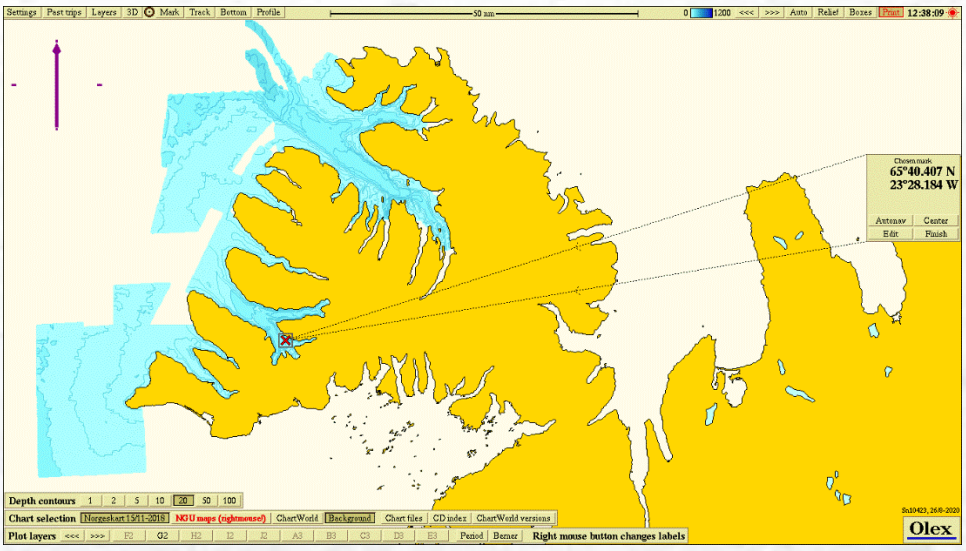
Akvaplan niva

Rapport Report

Arnarlax

C-survey (fallow period)

Steinanes, 2020.



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Summary / Sammendrag
The results from the monitoring at the farming site Steinanes in June 2020 showed that the sediments was somewhat loaded with organic carbon. The copper concentration was slightly elevated in the local impact zone, but within reported natural levels for bottom sediment around Iceland (Egilsson *et al.*, 1999). Some load effect was recorded in the soft bottom communities. The faunal index nEQR was between 0,470 and 0,585. The nEQR values indicate moderate disturbance of the communities. NS 9410:2016-assessment of the community in the local impact zone (C1) showed environmental condition 1 (Very good). No pollution indicators were recorded among the top-10 species 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 90 % in the bottom water.

Project manager / Prosjektleder

Snorri Gunnarsson

Quality control / Kvalitetskontroll

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Date: 2020.09.21 12:22:46 +02'00'

Contents

Foreword

Akvaplan-niva completed an environmental survey of the type C at the Steinanes 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 six stations are included in the survey. This survey is done upon request from Arnarlax Hf.

The following personnel have contributed in this work:

Snorri Gunnarsson	Akvaplan-niva	Field work, report, project leader.
Roger Velvin	Akvaplan-niva	Identification of bottom fauna (Various taxa). Report, professional assessments and interpretations.
Hans-Petter Mannvik	Akvaplan-niva	Identification of bottom fauna (Echinodermata). 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).
Andrey Sikorsky	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 21.09.2020

Snorri Gunnarsson

Project leader

1 Summary of C-results

Information client			
Title :	Arnarlax C-survey (fallow period) Steinanes, 2020.		
Report nr.	62254.01	Site:	Steinanes
Site nr.		Map coordinates (construction):	65°40.407 N 23°28.184 V
		Municipality:	
MTB-permission:	Site MTB	Operations manager:	Rolf Orjan Nordli
Client:	Arnarlax		

Biomass/production status at time of survey 10.06.2020			
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 (since 23.11 2019)	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)	0,474	Fauna C1 (closest to farm)	1,79
Fauna C2	0,581	Fauna C2 (reference)	2,23
Fauna C3	0,484	Fauna C3	2,07
Fauna C4 (deep area)	0,487	Fauna C4 (deep are)	2,25
Fauna C5	0,470	Fauna C5	1,69
Fauna C6	0,518	Fauna C6	2,08
Date fieldwork:	10.06.2020	**Date of report:**	21.09.2020
Notes to other results (sediment, pH/Eh, oxygen)			nTOC from 29,0 (C2) to 40,5 mg/g (C4). Copper 50,5 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:	

2 Introduction

2.1 Background and aim of study

Akvaplan-niva, on behalf of Arnarlax, completed a C-survey for a fish farming site Steinanes 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 included in the survey are described in NS 9410:2016.

A classification or threshold values for this type of survey has 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 criterias regarding faunal indexes and values of copper, are not developed according to Icelandic conditions. For further descriptions of these indexes see details in Appendix 1 and Miljødirektoratets Veileder 02:2018.

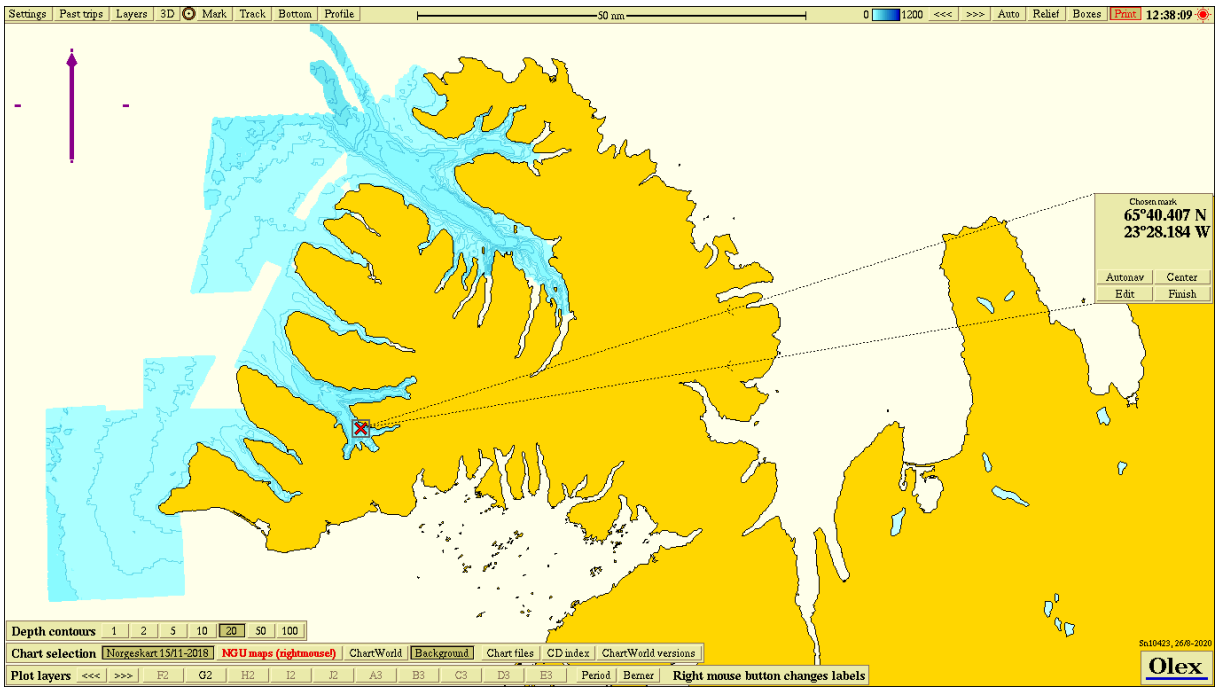

Figure 1. Overview of Arnarfjörður with the farming site Steinanes (red cross). The map coordinates for the midpoint of the farming site are given at right site of the picture.

2.2 Site operation and feed use

The Steinanes site has been in the fallow state since 23rd of November 2019. Previously there has been farmed one generation of salmon at the site. The plant is a frame mooring with a total of fourteen 160 meters circumference cages in a 2 x 7 configuration. The planned time for setting out next generation at the site is June 2020. The previous generation salmon was farmed at the site from June 2017 to November 2019.

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 8.240 tonnes, used as MTB here (Baldvinsdóttir, pers reference).

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 9410:2016 (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 Steinanes, 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 (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.
Cu 6 (transect zone)	Quantitative analyses of bottom fauna. TOC. Korn. TOM. TN. pH/Eh.

Field work was completed on 10.06.2020.

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 8.240 tonnes (used as MTB here). According to the standard, six sampling stations should be included. Depth and position of the stations are given in Table 2 and shown in Figure 2. The stations were located in accordance to the direction of the main oceanic current direction at 15 m depth (Eriksen, 2016).

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

Station	Depth, m	Distance from frame, m	Position N	Position W
C1	91	25	65° 40.282	23° 28.263
C2	89	500	65° 40.195	23° 27.532
C3	93	110	65° 40.378	23° 28.497
C4	93	142	65° 40.244	23° 28.142
C5	86	135	65° 40.426	23° 28.631
C6	93	175	65° 40.235	23° 28.105

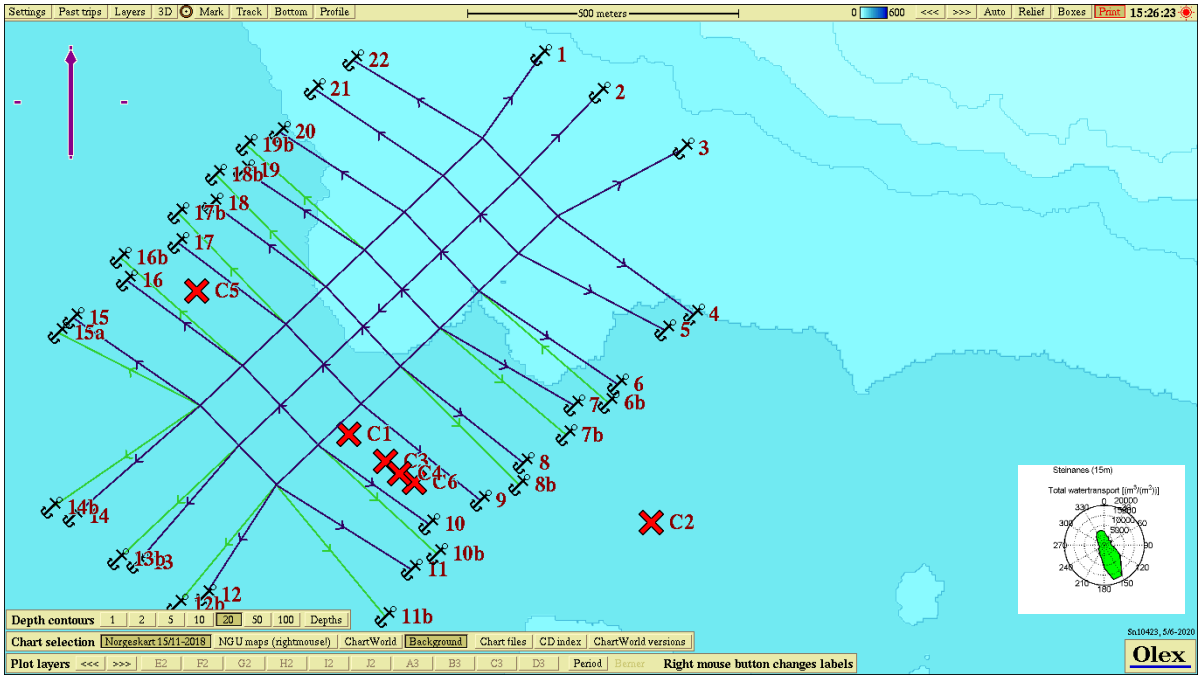

Figure 2. Map showing the sampling stations for the C-survey at Steinanes, 2020. Current measurements used were from 15 m depth (Eriksen, 2016).

3.3 Hydrography and oxygen

At station C4, hydrographic measurements, salinity, temperature, density and oxygen saturation, were carried out for vertical profiles from the surface to the 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, TN and Cu were taken off 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 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).

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.

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 in the surface and 2ºC near the bottom, and oxygen saturation 120 % in the upper layer and 90 % in the bottom layer.

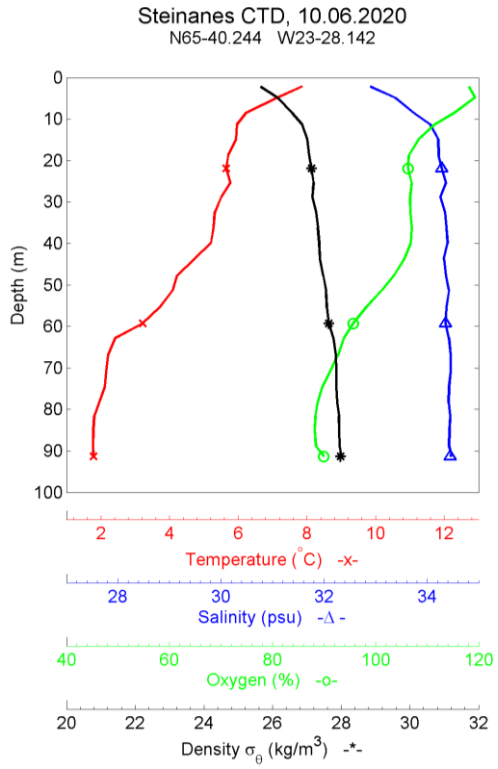

Figure 3. Vertical profiles. Temperature, salinity, density and oxygen at C4 at Steinanes, 2020.

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

The level of total organic material (TOM), total organic carbon (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 11,7 to 14,1 %. TN-levels were low (3,3 – 5,5 mg/g) as was the C/N-ratio. TOC was high at station C4 and moderate high at the other stations. nTOC varied from 29,0 (C2) to 40,5 mg/g TS (C4). The bottom sediments grain size were moderately fine to fine with pelite ratio between 64 and 87 %.

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. Steinanes, 2020.

St.	Sediment description	TOM	TOC	nTOC*	TN	C/N	Pelitt	pH/Eh
C1	Muddy and sand, olive green, no smell, some crushed shells.	13,7	26,8	29,1	4,9	5,5	87	7,8 / 319
C2	Muddy and fine gravel, olive green, no smell, some crushed shells.	11,7	22,5	29,0	4,2	5,3	64	7,5 / 269
C3	Muddy and fine gravel, olive green, no smell, some crushed shells.	14,1	27,6	30,6	5,5	5,0	83	7,7 / 270
C4	Muddy, olive green, no smell, some crushed shells.	13,6	35,6	40,5	3,3	10,6	73	7,8 / 315
C5	Muddy and fine gravel, olive green, no smell, some crushed shells.	12,6	29,2	32,8	4,8	6,0	80	7,6 / 294
C6	Muddy and fine gravel, olive green, no smell, some crushed shells.	12,3	25,2	30,5	5,0	5,0	71	7,5 / 281

4.3 Copper

The level of copper in the bottom sediments are shown in Table 4. The level of copper was 50,5 mg/kg.

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

St.	Cu repl. 1
C1	50,5

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 397 (C6) to 1403 (C3) and number of species from 19 (C4) to 33 (C2). The diversity H' varied from 1,69 to 2,25. The overall index of nEQR was within 0,470 and 0,585. The nEQR values indicate moderate 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 0,39 to 0,58 which indicates a somewhat uneven distribution.

Table 5. Number of species and individuals pr. 0,2 m^2. 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 Steinanes, 2020.

St.	Numb. ind.	Numb. species	H´	ES_{100}	NQI1	ISI_{2012}	NSI	nEQR	AMBI	J
C1	933	26	1,79	9,7	0,50	8,54	17,40	0,474	4,218	0,42
C2	521	33	2,23	15,3	0,55	8,65	22,47	0,581	3,921	0,49
C3	1403	28	2,07	10,4	0,52	7,69	17,97	0,484	4,065	0,45
C4	507	19	2,25	10,5	0,51	7,44	18,57	0,487	3,932	0,58
C5	1142	28	1,69	9,5	0,50	8,61	17,36	0,470	4,252	0,39
C6	397	20	2,08	11,6	0,52	8,00	20,67	0,518	3,955	0,53

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 community 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 Steinanes site 2020.

Station	Site name	Num. species	Dominating taxa	Environmental condition-NS 9410
C1	Steinanes	26	Chaetozone setosa – 61 %	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 3.

All curves started relatively low (≤ 14 species) and stretched out in varying degrees towards higher classes. These did not give any clear indications of fauna condition.

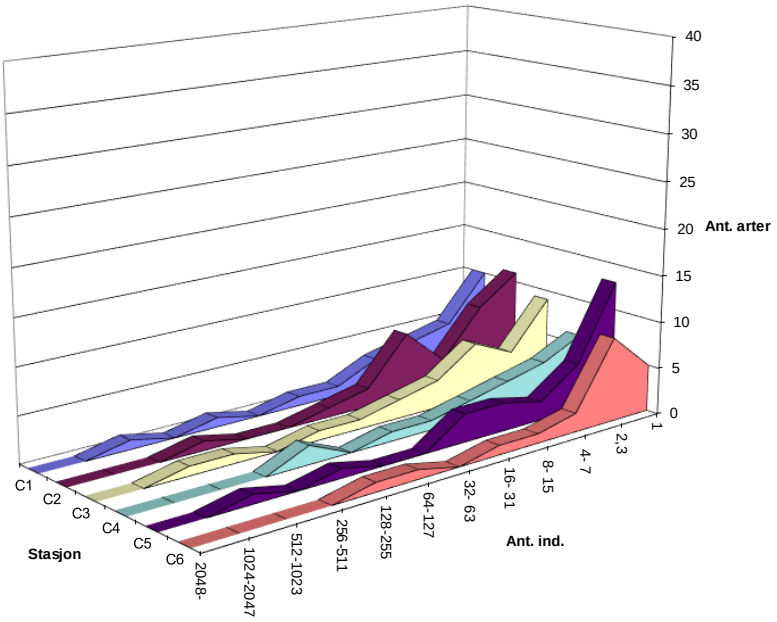

Figure 4. The soft bottom fauna shown as number of species against number of individuals pr. species in geometric classes. Steinanes, 2020.

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 fauna composition at the stations was more than 55 % similar in the survey.

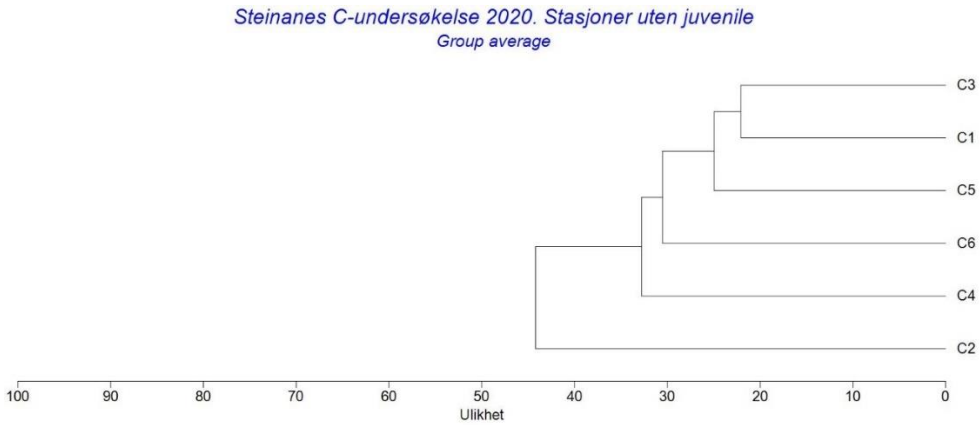

Figure 5. Cluster diagram for the soft bottom fauna at the C- sampling stations at Steinanes, 2020.

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).

Station C1, C3, C4 and C5 were dominated by the opportunistic polychaeta *Chaetozone setosa* with between 44 and 66 % of the individuals. Station C2 and C6 were dominated by the neutral polychaeta *Prionospio steenstrupi* with 62 and 55 %, respectively, of the individuals. The other most dominant species at the stations were a mixture of neutral, tolerant, opportunistic and some sensitive 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 on the C stations. Steinanes, 2020.*

C1	Numb.	Cum.	EG	C2	Numb.	Cum.	EG
Chaetozone setosa	570	61 %	IV	Prionospio steenstrupi	327	62 %	II
Prionospio steenstrupi	229	85 %	II	Chaetozone setosa	41	69 %	IV
Thyasira sarsii	43	90 %	IV	Heteromastus filiformis	24	74 %	IV
Ophelina acuminata	18	92 %	II	Laphania boecki	17	77 %	II
Eteone flava/longa	13	93 %	ik	Ophelina acuminata	13	80 %	II
Ampharete borealis	10	94 %	III	Thyasira sarsii	12	82 %	IV
Ampharete finmarchica	9	95 %	II	Praxillella gracilis	10	84 %	IV
Yoldia hyperborea	5	96 %	ik	Eteone flava/longa	8	85 %	ik
Heteromastus filiformis	4	96 %	IV	Melinna cristata	8	87 %	II
Melinna cristata	4	97 %	II	Nuculana pernula	8	88 %	II
C3	**Numb.**	**Cum.**	**EG**	**C4**	**Numb.**	**Cum.**	**EG**
Chaetozone setosa	735	52 %	IV	Chaetozone setosa	226	44 %	IV
Prionospio steenstrupi	398	81 %	II	Prionospio steenstrupi	152	74 %	II
Ampharete borealis	84	87 %	III	Ampharete borealis	44	83 %	III
Thyasira sarsii	60	91 %	IV	Thyasira sarsii	31	89 %	IV
Eteone flava/longa	30	93 %	ik	Ophelina acuminata	15	92 %	II
Ophelina acuminata	16	94 %	II	Eteone flava/longa	10	94 %	ik
Euchone papillosa	10	95 %	III	Melinna cristata	6	95 %	II
Schistomeringos sp.	8	96 %	I	Ampharete finmarchica	4	96 %	II
Yoldia hyperborea	8	96 %	ik	Nephtys ciliata	4	97 %	III
Heteromastus filiformis	7	97 %	IV	Heteromastus filiformis	3	97 %	IV
C5	**Numb.**	**Cum.**	**EG**	**C6**			
Chaetozone setosa	760	66 %	IV	Prionospio steenstrupi	217	55 %	II
Prionospio steenstrupi	241	88 %	II	Chaetozone setosa	103	80 %	IV
Ophelina acuminata	28	90 %	II	Ampharete borealis	28	87 %	III
Thyasira sarsii	27	92 %	IV	Thyasira sarsii	13	91 %	IV
Ampharete borealis	18	94 %	III	Ophelina acuminata	5	92 %	II
Eteone flava/longa	11	95 %	ik	Schistomeringos sp.	4	93 %	I
Heteromastus filiformis	10	96 %	IV	Euchone papillosa	3	94 %	III
Schistomeringos sp.	10	97 %	I	Lumbrineris mixochaeta	3	94 %	IV
Galathowenia oculata	6	97 %	III	Nemertea indet.	3	95 %	III
Cistenides hyperborea	4	97 %	III	Nephtys ciliata	3	96 %	III

*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 Steinanes in June 2020, can be summarized as follows:

- The hydrography measurements showed good oxygen conditions throughout the water column with 90 % saturation in the bottom layer in June 2020.
- TOC was high at station C4 and moderate high at the other stations. nTOC varied from 29,0 (C2) to 40,5 mg/g TS (C4). TOM-levels varied from 11,7 to 14,1 %. TN-levels were low (3,3 – 5,5 mg/g) as was the C/N-ratio. The copper level in sediment at C1 was slightly elavated (50,5 mg/kg) according to Norwegian standards, but well within reported natural levels in Icelandic coastal areas (Egilsson *et al*. 1999). The bottom

sediments grain size were moderately fine to fine with pelite ratio between 64 and 87 %. 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 397 (C6) to 1403 (C3) and number of species from 19 (C4) to 33 (C2). The diversity H' varied from 1,69 to 2,25. The overall index of nEQR was within 0,470 and 0,585. The nEQR values indicate moderate disturbance of the communities.

4.5.2 Conclusion

The results from the monitoring at the farming site Steinanes in June 2020 showed that the sediments were somewhat loaded with organic carbon. The copper concentration was slightly elevated in the local impact zone, but within reported natural levels for bottom sediment around Iceland (Egilsson *et al*., 1999). Some load effect was recorded in the softbottom communities. The faunal index nEQR was between 0,470 and 0,585. The nEQR values indicate moderate disturbance of the communities. NS 9410:2016-assessment of the community in the local impact zone (C1) showed environmental condition 1 (Very good). No pollution indicators were recorded among the top-10 species 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 90 % in the bottom water.

Previously there have been two bottom surveys at the Steinanes site, a pre-survey in June 2017 (Mannvik and Eriksen, 2018) and survey at max biomass in September 2018 (Mannvik & Gunnarsson, 2019). The results from the current survey are generally in line with the findings in the previous two surveys. In comparison to the pre-survey in 2017, the nEQR index is slightly higher in the two latter surveys and the same is the case for the diversity index (H') and species and number of indivuduals has also increased since the pre-survey. No pollution indicators were recorded among the top-10 at any of the stations in three surveys.

5 References

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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 Steinanes, 2020:

Antall arter og individer per stasjon

st.nr.	tot.	C1	C2	C3	C4	C5	C6
no. ind.	4903	933	521	1403	507	1142	397
no. spe.	55	26	33	28	19	28	20

Bunndyrindekser per replikat

st.nr.	tot.	C1_01	C1_02	C2_01	C2_02	C3_01	C3_02
no. ind.	4903	504	429	214	307	558	845
no. spe.	55	21	17	17	30	23	24
Shannon-Wiener:		1,9	1,6	1,7	2,8	2,0	2,1
Pielou		0,44	0,40	0,42	0,56	0,45	0,46
ES100		11	9	12	19	10	11
SN		1,67	1,57	1,69	1,95	1,70	1,67
ISI-2012		8,52	8,57	8,69	8,61	7,66	7,72
AMBI		4,167	4,269	4,155	3,686	4,028	4,101
NQI1		0,51	0,48	0,51	0,59	0,52	0,51
NSI		17,7	17,1	22,4	22,6	17,6	18,4
DI		0,652	0,582	0,280	0,437	0,697	0,877

st.nr.		C4_01	C4_02	C5_01	C5_02	C6_01	C6_02
no. ind.		304	203	716	426	249	148
no. spe.		16	14	20	21	14	17
Shannon-Wiener:		2,2	2,3	1,4	2,0	1,7	2,5
Pielou		0,55	0,60	0,33	0,45	0,44	0,61
ES100		11	11	8	11	9	14
SN		1,59	1,58	1,59	1,69	1,55	1,76
ISI-2012		7,06	7,83	7,79	9,43	7,95	8,06
AMBI		3,954	3,909	4,294	4,21	4,211	3,699
NQI1		0,51	0,51	0,49	0,51	0,48	0,55
NSI		18,4	18,7	16,6	18,2	21,0	20,4
DI		0,433	0,257	0,805	0,579	0,346	0,120

Bunndyrindekser, gjennomsnitt per stasjon

st.nr.		C1	C2	C3	C4	C5	C6
Shannon-Wiener:		1,79	2,23	2,07	2,25	1,69	2,08
Pielou		0,42	0,49	0,45	0,58	0,39	0,53
ES100		9,7	15,3	10,4	10,5	9,5	11,6
SN		1,62	1,82	1,68	1,59	1,64	1,65
ISI-2012		8,54	8,65	7,69	7,44	8,61	8,00
AMBI		4,218	3,921	4,065	3,932	4,252	3,955
NQI1		0,50	0,55	0,52	0,51	0,50	0,52
NSI		17,40	22,47	17,97	18,57	17,36	20,67
Tilstandsklasse nEQR *)		0,474	0,581	0,484	0,487	0,470	0,518

Geometriske klasser

int.	C1	C2	C3	C4	C5	C6
1	10	11	9	6	13	5
2,3	5	8	4	4	5	9
4- 7	4	3	6	3	2	2
8- 15	3	7	3	2	3	1
16- 31	1	2	2	1	3	1
32- 63	1	1	1	1	0	0
64-127	0	0	1	0	0	1
128-255	1	0	0	2	1	1
256-511	0	1	1	0	0	0
512-1023	1	0	1	0	1	0
1024-2047	0	0	0	0	0	0
2048-	0	0	0	0	0	0

Artsliste

Steinanes C-undersøkelse 2020

Rekke	Klasse	Art/Taxa	01	02	Sum
Stasjonsnr.: C1					
ANNELIDA					
	Polychaeta				
		Ampharete borealis	3	7	10
		Ampharete finmarchica	7	2	9
		Chaetozone setosa	290	280	570
		Chaetozone sp.	3		3
		Cistenides hyperborea	1	1	2
		Cossura longocirrata	1		1
		Eteone flava/longa	7	6	13
		Euchone papillosa	1		1
		Galathowenia oculata	1	2	3
		Harmothoe sp.	1		1
		Heteromastus filiformis	3	1	4
		Laphania boecki	1		1
		Lumbrineris sp.		1	1
		Melinna cristata	4		4
		Nephtys ciliata	2	1	3
		Ophelina acuminata	10	8	18
		Ophryotrocha sp.	1		1
		Prionospio steenstrupi	133	96	229
		Pseudopolydora paucibranchiata		1	1
		Schistomeringos sp.	2	2	4
		Scoletoma sp.	3		3
		Spio limicola		1	1
		Tharyx killariensis		1	1
MOLLUSCA					
	Bivalvia				
		Nuculana sp. juv.	1		1
		Thyasira sarsii	25	18	43
		Thyasiridae indet.		1	1
		Yoldia hyperborea	5		5
ECHINODERMATA					
	Asteroidea				
		Asteroidea indet. juv.	1		1
		Maks:	290	280	570
		Antall:	23	17	28
		Sum:			935
Stasjonsnr.: C2					
NEMERTINI					
		Nemertea indet.	2	1	3
ANNELIDA					
	Polychaeta				
		Ampharete borealis		1	1
		Ampharete finmarchica	4	2	6
		Ampharete petersenae	1	1	2
		Anobothrus gracilis		3	3
		Aphelochaeta sp.		1	1
		Chaetozone setosa	30	11	41
		Chone sp.		1	1
		Eteone flava/longa	2	6	8

Rekke	Klasse	Art/Taxa	01	02	Sum
		Euchone papillosa		4	4
		Euchone sp.		2	2
		Euclymeninae indet.		1	1
		Heteromastus filiformis	2	22	24
		Laphania boecki		17	17
		Lumbrineris aniara	1		1
		Melinna cristata	2	6	8
		Nephtys ciliata	2	1	3
		Nephtys incisa	1		1
		Notomastus latericeus		1	1
		Ophelina acuminata	9	4	13
		Praxillella gracilis	1	9	10
		Prionospio steenstrupi	151	176	327
		Schistomeringos sp.	1	1	2
		Scoletoma sp.		8	8
CRUSTACEA					
	Malacostraca				
		Leucon sp.		1	1
		Phoxocephalus holbolli		2	2
		Crustacea indet. juv.		1	1
MOLLUSCA					
	Bivalvia				
		Ciliatocardium ciliatum		1	1
		Ennucula tenuis		1	1
		Macoma calcarea		3	3
		Nuculana pernula	2	6	8
		Nuculana sp. juv.		6	6
		Thyasira gouldi		4	4
		Thyasira sarsii	2	10	12
		Yoldia hyperborea	1		1
ECHINODERMATA					
	Asteroidea				
		Asteroidea indet. juv.	1	1	2
		Maks:	151	176	327
		Antall:	18	33	36
		Sum:			530

Stasjonsnr.: C3

NEMERTINI					
		Nemertea indet.	1	5	6
ANNELIDA					
	Polychaeta				
		Ampharete borealis	47	37	84
		Ampharete finmarchica	1	3	4
		Anobothrus gracilis	1		1
		Chaetozone setosa	318	417	735
		Cistenides hyperborea		1	1
		Cossura longocirrata	1		1
		Eteone barbata		1	1
		Eteone flava/longa	8	22	30
		Euchone papillosa	3	7	10
		Galathowenia oculata	1	2	3
		Goniada maculata		1	1
		Heteromastus filiformis	2	5	7

Rekke	Klasse	Art/Taxa	01	02	Sum
		Lumbrineris mixochaeta	1		1
		Lumbrineris sp.		1	1
		Melinna cristata	1	5	6
		Nephtys ciliata	3	4	7
		Nephtys paradoxa	1		1
		Ophelina acuminata	7	9	16
		Ophryotrocha sp.	1	1	2
		Prionospio steenstrupi	126	272	398
		Schistomeringos sp.	3	5	8
		Scoletoma sp.		1	1
		Spio limicola	1	2	3
MOLLUSCA					
	Bivalvia				
		Ennucula tenuis	1	2	3
		Thyasira sarsii	25	35	60
		Thyasiridae indet.	2	2	4
		Yoldia hyperborea	3	5	8
		Maks:	318	417	735
		Antall:	23	24	28
		Sum:			1403

Stasjonsnr.: C4

NEMERTINI					
		Nemertea indet.	1		1
ANNELIDA					
	Polychaeta				
		Ampharete borealis	28	16	44
		Ampharete finmarchica	2	2	4
		Chaetozone setosa	146	80	226
		Cistenides hyperborea		1	1
		Eteone flava/longa	8	2	10
		Heteromastus filiformis	2	1	3
		Lagis koreni		1	1
		Melinna cristata	4	2	6
		Nephtys ciliata	1	3	4
		Nephtys paradoxa		1	1
		Ophelina acuminata	11	4	15
		Prionospio steenstrupi	84	68	152
CRUSTACEA					
	Malacostraca				
		Leucon sp.	1	1	2
		Stenothoidae indet.	1		1
MOLLUSCA					
	Bivalvia				
		Macoma calcarea	1		1
		Nuculana sp. juv.		1	1
		Thyasira sarsii	10	21	31
		Thyasiridae indet.	2		2
		Yoldia hyperborea	2		2
ECHINODERMATA					
	Asteroidea				
		Asteroidea indet. juv.		1	1
		Maks:	146	80	226
		Antall:	16	16	21
		Sum:			509

Rekke	Klasse	Art/Taxa	01	02	Sum
Stasjonsnr.: C5					
NEMERTINI					
		Nemertea indet.	1	2	3
ANNELIDA					
	Polychaeta				
		Ampharete borealis	15	3	18
		Ampharete finmarchica	1	2	3
		Ampharete petersenae	1		1
		Chaetozone setosa	530	230	760
		Cistenides hyperborea	1	3	4
		Cossura longocirrata	1		1
		Eteone barbata		1	1
		Eteone flava/longa	4	7	11
		Euchone papillosa		1	1
		Galathowenia oculata	6		6
		Harmothoe fernandi		1	1
		Heteromastus filiformis	2	8	10
		Lanassa venusta	1		1
		Laphania boecki		1	1
		Melinna cristata	3		3
		Nephtys ciliata		1	1
		Ophelina acuminata	21	7	28
		Praxillella gracilis		1	1
		Prionospio steenstrupi	110	131	241
		Scalibregma inflatum	1		1
		Schistomeringos sp.	3	7	10
		Spio limicola	2	1	3
CRUSTACEA					
		Crustacea indet. juv.	1		1
MOLLUSCA					
	Bivalvia				
		Abra nitida	1		1
		Nuculana pernula		1	1
		Nuculana sp. juv.	1		1
		Thyasira sarsii	11	16	27
		Thyasiridae indet.		1	1
		Yoldia hyperborea	1	1	2
		Maks:	530	230	760
		Antall:	22	21	30
		Sum:			1144
Stasjonsnr.: C6					
NEMERTINI					
		Nemertea indet.	2	1	3
ANNELIDA					
	Polychaeta				
		Ampharete borealis	8	20	28
		Ampharete finmarchica	1	1	2
		Chaetozone setosa	66	37	103
		Eteone flava/longa		1	1
		Euchone papillosa		3	3
		Heteromastus filiformis	1		1
		Lumbrineris mixochaeta	3		3

Rekke	Klasse	Art/Taxa	01	02	Sum
		Lumbrineris sp.	1	1	2
		Melinna cristata	1	1	2
		Nephtys ciliata	1	2	3
		Ophelina acuminata	4	1	5
		Prionospio steenstrupi	153	64	217
		Schistomeringos sp.	2	2	4
		Spio limicola		2	2
MOLLUSCA					
	Bivalvia				
		Ennucula tenuis		1	1
		Hiatella arctica	1		1
		Nuculana sp. juv.		1	1
		Thyasira sarsii	5	8	13
		Thyasiridae indet.		2	2
		Yoldia hyperborea		1	1
		Maks:	153	64	217
		Antall:	14	18	21
		Sum:			398
				TOTAL:	***Maks:*** 760
					Sum: 4919

Appendix 2. Analyserapport – Geokjemiske analyser (in norwegian)

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:	**Arnarlax Hf**
Kunde referanse:	**Steinanes, C and B survey 2020 Fallow**
Kontaktperson kunde:	
e-post:	
Kontaktperson Akvaplan-niva:	Snorri Gunnarsson
Dato:	20.07.2020
Rapport nr.:	**62254**
Analyseparameter(e):	Korn, TOM, TOC, TN, Cu
Kontaktperson:	Oda S. B. Wilhelmsen
Analyseansvarlig:	Oda Sofie Bye Wilhelmsen (sign.)
Underskriftsberettiget:	Lisa Torske Digitally signed by Lisa Torske Date: 2020.07.20 16:33:28 +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:

Prøve fra stasjon C2 inneholder skjellbiter og småstein større enn 15 mm som ikke er inkludet i kornanalysen. Steinene ville utgjøre 12,8 vekt% av den totale prøven

Lab-id.	Kundens id.	Beskaffenhet ved mottak	Mottatt lab	Parametere	Analyse-periode
62254/C1	C1	Frossen	19.06.2020	Korn, TOM, TOC, TN, Cu	24.06.20 - 09.07.20
62254/C2	C2	Frossen	19.06.2020	Korn, TOM, TOC, TN	29.06.20 - 09.07.20
62254/C3	C3	Frossen	19.06.2020	Korn, TOM, TOC, TN	29.06.20 - 09.07.20
62254/C4	C4	Frossen	19.06.2020	Korn, TOM, TOC, TN	29.06.20 - 09.07.20
62254/C5	C5	Frossen	19.06.2020	Korn, TOM, TOC, TN	29.06.20 - 09.07.20
62254/C6	C6	Frossen	19.06.2020	Korn, TOM, TOC, TN	29.06.20 - 09.07.20

Følgende analysemetoder er benyttet

Parameter	Metoderereferanse
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	27	4,9	13,7	87,1	12,9	50,5	29,1	5,5
C2	22	4,2	11,7	64,0	36,0	ia	29,0	5,3
C3	28	5,5	14,1	83,1	16,9	ia	30,6	5,0
C4	36	3,3	13,6	72,5	27,5	ia	40,5	10,6
C5	29	4,8	12,6	80,3	19,7	ia	32,8	6,0
C6	25	5,0	12,3	70,5	29,5	ia	30,5	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