampling stations according to Appendix D in NS 9410:2016.

Table 4. Sediment description, TOM (%), TOC (mg/g), TN (mg/g), C/N, grain size distribution (pelite ratio % <0.063 mm) and pH/Eh. Tjaldanes, 2021.

St.	Sediment description	TOM	TOC	nTOC*	TN	C/N	Pelitt	pH/Eh
C1	Olive green/grey, muddy. Some crushed shell. Grabs full of sediment.	9.1	22.8	33.9	2.9	7.9	38.5	7.78/329
C2	Olive green/grey, muddy. Grabs full of sediment.	12.6	28.9	32.2	4.5	6.4	81.5	7.86/373
C3	Olive green/grey, muddy. Grabs full of sediment.	12.1	29.8	37.2	4.9	6.1	58.8	7,85/346
C4	Olive green/grey, muddy. Grabs full of sediment.	10.7	26.2	30.8	3.6	7.3	74.6	7.72/350
C5	Olive green/grey, muddy.	9.1	23.4	32.6	4.0	5.9	48.8	7.42/315

4.2.2 Copper

Levels of copper in the bottom sediments are shown in Table 5. The level of copper was 48.1 mg/kg.

Table 5. Copper (Cu), mg/kg DW. Tjaldanes, 2021.

St.	Cu
C1	48.1

4.3 Soft-bottom fauna

4.3.1 Faunal indices

Results from the quantitative soft bottom faunal analyses at the C-stations are presented in Table 6. The faunal index nEQR is presented without the density index (DI) in accordance with recommendations from the Norwegian Environment Agency (Miljødirektoratet).

The number of individuals varied from 414 (C5) to 577 (C4) and number of species from 8 (C5) to 25 (C2). The diversity H' varied from 1.41 to 2.74. At all stations, the overall index of nEQR was lower than 0.6. The nEQR values indicate moderate to bad conditions and disturbance of the communities.

J (Pielous evenness index) is a measure of how equally individuals are divided between species and will vary between 0 and 1. A station with low-value has a "crooked" individual distribution between the species, indicating a disturbed bottom fauna community. The index varied from 0.50 to 0.70 which indicates a somewhat uneven distribution.

Table 6. Number of species and individuals pr. 0,2 m2. H´ = Shannon-Wieners diversity index. ES100 = Hurlberts diversity index. NQI1 = overall index (diversity and sensitivity). ISI2012 = sensitivity index. NSI = sensitivity index. J = Pielous evenness index. AMBI = AZTI marine biotic index (part of NQI1). nEQR = normalized EQR (excl. DI). C-stations at Tjaldanes, 2021.

St.	No. ind.	No. species	H´	ES_{100}	NQI1	ISI_{2012}	NSI	nEQR	AMBI	J
C1	551	21	2.28	11.34	0.45	7.04	12.46	0.419	4.759	0.57
C2	519	25	2.43	12.39	0.53	8.59	21.50	0.558	3.841	0.58
C3	488	15	2.55	9.83	0.46	6.62	15.92	0.436	4.301	0.70
C4	577	23	2.74	12.13	0.50	7.08	17.89	0.495	4.165	0.68
C5	414	8	1.41	6.00	0.34	5.41	10.11	0.258	5.236	0.50

4.3.2 NS 9410 Evaluation of the bottom fauna at station C1 (local impact zone).

According to NS 9410 the classification of the environmental status in the local impact zone can also be evaluated based on the number of species and their dominance in the bottom faunal community (see chapter 8.6.2 in NS 9410:2016).

The soft bottom communities were classified to environmental condition 1 "Very good". The criteria for condition 1 are that there are at least 20 species/0.2 m^2 and that none of these are in numbers exceeding 65 % of the individuals (Table 7). The data for number of species and dominating taxa at station C1 is given in Table 6 and Table 8.

Table 7. Classification of the environmental status of the soft bottom fauna at station C1 at the Tjaldanes site 2021.

Station	Site name	Num. species	Dominating taxa	Environmental condition-NS 9410
C1	Tjaldanes	21	*Capitella capitata* – 58 %	1 – Very good

Geometric classes

Figure 4 shows the number of species plotted against the number of individuals, where the number of individuals is divided into geometric classes. An explanation of the concept of geometric classes is given in Appendix 1.

All curves started relatively low (≤ 15 species) and stretched out in varying degrees towards higher classes. These did not give any clear indications of fauna condition.

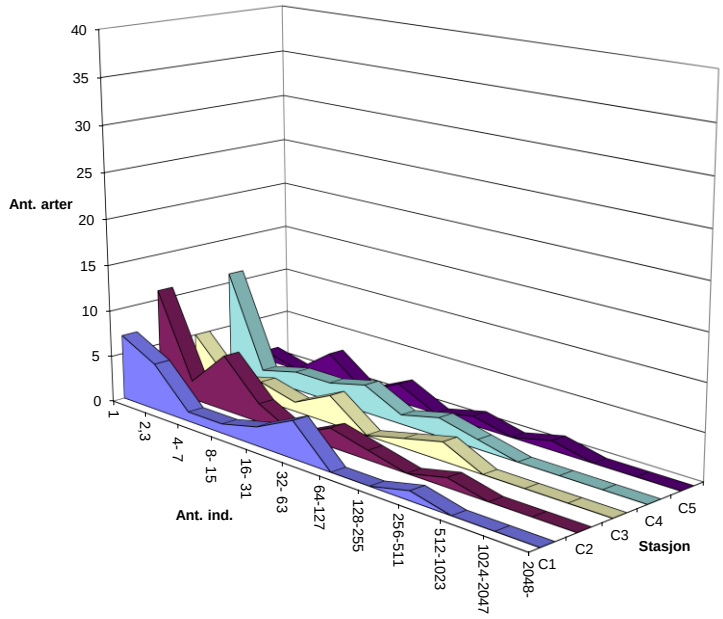

Figure 4. The soft bottom fauna shown as number of species against number of individuals per species in geometric classes. Tjaldanes, 2021.

4.3.3 Cluster analyses

To investigate the similarity of the faunal composition between the sampling stations, the multivariate technique cluster analysis was used. The results of this are presented in dendrogram in Figure 5.

The faunal composition at stations C4, C3, C1 and C5 were 58 % similar, and C2 was 50 % similar to these stations.

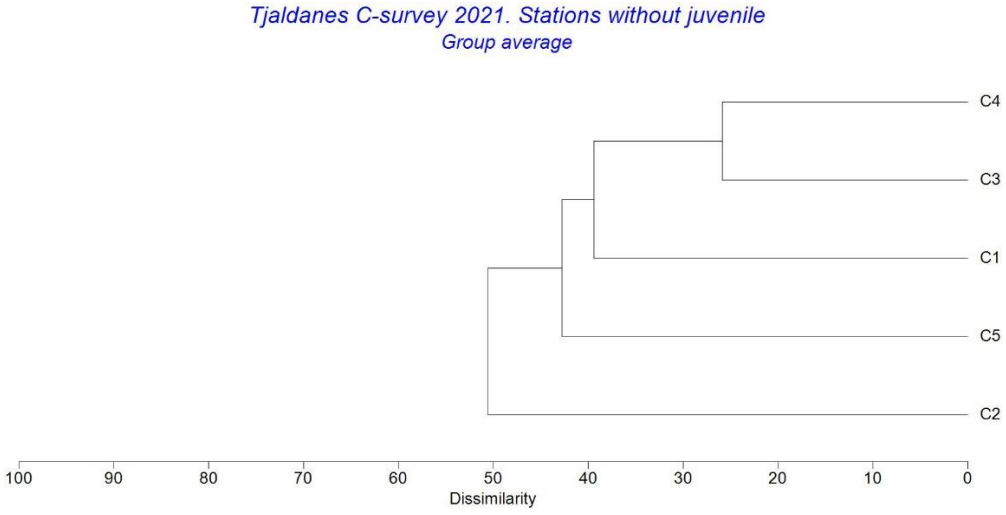

Figure 5. Cluster diagram for the soft bottom fauna at the C- sampling stations at Tjaldanes, 2021.

4.3.4 Species composition

The main features of the species composition are shown in the form of a top ten species list from each station in Table 8.

In Rygg and Norling (2013) the species are divided into five ecological groups (EG) based on the value of the sensitivity index. These groups run from sensitive species (group I) to pollution indicators (group V).

Stations C1, C3 and C5 were dominated by the pollution indicator species *Capitella capitata* (polychaeta) with 58, 30 and 64 % of the individuals accordingly. The other most dominant species at these stations were a mixture of opportunistic, neutral, tolerant and one sensitive species.

The fauna at stations C2 and C4 were dominated by the neutral polychaeta *Prionospio steenstrupi* comprising 50 and 35 % of the individuals. The other most dominant species at these stations were a mixture of neutral, tolerant, opportunistic, and sensitive species.

The pollution indicator species *Capitella capitata* is among the most dominant at C1, C3, C4 and C5 but was not recorded at station C2.

Table 8. Number of individuals, cumulative percentage, and ecological group for the ten most dominant species on the C stations. Tjaldanes, 2021.*

C1	EG	Numb.	Cum.	C2	EG	Numb.	Cum.
Capitella capitata	V	319	58 %	*Prionospio steenstrupi*	II	262	50 %
Macoma calcarea	IV	45	66 %	*Ophelina acuminata*	II	68	63 %
Thyasira sarsii	IV	43	74 %	*Chaetozone setosa*	IV	62	75 %
Prionospio steenstrupi	II	40	81 %	*Thyasira sarsii*	IV	61	87 %
Ophelina acuminata	II	37	88 %	*Melinna cristata*	II	12	89 %
Schistomeringos sp.	I	20	91 %	*Heteromastus filiformis*	IV	9	91 %
Heteromastus filiformis	IV	16	94 %	Euclymeninae indet.	I	7	93 %
Ophryotrocha sp.	IV	9	96 %	*Ampharete finmarchica*	II	6	94 %
Chaetozone setosa	IV	5	97 %	*Ampharete borealis*	III	5	95 %
Aphelochaeta sp.	II	2	97 %	*Ennucula tenuis*	II	4	95 %
Chaetozone sp.	III	2	98 %	*Eteone flava/longa*	Ik	4	96 %
Eteone flava/longa	Ik	2	98 %	*Schistomeringos* sp.	I	4	97 %
Goniada maculata	II	2	98 %				
Oedicerotidae indet.	Ik	2	99 %				
Pholoe inornata	III	2	99 %				

C3	EG	Numb.	Cum.	C4	EG	Numb.	Cum.
Capitella capitata	V	147	30 %	*Prionospio steenstrupi*	II	204	35 %
Prionospio steenstrupi	II	136	58 %	*Capitella capitata*	V	114	55 %
Thyasira sarsii	IV	94	77 %	*Thyasira sarsii*	IV	108	74 %
Ophelina acuminata	II	30	83 %	*Ophelina acuminata*	II	36	80 %
Macoma calcarea	IV	27	89 %	*Chaetozone setosa*	IV	25	84 %
Chaetozone setosa	IV	25	94 %	*Heteromastus filiformis*	IV	25	89 %
Heteromastus filiformis	IV	11	96 %	*Macoma calcarea*	IV	17	92 %
Schistomeringos sp.	I	6	98 %	*Chaetozone* sp.	III	12	94 %
Eteone flava/longa	Ik	4	98 %	*Schistomeringos* sp.	I	12	96 %
Ennucula tenuis	II	3	99 %	*Eteone flava/longa*		7	97 %

C5	EG	Numb.	Cum.
Capitella capitata	V	266	64 %
Ophryotrocha sp.	IV	84	84 %
Thyasira sarsii	IV	29	91 %
Ophelina acuminata	II	18	96 %
Macoma calcarea	IV	6	97 %
Prionospio steenstrupi	II	6	99 %
Eteone flava/longa	Ik	4	100 %
Arenicola marina juv.	Ik	1	100 %
Heteromastus filiformis	IV	1	100 %

*Ecological groups: EG I = sensitive species. EG II = neutral species. EG III = tolerant species. EG IV = opportunistic species. EG V = pollution indicator species. From Rygg and Norling, 2013. Ik = unidentified group.

5 Summary and Conclusions

5.1 Summary

The results from the environmental monitoring (type C) at Tjaldanes, 2021, can be summarized as follows:

- The hydrography measurements showed good oxygen conditions throughout the water column with 83 % saturation in the bottom layer in June 2021.
- TOC was rather high at all stations and nTOC varied from 30.8 to 37.2 mg/g DW. TOM-levels varied from 9.1 to 12.6 %. TN-levels were low (2.9 – 4.9 mg/g) as was the C/N-ratio. The copper level in the sediment at C1 was 48.1 mg/kg but within reported natural levels of 55 mg/kg in Icelandic coastal areas (Egilsson *et al.* 1999). The bottom sediments grain size varied from moderately coarse to fine with a pelite ratio ranging from 38.5 to 81.5 %. The redox measurements (pH/Eh) gave point 0 acc. Appendix D in NS 9410:2016 for all the stations.
- The number of individuals varied from 414 (C5) to 577 (C4) and number of species from 8 (C5) to 25 (C2). The diversity H' varied from 1.41 to 2.74. At all stations, the overall index of nEQR was lower than 0.6. The nEQR values indicate moderate to bad conditions and disturbance of the communities.

5.2 Conclusions

The results from the monitoring at the farming site Tjaldanes in June 2021 showed that the sediment was somewhat loaded with organic carbon and the copper concentrations were within reported natural levels for bottom sediment around Iceland (Egilsson *et al.*, 1999). There was a load effect recorded in the fauna and faunal index nEQR indicating moderate to bad conditions at all stations (<0.6). The diversity index H' was below 3 at all stations. The NS 9410:2016-assessment of the community in the local impact zone (C1) showed environmental condition 1 (Very good). The pollution indicator species *Capitella capitata* was recorded among the top-10 species at stations C1, C3, C4 and C5. The redox measurements (pH/Eh) gave point 0 acc. Appendix D in NS 9410:2016 for all the stations. The oxygen saturation in June was good in the whole water column with 83 % in the bottom water.

5.3 Environmental trend since the last C-survey

A C-survey at fallow period was carried out at the location in 2019 (Mannvik & Gunnarsson, 2019). The conclusion from that study was: " *The results of monitoring at the fish farm site Tjaldaneseyrar in 2019 indicated that the sediment was somewhat loaded with organic carbon and the copper concentrations were slightly elevated at C1. No load effect was recorded in fauna and fauna index nEQR showed moderate impact for all stations (< 0.6). The Diversity index H ' was just over 3 on C5 and under 3 at the other stations where it ranged from 1.4 to 2.1. NS 9410:2016-assessment of the fauna community in the local impact zone (C1) was rated with environmental condition 2 (good). No pollution indicators were recorded among the top-10 on any of the stations. The redox measurements (pH/Eh) gave points 0 acc. Appendix D in NS 9410:2016 for all the sampling stations. The oxygen saturation in March was good in the whole water column with 100% in the bottom water."*

The stations positions differ somewhat between these two surveys (the farming site was moved further out into the fjord between generations), therefore, only a general comparison of the results has been carried out.

The faunal index nEQR in the current survey is generally within the same range as during the previous survey (from <0.6 to > 0.4). The only station with a lower value is C5 which had been moved significantly closer to the site location (25 vs 80 m previously). The diversity index H' is however higher in the current survey except for station C5. The pollution indicator species *Capitella capitata,* which is most dominant at C1, C3 and C5 in 2021, was not registered among the top-10 species at any station in 2019. The nTOC in the sediment has not increased since the previous survey. The copper level at C1 is still within the natural level of copper reported for bottom sediments around Iceland. The oxygen saturation was good in the whole water column in both surveys.

6 References

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7 Appendix (In Norwegian)

7.1 Statistical methods

7.1.1 Diversity

Diversitet er et begrep som uttrykker mangfoldet i dyre- og plantesamfunnet på en lokalitet. Det finnes en rekke ulike mål for diversitet. Noen tar mest hensyn til artsrikheten (mål for artsrikheten), andre legger mer vekt på individfordelingen mellom artene (mål for jevnhet og dominans). Ulike mål uttrykker derved forskjellige sider ved dyresamfunnet. Diversitetsmål er "klassiske" i forurensningsundersøkelser fordi miljøforstyrrelser typisk påvirker samfunnets sammensetning. Svakheten ved diversitetsmålene er at de ikke

alltid fanger opp endringer i samfunnsstrukturen. Dersom en art blir erstattet med like mange individer av en ny art, vil ikke det gjøre noe utslag på diversitetsindeksene.

Shannon-Wieners indeks (Shannon & Weaver, 1949) er gitt ved formelen:

$$H' = -\sum_{i=1}^{s} \frac{n_i}{N} \log_2 \left(\frac{n_i}{N} \right)$$

der n_i = antall individer av art i i prøven
N = total antall individer
s = antall arter

Indeksen tar hensyn både til antall arter og mengdefordelingen mellom artene, men det synes som indeksen er mest følsom for individfordelingen. En lav verdi indikerer et artsfattig samfunn og/eller et samfunn som er dominert av en eller få arter. En høy verdi indikerer et artsrikt samfunn.

7.1.2 Pielous mål for jevnhet (Pielou, 1966)

har følgende formel, der symbolene er som i Shannon-Wieners indeks

$$J = \frac{H'}{\log_2 s}$$

7.1.3 Hurlberts diversitetskurver

Grafisk kan diversiteten uttrykkes i form av antall arter som funksjon av antall individer. Med utgangspunkt i total antall arter og individer i en prøve søker man å beregne hvor mange arter man ville vente å finne i delprøver med færre individer. Diversitetsmålet blir derved uavhengig av prøvestørrelsen og gjør at lokaliteter med ulik individtetthet kan sammenlignes direkte. Hurlbert (1971) har gitt en metode for å beregne slike diversitetskurver basert på sannsynlighetsberegning.

ES_n er forventet antall arter i en delprøve på n tilfeldig valgte individer fra en prøve som inneholder total N individer og s arter og har følgende formel:

$$ES_n = \sum_{i=1}^{s} \left[1 - \frac{\binom{N-N_i}{n}}{\binom{N}{n}} \right]$$

der N = total antall individ i prøven
N_i = antall individ av art i
n = antall individ i en gitt delprøve (av de N)
s = total antall arter i prøven

7.1.4 Plott av antall arter i forhold til antall individer

Artene deles inn i grupper/klasser etter hvor mange individer som er registrert i en prøve. Det vanlige er å sette klasse I = 1 individ pr. art, klasse II = 2-3 individer, klasse III = 4-7 individer, klasse IV = 8-15 individer, osv., slik at de nedre klassegrensene danner en følge av ledd på formen 2^x, x=0,1,2, ... En slik følge kalles en geometrisk følge, derfor kalles klassene for geometriske klasser. Hvis antall arter innenfor hver klasse plottes mot klasseverdien på en lineær skala, vil det fremkomme en kurve som uttrykker individfordelingen mellom

artene i samfunnet. Det har vist seg at i prøver fra upåvirkede samfunn vil det være mange arter med lavt individantall og få arter med høyt individantall, slik at vi får en entoppet, asymmetrisk kurve med lang "hale" mot høye klasseverdier. Denne kurven vil være godt tilpasset en log-normal fordelingskurve.

Ved moderat forurensing forsvinner en del av de individfattige artene, mens noen som blir begunstiget, øker i antall. Slik flater kurven ut, og strekker seg mot høyere klasser eller den får ekstra topper. Under slike forhold mister kurven enhver likhet med den statistiske log-normalfordelingen. Derfor kan avvik fra log-normalfordelingen tolkes som et resultat av en påvirkning/forurensing. Det har vist seg at denne metoden tidlig gir utslag ved miljøforstyrrelse. Ved sterk forurensning blir det bare noen få, men ofte svært tallrike arter tilbake. Log-normalfordelingskurven vil da ofte gjenoppstå, men med en lavere topp og spredt over flere klasser enn for uforstyrrede samfunn.

7.1.5 Faunaens fordelingsmønster

Variasjoner i faunaens fordelingsmønster over området beskrives ved å sammenligne tettheten av artene på hver stasjon. Til dette brukes multivariate klassifikasjons- og ordinasjons-analyser (Cluster og MDS).

Analysene i denne undersøkelsen ble utført ved hjelp av programpakken PRIMER v5. Inngangsdata er individantall pr. art, pr. prøve. Prøvene kan være replikater eller stasjoner. Det tas ikke hensyn til hvilke arter som opptrer. Forut for klassifikasjons- og ordinasjonsanalysene ble artslistene dobbelt kvadratrot-transformert. Dette ble gjort for å redusere avviket mellom høye og lave tetthetsverdier og dermed redusere eventuelle effekter av tallmessig dominans hos noen få arter i datasettet.

7.1.6 Clusteranalyse

Analysen undersøker faunalikheten mellom prøver. For å sammenligne to prøver ble Bray-Curtis ulikhetsindeks benyttet (Bray & Curtis, 1957):

$$d_{ij} = \frac{\sum_{k=1}^{n} \left| X_{ki} - X_{kj} \right|}{\sum_{k=1}^{n} (X_{ki} + X_{kj})}$$

der n = antall arter sammenlignet
X_{ki} = antall individ av art k i prøve nr. i
X_{kj} = antall individ av art k i prøve nr. j

Indeksen avtar med økende likhet. Vi får verdien 1 hvis prøvene er helt ulike, dvs. ikke har noen felles arter. Identiske arts- og individtall vil gi verdien 0. Prøver blir gruppert sammen etter graden av likhet ved å bruke "group-average linkage". Forholdsvis like prøver danner en gruppe (cluster). Resultatet presenteres i et trediagram (dendrogram).

7.1.7 Ømfintlighet (AMBI, ISI og NSI)

Ømfintligheten bestemmes ved indeksene ISI og AMBI. Beregning av ISI er beskrevet av Rygg (2002). Sensitivitetsindeksen AMBI (Azti Marin Biotic Index) tilordner en ømfintlighetsklasse (økologisk gruppe, EG): EG-1: sensitive arter, EG-II: indifferente arter, EG-III: tolerante arter, EG-IV: opportunistiske arter, EG-V: forurensningsindikerende arter. Sammensetningen av makroevertebratsamfunnet i form av andelen av økologiske grupper indikerer omfanget av en forurensningspåvirkning.

NSI er en sensitivitetsindeks som ligner AMBI, men er utviklet med basis i norske faunadata og ved bruk av en objektiv statistisk metode. En prøves NSI verdi beregnes ved gjennomsnittet av sensitivitetsverdiene av alle individene i prøven.

7.1.8 Sammensatte indekser (NQI1 og NQI2)

Sammensatte indekser NQI1 og NQI2 bestemmes både ut fra artsmangfold og ømfintlighet. NQI1 er brukt i NEAGIG (den nordøst-atlantiske interkalibreringen). De fleste land bruker nå sammensatte indekser av samme type som NQI1 og NQI2.

NQI1 indeksen er beskrevet ved hjelp av formelen:

7.1.9 NQI1 (Norwegian quality status, version 1) = [0.5* (1-AMBI/7) + 0.5*(SN/2.7)* (N/(N+5)]

Diversitetsindeksen SN = lnS/ln(lnN), hvor S er antall arter og N er antall individer i prøven

7.1.10 References

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7.2 Statistical results Tjaldanes, 2021

7.2.1 Number of species and individuals per station

St.	C1	C2	C3	C4	C5
Ant. ind.	551	519	488	577	414
Ant. arter	21	25	15	23	8

7.2.2 Benthos indices per replicate

st.nr.	tot.	C1_01	C1_02	C2_01	C2_02	C3_01	C3_02	C4_01	C4_02	C5_01	C5_02
no. ind.	2549	256	295	260	259	253	235	366	211	207	207
no. spe.	45	18	14	20	17	14	11	19	14	7	7
Shannon-Wiener:		2,37	2,19	2,44	2,42	2,59	2,51	2,79	2,69	1,30	1,53
Pielou		0,57	0,58	0,57	0,59	0,68	0,73	0,66	0,71	0,46	0,54
ES100		12,57	10,11	12,98	11,79	9,98	9,69	12,39	11,88	5,36	6,64
SN		1,69	1,52	1,75	1,65	1,54	1,41	1,66	1,57	1,16	1,16
ISI-2012		7,15	6,92	9,23	7,94	7,44	5,81	7,69	6,47	4,80	6,03
AMBI		4,844	4,673	3,837	3,844	4,364	4,238	4,250	4,079	5,297	5,174
NQI1		0,46	0,44	0,54	0,53	0,47	0,45	0,50	0,49	0,33	0,34
NSI		12,47	12,45	21,44	21,56	15,63	16,21	17,20	18,58	10,00	10,22

7.2.3 Benthos indices, averages per station

St.	C1	C2	C3	C4	C5
Ant. ind.	551	519	488	577	414
Ant. arter	21	25	15	23	8
H'	2,28	2,43	2,55	2,74	1,41
ES_{100}	11,3	12,4	9,8	12,1	6,0
NQI1	0,452	0,534	0,461	0,496	0,336
ISI_{2012}	7,04	8,59	6,62	7,08	5,41
NSI	12,46	21,50	15,92	17,89	10,11
nEQR	0,419	0,558	0,436	0,495	0,258

7.2.4 Geometric classes

int.	cla.	C1	C2	C3	C4	C5
1	1	7	11	5	11	1
2,3	2	5	2	1	1	0
4- 7	3	1	6	2	2	3
8- 15	4	1	2	1	2	0
16- 31	5	2	0	3	3	2
32- 63	6	4	2	0	1	0
64-127	7	0	1	1	2	1
128-255	8	0	0	2	1	0
256-511	9	1	1	0	0	1
512-1023	10	0	0	0	0	0
1024-2047	11	0	0	0	0	0
2048-	12	0	0	0	0	0

7.3 Species lists

Artsliste — *Tjaldanes C-survey 2021*

Rekke	*Klasse*	*Art/Taxa*	*01*	*02*	*Sum*
Stasjonsnr.: C1					
ANNELIDA					
	Polychaeta				
		Ampharete borealis	1		1
		Aphelochaeta sp.		2	2
		Capitella capitata	148	171	319
		Chaetozone setosa	2	3	5
		Chaetozone sp.	1	1	2
		Eteone flava/longa	2		2
		Goniada maculata	1	1	2
		Heteromastus filiformis	10	6	16
		Ophelina acuminata	18	19	37
		Ophryotrocha sp.	7	2	9
		Pholoe inornata		1	1
		Prionospio steenstrupi	22	18	40
		Scalibregma inflatum	1		1
		Schistomeringos sp.	8	12	20
CRUSTACEA					
	Malacostraca				
		Oedicerotidae indet.	2		2
		Westwoodilla caecula	1		1
MOLLUSCA					
	Opistobranchia				
		Diaphana minuta	1		1
	Bivalvia				
		Macoma calcarea	14	31	45
		Mytilus edulis		1	1
		Thyasira sarsii	16	27	43
		Thyasiridae indet.	1		1
		Maks:	148	171	319
		Antall:	18	14	21
		Sum:			551
Stasjonsnr.: C2					
ANNELIDA					
	Polychaeta				
		Ampharete borealis	4	1	5
		Ampharete finmarchica	1	5	6
		Amphitrite cirrata	1		1
		Chaetozone setosa	28	34	62
		Chone sp.		1	1
		Eteone flava/longa	3	1	4
		Euchone papillosa		1	1
		Euclymeninae indet.	2	5	7
		Galathowenia oculata		1	1
		Heteromastus filiformis	5	4	9
		Laonice cirrata	1		1
		Laphania boecki	1		1
		Melinna cristata	7	5	12
		Ophelina acuminata	28	40	68
		Prionospio steenstrupi	135	127	262
		Schistomeringos sp.	2	2	4
		Syllis cornuta	1		1

Rekke	Klasse	Art/Taxa	01	02	Sum
		Terebellides sp.	1		1
MOLLUSCA					
	Prosobranchia				
		Curtitoma trevelliana	1		1
	Bivalvia				
		Ennucula tenuis	3	1	4
		Macoma calcarea		2	2
		Nuculana pernula	1		1
		Thyasira sarsii	34	27	61
		Yoldia hyperborea		2	2
ECHINODERMATA					
	Asteroidea				
		Asteroidea indet. juv.		1	1
		Ctenodiscus crispatus	1		1
		Maks:	135	127	262
		Antall:	20	18	26
		Sum:			520

Stasjonsnr.: C3

NEMERTINI					
		Nemertea indet.		1	1
ANNELIDA					
	Polychaeta				
		Capitella capitata	85	62	147
		Chaetozone setosa	13	12	25
		Eteone flava/longa	1	3	4
		Heteromastus filiformis	7	4	11
		Lumbrineris aniara	1		1
		Ophelina acuminata	18	12	30
		Prionospio steenstrupi	67	69	136
		Schistomeringos sp.	2	4	6
CRUSTACEA					
	Malacostraca				
		Leucon sp.	1		1
		Liljeborgia macronyx	1		1
MOLLUSCA					
	Bivalvia				
		Ennucula tenuis	1	2	3
		Macoma calcarea	18	9	27
		Thyasira sarsii	37	57	94
		Yoldia hyperborea	1		1
		Maks:	85	69	147
		Antall:	14	11	15
		Sum:			488

Stasjonsnr.: C4

NEMERTINI					
		Nemertea indet.	1		1
ANNELIDA					
	Polychaeta				
		Ampharete finmarchica	1		1
		Bylgides groenlandicus		1	1
		Capitella capitata	89	25	114
		Chaetozone setosa	14	11	25
		Chaetozone sp.	7	5	12
		Cossura longocirrata		1	1

Rekke	Klasse	Art/Taxa		01	02		Sum
		Eteone flava/longa		4	3		7
		Euchone papillosa		1			1
		Galathowenia oculata			1		1
		Heteromastus filiformis		16	9		25
		Melinna cristata		1			1
		Nephtys ciliata		1			1
		Ophelina acuminata		23	13		36
		Ophryotrocha sp.			2		2
		Praxillella gracilis		1			1
		Prionospio steenstrupi		121	83		204
		Schistomeringos sp.		7	5		12
MOLLUSCA							
	Bivalvia						
		Ennucula tenuis		4			4
		Macoma calcarea		12	5		17
		Nuculana pernula		1			1
		Thyasira sarsii		61	47		108
		Yoldia hyperborea		1			1
			Maks:	121	83		204
			Antall:	19	14		23
			Sum:				577
Stasjonsnr.: C5							
ANNELIDA							
	Polychaeta						
		Arenicola marina juv.		1			1
		Capitella capitata		121	145		266
		Eteone flava/longa		2	2		4
		Heteromastus filiformis		1			1
		Ophelina acuminata		1	17		18
		Ophryotrocha sp.		76	8		84
		Prionospio steenstrupi			6		6
MOLLUSCA							
	Bivalvia						
		Macoma calcarea		2	4		6
		Thyasira sarsii		4	25		29
			Maks:	121	145		266
			Antall:	8	7		9
			Sum:				415
					TOTAL:	***Maks:***	319
						Sum:	2551

7.4 Analytical report

Akvaplan niva

NORSK AKKREDITERING TEST 079

ANALYSERAPPORT

Kunde:	Arnarlax	Rapport nr.:	P2100074
Kundemerking:	63266		
Kontaktperson kunde:		Rapportdato	2021-07-23
		Ankomst dato	2021-06-29

Lab-id. P2100074-01

Objekt	Kundens ID	Beskrivelse	Notering	Mottatt lab
Sediment	C1	63266 Tjaldanes C og B undersøkelse at fallow period 2021		2021-06-29

Analyseresultat						
Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC	23	mg/g TS	2021-07-19	2021-07-21	DIN 19539:2016	±2.3
TNb	2.9	mg/g TS	2021-07-19	2021-07-21	NS-EN 16168:2012	±0.4
N TOC	33.9	mg/g TS	2021-07-23	2021-07-23	Veileder 02:2018	
C/N - forhold	7.9		2021-07-23	2021-07-23		
TOM	9.1	% TS	2021-07-16	2021-07-20	Intern metode	±0.0
Vekt % 2 mm	0	wt% TS	2021-07-16	2021-07-21	Intern metode	
Vekt % 1 mm	0.2	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.0
Vekt % 0.500 mm	1.4	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.1
Vekt % 0.250 mm	19.2	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±1.0
Vekt % 0.125 mm	12.3	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.6
Vekt % 0.063 mm	28.3	wt% TS	2021-07-16	2021-07-21	Intern metode (Bale/Kenny 2005)	±1.4
Vekt % < 0.063 mm	38.5	wt% TS	2021-07-16	2021-07-21	Intern metode (Bale/Kenny 2005)	±1.9
Pelitt	38.5	% TS	2021-07-16	2021-07-21	Intern metode	
Sand	61.5	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	
Grus	0	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	
Cu (kobber) [a]	48.1	mg/kg TS	2021-07-19	2021-07-21	Intern metode	

[a] Prøvingen er utført av eksternt laboratorium, ALS Laboratory Group

* = Ikke akkreditert resultat

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Rapporten er godkjent og digitalt undertegnet av:
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ANALYSERAPPORT

Kunde:	Arnarlax	**Rapport nr.:**	P2100074
Kundemerking:	63266		
Kontaktperson kunde:		**Rapportdato**	2021-07-23
		Ankomst dato	2021-06-29

Lab-id. P2100074-02

Objekt	Kundens ID	Beskrivelse	Notering	Mottatt lab
Sediment	C2	63266 Tjaldanes C og B undersøkelse at fallow period 2021		2021-06-29

Analyseresultat

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC	29	mg/g TS	2021-07-19	2021-07-21	DIN 19539:2016	±2.9
TNb	4.5	mg/g TS	2021-07-19	2021-07-21	NS-EN 16168:2012	±0.7
N TOC	32.2	mg/g TS	2021-07-23	2021-07-23	Veileder 02:2018	
C/N - forhold	6.4		2021-07-23	2021-07-23		
TOM	12.6	% TS	2021-07-16	2021-07-20	Intern metode	±0.0
Vekt % 2 mm	0.4	wt% TS	2021-07-16	2021-07-21	Intern metode	±0.0
Vekt % 1 mm	1.1	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.1
Vekt % 0.500 mm	2.0	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.1
Vekt % 0.250 mm	3.7	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.2
Vekt % 0.125 mm	3.7	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.2
Vekt % 0.063 mm	7.6	wt% TS	2021-07-16	2021-07-21	Intern metode (Bale/Kenny 2005)	±0.4
Vekt % < 0.063 mm	81.5	wt% TS	2021-07-16	2021-07-21	Intern metode (Bale/Kenny 2005)	±4.1
Pelitt	81.5	% TS	2021-07-16	2021-07-21	Intern metode	
Sand	18.1	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	
Grus	0.4	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	

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ANALYSERAPPORT

Kunde:	Arnarlax	**Rapport nr.:**	P2100074
Kundemerking:	63266		
Kontaktperson kunde:		**Rapportdato**	2021-07-23
		Ankomst dato	2021-06-29

Lab-id. P2100074-03

Objekt	Kundens ID	Beskrivelse	Notering	Mottatt lab
Sediment	C3	63266 Tjaldanes C og B undersøkelse at fallow period 2021		2021-06-29

Analyseresultat

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC	30	mg/g TS	2021-07-19	2021-07-21	DIN 19539:2016	±3.0
TNb	4.9	mg/g TS	2021-07-19	2021-07-21	NS-EN 16168:2012	±0.7
N TOC	37.2	mg/g TS	2021-07-23	2021-07-23	Veileder 02:2018	
C/N - forhold	6.1		2021-07-23	2021-07-23		
TOM	12.1	% TS	2021-07-16	2021-07-20	Intern metode	±0.0
Vekt % 2 mm	1.0	wt% TS	2021-07-16	2021-07-21	Intern metode	±0.1
Vekt % 1 mm	4.9	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.2
Vekt % 0.500 mm	9.0	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.5
Vekt % 0.250 mm	9.1	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.5
Vekt % 0.125 mm	6.5	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.3
Vekt % 0.063 mm	10.7	wt% TS	2021-07-16	2021-07-21	Intern metode (Bale/Kenny 2005)	±0.5
Vekt % < 0.063 mm	58.8	wt% TS	2021-07-16	2021-07-21	Intern metode (Bale/Kenny 2005)	±2.9
Pelitt	58.8	% TS	2021-07-16	2021-07-21	Intern metode	
Sand	40.2	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	
Grus	1.0	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	

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ANALYSERAPPORT

Kunde:	Arnarlax	**Rapport nr.:**	P2100074
Kundemerking:	63266		
Kontaktperson kunde:		**Rapportdato**	2021-07-23
		Ankomst dato	2021-06-29

Lab-id. P2100074-04

Objekt	Kundens ID	Beskrivelse	Notering	Mottatt lab
Sediment	C4	63266 Tjaldanes C og B undersøkelse at fallow period 2021		2021-06-29

Analyseresultat

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC	26	mg/g TS	2021-07-19	2021-07-21	DIN 19539:2016	±2.6
TNb	3.6	mg/g TS	2021-07-19	2021-07-21	NS-EN 16168:2012	±0.5
N TOC	30.8	mg/g TS	2021-07-23	2021-07-23	Veileder 02:2018	
C/N - forhold	7.3		2021-07-23	2021-07-23		
TOM	10.7	% TS	2021-07-16	2021-07-20	Intern metode	±0.0
Vekt % 2 mm	0.2	wt% TS	2021-07-16	2021-07-21	Intern metode	±0.0
Vekt % 1 mm	0.7	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.0
Vekt % 0.500 mm	3.7	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.2
Vekt % 0.250 mm	6.2	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.3
Vekt % 0.125 mm	4.5	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.2
Vekt % 0.063 mm	10.0	wt% TS	2021-07-16	2021-07-21	Intern metode (Bale/Kenny 2005)	±0.5
Vekt % < 0.063 mm	74.6	wt% TS	2021-07-16	2021-07-21	Intern metode (Bale/Kenny 2005)	±3.7
Pelitt	74.6	% TS	2021-07-16	2021-07-21	Intern metode	
Sand	25.2	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	
Grus	0.2	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	

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ANALYSERAPPORT

Kunde:	Arnarlax	**Rapport nr.:**	P2100074
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		Ankomst dato	2021-06-29

Lab-id. P2100074-05

Objekt	Kundens ID	Beskrivelse	Notering	Mottatt lab
Sediment	C5	63266 Tjaldanes C og B undersøkelse at fallow period 2021		2021-06-29

Analyseresultat

Parameter	Resultat	Enhet	Analysedato start	Analysedato slutt	Standard	Måleusikkerhet
TOC	23	mg/g TS	2021-07-19	2021-07-21	DIN 19539:2016	±2.3
TNb	4.0	mg/g TS	2021-07-19	2021-07-21	NS-EN 16168:2012	±0.6
N TOC	32.6	mg/g TS	2021-07-23	2021-07-23	Veileder 02:2018	
C/N - forhold	5.9		2021-07-23	2021-07-23		
TOM	9.1	% TS	2021-07-16	2021-07-20	Intern metode	±0.0
Vekt % 2 mm	0	wt% TS	2021-07-16	2021-07-21	Intern metode	
Vekt % 1 mm	0	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	
Vekt % 0.500 mm	1.2	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.1
Vekt % 0.250 mm	5.8	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.3
Vekt % 0.125 mm	11.6	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	±0.6
Vekt % 0.063 mm	32.6	wt% TS	2021-07-16	2021-07-21	Intern metode (Bale/Kenny 2005)	±1.6
Vekt % < 0.063 mm	48.8	wt% TS	2021-07-16	2021-07-21	Intern metode (Bale/Kenny 2005)	±2.4
Pelitt	48.8	% TS	2021-07-16	2021-07-21	Intern metode	
Sand	51.2	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	
Grus	0	wt% TS	2021-07-16	2021-07-21	Intern metode (Buchanan 1984)	

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ANALYSERAPPORT

Kunde:	Arnarlax	**Rapport nr.:**	P2100074
Kundemerking:	63266		
Kontaktperson kunde:		**Rapportdato**	2021-07-23
		Ankomst dato	2021-06-29

Analyseansvarlig: Ingar H. Wasbotten

Signatur: Ingar H. Wasbotten

Underskriftsberettiget: Ingar H. Wasbotten

Signatur: Ingar H. Wasbotten

Analysene gjelder bare for de prøver som er testet. De oppgitte analyseresultat omfatter ikke feil som måtte følge av prøvetagningen, inhomogenitet eller andre forhold som kan ha påvirket prøven før den ble mottatt av laboratoriet. Rapporten får kun kopieres i sin helhet og uten noen form for endringer. En eventuell klage skal leveres laboratoriet senest en måned etter mottak av analyseresultat. Nærmere informasjon om analysemetodene (måleusikkerhet, metodeprinsipp etc.) fås ved henvendelse til Akvaplan-Niva AS

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