

# Rapport Report

Eyri, Arnarlax B survey, November 2022 (max biomass)





Akvaplan-niva AS: APN 64474.B01



Information client									
Title	Eyri, Arnarlax. B survey	Eyri, Arnarlax. B survey (max biomass, November 2022							
Report number	APN-64474.B01	APN-64474.B01							
Site name	Eyri	Coordinates site	65°34,723N						
			23°58,675V						
County	Vestur -	Municipality	Vesturbyggð						
	Barðastrandarsýsla								
MTB-or estimated max	8.193 tonnes	Site manager/contact	Silja Baldvinsdóttir						
biomass									
Client name	Arnarlax								

Biomass/production/status at date of survey								
Biomass at date of survey	7.699 t	Feed	use	10.468 t				
Fish type	Salmon	Amo	unt produced	7.986 t				
Type/time of survey			Comments					
At maximal biomass see kap 7.9	$\boxtimes$							
A follow up survey								
Half maximal biomass								
Survey prior to putting out smolt								
A pre-survey new site	pre-survey new site							
Other								
Last fallowing period:	Sept ´20 - May	´21						

Results from B-survey according to NS 9410:2016 (main results)								
Parameters and indexes Parameters and site status								
Gr. II. pH/Eh	1,10	Gr. II. pH/Eh	2					
Gr. III. Sensory 1,57		Gr. III. Sensory	2					
GR. II + III	1,34	GR. II+ III	2					
Date fieldwork	02.01 2023							
Site status (NS 941	2							

Report writing and project leader	Snorri Gunnarsson	Signature	morn lumerson
Quality control	Gyda W. Lorås	Signature	

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### Table of contents

PREFACE	.2
1 INTRODUCTION	.3
2 METHODS	.4
2.1 Field equipment	.4
3 STUDY SITE, PRODUCTION AND SURVEY DESIGN	. 5
<ul> <li>3.1 Study site and production</li></ul>	.5 .5 .6
4 RESULTS	. 8
5 CONCLUSION	.9
6 REFERENCES 1	0
7 APPENDIX 1	1
<ul> <li>7.1 Survey data sheet (B.1 &amp; B.2), NS 9410:2016</li></ul>	1  5  9

The B-survey is carried out in accordance to the Norwegian standard NS 9410:2016 -"Environmental monitoring of benthic impact from marine fish farms". Impact assessment is based on sediment condition (chemistry, sensory & presence/absence of fauna). The environmental survey is regulated by § 35 in the Norwegian "akvakulturdriftsforskriften". The survey also fulfills the requirements regarding seabed surveys outlined in the standard ISO 12878.

The primary objective of a B-survey is to assess the benthic impact beneath and in the close vicinity (near zone) of a marine fish farm by applying methods, thresholds and classifications as defined in NS9410:2016.

The following have participated in the survey:

Snorri Gunnarsson Akvaplan-niva AS		Prosjektleder.
Snorri Gunnarsson	Akvaplan-niva AS	Fieldwork and Report. Charts (Olex).
Gyda W. Lorås	Akvaplan-niva AS	Quality assurance

The sampling at Eyri was done 18.11 2022.

Accredited survey:

The following parts of the survey are done in accordance with accreditation methods:

Sampling and treatment of sediment samples, analysis of samples and evaluations of the results. Thresholds and classifications of assessment criteria applied in this report are based on Norwegian environmental conditions as Iceland specific criteria have yet not been developed. This should be taken into consideration when reviewing site status.



Akvaplan-niva AS er akkreditert av Norsk Akkreditering for prøvetaking og faglig vurderinger og fortolkninger, akkrediteringsnummer TEST 079.

Akkrediteringen er iht. NS-EN ISO/IEC 17025

Akkrediteringen omfatter bla. NS 9410, NS-EN ISO 5667-19 og NS-EN ISO 16665.

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

Kópavogur 02.01 2023

Snorri Gunnarsson Project manager

## **1** Introduction

Sampling was undertaken on 18.11.2022 by Akvaplan-niva AS, who has been contracted by Arnarlax in relation to the company's fish farming activity at the site Eyri in Patreksfjörður, Vesturbyggð municipality.

The objective of the B-survey is to document the environmental condition in the near zone (beneath and in the close vicinity) of a fish farm by evaluating sediment condition (chemistry, sensory & presence/absence of fauna) as defined in NS 9410:2016 (and ISO 12878). The B-survey is a tool for trend monitoring and allows to assess the status of organic enrichment beneath the net pens at various stages of the production cycle.

The survey was undertaken at the time of max biomass of current production cycle. Sampling stations in this survey are placed within the near zone of the current farm location. Eyri has an estimated max. biomass of 8.193 t for current generation farmed fish (Silja Baldvinsdóttir, personal reference) and thus a total of 20 stations were sampled.



Figure 1 shows a map of the Patreksfjörður in Vestfirðir where the fish farm Eyri is located.

Figure 1. An overview map where Eyri is marked. Other fish farming area in the nearest vicinity (KvígindisdalurPatreksförður) is also shown.

Monitoring of the environmental impact of fish farming activities on the seabed is standardised and regulated. All fish farming sites in the sea are to be regularly assessed. This B-survey follows guidelines and methods outlined in NS 9410:2016 and ISO 12878. The Icelandic Environmental agency (Umhverfisstofnun) can also set specific requirements regarding frequency of surveys for different fish farming sites, which can overrule the above-mentioned standards.

The B-survey is a trend monitoring tool with the focus on sediment condition (benthic impact) beneath and in the close vicinity of the fish cages (near zone). Sediment is collected using a grab (min 250 cm<sup>2</sup>). Sediment condition for each sample is assessed using three indicators: sediment chemistry (pH and redox potential), sensory evaluation (gas bubbles, smell, texture, colour and thickness of sludge) and the presence or absence of fauna. The performance of these indicators against predefined thresholds categorizes the farming locations into four different site conditions (see Table 1), which are used to determine the sampling frequency.

Table 1. Frequency of category B-research for the location of the farm based on state of the defined farming area.

Site condition at the time of sampling	Sampling frequency for B-surveys (NS 9410:2016)
1-very good	At next max biomass
2-good	Prior to putting next generation into sea and again at next max biomass.
	<ul> <li>Prior to putting next generation into sea.</li> <li>Based on the site condition prior to putting next generation into sea:</li> <li>Condition 1 – next site survey at next max biomass</li> <li>Condition 2 – next site survey at next 50% max biomass and at max biomass</li> </ul>
3-Dad	<ul> <li>Condition 3 – next site survey at next 50% max biomass and at max biomass. Some conditions should apply for farming of next generation at the site</li> <li>If any of the samples result in character 4 it is a sign of overload.</li> </ul>
4-very bad	Overload

#### 2.1 Field equipment

The following field equipment was used during the site survey: Grab: Van Veen grab 0,1 m<sup>2</sup> Sieve 1 mm: Akvaplan-niva pH meter: Electrode, YSI Professional Plus Redox-meter: Electrode, YSI Professional Plus Position determination– Garmin GPS mapping tool. Digital camera

#### 3.1 Study site and production

The Eyri site is in Patreksfjörður, just outside of Patreksfjörður village and about 2 km southeast from Patreksfjörður harbour. The cages are lined in a west direction from land (270 degrees). The depth under cages ranges from about 52 - 54 m. The fish farm at the site is a 2x7 setup, total 14 cages each with 160 m circumference. During the last production cycle all 14 cages of were used.

This is the second farmed fish at the current location of cages at the site. The smolts were put into sea in summer/fall 2021 (451 tons). At the date of the survey the standing biomass was 7.699 tons (mean weight 4.8 kg). The previous generation salmon farmed at the site was started with putting out smolts in the period from summer/fall 2018 and farmed until September 2020.

Table 2 shows the production and feed usage for previous and current generation to sampling date.

Table 2. Production and feed usage at Eyri, data is based on info given from the fish farmer.

Generation of fish (G)	Production (tonnes)	Feed usage (tonnes)		
Generation 2018 – 2020	5.143	7.177		
Generation 2021- 18.11 2022	7.986	10.468		

#### 3.2 Present and past site surveys

Table 3 provides an overview of sampling dates and results of current and historic B-surveys undertaken at the site following NS 9410:2016.

Date of sampling	Report number	Survey type	Overall site status
18.11.2022	APN 64474.B01	B-survey max biomass	2
28.05 2021	APN 63202.B01	B-survey fallow period	1
05.03.2020	APN-61958.B02	B-survey max biomass	1
17.05.2018	APN-60033.B01	B-pre survey	1

Table 3. Current and historic B surveys taken at Eyri.

#### 3.3 Hydrodynamic conditions

Measurement of dispersing current was done at the site in March – May 2020 measurements at 43 m depth (Gunnarsson, 2020b). Dominating current (43 m) is in direction north by north-west (330 degrees; Figure 2) with a smaller counter current in south by south-east direction. Average current speed is measured to be 5.0 cm/s. Highest current speed is measured to be 20.8 cm/s and 5.9 % of the measurements are < 1 cm/s.

#### 3.4 Survey design

The placement of the 20 sampling stations is shown in Figure 2 with positions listed in Table 4. Stations are distributed within the near zone of the new frame position following criteria outlined in NS 9410:2016. The typical depth in the local impact zone is in the range from 52 - 55 m, with a slightly deeper area on northern part of the mooring frame. The sampling stations had a depth varying from 52 to 55 m. Sampling stations were placed to represent the varied environmental conditions within the near zone and cover thus both the deeper and shallower areas. The placement of sampling stations is regarded to be in accordance with the requirements outlined in NS 9410:2016.



Figure 2. Site specific map of Eyri showing frame, mooring lines and farming area. Sampling stations st. 1 - 20 are marked with crosses. The color of each cross represents the environmental condition at the respective station following the classification as outlined in NS 9410:2016, chapter 7.11. Colour codes: Blue = very good, green = good, yellow = bad, red = very bad. Current rose placed in the lower left corner shows main current direction at 43 m (Gunnarsson, 2020b).

Station number	North	West	Depth (m)
St 1	65°34,772	23°59,089	54
St 2	65°34,746	23°59,058	53
St 3	65°34,771	23°58,955	54
St 4	65°34,754	23°58,922	53
St 5	65°34,771	23°58,827	54
St 6	65°34,750	23°58,794	54
St 7	65°34,772	23°58,698	55
St 8	65°34,748	23°58,663	54
St 9	65°34,770	23°58,564	55
St 10	65°34,747	23°58,527	54
St 11	65°34,770	23°58,422	55
St 12	65°34,753	23°58,396	54
St 13	65°34,769	23°58,298	53
St 14	65°34,681	23°58,304	53
St 15	65°34,684	23°58,441	53
St 16	65°34,683	23°58,573	52
St 17	65°34,704	23°58,739	53
St 18	65°34,683	23°58,837	52
St 19	65°34,684	23°58,968	52
St 20	65°34,683	23°59,101	52

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

## 4 Results

Results for the different parameters are given in Table 5. The completed fieldwork sampling sheet with calculations for each parameter is attached in appendix.

Table 5. Results from the parameter classifications in the near zone of the fish farm.

Parameter	Condition
Group II - parameters (pH/Eh)	2
Group III – parameters, (sensory)	2
Group II + III – parameters (mean value)	2
Site condition	2

Substrate was collected at all 20 sampling stations (100% soft bottom). Sediment samples consisted mainly of clay in all parts of the local impact zone. Fauna was recorded at all stations with polychaetes being most prominent. The substrate was of brown/black colour at fourteen stations and light grey colour at the resting six stations. Signs of out-gassing were observed at five stations (st. 7, 11, 13, 19 and 20). A slight smell of H<sub>2</sub>S was recorded at thirteen stations and strong smell at five stations. Faeces were observed in samples at seventeen stations and feed particles at three stations.

Based on the classification of sediment chemistry (ph/Eh) and the sensory assessments four stations of this survey received status 4 - "very bad", one station received status 3 - "bad", two stations received status 2 - "good" and thirteen station status 1 - "very good" (Figure 2).

Taken together the site receives the environmental status was 2 - "good" (average group II-III index =1.34).

## **5** Conclusion

Applying the indicator thresholds and classification outlined in NS 9410:2016 it is shown that Eyri receives site status 2 - " good" at the time of this B survey. Samples were collected with a Van Veen grab (0,1 m<sup>2</sup>) at 20 stations distributed around the 14 cages, which are placed in the frame during current production cycle. Thirteen sampling stations received status 1 - "very good", two stations received status 2 - "good", one station received status 3 - "bad" and four stations received status 4 - "very bad"

The survey was undertaken during the time of max biomass for the present production cycle. The results indicate some organic load in the local impact zone. The four stations with status "very bad" were located both in the northern and eastern part of the frame (st. 7 and 13) and southern and western part (st. 19 and 20). Other stations with reduced environmental condition were found both at the northern and southern part of the frame (Figure 2). Signs of organic accumulation are therefore found in most parts of the local impact zone.

In two last B-surveys, one at max biomass for previous generation in March 2020 (Gunnarsson, 2020) and the other at last fallow period in May 2021 (Gústavsson, 2021) the overall site condition was 1 "very good" in both surveys. The site condition has therefore worsened during the farming of current generation. The previous survey at max biomass was done in March 2020 (Gunnarsson 2020a) with standing biomass at 4.856 ton. At the date of current B survey, the standing biomass was 7.699 which is a significant production increase from the past generation and this can be seen in evidently higher organic load in the local impact zone for the present generation farmed fish. In the next B-surveys it will be important to follow up on if this reduced site condition continues and if counteractive measures are needed.

Following the criteria outlined in NS 9410:2016 the site receives the status 2 - " good".

## **6** References

Forskrift om drift av akvakulturanlegg (akvakulturdriftsforskriften) §§ 35 og 36.

Gunnarsson, S., 2018. Eyri, Arnarlax hf. Foreundersøkelse (B-undersøkelse), mai 2018 Akvaplan-niva AS report nr. 60033.01.

Gunnarsson, S., 2020a. Eyri, Arnarlax. B-bottom survey March 2020 (maximum biomass survey). Akvaplan-niva AS report nr. 61958.B02.

Gunnarsson, S. 2020b. Arnarlax hf. Eyri current measurement. 43 meters depth. Akvaplan-niva AS project nr. 62001.01.

Gústavsson, A., 2021. Eyri, Arnarlax B-bottom survey, May 2021 (fallow period). Akvaplanniva AS report nr. 63202.B01.

ISO 5667-19:2004. Guidance on sampling of marine sediments.

ISO 12878:2012. Environmental monitoring of the impacts from marine finfish farms on soft bottom.

Norsk Standard NS 9410:2016. Miljøovervåking av bunnpåvirkning fra marine akvakulturanlegg.

Personal reference. Silja Baldvinsdóttir, Quality manager Arnarlax. 2022

## 7 Appendix

### 7.1 Survey data sheet (B.1 & B.2), NS 9410:2016.

	Sample scheme B.1												
		Company			Arnarlax			1	Date:			18.11	2022
		Site:			Eyri				Site no.:				
		Fieldworker:		Snorri Gunnarsson			]						
Gr	Parameter	Point			1	Sample r	umber	<b>.</b>	<b>T</b>	1			
	Dattaura	an a C (a aft) all and L (ba ad)	1	2	3	4	5	6	7	8	9	10	
	Bollomi	ype. S (solt) eller H (hard)	S	S	S	S	S	S	S	S	S	S	l
Т	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0	0	0	0	0	<u>i</u>
Ш	pН	value	7.71	7.47	7.51	7.41	7.50	7.35	6.76	7.52	7.24	7.44	
	Eh (mV)	ORP	128	-78	-15	-20	37	-80	-144	-80	-56	-33	
	. ,	plus ref. verdi	328	122	185	180	237	120	56	120	144	167	
	pH/Eh	from figure	0	0	0	0	0	0	5	0	1	0	
		Status station	1	1	1	1	1	1	4	1	1	1	
		[]	Buffer-temp	9.0	С	Sea temp	6.6	С	Sedime	ont temp	6.7	С	
		pHsea 7.98	ORP sea	252.0	mV	Eh sea	452.0	mV	Reference	electrode	200.0	mV	
ш	Gas bubbles	Yes (4) No (0)	0	0	0	0	0	0	4	0	0	0	
	Colour	Light/grey (0)	0	0				0			0	0	
		Brown/black (2)			2	2	2		2	2			ļ
		None (0)	0	0									
	Smell	Light (2)			2	2	2	2		2	2	2	
		Strong (4)							4				
		Solid (0)	0	0	0	0	0	0	0	0	0	0	
	Consistency	Soft (2)											
		Aqueous (4)											
		v < 1/4 (0)											
	Grab volume (v)	1/4 < v < 3/4 (1)											
		v > 3/4 (2)	2	2	2	2	2	2	2	2	2	2	
		t < 2 cm (0)	0	0	0	0	0	0		0	0	0	
	Thickness of slidge (t)	2 < t < 8 cm (1)							1				
		t > 8 cm (2)											
		Sum	2.0	2.0	6.0	6.0	6.0	4.0	13.0	6.0	4.0	4.0	
		Corrected (*0,22)	0.4	0.4	1.3	1.3	1.3	0.9	2.9	1.3	0.9	0.9	
		Status station			2	2	2	<u> </u>		2		<u> </u>	1
						1		1	1				
		Average group II & II	0.2	0.2	0.7	0.7	0.7	0.4	3.9 4	0.7	0.9	0.4	
		Status station							-			<u> </u>	1
	Grab ID	к-з	]										
	pH/Eh ID	-	-										
		Ysi proffesional plus							page 1 of	f 4 pages			

	Sample scheme B.1													
		Company:			Arnarlax			Date:				18.11 2022		
		Site:	Eyri					Site no.:				0		
		Snorri Gunnarsson												
Gr	Parameter	Point				Sample (	number						Index	_
			11	12	13	14	15	16	17	18	19	20	S%	H%
	Bottom	type: S (soft) or H (hard)	s	S	S	S	s	s	s	S	S	s	100	0
Т	Animals >	Yes (0) No (1)	0	0	0	0	0	0	0	0	0	0	1	
		L	1	1	1	<u> </u>	1		<u> </u>	1			1	
				 	1	1	1	1	1	1		1	1	
Ш	рН	value	7.2	7.5	7.0	7.2	7.5	7.6	7.1	7.6	6.5	6.5		
	Eh (mV)	ORP	-58	-15	-83	37	72	53	-65	90	-53	-93		
		plus ref. verdi	142	185	117	237	272	253	135	290	147	107		
	pH/Eh	from figure	1	0	3	1	0	0	1	0	5	5	1.1	10
		Status group II	1	Buffertem	3 90	C	T Saa tamu	66	C	Sediment	4 67	4 C		
		pH sea 7.98	∠ ORP sea	252	mV	Eh sea	452	mV	Reference	e electrode	200	mV		
		) (1) No (0)				0			0					
	Gas bubbles	Yes (4) No (0)	4	0	4	0	0	0	0	0	4	4		
	Colour	Light/grey (0)						0						
		Brown/black (2)	2	2	2	2	2		2	2	2	2		
	Smell	None (0)												
	Smell	Light (2)		2		2	2	2	2	2				
		Strong (4)	4		4						4	4		
	Consistency	Solid (0)		0		0	0	0	0	0	0	0		
		Soft (2)	2		2									
	Grab volume (v)	Aqueous (4)												
		v < 1/4 (0)												
		1/4 < v < 3/4 (1)												
		v > 3/4 (2)	2	2	2	2	2	2	2	2	2	2	-	
	Thickness of	t < 2 cm (0)		0		0	0	0	0	0				
	slidge (t)	2 < t < 8 cm (1)	1		1						1	1		
		t > 8 cm (2) Sum	15.0	60	15.0	6.0	6.0	4.0	60	6.0	13.0	13.0		
		Corrected (*0,22)	3.3	1.3	3.3	1.3	1.3	0.9	1.3	1.3	2.9	2.9	1.(	57
		Status station	4	2	4	2	2	1	2	2	3	3		
		Status group III		2	J									
		Average group II & III	2.2	0.7	3.2	1.2	0.7	0.4	1.2	0.7	3.9	3.9	1.3	34
		Status station	3	1 2	4	2	1	1	2	1	4	4	J	
		Status group in a in			J									
		pH/Eh												
		Corr.sum Index	Status											
		Average												
		< 1,1	1	-										
		2,1-<3,1	3	-										
		≥3,1	4	]							St	atus site:	2	2
	Grab ID	К-3												
	pH / Eh ID	Ysi proffesional plus								page 2 of	4 pages			

Sample scheme B.2											
Company:		Arnarlax					Da	ite:	18.11 2022		
Site:		Eyri					Site	no.:	0		
Fieldworker:			Snorri Gu	innarsson							
Sample number		1	2	3	4	5	6	7	8	9	10
Depth (m)		54	53	54	53	54	54	55	54	55	54
Number of trials		1	1	1	1	1	1	1	1	1	1
Gas bubbles (in samp	ole)	No	No	No	No	No	No	Yes	No	No	No
	Clay	х	х	х	х	x	х	х	х	х	х
	Silt										
Sediment type	Sand										
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count											
Polychaetes, count		>100	>100	>100	>100	>50	>100	>30	>50	>100	>100
Other animals, count											
Beggiatoa											
Feed					х				x		
Faeces				х		Х	х	Х	Х	Х	Х
Comments											
			2.		4				<b>K</b> 2		
Grab		Area	[m⁻]	0	.1		Gra	<b>טו</b> מ	l	к-3	
										page 3	of 4 pages

Sample scheme B.2												
Company:		Arnarlax					Da	te:	18.11 2022			
Site:		Eyri					Site no.:		0			
Fieldworker:			Snorri Gu	unnarsson								
											_	_
Sample number		11	12	13	14	15	16	17	18	19	20	
Depth (m)		55	54	53	53	53	52	53	52	52	52	
Number of trials		1	1	1	1	1	1	1	1	1	1	
Gas bubbles (in samp	ole)	Yes	No	Yes	No	No	No	No	No	Yes	Yes	
	Clay	х	х	x	x	x	х	x	х	х	х	
	Silt											
Sediment type	Sand											
	Gravel											
	Shellsand											
Reef												
Rocky bottom (cobble	es, boulders)											
Echinodermata, coun	nt											
Crustaceans, count												
Molluscs, count												
Polychaetes, count		>20	>100	>10	>100	>100	>100	>20	>50	8	2	
Other animals, count												
Beggiatoa												
Feed									х			
Faeces		X	X	X	X	x	X	X	X	Х	Х	4
Comments		St 17. Some fine dead black algae (sieving difficult)										
		Ang	[m2]		1				K 0			4
Signature fieldworke	r:	Area	[m-]	0	, I		Gra			K-J		-
			Promi Generation page 4 of 4						of 4 pag	es		

## 7.2 Pictures of samples at Eyri.



St 6	6	6
St 7		
St 8		
St 9	9	9
St 10		

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

St 16	16	16
St 17		17
St 18	18	18
St 19		19
St 20		20



#### 7.3 Bottom topography and 3D view

*Figure 3. Bottom topography in 3D at Eyri with each sampling station according to info in Figure 1 and Table 4.*