NÁTTÚRUSTOFA VESTFJARÐA

Environmental impact assessment at peak biomass for Gemlufall salmon farming site 2018

Worked for Arctic Sea Farm

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Abstract:
Peak biomass survey at Gemlufall salmon farm site manage by Arctic Sea Farm was conducted in the end of November 2018. Sampling was performed in accordance with ISO 12878 and ASC Salmon standars. Visual, chemical parameters togher with benthic community analyse were performed. Result show no visual sign of heavy impact and redox potential was positive at all stations. Benthic community was in good state. According to our findings Gemlufall mariculture site fullfils all indicators contain in criterion 2.1 of the ASC standard and was found in „Good“ condition in accordance to NS 9410:2016 standard after this farming period. The phospor released during the period was estimated to be around 8,3 kg/tonn of farmed fish and within the theshold demanded by environmental authority. The Allowable Zone of Effect (AZE) was defined to extend at 30 m from cages array. Copper nets were not used therefore site is implicitly satisfying indicator 4.7.4 of ASC standard.

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Content

SUMMARY OF ASC V 1.1, CRITERION 2.1

Stations inside the AZE

Stations outside the AZE

ASC indicator	ASC requirement	Results											Fullfill
		A	B	C	D	E	F	G	H	I	J	K	
2.1.1	Redox pot. > 0 mV for stations outside the AZE area	84	121	133	129	104	132	150	25	66	140	148	Yes
2.1.2	AZTI Marine Biotic Index (AMBI) score ≤ 3.3, for stations outside the AZE area	4,8	4,5	2,5	2,4	5,7	2,3	2,2	2,2	2,6	2,4	2,4	Yes
2.1.3	≥ 2 taxa within AZE which are not pollution ind., with more than 100 ind./m^2	6	4	8	/	3	11	/	/	/	/	/	Yes
2.1.4	Definition of site-specific AZE	See chapter in the report											
4.7.4	Copper level	No copper nets were used in Gemlufall during this farming period											

SUMMARY ACCORDING TO NS 9410 STANDARD

NS 9410:2016 Requirements	Results* for 0,05 m^2	
	St. B (C1)	St. H
5 to 19 taxa in 0,2 m^2	11	14
More than 20 individuals in 0,2 m^2	152	115
No taxa with more than 90% individuals	49%	53%
Environmental condition (miljøtilstand)	2-Good	2- Good

(* see chapter in report)

INTRODUCTION

Environmental impact after salmon farming for Gemlufall mariculture site was assessed by monitoring the status of sea bottom sediment in accordance with the environmental monitoring plan (Cristian Gallo and Margrét Thorsteinsson 2017) for aquaculture sites located in Dýrafjörður (Iceland). This survey intended to investigate sediment parameters and bottom animal community at peak biomass in the proximity of the mariculture plant. Sampling was carried out in accordance with ISO 12878 standard (operational transect monitoring) and by will of the client also in accordance with ASC Salmon standard (ASC v 1.1).

Gemlufall site comprises 10 cages (50 m diameter) set down in a double row in the direction north-south. Salmon was stocked from the end of June 2017 until September 2017 after 6 months of fallowing. Site has an operative licence for production of 2.000 tonn of salmon (Umhverfisstofnun 2017). Bottom conditions were last monitored the 10th of July 2017 (Cristian Gallo 2018) and those findings will be compared with the results of this survey.

Interpretation of results from the aquaculture survey needs to take into consideration several traits of the macrofauna community such as its composition, its diversity and the presence or absence of certain indicator species (Pearson & Rosenberg 1978, Rygg 2002, Dean 2008). Visual and chemical parameter (smell, redox potential, free sulphide and pH) were also carried out at all sampled stations. Sediment samples were also taken for each station for possible extra chemical analyses.

Phosphor released by the mariculture plant was estimated in order to fulfil threshold limit imposed by the Icelandic Environmental Authority (Umhverfisstofnun) in the operating licence.

Copper nets were not used by Arctic Sea Farm company, therefore sediment was not analysed for copper in this survey in accordance with indicator 4.7.4 of ASC standard.

Extension of the Allowable Zone of Effect (AZE) area was defined according to modelled estimation describe in Bannister et al. (2016).

METHODOLOGY

Sampling stations

The survey was conducted in accordance with ISO 12878 and ASC standards. Sampling stations were located at varying distance from the aquaculture cages (Fig.1) and partially reproduce sampling performed at the end of the fallowing period (stations A- E). A total of 11 stations were sampled, in detail: stations A and E were located at the cage edges, one at each end of the long axis of the farm. Stations B, C and F were located within the AZE area, 25 m from the edge. Stations G, H and J were located 55 m from the edge of the array of cages. Stations D and I were located 100 m from the edge of the array of cages while station K was located at 850 meters from the cage array, in a similar water depth and substratum type, and served as a reference station. GPS coordinates, depths and distances from cages can be seen in Table 1. The transect made of stations B, H and I was orientated downstream, while the transect made of stations C, J and D was orientated upstream with respect to the direction of the residual current at 15 m depth (Steinar Dalheim Eriksen 2017).

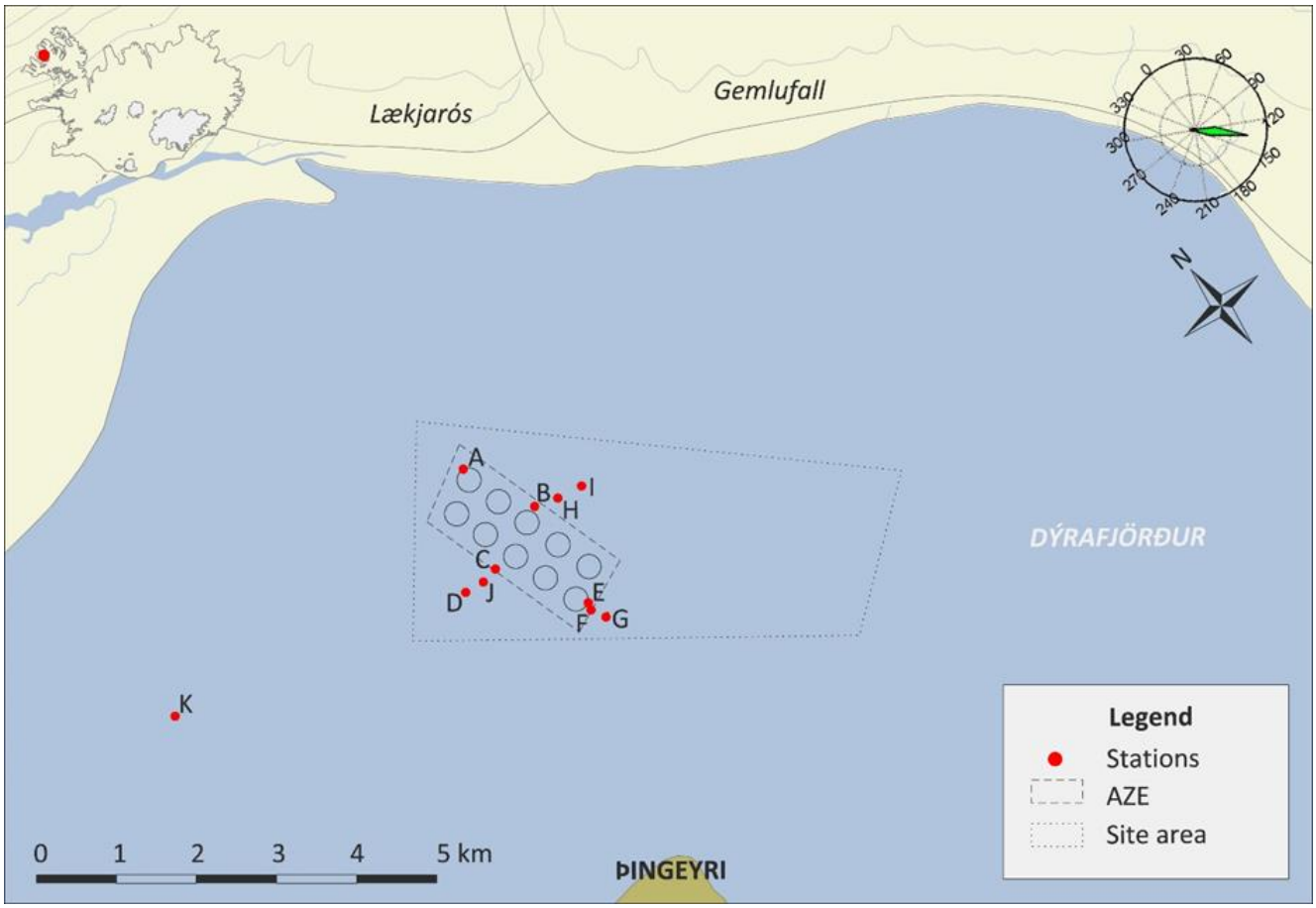

Figure 1. Map of Gemlufall site with location of sampled stations (red dots), AZE area and border of aquaculture site. Stations A and E were located at cage edges. Stations B, C and F at 25 m from cages array. Stations G, H and J at 55 m from cages array. Stations D and I at 100 m and station K at 850 m from cages array. Map: NAVE/Hulda Birna Albertsdóttir.

Table 1. Position, depth and distance from the cages for sampled stations in Gemlufall (Dýrafjörður).

Station	Gps coordinates *decimal minutes*	Depth (m)	Distance from cages array (m)
A	N65° 53.481' W23° 29.185'	31	0
B	N65° 53.383' W23° 29.074'	31	25
C	N65° 53.349' W23° 29.301'	32	25
D	N65° 53.349' W23° 29.425'	32	100
E	N65° 53.237' W23° 29.128'	32	0
F	N65° 53.227' W23° 29.135'	32	25
G	N65° 53.207' W23° 29.111'	32	55
H	N65° 53.373' W23° 28.997'	31	55
I	N65° 53.366' W23° 28.911'	31	100
J	N65° 53.345' W23° 29.358'	32	55
K	N65° 53.456' W23° 30.428'	34	850

Sampling method

Sampling was conducted from a boat by using a Van Veen grab with 250 cm^2 of sampling area. Two samples were taken at each station for visual, chemical parameters and biological analysation; sediments were described in colour, texture and smell. Redox potential and pH were measured on the upper 2 cm of grab content. Samples were then sieved through a 1 mm sieve with running sea water, submerged with a fixative solution of formaldehyde (5-10%) and an adequate amount of borax and individually marked. The formaldehyde solution was substituted with an ethanol solution (70%) after 4-5 days. A third sample was taken, and part of the upper 2 cm sediment set into a plastic container and individually marked, these sample are kept in freezer at -18°C according to ISO 16665 and ISO 56667-19 standard. Animals were successively collected, counted and identified to the lowest feasible taxonomical level using a Leica MZ 12 stereoscope. Foraminifera, if present, were not collected.

Statistical and indices calculations

Univariate analysis and Bray-Curtis similarity test were performed using the Primer 6 program (Clarke & Warwick 1994). To avoid artificial inflation of diversity, juvenile and non-juvenile specimens were combined. The Shannon-Wiener diversity index (H') and Evenness index (J´) were calculated (Grey et. al 1992; Brage og Thélin 1993). AMBI benthic index was calculated using AMBI software version 5.0.

Phosphor release

Release of phosphor in the environment (Pr) was estimated by subtracting the amount of phosphor incorporated in the fish (Pi) from the total amount of phosphor introduced with feeding (Pf).

Pr= Pf- Pi

Arctic Sea Farm kept a log of data regarding feed used, estimated biomass in the cages and fish mortality (Table 2). Fish were 200 g when set into cages therefore this starting biomass was deducted from the closing biomass and mortality biomass before calculating the incorporated phosphor. The number of fish in cages at peak biomass was estimated to be 599.281 and number of diseased fish was 219.347. Phosphor content varies slightly between different pellet sizes with an average content of 9,98 g/kg. Farmed salmon are considered to incorporate an amount of 4,5x 10^{-3} g of phosphor per gram of fish (Bergheim A. and B. Braaten 2007).

Table 2. Gemlufall production cycle 2017-2018. Fish biomass, feed used and mortality biomass (kg). Bernharður Guðmundsson, 28.11.2018 by mail.

Month	Closing biomass [kg]	Feed used in period [kg]	Mortality biomass [kg]
juni 2017	28817	273,2	41
juli 2017	61764	33275,8	345
august 2017	145183	57108,2	1188
september 2017	236583	101179,6	5573
oktober 2017	310027	116688,1	12549
november 2017	363451	86477,9	12172
december 2017	419341	70905,2	4629
januar 2018	476557	68985,3	2438
februar 2018	517447	49270,7	2325
mars 2018	564775	55830	2143
april 2018	605443	71120	2751
mai 2018	717855	131432	2894
juni 2018	881865	190218	3655
juli 2018	1101706	257800	4964
august 2018	1408737	365557	5668
september 2018	1723954	381238	6578
oktober 2018	1978957	338803	6193
november 2018	2158976	223841	5277
Total	**2158976**	**2600003**	**81382**

RESULTS

Visual and chemical parameters

Sediment colour was black/grey for all sampled stations. Texture was also similar between stations, mainly mud (< 250 µm) with small differences in vegetative (algae fragments) and broken shell contents. Sulphur smell was slightly detected in the sample taken directly under cages and on two of the three stations located at 25 m from the cage array both upstream and downstream. No presence of gas bubbles or mats of bacteria were visible (Table 3).

Table 3. Visual parameters (colour, smell, texture and presence of bubbles or bacterial mats bacteria) of sediment for each sampled station in Gemlufall (Dýrafjörður).

Station	Colour	Smell	Bubbles or mats	Texture
A	Black/grey	Slight	No	Mud. Less than 5% shell and algae fragments
B	Black/grey	Slight	No	Mud. Less than 5% shell and algae fragments
C	Black/grey	No	No	Mud. Less than 5% shell and algae fragments
D	Black/grey	No	No	Mud. Less than 5% shell and algae fragments
E	Black/grey	Slight	No	Mud. 5% shell and algae fragments
F	Black/grey	No	No	Mud. Less than 5% shell and algae fragments
G	Black/grey	No	No	Mud. Less than 5% shell and algae fragments
H	Black/grey	Slight	No	Mud. Less than 5% shell and algae fragments
I	Black/grey	No	No	Mud. Less than 5% shell and algae fragments
J	Black/grey	No	No	Mud. 5% shell and algae fragments
K	Black/grey	No	No	Mud. Shell of *Arctica islandica* (dead). Less than 5% shell and algae fragments

Sediments temperature, measured in the first 2 cm, was around 5,2 °C for all samples collected. Redox potential (Eh) was re-calculated according with value given by probe producer based on used filling solution. All values were greater than zero. pH was slightly acidic with values ranging from 6, 58 to 6, 99 (Table 4). Based on these findings, Gemlufall mariculture site fulfils ASC indicator 2.1.1.

Table 4. Chemical parameters. Redox potential (mV), pH and temperature as average of 2 sample. All parameters were measured on top 2 cm of sampled sediment.

Station	Temp. (°C)	Redox Eh (mV)	pH
A	5,2	84	6,99
B	5,2	121	6,81
C	5,2	133	6,76
D	5,1	129	6,88
E	5,2	104	6,82
F	5,3	132	6,92
G	5,2	150	6,92
H	5,2	25	6,72
I	5,2	66	6,67
J	5,2	140	6,58
K	5,2	148	6,76

Benthic comunity

List of taxa (species, families or phylum) for each station after 1 mm mesh size sieving, based on average of two samples and adapted to 1 m^2 can be seen in Table 6 in Appendix 1. Same species is expressed separately between juvenile and non-juvenile individual according with experience of the taxonomist.

Based on these findings the Pielou´s evenness index (J´), the Shannon- Wiener diversity index (H´) and the AMBI benthic index were calculated. Table 7 in Appendix 2 was used for statistical computations in the univariate analysis. Results of those indices can be seen in Table 5 together with number of taxa and abundances.

Table 5. Number of taxa (S), abundance (N), evenness index (J´), Shannon-Wiener index (H´ log2) and AMBI index for sampled stations in Gemlufall 2018. Station inside AZE, Station outside AZE.

Station	S	N	J'	H'(log2)	AMBI
A	10	2900	0,63	2,10	4,80
B	11	3040	0,63	2,20	4,51
C	20	6900	0,62	2,68	2,46
D	17	8060	0,58	2,39	2,40
E	9	8220	0,22	0,71	5,67
F	21	6060	0,62	2,71	2,27
G	21	6780	0,64	2,80	2,23
H	14	2300	0,64	2,43	2,16
I	20	5940	0,64	2,75	2,65
J	24	10360	0,64	2,93	2,43
K	26	6580	0,68	3,18	2,41

Number of taxa ranges from 9 to 21 on stations inside the AZE area (inside 30 m from the cage array). Outside of the area (55 m from cage array) number of taxa ranges from 14 to 24 with lower numbers downstream. Stations located at 100 m, from cage array, count between 17 and 20 taxa while the reference station had the most taxa (26).

J´ ranged between 0,58 and 0,68 for most stations apart fror station E (0,22), which had a minor number of species and predominant presence of *Capitella capitata*. H´ranged from 2,43 to 2,93 on the stations sampled outside of the AZE area (G, H and J). These values are slightly under the threshold of 3 demanded by ASC standard but the value found at the reference station (K) was just above this threshold. To answer the same demand AMBI benthic index was also calculated. AMBI values for those stations outside the AZE area range from 2,16 to 2,43 which is less than the demanded threshold of 3,3. Benthic indices are developed to give a better picture of animal community in connection to organic enrichment. Based on these findings, Gemlufall mariculture site fulfils ASC indicator 2.1.2.

The animal community in Gemlufall shows a major sign of disturbance only at station E (directly under the cage on the lowest side of the site). Nonetheless, 3 species, which are not considered pollution indicators, were present at this location with more than 100 ind./$m^{2.}$ Eleven similar species were instead found at station F, still inside AZE area at 25 m on the same side of the cages. Polychaeta species *Galathowenia oculata*, *Owenia fusiformis*, *Prionospio steenstrupi, Scalibregma inflatum* and bivalve species *Abra nitida, Ennucula tenuis*,

Macoma calcarea and *Thyasira flexuosa* were found inside the AZE area. According to these findings, Gemlufall mariculture site fulfils ASC indicator 2.1.3.

The animal community in proximity of cages at Gemlufall mariculture site comprises two main groups Gastropoda Bivalvia and Annelida Polychaeta (Figure 2). The most abundant species was bivalve *Ennucula tenuis,* followed by another bivalve *Abra nitida* (80 % of those were analysed as juvenile) and by polychaet *Capitella capitata,* a less sensitive species present mainly on stations located at the cages.

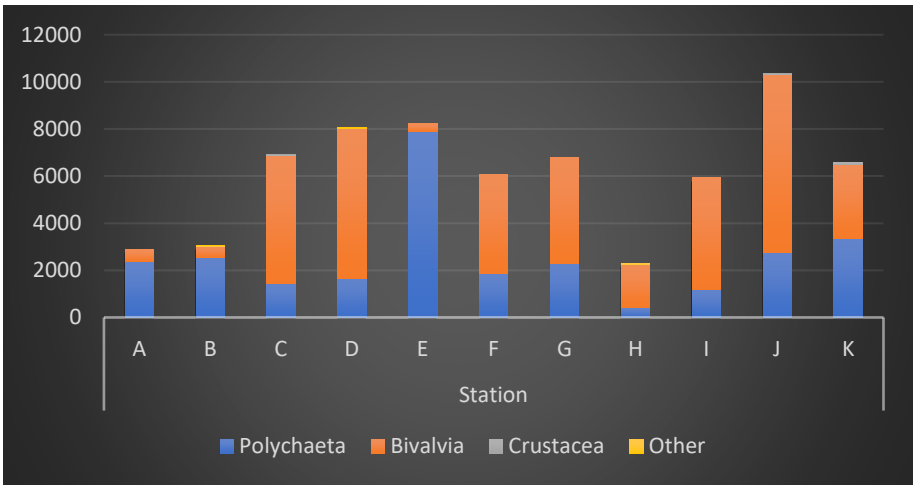

Figure 2. Major invertebrate taxa at Gemlufall mariculture site (peak biomass survey 2018).

Similarity between stations

Bray- Curtis test was conducted to assess similarity between stations in this survey. Table 7 in Appendix 2 was used for the simirarity test for this survey. Similarity test assembled stations in two groups. Where impact was little or absent similarity was 50% and higher. This group present a 20% similarity with stations located at cages and at 25 meters downstream where impact was more pronounced (Figure 3).

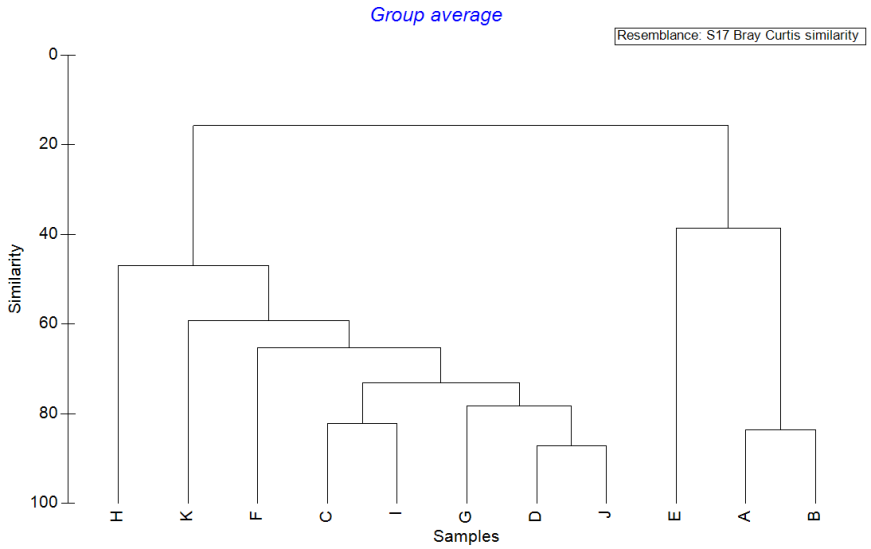

Figure 3. Bray-Curtis similarity test between stations in this survey.

Similarity between stations (after fallowing and at peak biomass)

Bray- Curtis test was conducted to assess similarity between stations sampled at same location in this survey and in the survey conducted after fallowing. Table 8 in Appendix 3 was used in this similarity test. Due to different mesh sieve size and different sampling season a Single linkage was believed to give more accurate picture. Pre- farming condition show around 60% similarity with station C and D taken at peak biomass. Similarity between this group and stations located at cage and at 25 meters downstream was around 20%.

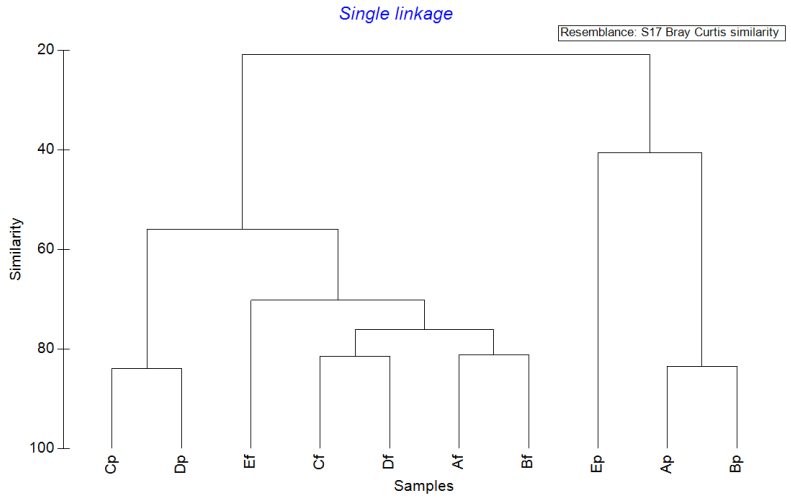

Figure 4. Bray-Curtis similarity test between stations in this survey ans survey done after the fallowing period.

Interpretation of results according to NS 9410:2016

Results of this survey, even though the sampling was not intended to fulfil the NS 9410:2016, were used to get sediment status class according to parameters expressed in chapter 8.6.2 of the Norwegian standard. Sampling size in this survey was 250 cm^2 not 1000 cm^2 as demanded in the NS9410:2016 standard, this will make the demands of the standard even stricter by reducing sampling size to ¼. Station B is located at 25 m downstream from the cages, and therefore fulfils sampling demand of this standard (C1).

A total of 11 taxa were found at station B, with a total of 152 individuals on a 0,05 m^2 sampling area and *Capitella capitata* only represented 49% of those. According to this finding the Gemlufall mariculture site was found in "Good" environmental condition based on the threshold in the NS 9410.

Station H located 55 m downstream had 14 taxa, with 115 individuals on 0,05m^2 and *Ennucula tenuis* as the predominant species with 61 individuals (53%) also points to "Good" environmental conditions for the site.

Phosphor release

Pr= Pf- Pi

Pr= (9,98 x 2.600) – 4,5 x 10^{-3} x (2.158.976 -119.856) – 4,5 x 10^{-3} x (81.382- 43.869) = 16.603/2.000= 8,3 kg/tonn

The total estimated amount of phosphor released in the environment by the Gemlufall farming site during the farming period from june 2017 til November 2018 is 8,3 kg/tonn of farmed fish, therefore it was under the threshold prescribed by the operation licence (starfsleyfi) in chapter 3.4 (efnalosun) which was set at 10,0 kg/tonn (Umhverfisstofnun 2017).

AZE area extension

A site-specific Allowable Zone of Effect (AZE) should be defined according to indicator 2.1.4 of the ASC Salmon standard. The most recent dispersion model for settling of salmon faecal particles on fjord ecosystems has been developed by Bannister et. al (2016). This model estimated that between 58 and 78% of faecal material settle with velocity between 5 and 10 cm/sec. Using a sinking velocity (Vs) of 7,5 cm/sec, the average current rate (Cr) of 7 cm/sec measured for Gemlufall site (Steinar Dalheim Eriksen, 2017) and the site bottom depth (D) of 32 m the AZE can be estimated to stretch at 30 meter from cage array according to the formula L= Cr x D/ Vs.

CONCLUSIONS

The survey was conducted at peak biomass to assess the environmental impact for the farming period 2017-2018 in Gemlufall mariculture site. Visual, chemical parameters show signs of moderate impact at cages but slight or no impact outside of the AZE. Redox potential was positive at all stations. The animal community reflects those chemical condition and bio- diversity for those stations located outside the AZE was similar to those found at the reference station. Animal community was found in “Good” condition according to NS 9410 standard and the site fulfils all indicators in the 2.1 criterion of the ASC standard. Site-specific AZE was defined, according to suitable despersal model and due to sea depth at site was set at 30 m from cage array. Phospor release was estimated to be in the threshold given by the authority.

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APPENDIX 1

Table 6. Species list of benthic community per station sampled in Gemlufall aquaculture site the 26 November 2018 after sieving with 1mm mesh size sieve. All values (individuals/ m^2) represent the average of two samples adapted to 1 m^2.

Family/*Species*	Station										
Polychaeta	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Ampharete sp.	0	0	0	0	0	0	0	0	0	0	20
Capitella capitata	1720	1500	0	0	7420	120	0	0	0	0	0
Chaetozone setosa	100	0	80	80	0	100	20	0	80	200	80
Cossura longocirrata	0	0	0	0	0	20	0	0	0	20	0
Eteone longa	240	600	80	40	120	260	60	60	80	320	60
Euchone sp. juv	0	0	20	0	0	0	20	0	20	0	20
Galathowenia oculata	0	20	380	760	0	140	780	40	120	740	1880
Glycera alba	0	0	20	0	0	0	0	0	0	0	0
Goniada maculata	0	0	0	0	0	0	20	0	0	0	0
Harmothoe sp.	0	0	0	0	0	0	0	0	20	0	0
Lagis koreni	280	360	240	240	120	460	200	160	420	300	220
Levinsenia gracilis	0	20	80	60	0	40	100	40	60	100	0
Malacoceros fuliginosus	0	0	0	0	60	0	0	0	0	0	0
Maldane sarsi	0	0	20	0	0	0	0	0	0	0	40
Mediomastus fragilis	0	0	0	0	0	20	0	0	20	20	20
Melinna cristata	0	0	0	0	0	0	0	0	0	0	20
Microphthalmus aberrans	0	0	0	0	160	0	0	0	0	0	0
Nephtys cf incisa	0	0	20	20	0	0	20	20	0	0	0
Nephtys sp.	0	0	20	0	0	40	20	20	0	20	80
Owenia fusiformis	0	0	240	240	0	260	620	60	20	480	580
Parougia nigridentata	20	20	20	0	0	0	20	0	80	0	0
Pholoe minuta/inornata	20	20	20	0	0	0	20	0	0	60	0
Praxillella praetermissa	0	0	0	20	0	80	60	0	20	20	60
Prionospio steenstrupi	0	0	60	40	0	100	60	0	40	40	0
Scalibregma inflatum	0	0	0	0	0	180	0	0	0	0	0
Scoloplos armiger	0	0	40	0	0	20	20	0	80	40	60
Sphaerodoridae juv	0	0	0	0	20	0	0	0	0	0	0
Spio sp. juv	0	0	0	20	0	20	60	0	20	120	40
Sternaspis scutata/islandica	0	0	100	140	0	0	180	40	100	280	160
Typosyllis armillaris	0	0	0	0	0	0	0	0	0	0	20

Table continues in the next page...

Phylum/Family/*Species*	**Station**										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Gastropoda Bivalvia											
Abra nitida	40	0	140	440	0	320	360	100	540	460	80
Abra nitida juv	0	0	2040	2300	0	0	780	120	1320	2560	1000
Astarte sp juv	0	0	0	0	0	20	0	0	0	0	0
Clinocardium ciliatum cf juv	0	0	0	0	0	0	0	0	0	40	20
Ennucula tenuis	240	260	2400	3100	260	3280	2880	1220	1740	3360	1400
Macoma calcarea juv	100	40	140	80	20	220	80	0	180	300	40
Mya sp. juv	0	0	0	0	0	0	0	0	0	0	20
Mysia undata cf	0	0	0	0	0	0	0	0	0	0	20
Nuculana pernula	0	0	0	0	0	0	0	40	0	0	0
Nuculana minuta	0	0	0	0	0	20	0	0	20	40	60
Nuculana sp. juv	0	0	0	40	0	0	60	0	0	0	160
Thyasira cf flexuosa juv	120	0	600	200	20	0	160	140	620	580	260
Thyasira flexuosa cf sarsi	20	180	120	220	20	340	180	180	340	200	60
Yoldia hyperborea	0	0	0	0	0	0	0	0	0	20	0
Crustacea											
Leucon nasicoides	0	0	20	0	0	0	0	0	0	0	60
Monoculodes sp.	0	0	0	0	0	0	0	0	0	0	40
Pleurogonium spinosissimum	0	0	0	0	0	0	0	0	0	20	0
Asteroidea	0	0	0	0	0	0	0	20	0	0	0
Nemertea	0	20	0	0	0	0	0	20	0	0	0
Priapulida	0	0	0	0	0	0	0	20	0	0	0
Sipuncula	0	0	0	20	0	0	0	0	0	0	0

APPENDIX 2.

Table 7. Abundance (individuals/m^2) for benthic community, for Gemlufall mariculture site, used for indeces calculations and similarity test between stations.

Taxa	A	B	C	D	E	F	G	H	I	J	K
Abra nitida	40	0	2180	2740	0	320	1140	220	1860	3020	1080
Ampharete sp	0	0	0	0	0	0	0	0	0	0	20
Astarte sp juv	0	0	0	0	0	20	0	0	0	0	0
Asteroidea	0	0	0	0	0	0	0	20	0	0	0
Capitella capitata	1720	1500	0	0	7420	120	0	0	0	0	0
Chaetozone setosa	100	0	80	80	0	100	20	0	80	200	80
Clinocardium ciliatum cf juv	0	0	0	0	0	0	0	0	0	40	20
Cossura longocirrata	0	0	0	0	0	20	0	0	0	20	0
Ennucula tenuis	240	260	2400	3100	260	3280	2880	1220	1740	3360	1400
Eteone longa	240	600	80	40	120	260	60	60	80	320	60
Euchone sp juv	0	0	20	0	0	0	20	0	20	0	20
Galathowenia oculata	0	20	380	760	0	140	780	40	120	740	1880
Glycera alba	0	0	20	0	0	0	0	0	0	0	0
Goniada maculata	0	0	0	0	0	0	20	0	0	0	0
Harmothoe sp	0	0	0	0	0	0	0	0	20	0	0
Lagis koreni	280	360	240	240	120	460	200	160	420	300	220
Leucon nasicoides	0	0	20	0	0	0	0	0	0	0	60
Levinsenia gracilis	0	20	80	60	0	40	100	40	60	100	0
Macoma calcarea juv	100	40	140	80	20	220	80	0	180	300	40
Malacoceros fuliginosus	0	0	0	0	60	0	0	0	0	0	0
Maldane sarsi	0	0	20	0	0	0	0	0	0	0	40
Mediomastus fragilis	0	0	0	0	0	20	0	0	20	20	20
Melinna cristata	0	0	0	0	0	0	0	0	0	0	20
Microphthalmus aberrans	0	0	0	0	160	0	0	0	0	0	0
Monoculodes sp	0	0	0	0	0	0	0	0	0	0	40
Mya sp juv	0	0	0	0	0	0	0	0	0	0	20
Mysia undata cf	0	0	0	0	0	0	0	0	0	0	20
Nemertea	0	20	0	0	0	0	0	20	0	0	0
Nephtys sp	0	0	40	20	0	40	40	40	0	20	80
Nuculana sp	0	0	0	40	0	20	60	40	20	40	220
Owenia fusiformis	0	0	240	240	0	260	620	60	20	480	580
Parougia nigridentata	20	20	20	0	0	0	20	0	80	0	0
Pholoe minuta/inornata	20	20	20	0	0	0	20	0	0	60	0
Pleurogonium spinosissimum	0	0	0	0	0	0	0	0	0	20	0
Praxillella praetermissa	0	0	0	20	0	80	60	0	20	20	60
Priapulida	0	0	0	0	0	0	0	20	0	0	0
Prionospio steenstrupi	0	0	60	40	0	100	60	0	40	40	0
Scalibregma inflatum	0	0	0	0	0	180	0	0	0	0	0
Scoloplos armiger	0	0	40	0	0	20	20	0	80	40	60
Sipunculida	0	0	0	20	0	0	0	0	0	0	0
Sphaerodoridae juv	0	0	0	0	20	0	0	0	0	0	0
Spio sp juv	0	0	0	20	0	20	60	0	20	120	40
Sternaspis scutata/islandica	0	0	100	140	0	0	180	40	100	280	160
Thyasira flexuosa	140	180	720	420	40	340	340	320	960	780	320
Typosyllis armillaris	0	0	0	0	0	0	0	0	0	0	20
Yoldia hyperborea	0	0	0	0	0	0	0	0	0	20	0

APPENDIX 3.

Table 8. Abundance (individuals/m²) for benthic community, for Gemlufall mariculture site, used for similarity test between stations and between peak biomass survey (1mm mesh size sieve) and survey conducted after fallowing (0,5 mm mesh size sieve).

Taxa	after fallowing (500µm sieve)					peak biomass (1mm sive)				
	A	B	C	D	E	A	B	C	D	E
Abra nitida	67	33	300	33	733	40	0	2180	2740	0
Capitella capitata	0	0	33	17	0	1720	1500	0	0	7420
Chaetozone setosa	233	367	300	200	650	100	0	80	80	0
Cossura longocirrata	333	250	250	233	100	0	0	0	0	0
Dulichia sp.	0	0	17	17	0	0	0	0	0	0
Ennucula tenuis	483	633	1100	917	1833	240	260	2400	3100	260
Eteone longa	83	117	117	150	200	240	600	80	40	120
Euchone sp.	34	167	267	117	567	0	0	20	0	0
Galathowenia oculata	417	233	850	633	733	0	20	380	760	0
Glycera alba	0	0	17	0	17	0	0	20	0	0
Harmothoe sp.	17	0	33	17	0	0	0	0	0	0
Lagis koreni	0	0	50	0	0	280	360	240	240	120
Laonice bahusiensis	0	0	0	17	0	0	0	0	0	0
Leucon nasicoides	0	0	17	0	0	0	0	20	0	0
Levinsenia gracilis	450	383	483	433	667	0	20	80	60	0
Lumbrineris sp.	0	0	17	0	0	0	0	0	0	0
Macoma calcarea	0	17	0	0	0	100	40	140	80	20
Malacoceros fuliginosus	0	0	0	0	0	0	0	0	0	60
Maldane sarsi	0	0	0	0	0	0	0	20	0	0
Mediomastus fragilis	33	0	0	0	0	0	0	0	0	0
Melinna cristata	0	0	33	0	17	0	0	0	0	0
Microphthalmus aberrans	0	0	0	17	0	0	0	0	0	160
Mya sp.	0	0	0	17	50	0	0	0	0	0
Nemertea	0	0	0	0	17	0	20	0	0	0
Nephtys sp.	17	50	17	17	83	0	0	40	20	0
Nuculana sp.	67	50	100	67	100	0	0	0	40	0
Owenia fusiformis	50	0	200	133	517	0	0	240	240	0
Parougia nigridentata	17	17	17	17	17	20	20	20	0	0
Pholoe sp.	0	0	17	0	0	20	20	20	0	0
Praxillella sp.	17	0	34	50	50	0	0	0	20	0
Prionospio sp.	66	67	50	33	17	0	0	60	40	0
Sabellides borealis	17	0	83	67	0	0	0	0	0	0
Scalibregma inflatum	0	0	67	17	0	0	0	0	0	0
Scoloplos armiger	0	0	0	0	83	0	0	40	0	0
Sipunculidae	0	0	0	0	0	0	0	0	20	0
Sphaerodoridae juv	0	0	0	0	0	0	0	0	0	20
Spio sp.	67	50	100	67	233	0	0	0	20	0
Sternaspis scutata/islandica	567	433	583	733	333	0	0	100	140	0
Syllis sp.	67	17	33	17	0	0	0	0	0	0
Terebellidae	0	0	0	17	0	0	0	0	0	0
Thyasira flexuosa	650	533	450	283	300	140	180	720	420	40
Yoldia hyperborea	0	17	0	17	0	0	0	0	0	0