

FINFISH AQUACULTURE SITE AQUACULTURE STEWARDSHIP COUNCIL REPORT CULLODEN, JERVIS INLET, BC

SITE LICENSE: AQ#1697

SURVEY TYPE: ASC

SURVEY DATE: MARCH 23, 2020

REPORT DATE: APRIL 8, 2020

PREPARED FOR:

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Summary

This document presents the qualitative and quantitative assessment of sediment obtained during the survey completed at the Culloden finfish aquaculture site operated by Grieg Seafood BC Ltd in Jervis Inlet, BC, on March 23, 2020. Sediment was collected and the data analyzed according to the *Aquaculture Activities Regulations* (AAR) and adapted to address Criterion 2.1 and 5.2 of the Aquaculture Stewardship Council (ASC) Salmon Standard.

The measured and observed characteristics of the sediment collected during the sampling confirmed that the stations outside the Allowable Zone of Effect (AZE) on Transects B and C had mean sulphide levels less than the ASC Salmon Standard acceptable limit of 1500 µm. Redox potential measured in sediment obtained outside the AZE on Transect B and C was greater than the ASC Salmon Standard acceptable lower limit of 0 mV. Sediment could not be obtained at the station outside the AZE on Transect A and therefore sulphide and redox measurements were not possible.

As required by Criterion 5.2 of the ASC monitoring for parasiticide residue was completed at the station outside the AZE on Transects B and C and at two reference stations. Emamectin benzoate and florfenicol was below detectable limits in all collected samples.

An assessment and identification of the benthic organisms present in the sediment was not completed to evaluate for potential impacts to habitat, as BC salmon farms have been granted a variance to Indicators 2.1.2 and 2.1.3 and instead rely on the scientifically proven and federally regulated sulfide surrogates (ASC VR224)¹.

¹ <http://variance-requests.asc-aqua.org/questions/vr-224-benthic-biodiversity-and-benthic-effects-salmon-v1-0-2-1-2-2-1-3/>

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1.0 Introduction

This document presents the marine sediment data collected as part of a benthic study completed at the Culloden finfish aquaculture site operated by Grieg Seafood BC Ltd (Campbell River, BC). The Culloden site is located in Jervis Inlet, BC (Figure 1).

The study was completed by adapting the methodology required for operational monitoring of waste dispersion required under *Aquaculture Activities Regulations* (AAR) and comparing the results with the indicators listed in Criterion 2.1 of the Aquaculture Stewardship Council (ASC) Salmon Standard. Additional analysis of the collected sediment was also completed to address Criterion 5.2 of the ASC.

The purpose of the ASC Salmon Standard is to evaluate concerns of potential environmental impact related to salmon farming. The Standard is based on a combination of requirements and performance levels that must be reached in order to determine if potential impacts are being addressed. Principle 2 of the Standard addresses the “*potential impacts from salmon farms on natural habitat, local biodiversity and ecosystem function*” (ASC, 2012).

This survey was specifically designed to address Criterion 2.1 within Principle 2 of the ASC Salmon Standard which involved the collection of sediment within and outside of the Allowable Zone of Effect (AZE). Sediment was analyzed for redox potential and sulphide levels to evaluate benthic habitat conditions. In addition, testing for parasiticide residue in sediment collected at the two reference stations and at the stations outside the AZE was completed to address Criterion 5.2.1 of the ASC.

An assessment and identification of the benthic organisms present in the sediment was not completed to evaluate for potential impacts to habitat, biodiversity and ecosystem function, as BC salmon farms have been granted a variance to Indicators 2.1.2 and 2.1.3 and instead rely on the scientifically proven and federally regulated sulfide surrogates (ASC VR224).

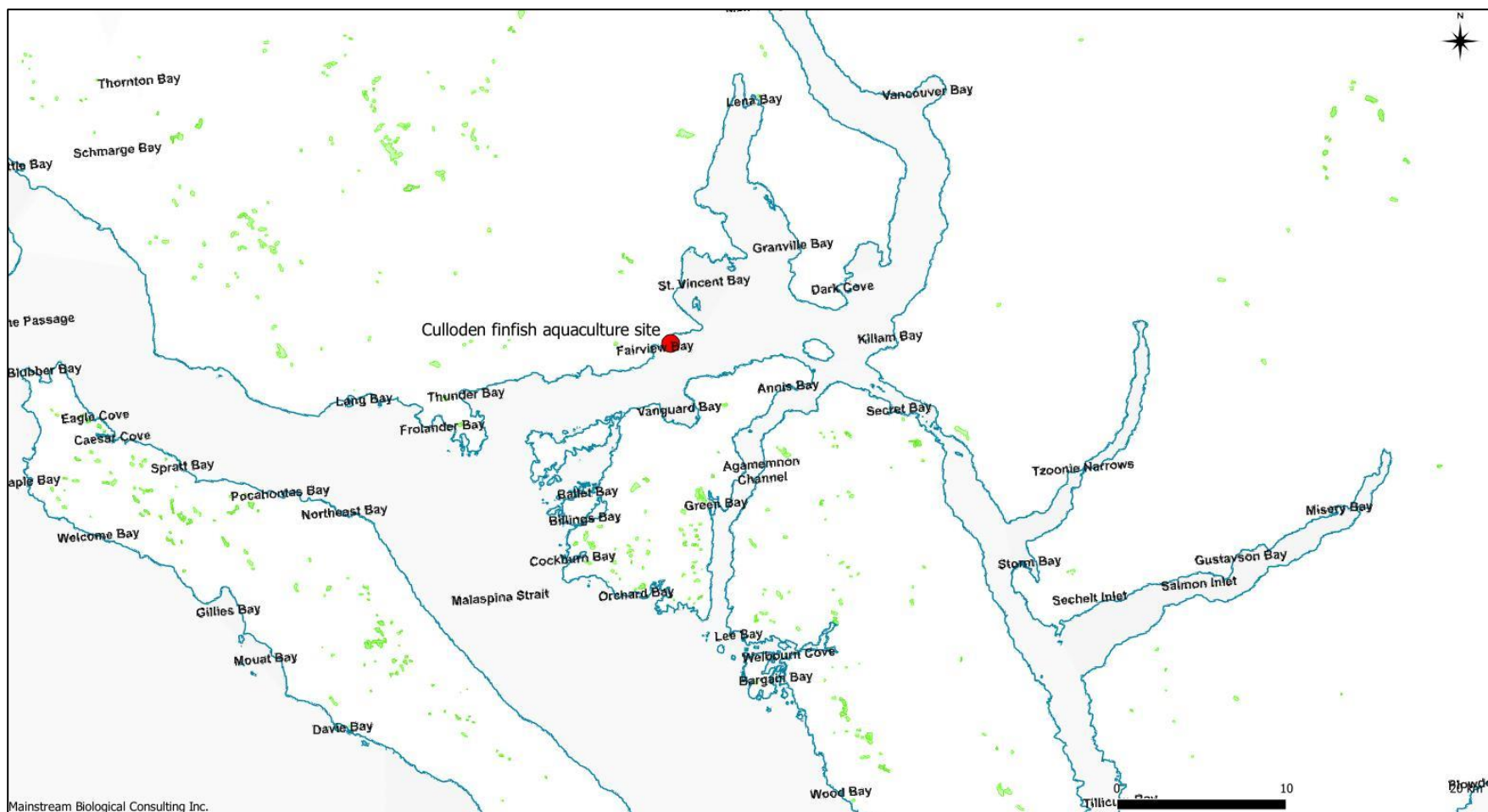


Figure 1: An overview map showing the approximate location of the Culloden finfish aquaculture farm site (red dot) in Jervis Inlet, BC.

2.0 Methods

The substrate at the designated sampling locations at the Culloden finfish aquaculture site had not previously been sampled for ASC or identified to consist of “soft” sediment. Therefore, the field activities involved locating stations and attempting sediment grabs. The collection of sediment samples for physical and chemical analysis was completed when successful soft stations were located.

2.1 Field Sampling

The potential locations of sediment sampling stations were provided by Grieg Seafood BC Ltd.

Individual sediment sampling stations were located along three Transects A, B, and C. Stations within the AZE were located 5 m inside the 1 g DEPOMOD contour (Figure 2) for all three transects and also at the perimeter of the containment system for Transects A and B. Stations outside the AZE were located 25 m outside of the 1 g DEPOMOD contour. Additional stations were established at two reference sites within the range of 500 m to 1000 m from the aquaculture containment system as outlined in the ASC Salmon Standard (Figure 3).

Sediment was collected using a Petite Ponar sampler. Two sediment samples were collected at each successful station. Stations 0A and the station outside the AZE on Transect A had four attempted but unsuccessful sediment grabs.

The coordinates of the sample locations were recorded using a Trimble GeoExplorer GeoXT (Firmware v1.05) using TerraSync 3.30 software and equipped with an external Hurricane antenna.

Data filters were set to standards recommended by the Resource Inventory Standards Committee (RISC)², with at least 15 fixes taken per location, using satellites greater than 15 % above the horizon with signal to noise ratios (SNR) greater than 40 and a horizontal dilution of precision (HDOP) of five. The GPS data was corrected post-mission with Pathfinder Office v5.40 software using data from the Nanoose WCDA base station (NANO).

The Trimble antenna was attached to the grab davit and positional fixes were obtained while the grab was completing the estimated bottom third of its descent. Positional fixes were completed when the grab was on the bottom and the drop line was as close vertical as possible.

² Integrated Land Management Bureau. 2008. Province of British Columbia Standards, Specifications and Guidelines for Resource Surveys Using Global Positioning System (GPS) Technology. Release 4.0d.

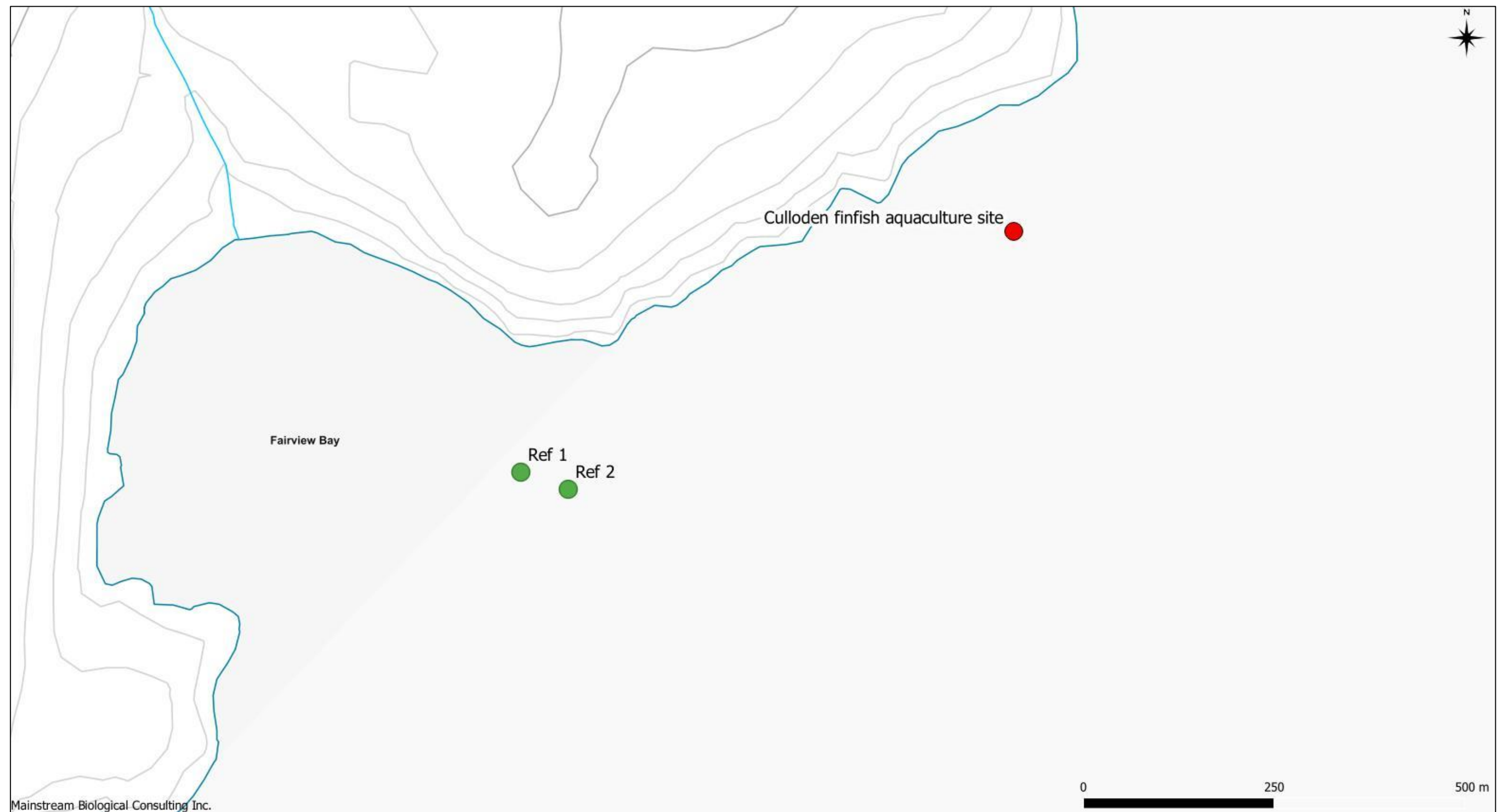


Figure 3: The locations of the reference stations for the ASC survey at the Culloden finfish aquaculture site in relation to the site and surrounding area on March 23, 2020.

The time at which each sample was successfully obtained and physical characteristics of the collected sediment were recorded. A digital photograph of each sample was also taken. As per Indicator 2.1.1, levels of free sulphides and redox potential of each sediment sample were measured in the field using an Orion A324 meter and the appropriate ISE probes. A digital thermometer was used to measure the temperature of the sediment.

As per Indicator 5.2.1, portions of the grab samples collected at the stations outside the AZE on Transects B and C as well as the reference stations were retained for analysis. Retained samples were stored at 4° Celsius and transported to SGS Canada Inc for analysis for emamectin benzoate and florfenicol.

2.2 Data Analysis

In order to evaluate if the benthic conditions at and near the Culloden site met the requirements of Criterion 2.1 of the ASC Salmon Standard, the data collected was compared to required levels for indicators of potential finfish farm impacts. These indicators represent a combination of chemical and biodiversity measurements to evaluate the status of benthic health, biodiversity and ecosystem function and to detect potential impacts related to the salmon farm operation. The indicators considered for this assessment are summarized below in Table 1.

Additional analysis of parasiticide residue was completed to fulfill the requirement for monitoring of these chemicals but there is no required level presented in the ASC to compare these results to.

Table 1: Summary of indicators of benthic health, biodiversity and ecosystem function that were considered during the evaluation of the Culloden finfish aquaculture site. The indicators have been adopted from Criterion 2.1 of the ASC Salmon Standard.

Criterion Number	Indicator	ASC Salmon Standard Requirement
2.1.1	Redox potential in sediment outside the AZE ¹ .	>0 millivolts (mV)
2.1.1	Sulphide levels in sediment outside the AZE.	≤1500 microMoles / L (μM)

1: AZE = Allowable Zone of Effect

3.0 Results and Discussion

Representative photographs of sediment obtained at each sampling station are presented in Appendix 1. Raw data obtained from sediment sampled in the field is presented in Appendix 2 and the summarized data is presented in Appendix 3.

The sediment successfully collected at the Culloden sampling stations typically consisted of green mud with abundant sponge particles.

3.1 Redox Potential and Sulphide Levels

Following Criterion 2.1.1 of the ASC Salmon Standard, the results of redox potential and sulphide testing at the station outside the AZE were analyzed to help evaluate if the Culloden facility was meeting the certification requirements (Appendix 3).

The mean sulphide level in sediment collected at the stations outside AZE on Transects B and C (38.4 μM and 62.4 μM respectively) on March 23, 2020 were less than the ASC Salmon Standard sulphide upper limit of 1500 μM .

Mean redox potential in sediment collected at the stations outside the AZE on Transect B and C (19.8 mV and 62.2 mV respectively) were greater than the 0 mV minimum requirement cited in Criterion 2.1.1 of the ASC Salmon Standard.

Sulphide level and redox potential measurements were not possible at the station outside the AZE on Transect A as all attempted grabs were unsuccessful.

Table 2 The location and results of each unsuccessful grab attempt at the stations 0A, Inside A and Outside AZE A at the Culloden finfish aquaculture site during the ASC survey on March 23, 2020.

Station	Latitude	Longitude	Sampling Device	Comments
Station 0A	49 47.80587	124 05.78390	Petite Ponar	Skiff of shell hash, sponge
Station 0A	49 47.80545	124 05.78026	Petite Ponar	Shell hash, cedar needle, sand, sponge
Station 0A	49 47.80566	124 05.78085	Petite Ponar	Empty
Station 0A	49 47.80573	124 05.78119	Petite Ponar	Skiff of sand, shell hash, sponge
Inside AZE A	49 47.81000	124 05.72247	Petite Ponar	Sponge, no sediment
Outside AZE A	49 47.81574	124 05.69679	Petite Ponar	Empty
Outside AZE A	49 47.82409	124 05.70094	Petite Ponar	Empty
Outside AZE A	49 47.82703	124 05.70304	Petite Ponar	Skiff of sand
Outside AZE A	49 47.82102	124 05.69952	Petite Ponar	Empty

3.2 Parasiticide Residue

Analysis of the sediment collected from the stations outside the AZE on Transects B, C and the two reference stations for emamectin benzoate and florfenicol are shown in Table 3. The analysis was completed to fulfill the requirement of the ASC Salmon Standard Criterion number 5.2.1. All of the collected sediment samples analyzed had parasiticide residue concentrations less than the laboratory detectable limit.

Table 3: The parasiticide residue concentration of collected sediment at the stations outside the AZE on Transects B, C and the two reference stations at the Culloden finfish aquaculture site on March 23, 2020.

Station Name	Sample Number	Emamectin Benzoate (ppm)	Florfenicol (ng/g)	Florfenicol Amine (ng/g)
Detection Limit		1.0	2.00	5.00
Outside AZE B	1	<1.0	<2.00	<5.00
Outside AZE B	2	<1.0	<2.00	<5.00
Outside AZE C	1	<1.0	<2.00	<5.00
Outside AZE C	2	<1.0	<2.00	<5.00
Reference 1	1	<1.0	<2.00	<5.00
Reference 1	2	<1.0	<2.00	<5.00
Reference 2	1	<1.0	<2.00	<5.00
Reference 2	2	<1.0	<2.00	<5.00

4.0 References

- Aquaculture Stewardship Council. 2012. ASC Salmon Standard Version 1.3. Available online: www.asc-aqua.org.
- Salas, F., Patrício, J. and Marques, J.C. 2006. Ecological Indicators in Coastal and Estuarine Environmental Quality Assessment - A user friendly guide for practitioners. Imprensa da Universidade de Coimbra.

Appendix 1 – Sample Photographs



Photo 1

Typical unsuccessful grab attempt at the 0m station on Transect A at the Culloden site on March 23, 2020.



Photo 2

Sediment sample collected at the station inside the AZE on Transect A at the Culloden site on March 23, 2020.



A typical unsuccessful grab attempt at the station outside the AZE on Transect A at the Culloden site on March 23, 2020.



Photo 4

Sediment sample collected at the 0B station at Culloden site on March 23, 2020.



Photo 5

Sediment sample collected at the station inside the AZE on Transect B at the Culloden site on March 23, 2020.



Photo 6

Sediment sample collected at the station outside the AZE on Transect B at the Culloden site on March 23, 2020.



Photo 7

Sediment sample collected at the station inside the AZE on Transect C at the Culloden site on March 23, 2020.



Photo 8

Sediment sample collected at the station outside the AZE on Transect C at Culloden site on March 23, 2020.



Photo 9

Sediment sample collected at the Reference 1 at the Culloden site on March 23, 2020.



Photo 10

Sediment sample collected at the Reference 2 at the Culloden site on March 23, 2020.

Appendix 2 – Culloden Field Data

Reference Information:

Farm site:	Culloden	Field Crew:	N. Delange, E. Weiss
Aquaculture Company:	Grieg Seafood BC Ltd	Field Investigator:	Mainstream Biological Consulting Inc.
Site Reference #:	AQ#1697	Laboratory:	SGS Canada Inc
Geographic Region:	Jervis Inlet, BC		

<i>Transect A, B, C Name</i>	<i>Sampling Station Name</i>	<i>Replicate Number</i>	<i>Transect A, B, C Bearing (Magnetic)</i>	<i>Reference Station (Y/N)</i>	<i>Distance from Pens (m)</i>	<i>Sampling Device Type</i>	<i>Sampling Device Capacity (m2)</i>	<i>Quality Control Replicate (Y/N)</i>	<i>Replicate Analysis Type</i>	<i>Sample Date (YYYY-MM-DD)</i>	<i>Sample Time (24HH:MM)</i>	<i>Sample Latitude (Degrees)</i>	<i>Sample Latitude (Minutes)</i>	<i>Sample Longitude (Degrees)</i>	<i>Sample Longitude (Minutes)</i>	<i>GPS Correction Status</i>	<i>Ocean Depth (m)</i>	<i>Sample Depth (cm)</i>
A	5m	1			63	Petite Ponar	0.02			2020-03-23	11:11	49	47.8148	124	5.7244	Post-process corrected	43	9
A	5m	1			63	Petite Ponar	0.02	Y	Duplicate	2020-03-23	11:11	49	47.8148	124	5.7244	Post-process corrected	43	9
A	5m	1			63	Petite Ponar	0.02	Y	Triplicate	2020-03-23	11:11	49	47.8148	124	5.7244	Post-process corrected	43	9
A	5m	2			63	Petite Ponar	0.02			2020-03-23	11:22	49	47.8166	124	5.7253	Post-process corrected	43	8
B	0m	1			0	Petite Ponar	0.02			2020-03-23	14:16	49	47.7645	124	5.9283	Post-process corrected	42	8
B	0m	2			0	Petite Ponar	0.02			2020-03-23	14:21	49	47.7644	124	5.9282	Post-process corrected	42	6
B	5m	1			171	Petite Ponar	0.02			2020-03-23	15:02	49	47.7222	124	5.9913	Post-process corrected	84.6	5
B	5m	2			171	Petite Ponar	0.02			2020-03-23	15:08	49	47.7268	124	5.9980	Post-process corrected	84.6	7
B	25m	1			200	Petite Ponar	0.02			2020-03-23	15:22	49	47.7125	124	6.0119	Post-process corrected	95.9	9
B	25m	2			200	Petite Ponar	0.02			2020-03-23	15:27	49	47.7241	124	6.0256	Post-process corrected	95.9	9
C	5m	1			130	Petite Ponar	0.02			2020-03-23	16:23	49	47.7006	124	5.8181	Post-process corrected	118	6
C	5m	2			130	Petite Ponar	0.02			2020-03-23	16:40	49	47.7009	124	5.8268	Post-process corrected	118	5
C	25m	1			162	Petite Ponar	0.02			2020-03-23	16:57	49	47.6837	124	5.8183	Post-process corrected	125	8
C	25m	2			162	Petite Ponar	0.02			2020-03-23	17:09	49	47.6830	124	5.8242	Uncorrected	125	8
Ref 1	Ref 1	1		Y	1290	Petite Ponar	0.02			2020-03-23	17:32	49	47.4054	124	6.8534	Uncorrected	57.8	8
Ref 1	Ref 1	2		Y	1290	Petite Ponar	0.02			2020-03-23	17:35	49	47.4043	124	6.8492	Uncorrected	57.8	8
Ref 2	Ref 2	1		Y	1220	Petite Ponar	0.02			2020-03-23	18:11	49	47.3934	124	6.7985	Uncorrected	94.9	7
Ref 2	Ref 2	2		Y	1220	Petite Ponar	0.02			2020-03-23	18:19	49	47.3996	124	6.8015	Uncorrected	94.9	9

<i>Transect A, B, C Name</i>	<i>Sampling Station Name</i>	<i>Replicate Number</i>	<i>Free Sulphide (micromolar)</i>	<i>Sediment Temperature (deg C)</i>	<i>Eh Uncorrected (mV)</i>	<i>Eh Corrected (mV)</i>	<i>Cu (micro-g/g)</i>	<i>Zn (micro-g/g)</i>	<i>Li (micro-g/g)</i>	<i>Gravel Percent</i>	<i>Sand Percent</i>	<i>Mud Percent</i>	<i>TVS Percent</i>	<i>Beggiatoa Observed (Y/N)</i>	<i>OPC Observed (Y/N)</i>	<i>Fish Feed Observed (Y/N)</i>	<i>Fish Feces Observed (Y/N)</i>	<i>Odour Rating</i>	<i>Black Sediment Observed (Y/N)</i>	<i>Gas Bubbles Observed (Y/N)</i>
A	5m	1	11.2	7.8	-220.9	-4.9								N	N	N	N	0	N	N
A	5m	1	3.37	7.8	-252.6	-36.6								N	N	N	N	0	N	N
A	5m	1		7.8	-236.4	-20.4								N	N	N	N	0	N	N
A	5m	2	39.6	9.8	-204.8	9.2								N	N	N	N	0	N	N
B	0m	1	355	8.4	-160.7	55.3								N	N	N	N	2	N	N
B	0m	2	253	8.6	-167.1	47.9								N	N	N	N	2	N	N
B	5m	1	95.3	8.5	-184.6	30.4								N	N	N	N	0	N	N
B	5m	2	47.5	8.3	-182.7	33.3								N	N	N	N	0	N	N
B	25m	1	15.2	8.3	-187.3	28.7								N	N	N	N	0	N	N
B	25m	2	61.5	8.5	-204.1	10.9								N	N	N	N	0	N	N
C	5m	1	81.3	7.9	-176.2	39.8								N	N	N	N	0	N	N
C	5m	2	21.6	8.2	-186.2	29.8								N	N	N	N	0	N	N
C	25m	1	34.6	8.2	-162.3	53.7								N	N	N	N	0	N	N
C	25m	2	90.2	8.2	-145.4	70.6								N	N	N	N	0	N	N
Ref 1	Ref 1	1	13.9	7.7	-203.3	12.7								N	N	N	N	0	N	N
Ref 1	Ref 1	2	29.3	7.7	-111.3	104.7								N	N	N	N	0	N	N
Ref 2	Ref 2	1	26.4	7.9	-220.7	-4.7								N	N	N	N	0	N	N
Ref 2	Ref 2	2	28.6	7.8	-206.4	9.6								N	N	N	N	0	N	N

Table note:

- Odour rating: ranked on a scale of 0 (no odour) to 4 (very strong sulphide odour)

<i>Transect A, B, C Name</i>	<i>Sampling Station Name</i>	<i>Replicate Number</i>	<i>Flocculent Organic Material Observed (Y/N)</i>	<i>Shell Hash Observed (Y/N)</i>	<i>Terrigenous Material Observed (Y/N)</i>	<i>Farm Litter Observed (Y/N)</i>	<i>Macrophytes Observed (Y/N)</i>	<i>Megafauna Observed (Y/N)</i>	<i>Sediment Colour Observations</i>	<i>Sediment Texture Observations</i>	<i>Other Sample Observations (Comments)</i>
A	5m	1	N	N	N	N	N	Y	Green	Mud	Abundant sponge
A	5m	1	N	N	N	N	N	Y	Green	Mud	Abundant sponge
A	5m	1	N	N	N	N	N	Y	Green	Mud	Abundant sponge
A	5m	2	N	N	N	N	N	Y	Green	Mud	Abundant sponge
B	0m	1	N	Y	N	N	N	Y	Green	Mud	Sponge
B	0m	2	N	Y	N	N	N	Y	Green	Mud	Sponge
B	5m	1	N	Y	N	N	N	Y	Green	Mud	Sponge
B	5m	2	N	Y	N	N	N	Y	Green	Mud	Sponge
B	25m	1	N	N	N	N	N	Y	Green	Mud	Sponge, worm tube
B	25m	2	N	N	N	N	N	Y	Green	Mud	Sponge, worm tube
C	5m	1	N	N	N	N	N	Y	Green	Gravelly mud	Trace of sponge
C	5m	2	N	Y	N	N	N	Y	Green	Mud	Trace of sponge, worm tube
C	25m	1	N	N	Y	N	N	Y	Green	Mud	Cedar needle, sponge, worm tube
C	25m	2	N	N	N	N	N	Y	Green	Mud	Sponge, worm tube
Ref 1	Ref 1	1	N	N	N	N	N	Y	Green	Mud	Abundant sponge, worm tube
Ref 1	Ref 1	2	N	N	N	N	N	Y	Green	Mud	Abundant sponge, worm tube
Ref 2	Ref 2	1	N	N	N	N	N	Y	Green	Mud	Abundant sponge
Ref 2	Ref 2	2	N	N	N	N	N	Y	Green	Mud	Abundant sponge

Appendix 3 – Culloden ASC Survey Summary

Company:	Grieg Seafood BC Ltd	Sample date:	March 23, 2020
Farm Site:	Culloden	Field crew:	N. Delange, E. Weiss
Site License #:	AQ#1697	Analytical:	SGS Canada Inc
Site Location	Jervis Inlet, BC		

SULPHIDES Indicator 2.1.1 Requirement ≤ 1500 (μm)					
Station	Rep 1	Rep 2	n	Mean	ASC Criteria Met
Inside AZE A	112	396	2	254	
0m B	355	253	2	304	
Inside AZE B	95.3	47.5	2	71.4	
Outside AZE B	15.2	61.5	2	38.4	Yes
Inside AZE C	81.3	21.6	2	51.5	
Outside AZE C	34.6	90.2	2	62.4	Yes
Reference 1	13.9	29.3	2	21.6	
Reference 2	26.4	28.6	2	27.5	

REDOX POTENTIAL Indicator 2.1.1 Requirement > 0 mV					
Station	Rep 1	Rep 2	N	Mean	ASC Criteria Met
Inside AZE A	-4.9	9.2	2	2.2	
0m B	55.3	47.9	2	51.6	
Inside AZE B	30.4	33.3	2	31.9	
Outside AZE B	28.7	10.9	2	19.8	Yes
Inside AZE C	39.8	29.8	2	34.8	
Outside AZE C	53.7	70.6	2	62.2	Yes
Reference 1	12.7	104.7	2	58.7	
Reference 2	-4.7	9.6	2	2.5	
Reference 3			2		