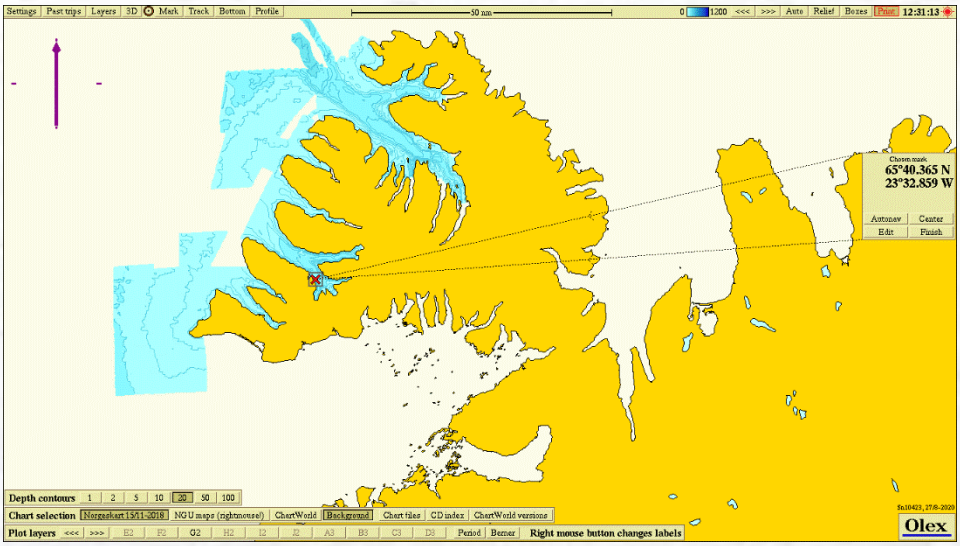
Akvaplan niva

Rapport Report

Arnarlax hf

C-survey (fallow period)

Haganes, 2020.



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Summary / Sammendrag
The results from the monitoring at the farming site Haganes in May 2020 showed that the sediment was somewhat loaded with organic carbon and the copper concentration at C1 was high (87.6 mg/kg), but within reported natural levels for bottom sediment around Iceland (Egilsson *et al*., 1999). No clear load effect was recorded in the fauna and faunal index nEQR varied from 0.550 (C1) to 0.649 (C5). The diversity index H' varied from 2.26 (C2) to 3.19 (C5). NS 9410:2016-assessment of the community in the local impact zone (C1) showed environmental condition 1 (Very good). No pollution indicator species were recorded among the top-10 at any of the stations. The redox measurements (pH/Eh) gave point 0 acc. Appendix D in NS 9410:2016 for all the sampling stations. The oxygen saturation in June was good in the whole water column with 98 % in the bottom water.

Project manager / Prosjektleder

Snorri Gunnarsson

Quality control / Kvalitetskontroll

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Contents

Foreword

Akvaplan-niva completed an environmental C-survey at the Haganes site. The C-survey is carried out in accordance with NS 9410:2016. The survey includes pH/redox measurements (Eh), hydrography, geochemical analyses and analyses of the bottom fauna at the fish farming site. Results from five stations are included in the survey. This survey is done upon request from Arnarlax hf hf.

The following personnel have contributed in this work:

Snorri Gunnarsson	Akvaplan-niva	Field work, report, project leader.
Hans-Petter Mannvik	Akvaplan-niva	Identification of bottom fauna (Echinodermata). Report, professional assessments and interpretations.
Roger Velvin	Akvaplan-niva	Identification of bottom fauna (Various taxa). QA report, professional assessments and interpretations.
Rune Palerud	Akvaplan-niva	Identification of bottom fauna (Crustaceans). Statistics.
Thomas Hansen	Akvaplan-niva	Identification of bottom fauna (Mollusca).
Marina V. Alonso	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 Silja Baldvinsdóttir, Arnarlax hf, for good cooperation.

Accreditation information:

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

NORSK AKKREDITERING TEST 079	Akvaplan-niva AS er akkreditert av Norsk Akkreditering for feltinnsamlinger av sediment og fauna, analyser av TOC, TOM, TN, kornstørrelse, makrofauna og faglig vurderinger og fortolkninger, akkrediteringsnr. TEST 079. Akkrediteringen er i hht. NS-EN ISO/IEC 17025.
Czech Accreditation Institute (Lab nr 1163)	ALS Laboratory Group er akkreditert av Czech Accreditation Institute (Lab nr 1163) for analyser av kobber.

Kópavogur, 31.08 2020

Snorri Gunnarsson

Project leader

1 Summary of C-results

Information client			
Title :	C-survey Haganes, 2020.		
Report nr.	62253.01	Site:	Haganes
Site nr.		Map coordinates (construction):	65°40,365 N 23°32,859 W
		Municipal:	Vesturbyggð
MTB-permission:	Site MTB	Operations manager: rett navn	Rolf Orjan Nordli
Client:	Arnarlax hf		

Biomass/production status at time of survey 11.06.2020			
Fish group:	Salmon	Biomass on examination:	0
Feed input:	0	Produced amount of fish:	0
Type/time of survey			
Maximum biomass:		Follow up study:	
Fallow (resting period):	X	New locationi:	

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 (closest to farm)	0,550	Fauna C1 (closest to farm)	3,12
Fauna C2	0,569	Fauna C2	2,26
Fauna C3	0,623	Fauna C3	2,52
Fauna C4 (deep area)	0,606	Fauna C4 (deep are)	2,75
Fauna C5	0,649	Fauna C5	3,19
Date fieldwork:	11.06.2020	**Date of report:**	31.08.2020
Notes to other results (sediment, pH/Eh, oxygen)			nTOC from 23.1 to 34.2 mg/g TS. Copper 87.6 at C1 Eh positive at all stations O_2-conditions were good throughout the water column.
Responsible for field work:	Snorri Gunnarsson	Signature:	

2 Introduction

2.1 Background and aim of study

Akvaplan-niva on behalf of Arnarlax hf completed a survey (type C) for a fish farming site Haganes in Arnarfjörður, Iceland (Figure 1).

The survey fulfils the requirements from the Icelandic authorities regarding bottom surveys referring to the standard 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 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 to the regional impact zones. The main emphasis is on the study of the soft bottom fauna which is conducted according to standards ISO 5567-19:2004 and ISO 16665:2014. The obligatory parameters that are included in the survey are described in NS 9410:2016.

A classification or threshold values for this type of survey have not been developed Icelandic officials so it is not possible to apply the classification based on Norwegian threshold values to Icelandic conditions. We do however report the results with these same indexes with reference to Norwegian threshold values but it should be emphasized that some of these (such as NSI) are developed according to Norwegian conditions. For further descriptions of these indexes see details in Appendix 1 and Miljødirektoratets Veileder 02:2018.

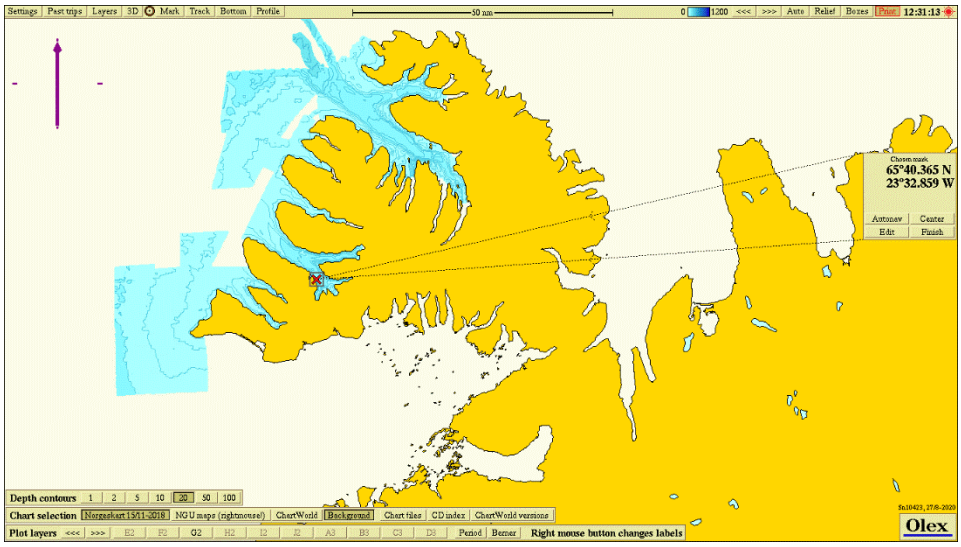

Figure 1. Overview of Arnarjörður with the farming site Haganes (red cross). The map coordinates for the midpoint of the farming site are given at right side of the picture.

2.2 Site operation and feed use

The Haganes plant is a frame mooring with a total of six 120 meters circumference cages in a 2 x 3 comfiguration. The Haganes site has been in a fallow state since fall 2019. Previously there have been farmed two generations salmon at the site. The last generation was farmed since June 2017 until early fall 2019. Production for the first generation was 2.414 tonnes salmon and feed use of 3.342 tonn and for the last generation 2.609 ton salmon and feed use 3.673 tonnes (Baldvinsdóttir pers. medd).

In Iceland, the MTB (maximum allowed biomass) limit is not given a 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 6.673 tonnes, used as MTB here (Baldvinsdóttir, pers. reference).

2.3 Previous surveys

Akvaplan-niva AS has done previous C surveys at the site Haganes. One in 2017 prior to putting out smolts into sea (Mannvik and Eriksen, 2017) and another in September 2018 at max biomass (Mannvik and Gunnarsson, 2019).

3 Materials and methods

3.1 Professional program

The choice of study parameters, placement of sampling stations and other criteria for the study is based on descriptions in NS 9410 (C-surveys). An overview of the planned professional program is given in Table 1.

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. *Kvalitetshåndbok for Akvaplan-niva.*
- Veileder 02:2018. *Klassifisering av miljøtilstand i vann*. Norsk klassifiseringssystem for vann i henhold til Vannforskriften. Veileder fra Direktoratgruppen.

Table 1. The planned professional program for the C-survey at Haganes, 2020. 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)	Quantitative analyses of bottom fauna. TOC. Korn. TOM. TN. Cu. pH/Eh.
C2 (outer transect zone)	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 (transect zone)	Quantitative analyses of bottom fauna. TOC. Korn. TOM. TN. pH/Eh.

Field work was completed on 11.06.2020.

3.2 Placement of stations and local conditions

The number of stations was calculated with reference to the sites estimated maximal standing biomass for the next generation which is 6.673 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 2 and shown in Figure 2. The stations were placed in accordance to the direction of the main oceanic current direction at 15 m depth (Eriksen, 2017). However sampling at the planned stations proved to be very challenging because of hard bottom (grab came repeatedly empty despite 4 or 5 efforts at each stations). Placement of stations was therefore moved slightly to vest towards a more deeper area at the site where more soft bottom area could be expected.

Table 2. Depth, distance between the nearest frame of the fish farm and sampling stations and coordinates for C-stations at Haganes, 2020.

Station	Depth, m	Distance from frame, m	Position N	Position W
C1	81	25	65º40.433	23º32.817
C2	92	500	65º40.703	23º32.950
C3	93	110	65º40.386	23º32.631
C4	95	115	65º40.441	23º32.659
C5	89	55	65º40.422	23º32.710

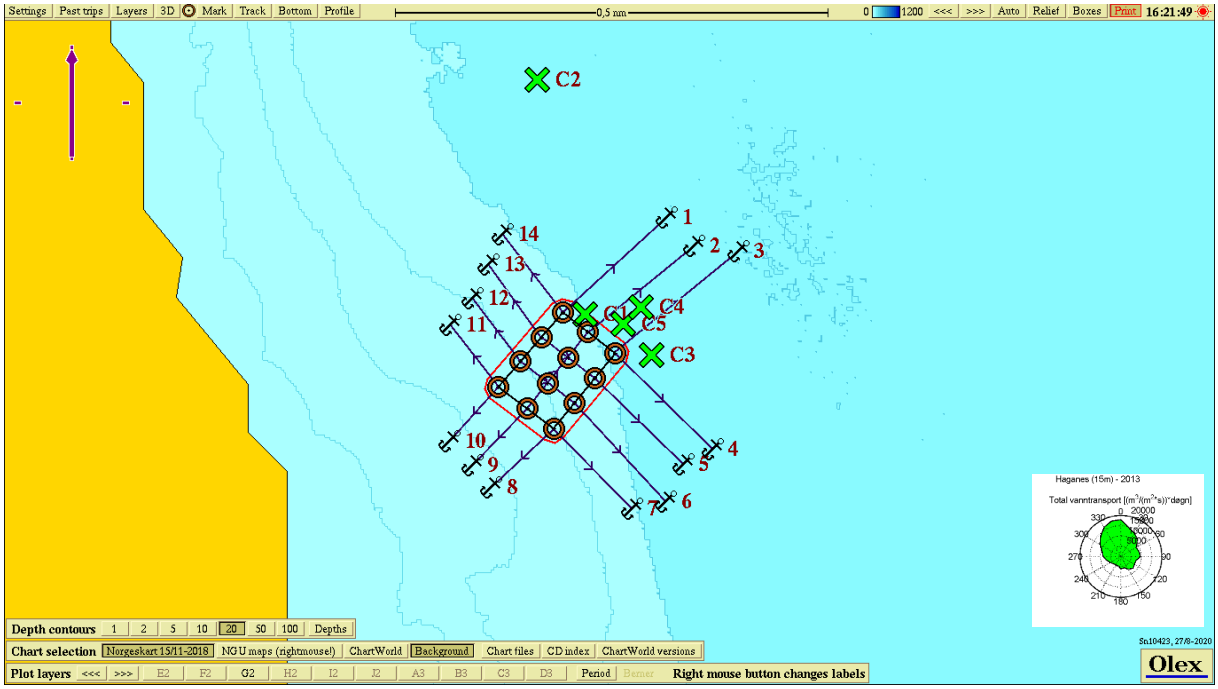

Figure 2. Map showing the sampling stations for the C-survey at Haganes, 2020. Current measurements used were from 15 m depth (Eriksen, 2017).

3.3 Hydrography and oxygen

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

3.4 Soft bottom sampling and analyses

3.4.1 Fieldwork

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

3.4.2 Total organic material (TOM)

The amount of TOM in 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 household 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.

3.4.3 Total nitrogen (TN)

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

3.4.4 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 content of total organic carbon (TOC) was determined by NDIR-detection in accordance with DIN19539:2016 (Investigation of solids – Temperature-dependent differentiation of total carbon (TOC_{400}, ROC, TIC_{900})). In order to classify the environmental conditions based on the content of TOC, the measured concentrations are normalized for proportion of fine substance (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).

The classification of the environment conditions for the sediment is based on normalized TOC, and was carried out according to "Veileder" 02:2018.

Classification of condition for organic content in the marine sediment.

nTOC, mg/g	< 20 I Very good	20 - 27 II Good	27 - 34 III Average	34 - 41 IV Bad	> 41 V Very bad

3.4.5 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.

Classification of the environmental condition with respect to Cu is based on reference to the Norwegian Environmental Directorate's "Veileder" 02:2018.

Classification for copper in the marine sediment.

Cu mg/kg	< 20 Klasse I	20 - 84 Klasse II	20 - 84 Klasse III	84 - 147 Klasse IV	> 147 Klasse V

3.4.6 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 to the manual of the instrument, 200 mV was added to the measured ORP (the Oxydation Reduction Potential) value.

3.5 Soft bottom fauna investigation

3.5.1 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, the fauna 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 favorable conditions for the fauna. However, moderate increases in organic load can stimulate the fauna and result in an increased number of species found. 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 fecal matter can, to a large degree, be attributed to changes in organic content (from the feed and fecal matter) in the sediment.

3.5.2 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 seive 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.

3.5.3 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 analyzed statistically. See Appendix 1 for description of analysis methods. The following statistical methods were used to describe community structure and to assess the similarity between different communities:

- 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
- Clusteranalyes
- The ten most dominant taxa per station (top-ten)

4 Results

4.1 Hydrography

The hydrographical profile for the deep station C4 in June 2020 is presented in Figure 3.

Temperature was around 8ºC at the surface and 2ºC at the bottom, and oxygen saturation 116 % in the upper layer and 98 % in the bottom layer.

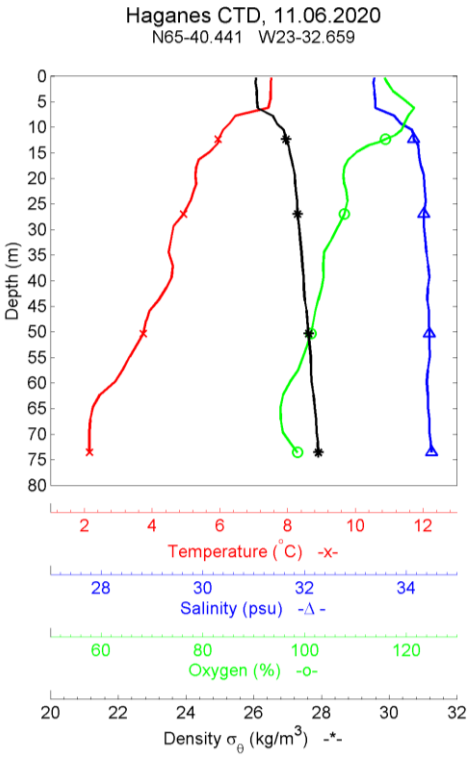

Figure 3. Vertical profiles. Temperature, salinity, density and oxygen at C4 at Haganes, 2020.

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

The level of total organic material (TOM), total organic carbon (TOC), total nitrogen (TN). C/N-relationship, grain size distribution in sediment (Pelitt) and pH/Eh in the sediment is presented in Table 3.

TOM-levels varied from 3.6 to 14.1 %. TN-levels were low (1.3 – 5.0 mg/g) as was the C/N-ratio. TOC was somewhat high at most of the stations and nTOC varied from 23.1 (C1) to 34.2 mg/g (C2). The bottom sediments grain size was coarse at C1 and fine at the other stations.

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

Table 3. Sediment description, TOM (%), TOC (mg/g), TN (mg/g), C/N, grain size distribution (pelitt ratio % <0,063 mm) and pH/Eh. Haganes, 2020.

St.	Sediment description	TOM	TOC	nTOC*	TN	C/N	Pelitt	pH/Eh
C1	Mud and sand, no smell, olive green.	3.6	7.8	23.1	1.3	6.1	15	7.7/ 392
C2	Mud, no smell, olive green.	14.1	31	34.2	3.7	8.4	83	7.7/ 225
C3	Mud, no smell, olive green.	12.6	24	25.7	4.7	5.1	88	7.7/ 295
C4	Mud, no smell, olive green.	13.3	26	29.4	5.0	5.2	82	7.8/ 314
C5	Mud, no smell, olive green.	10.3	21	25.0	4.2	5.0	77	7.7/ 350

4.3 Copper

The level of copper in the bottom sediment at C1 is shown in Table 4. The level was high with 87.6 mg/kg.

Table 4. Copper (Cu), mg/kg TS. C Haganes, 2020.

St.	Cu repl. 1
C1	87.6

4.4 Soft bottom fauna

4.4.1 Faunal indexes and ecological classification

Results from the quantitative soft bottom faunal analyses at the C-stations are presented in Table 5. 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 222 (C2) to 540 (C5) and number of species from 18 (C2) to 43 (C5). The diversity H' varied from 2.26 to 3.19. The overall index of nEQR varied from 0.550 (C1) to 0.649 (C5).

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 an uneven individual distribution between the species, indicating a disturbed bottom fauna community. The index varied from 0,58 to 0,73 which indicates a somewhat uneven distribution.

Table 5. 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 Haganes, 2020.

St.	Numb. ind.	Numb. species	H´	ES_{100}	NQI1	ISI_{2012}	NSI	nEQR	AMBI	J
C1	475	24	3,12	14,60	0,585	7,07	18,44	0,550	3,25	0,73
C2	222	18	2,26	13,33	0,542	8,77	22,27	0,569	3,65	0,59
C3	316	28	2,52	16,66	0,571	9,91	21,89	0,623	3,68	0,58
C4	382	35	2,75	17,31	0,591	8,46	20,90	0,606	3,54	0,60
C5	540	43	3,19	18,15	0,628	9,57	20,42	0,649	3,19	0,65

4.4.2 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 is 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 6). The data for number of species and dominating taxa at station C1 is given in Table 5 and Table 7.

Table 6. Classification of the environmental status of the soft bottom fauna at station C1 at the Haganes site 2020.

Station	Site name	Num. species	Dominating taxa	Environmental condition-NS 9410
C1	Haganes	24	Chaetozone setosa – 31 %	1 – Very good

4.4.3 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. For an explanation of the concept of geometric classes is given in Appendix 1.

The curve started lowest at C1 and highest at C5 and all curves stretched equally towards higher classes. None of these gave clear indications about the faunal conditions.

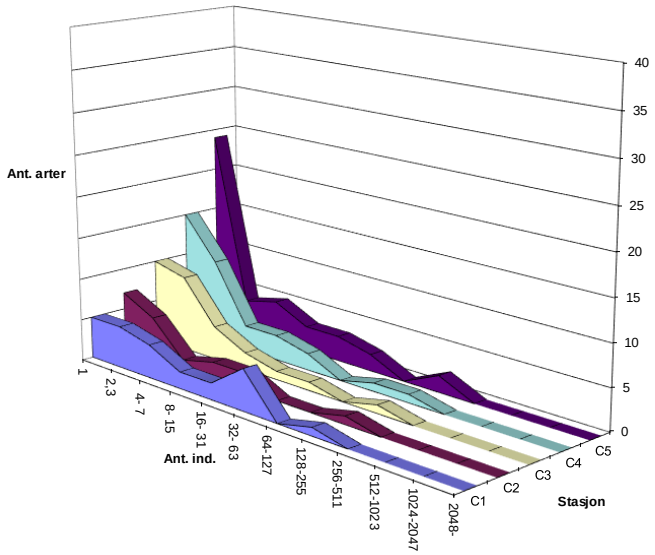

Figure 4. The soft bottom fauna shown as number of species against number of individuals pr. species in geometric classes. Haganes, 2020.

4.4.4 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 similarity of the fauna at C2 and C3 is 65 % as is the similarity at C4 and C5. These two groups of stations are 50 % similar and C1 is 37 % similar to the other stations.

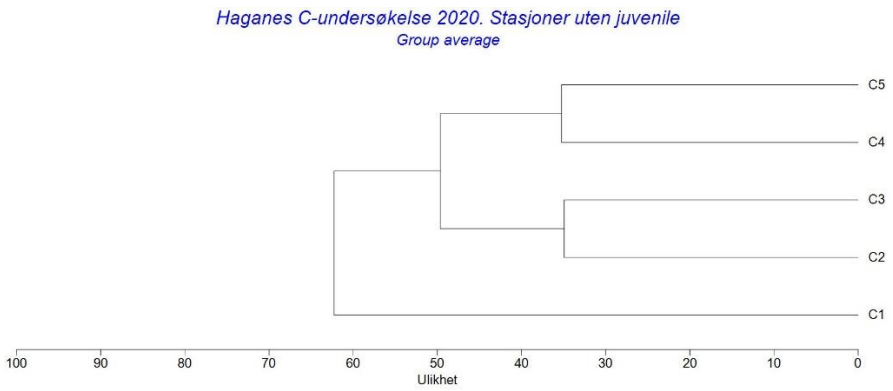

Figure 5. Cluster diagram for the soft bottom fauna at the C-stations at Haganes, 2020.

4.4.5 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 7.

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).

The opportunistic polychaete *Chaetozone setosa* is most dominant at C1 and C5 with 31 and 29 % of the individuals, respectively. The other most dominants at these stations are neutral and other opportunistic species.

The neutral polychaete *Prionospio steenstrupi* is the most dominant at the other stations with between 38 and 57 % of the individuals. The other most dominants at these stations are neutral, tolerant and opportunistic species.

No pollution indicators were recorded among the top-10 at any of the stations.

Table 7. Number of individuals, cumulative percentage and ecological group for the ten most dominant species at the C-stations. Haganes, 2020.*

C1	Numb.	Cum.	EG	C2	Numb.	Cum.	EG
Chaetozone setosa	147	31 %	IV	Prionospio steenstrupi	128	57 %	II
Ophelina acuminata	56	43 %	II	Ophelina acuminata	23	68 %	II
Prionospio steenstrupi	43	52 %	II	Chaetozone setosa	22	78 %	IV
Spio limicola	40	60 %	Ik	Ampharete borealis	12	83 %	III
Macoma calcarea	35	67 %	IV	Nuculana pernula	11	88 %	II
Axinopsida orbiculata	34	75 %	Ik	Ennucula tenuis	7	91 %	II
Ennucula tenuis	29	81 %	II	Leucon sp.	3	92 %	Ik
Mediomastus fragilis	27	86 %	IV	Thyasira sarsii	3	94 %	IV
Eteone flava/longa	13	89 %	Ik	Lumbrineris mixochaeta	2	95 %	IV
Parougia eliasoni	10	91 %	Ik	Mediomastus fragilis	2	96 %	IV
C3	**Numb.**	**Cum.**	**EG**	**C4**	**Numb.**	**Cum.**	**EG**
Prionospio steenstrupi	169	53 %	II	Prionospio steenstrupi	146	38 %	II
Chaetozone setosa	46	68 %	IV	Chaetozone setosa	96	63 %	IV
Ampharete borealis	24	75 %	III	Ampharete borealis	30	71 %	III
Ophelina acuminata	14	80 %	II	Ennucula tenuis	30	79 %	II
Ennucula tenuis	8	82 %	II	Leucon sp.	11	82 %	Ik
Leucon sp.	7	85 %	Ik	Lanassa venusta	8	84 %	II
Thyasira sarsii	7	87 %	IV	Nuculana pernula	8	86 %	II
Nuculana pernula	6	89 %	II	Thyasira sarsii	6	87 %	IV
Amphitrite cirrata	4	90 %	III	Ophelina acuminata	4	88 %	II
Harmothoe mariannae	3	91 %	Ik	Prionospio cirrifera	4	89 %	III

C5	Numb.	Cum.	EG
Chaetozone setosa	156	29 %	IV
Prionospio steenstrupi	138	54 %	II
Ennucula tenuis	62	66 %	II
Ampharete borealis	37	73 %	III
Nuculana pernula	21	77 %	II
Thyasira sarsii	20	80 %	IV
Lanassa venusta	19	84 %	II
Ophelina acuminata	11	86 %	II
Eteone flava/longa	10	88 %	Ik
Leucon sp.	9	89 %	Ik

*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.

4.5 Summary and conclusions – C-survey

4.5.1 Summary

The results from the environmental monitoring (type C) at Haganes, 2020, can be summarized as follows:

- The hydrography measurements showed good oxygen conditions throughout the water column with 98 % saturation in the bottom layer in June 2020.
- The number of individuals varied from 222 to 540 and number of species from 18 to 43. The diversity H' varied from 2.26 (C2) to 3.19 (C5). The overall index of nEQR varied from 0.550 (C1) to 0.649 (C5). No pollution indicator species were recorded among the top-10 at any of the stations.

- TOC was somewhat high at most of the stations and nTOC varied from 23.1 (C1) to 34.2 mg/g (C2). TOM-levels varied from 3.6 to 14.1 %. TN-levels were low (1.3 – 5.0 mg/g) as was the C/N-ratio. The copper level in the sediment at C1 was elavated (87.6 mg/kg) according to Norwegian standards, slightly higher than the reported average of 55 mg/kg, as natural levels for bottom sediment around Iceland (Egilsson *et al*., 1999). The sediment grain size was coarse at C1 and fine at the other stations. The redox measurements (pH/Eh) gave point 0 acc. Appendix D in NS 9410:2016 for all the stations.

4.5.2 Conclusion

The results from the monitoring at the farming site Haganes in May 2020 showed that the sediment was somewhat loaded with organic carbon and the copper concentration at C1 was high (87.6 mg/kg), which is slightly higher than the reported average of 55 mg/kg, as natural levels for bottom sediment around Iceland (Egilsson *et al*., 1999). No clear load effect was recorded in the fauna and faunal index nEQR varied from 0.550 (C1) to 0.649 (C5). The diversity index H' varied from 2.26 (C2) to 3.19 (C5). NS 9410:2016-assessment of the community in the local impact zone (C1) showed environmental condition 1 (Very good). No pollution indicator species were recorded among the top-10 at any of the stations. The redox measurements (pH/Eh) gave point 0 acc. Appendix D in NS 9410:2016 for all the sampling stations. The oxygen saturation in June was good in the whole water column with 98 % in the bottom water.

4.5.3 Environmental trend since the last C- survey

A combined ASC/C-survey was carried out at the location in 2018 (Mannvik & Gunnarsson, 2019). The station positions are different between these two surveys and, therefore, only a general comparison of the results is carried out.

The diversity index H' has generally increased since 2018 (H' 1,7 - 3,1) and is now between 2.3 and 3.2. A general increase can also be seen in the faunal index nEQR (2018; 0.381 – 0.567) and is now between 0.550 and 0.649. The pollution indicator species *Capitella capitata* (polychaete) was registered among the most dominants at station C1 and C3 in 2018, but is not among top-10 at any stations in the present survey. The TOC-levels are more or less similar to those found in 2018, while the level of copper at C1 has increase from 39.1 mg/kg in 2018 to 87.6 mg/kg in 2020.

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Pers. reference: Silja Baldvinsdóttir, Arnarlax hf.

6 Appendix

Appendix 1. Bunndyrstatistikk og artslister (in norwegian)

Diversitetsmål

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.

Pielous mål for jevnhet (Pielou, 1966)

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

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

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

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.

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.

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).

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.

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:

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

Referanser:

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Statistikk resultater Haganes, 2020:

Antall arter og individer per stasjon

st.nr.	tot.	C1	C2	C3	C4	C5
no. ind.	1935	475	222	316	382	540
no. spe.	75	24	18	28	35	43

Bunndyrindekser per replikat

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.	1935	265	210	100	122	176	140	155	227	250	290
no. spe.	75	21	18	14	14	26	16	17	33	25	34
Shannon-Wiener:		2,9	3,3	2,4	2,1	2,9	2,1	2,2	3,3	3,0	3,4
Pielou		0,67	0,80	0,63	0,56	0,63	0,52	0,53	0,66	0,65	0,66
ES100		15	14	14	13	19	14	14	21	17	19
SN		1,77	1,72	1,73	1,68	1,98	1,74	1,75	2,07	1,88	2,03
ISI-2012		6,98	7,16	8,49	9,05	9,94	9,87	8,92	8,00	9,88	9,26
AMBI		3,562	2,941	3,48	3,811	3,482	3,871	3,929	3,153	3,411	2,969
NQI1		0,57	0,60	0,56	0,53	0,61	0,53	0,53	0,65	0,60	0,66
NSI		18,4	18,5	22,1	22,5	21,3	22,5	21,8	20,0	21,0	19,8

Bunndyrindekser, gjennomsnitt per stasjon

st.nr.		C1	C2	C3	C4	C5
Shannon-Wiener:		3,12	2,26	2,52	2,75	3,19
Pielou		0,73	0,59	0,58	0,60	0,65
ES100		14,6	13,3	16,7	17,3	18,1
SN		1,75	1,70	1,86	1,91	1,96
ISI-2012		7,07	8,77	9,91	8,46	9,57
AMBI		3,252	3,646	3,677	3,541	3,190
NQI1		0,58	0,54	0,57	0,59	0,63
NSI		18,44	22,27	21,89	20,90	20,42
Tilstandsklasse nEQR		0,550	0,569	0,623	0,606	0,649

Geometriske klasser

int.	C1	C2	C3	C4	C5
1	5	7	10	15	24
2,3	5	5	9	10	4
4- 7	4	1	4	3	5
8- 15	2	2	2	3	3
16- 31	2	2	1	2	3
32- 63	5	0	1	0	2
64-127	0	0	0	1	0
128-255	1	1	1	1	2
256-511	0	0	0	0	0
512-1023	0	0	0	0	0
1024-2047	0	0	0	0	0
2048-	0	0	0	0	0

Artsliste

Haganes C-undersøkelse 2020

Rekke	Klasse	Art/Taxa	01	02	Sum
Stasjonsnr.: C1					
NEMERTINI					
		Nemertea indet.	1		1
ECHIURIDA					
		Echiurus echiurus		1	1
ANNELIDA					
	Polychaeta				
		Ampharete petersenae		6	6
		Bylgides sarsi	2		2
		Chaetozone setosa	104	43	147
		Cistenides hyperborea	2	3	5
		Eteone flava/longa	5	8	13
		Galathowenia oculata	1		1
		Gattyana amondseni	1		1
		Goniada maculata	2	1	3
		Mediomastus fragilis	3	24	27
		Ophelina acuminata	33	23	56
		Parougia eliasoni	9	1	10
		Prionospio steenstrupi	31	12	43
		Scalibregma inflatum	2		2
		Spio limicola	38	2	40
CRUSTACEA					
	Malacostraca				
		Leucon sp.	2		2
		Lysianassidae indet.	5	2	7
		Oedicerotidae indet.	5	1	6
MOLLUSCA					
	Prosobranchia				
		Oenopota sp.	1	2	3
	Bivalvia				
		Axinopsida orbiculata	1	33	34
		Ennucula tenuis	1	28	29
		Macoma calcarea	16	19	35
		Mytilus edulis		1	1
		Nuculana sp. juv.		1	1
		Maks:	104	43	147
		Antall:	21	19	25
		Sum:			476
Stasjonsnr.: C2					
ANNELIDA					
	Polychaeta				
		Ampharete borealis	4	8	12
		Amphitrite cirrata	1		1
		Chaetozone setosa	11	11	22
		Galathowenia oculata		1	1
		Laphania boecki		1	1
		Lumbrineris mixochaeta	1	1	2
		Mediomastus fragilis	2		2
		Melinna cristata		1	1
		Nephtys paradoxa	1	1	2
		Ophelina acuminata	7	16	23

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Rekke	Klasse	Art/Taxa	01	02	Sum
		Polycirrus norvegicus		1	1
		Prionospio steenstrupi	55	73	128
		Spiophanes kroyeri	1		1
CRUSTACEA					
	Malacostraca				
		Leucon sp.	2	1	3
MOLLUSCA					
	Bivalvia				
		Ennucula tenuis	4	3	7
		Nuculana pernula	9	2	11
		Thyasira sarsii	1	2	3
		Yoldia hyperborea	1		1
ECHINODERMATA					
	Asteroidea				
		Asteroidea indet. juv.	1		1
		Maks:	55	73	128
		Antall:	15	14	19
		Sum:			223

Stasjonsnr.: C3

ANNELIDA					
	Polychaeta				
		Ampharete borealis	16	8	24
		Amphitrite cirrata	2	2	4
		Chaetozone setosa	33	13	46
		Ditrupa arietina	2		2
		Eteone flava/longa	1		1
		Eunice pennata	1	1	2
		Eupolymnia nesidensis	1	1	2
		Goniada maculata	1		1
		Harmothoe mariannae	1	2	3
		Hesionidae indet.		1	1
		Jasmineira caudata	2		2
		Lumbrineris mixochaeta	1		1
		Malmgrenia mcintoshi	1		1
		Mediomastus fragilis		2	2
		Melinna cristata	1		1
		Nephtys paradoxa	1		1
		Nicomache lumbricalis	1		1
		Nicomachinae indet.	1	1	2
		Ophelina acuminata	6	8	14
		Polynoidae indet.	3		3
		Prionospio steenstrupi	78	91	169
		Syllis cornuta	1		1
CRUSTACEA					
	Malacostraca				
		Leucon sp.	6	1	7
MOLLUSCA					
	Prosobranchia				
		Oenopota sp.	1	2	3
	Bivalvia				
		Ennucula tenuis	5	3	8
		Nuculana pernula	4	2	6
		Thyasira sarsii	5	2	7
		Yoldia hyperborea	1		1
ECHINODERMATA					
	Asteroidea				
		Asteroidea indet. juv.		1	1
		Maks:	78	91	169
		Antall:	26	17	29
		Sum:			317

Stasjonsnr.: C4

NEMERTINI					
		Nemertea indet.		1	1
ANNELIDA					
	Polychaeta				
		Ampharete borealis	7	23	30
		Amphicteis gunneri		1	1
		Amythasides macroglossus		1	1
		Anobothrus gracilis		1	1
		Aonides paucibranchiata	1		1
		Chaetozone setosa	28	68	96
		Eteone flava/longa	1	2	3
		Galathowenia oculata		1	1

	Lanassa venusta	3	5	8
	Laphania boecki		3	3
	Lumbrineris mixochaeta	1	1	2
	Mediomastus fragilis		1	1
	Melinna cristata	1	1	2
	Ophelina acuminata	3	1	4
	Pectinaria belgica		1	1
	Praxillella gracilis	2	1	3
	Prionospio cirrifera	1	3	4
	Prionospio steenstrupi	92	54	146
	Proclea graffii		2	2
	Scalibregma hanseni		1	1
	Spio limicola		1	1
	Terebellides sp.		2	2
	Travisia forbesii		1	1
	Trichobranchus roseus	3		3
Oligochaeta				
	Oligochaeta indet.	1	1	2
CRUSTACEA				
Malacostraca				
	Bathymedon obtusifrons		1	1
	Leucon sp.	2	9	11
MOLLUSCA				
Bivalvia				
	Axinopsida orbiculata		1	1
	Ennucula tenuis	6	24	30
	Macoma calcarea		1	1
	Mytilus edulis		1	1
	Nuculana pernula	1	7	8
	Nuculana sp. juv.		1	1
	Thyasira sarsii	2	4	6
	Yoldia hyperborea		2	2
ECHINODERMATA				
Asteroidea				
	Asteroidea indet. juv.		1	1
	Maks:	92	68	146
	Antall:	17	35	37
	Sum:			384

Rekke	Klasse	Art/Taxa	01	02	Sum
Stasjonsnr.: C5					
ANNELIDA					
	Polychaeta				
		Ampharete borealis	10	27	37
		Ampharete finmarchica	2	3	5
		Amythasides macroglossus		1	1
		Anobothrus gracilis		1	1
		Aricidea wassi	1		1
		Chaetozone setosa	68	88	156
		Cossura longocirrata	1		1
		Eteone flava/longa	3	7	10
		Euchone rosea		1	1
		Euchone sp.		1	1
		Euclymeninae indet.		1	1
		Eunice pennata	2	1	3
		Galathowenia oculata		1	1
		Lanassa venusta	12	7	19
		Laphania boecki	4	1	5
		Lumbrineris mixochaeta		1	1
		Malmgrenia mcintoshi		1	1
		Mediomastus fragilis		1	1
		Myxicola infundibulum	1		1
		Nephtys pente	2	2	4
		Ophelina acuminata	9	2	11
		Polynoidae indet.		1	1
		Praxillella gracilis		1	1
		Praxillella praetermissa	5		5
		Prionospio cirrifera		1	1
		Prionospio steenstrupi	89	49	138
		Scalibregma hanseni		1	1
		Spio limicola	1		1
		Spiophanes kroyeri	1		1
		Terebellides sp.	1	2	3
CRUSTACEA					
	Malacostraca				
		Campylaspis sp.	1		1
		Diastylis scorpioides		1	1
		Leucon sp.	2	7	9
		Oedicerotidae indet.	1	1	2
		Rhachotropis sp.	1		1
MOLLUSCA					
	Bivalvia				
		Abra nitida		4	4
		Axinopsida orbiculata		1	1
		Ciliatocardium ciliatum		1	1
		Ennucula tenuis	18	44	62
		Macoma calcarea		2	2
		Nuculana pernula	8	13	21
		Thyasira sarsii	6	14	20
		Yoldia hyperborea	1		1
ECHINODERMATA					
	Asteroidea				
		Asteroidea indet. juv.	1		1
		Maks:	89	88	156
		Antall:	26	34	44
		Sum:			541
				TOTAL:	**Maks:** 169
					Sum: 1941

Appendix 2. Analyserapport – Geokjemiske analyser (in norwegian)

62253 Kjemirapport C-undersøkelse m klassifisering.xlsx_040520

Framsenteret
Postboks 6606 Langnes, 9296 Tromsø
Foretaksnr.: NO 937 375 158 MVA
Tel: 77 75 03 00
E-post: kjemi@akvaplan.niva.no

ANALYSERAPPORT
Sedimentprøver

Kunde:	**Arnarlaz hf.**
Kunde referanse:	**Haganes C og B undersøkelse sommer 2020**
Kontaktperson kunde:	
e-post:	
Kontaktperson Akvaplan-niva:	Snorri Gunnarsson
Dato:	17.07.2020
Rapport nr.:	**62253**
Analyseparameter(e):	Korn, TOM, TOC, TN, Cu
Kontaktperson:	Oda S. Bye Wilhelmsen
Analyseansvarlig:	(sign.)
Underskriftsberettiget:	Digitally signed by Oda Sofie Bye Wilhelmsen Date: 2020.07.17 14:29:36 +02'00' (sign.)

Prøvene ble sendt/levert til Akvaplan-Niva AS av oppdragsgiver, og merket som angitt i tabellen på side 2.
Resultater av analysene er gitt fra side 3.

MERKNADER:
Stasjon C1 inneholdt skjellbiter større enn 15 mm som ikke er inkludert i kornanalysen. Skjellbitene ville utgjøre ca 2 vekt% av den totale prøven.

Lab-id.	Kundens id.	Beskaffenhet ved mottak	Mottatt lab	Parametere	Analyse-periode
62253/C1	C1	Sediment	19.06.2020	Korn, TOM, TOC, TN, Cu	24.06.20 - 09.07.20
62253/C2	C2	Sediment	19.06.2020	Korn, TOM, TOC, TN	29.06.20 - 09.07.20
62253/C3	C3	Sediment	19.06.2020	Korn, TOM, TOC, TN	29.06.20 - 09.07.20
62253/C4	C4	Sediment	19.06.2020	Korn, TOM, TOC, TN	29.06.20 - 09.07.20
62253/C5	C5	Sediment	19.06.2020	Korn, TOM, TOC, TN	29.06.20 - 09.07.20

Følgende analysemetoder er benyttet

Parameter	Metodereferanse
Kornfordeling (splitt i to)	Sikting, basert på Bale, A.J. & Kenny, A.J. 2005. Sediment analysis and seabed characterisation . In: Eleftheriou,A; McIntyre, A.D. "Methods for the study of marine benthos", 3rd ed. Blackwell Science, Oxford, UK. ISBN 0-632-05488-3, pp. 43-86
Totalt organisk materiale-TOM	Intern metode basert på NS 4764:1980
Totalt organisk karbon-TOC	NDIR-deteksjon. Intern metode basert på DIN 19539:2016
Totalt bundet nitrogen - Total-N	Elektrokjemisk deteksjon. Intern metode basert på NS-EN 16168:2012. MERK: ved TOC-verdier større enn ca 60 mg/g TS kan TN-resultater bli underestimert
Kobber-Cu (utført av underlev.)	EPA 200.7, ISO 11885, EPA 6010 og SM 3120

Resultater

	TOC	TN	TOM	Pelitt	> 0,063 mm	Cu*	N TOC	C/N
Kundens id.:	mg/g TS	mg/g TS	% TS	vekt%	vekt%	mg/kg TS	mg/g TS	
C1	7,8	1,3	3,6	15,3	84,7	87,6	23,1	6,1
C2	31	3,7	14,1	83,0	17,0	ia	34,2	8,4
C3	24	4,7	12,6	88,4	11,6	ia	25,7	5,1
C4	26	5,0	13,3	82,1	17,9	ia	29,4	5,2
C5	21	4,2	10,3	77,0	23,0	ia	25,0	5,0

* Analysen er utført av ALS Laboratory Group, ALS Czech Republic s.r.o, Na Harfě 9/336, Praha, Tsjekkia

Akkreditering: Czech Accreditation Institute, labnr. 1163

N TOC (Normalisert TOC) = målt TOC mg/g + 18*(1-F), der F=andel finstoff (pelitt) gitt ved %pelitt/100.

ia = ikke analysert

Tilstandsklassifisering for organisk innhold i marine sedimenter ihht. Veileder 02:2018:

Normalisert TOC, mg/g TS	< 20 I Svært god	20-27 II God	27-34 III Moderat	34-41 IV Dårlig	> 41 V Svært dårlig

Tilstandsklassifisering for kobber (Cu) i marine sedimenter (grenseverdier fra M-608/2016):

Cu, mg/kg TS	< 20 Klasse I	20-84 Klasse II/III	84 - 147 Klasse IV	> 147 Klasse V