PLACENTIA BAY ATLANTIC SALMON AQUACULTURE PROJECT
ENVIRONMENTAL EFFECTS MONITORING PLAN (EEMP):
GENETIC AND ECOLOGICAL INTERACTIONS OF
ESCAPED FARMED ATLANTIC SALMON WITH WILD ATLANTIC SALMON

GRIEG NL

March 2020

Placentia Bay Atlantic Salmon Aquaculture Project
Environmental Effects Monitoring Plan:

Genetic and Ecological Interactions of Escaped Farmed Atlantic Salmon with Wild Atlantic Salmon

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1.0 Introduction

As part of the environmental assessment process for the Placentia Bay Atlantic Salmon Aquaculture Project, Grieg NL was required to prepare and submit Environmental Effects Monitoring Plans (EEMPs) subsequent to completion of the Environmental Impact Statement (EIS) but prior to initiation of hatchery operations (see Minister's release letter of 5 September 2018). The release of the Placentia Bay Atlantic Salmon Aquaculture Project from further environmental assessment by the Minister of the Department of Municipal Affairs and Environment (DMAE) was subject to Grieg NL meeting a series of terms and conditions, including eight components requiring EEMPs, as indicated in Condition 'b'. The EEMP for Genetic and Ecological Interactions of Escaped Farmed Atlantic Salmon with Wild Atlantic Salmon component is presented in this document. This EEMP is designed to monitor the potential effects of genetic and ecological interactions on the wild Atlantic salmon stocks in Placentia Bay and vicinity. The EEMP is largely based on consultation with Fisheries and Oceans Canada (DFO) in St. John's, Newfoundland and Labrador (NL), as well as scientific information provided in the peer-reviewed literature.

Grieg NL is committed to the implementation of this EEMP as an essential part of its Placentia Bay Atlantic Salmon Aquaculture Project. The organization of this document closely follows the requirements outlined in Section 7.4 of the EIS Guidelines (DMAE 2018). The EEMP will be reviewed on an annual basis and updated as needed throughout the Project life.

2.0 Objectives and Scheduling of Monitoring

The objective of the EEMP for 'Genetic and Ecological Interactions of Escaped Farmed Atlantic Salmon with Wild Atlantic Salmon' is to evaluate potential genetic and ecological effects on wild Atlantic salmon stocks as a result of interactions with escaped Grieg NL farmed salmon. Monitoring is designed to identify early indicators of potential interactions between escaped farmed salmon and wild salmon so that mitigation measures can be modified to further minimize potential effects of farmed salmon on the wild salmon stocks in Placentia Bay and vicinity. For the purposes of this EEMP, the principal threshold is the occurrence of one Grieg NL farmed salmon at a counting fence. While Section 7.2 of the EIS (LGL 2018) provides assessment of routine activities on the Wild Salmon Valued Environmental Component (VEC), including maintenance of farmed salmon health, EIS Section 7.7.1 assesses the potential effects of accidents and malfunctions on the wild salmon, specifically escape of Grieg NL farmed salmon from a sea cage that could potentially result in interaction between escaped farmed salmon and wild salmon in Placentia Bay. The EIS predicted that the reversible residual negative effects of the escape of farmed salmon on the Wild Salmon VEC would be not significant.

Grieg NL will employ proactive measures to minimize the potential of escapes of farmed salmon from Grieg NL sea cages, and the potential of escaped Grieg NL farmed salmon entering a Placentia Bay river that supports wild salmon stocks. Grieg NL will also employ river monitoring measures to determine whether or not escaped Grieg NL farmed salmon are entering Placentia Bay freshwater systems known to support wild salmon. Counting fences will be installed on select rivers to monitor upstream migration of adult salmon. Various types of data will be collected from every adult salmon caught and counted in a counting fence trap, as per DFO fishway and counting fence protocol. Each year, a maximum of 200 adult fish per monitoring river will be fin clipped to provide tissue for DFO archiving. Actual sample size will depend on the size of each river salmon run based on the enumeration of fish at each counting fence during

baseline data collection. Other measures, such as Environmental DNA (eDNA) sampling and analysis, may also be employed should either routine monitoring of a counting fence indicate presence of Grieg NL farmed salmon in that river, or following an acute escape (i.e., obvious large number of escaped fish in a single event) of Grieg NL farmed salmon.

To monitor potential ecological interactions between escaped Grieg NL farmed salmon and Placentia Bay wild salmon, adult salmon return data will be collected at the counting fences and subsequently analyzed once multiple years of data have been accumulated (i.e., comparison of baseline data collected prior to stocking of sea cages with farmed salmon with those data collected after sea cage stocking).

Prior to stocking of sea cages, counting fences on select rivers located near sea cage sites will be operational during the May to October period (flow conditions allowing) for at least one season to collect baseline data on adult salmon migrating upstream. Grieg NL will continue to monitor adult salmon on the select rivers annually for 10 years (two wild salmon generations) after the stocking of sea cages. As agreed in discussions with DFO on 25 April 2019, after monitoring the selected rivers for 10 years (2 generations) for evidence of interactions between wild Atlantic salmon and Grieg NL's farmed Atlantic salmon, then the monitoring program will be reassessed and adjusted accordingly at that time. This reassessment will be done in consultation with DFO. Sampling and genetic analysis of eDNA could potentially be conducted should either a Grieg NL farmed fish be detected at a counting fence or following an acute escape of a large number of Grieg NL farmed salmon. Timing of potential eDNA sampling would depend on various factors including the size/age of the escaped farmed fish and the timing of the acute escape.

A letter from DFO supports the premise that this EEMP is evolving and cannot at this time include more details regarding approaches to monitor genetic and ecological interactions between escaped Grieg NL farmed salmon and wild salmon (see Appendix 1).

3.0 Monitoring Design and Methodology

Grieg NL will proactively implement measures to decrease the potential for escape of its farmed salmon, to detect chronic escapes of its farmed salmon, to facilitate the identification of any farmed salmon that have escaped from the Grieg NL sea cages, and to recapture Grieg NL farmed salmon that have escaped during an acute event. This section provides descriptions of these measures as well as those associated with monitoring for genetic and ecological interaction. These measures are listed below:

- As per Aquaculture Policy (AP 2; DFLR 2019), Remotely Operated Vehicle (ROV)- or diver-mediated inspections of sea cage nets will be conducted and recorded every 30 days;
- Enumeration of farmed salmon at various stages of operations to detect escapes;
- Tracing Grieg NL farmed salmon in the event of an escape;
- Recapture of farmed salmon following an acute escape event;
- Monitoring for genetic interaction between Grieg NL farmed salmon and wild salmon; and
- Monitoring for ecological interaction between Grieg NL farmed salmon and wild salmon.

3.1 Sea Cage Inspection

As per Condition 'p' of the Government of Newfoundland and Labrador's EIS release letter, Grieg NL will conduct inspections of the portions of the sea cages that extend below the water's surface with a ROV or by other means every 30 days during June-September periods, and every 90 days during the remainder of the year or as per Aquaculture Policy (AP2; DFLR 2019), whichever is less. If damaged mesh is observed, immediate repairs to the net will be conducted by either ROV or some other method, depending on damage specifics. Grieg NL has discussed with DFLR that there may be instances in which a 30-day schedule may not be possible (i.e., weather delays). If this is the case, DFLR will be notified via email and/or phone that the inspection was not completed but will be completed on next available date. Note that the monitoring and maintenance of the sea cage systems is detailed in Grieg NL's Sea Cage Performance EEMP (LGL 2019).

3.2 Enumeration of Farmed Salmon

Farmed salmon will be counted and documented (via video monitoring and a counter) four times during each grow-out cycle: (1) from the RAS Hatchery into the transfer hose; (2) from the transfer hose into the well boat; (3) from the well boat into the sea cage; and (4) from the sea cage into the dead hold vessel. Also, all farmed salmon mortalities will be carefully documented. The acceptable margin of error associated with counts from hatchery to well boat is 3–4%. At harvest, any unexplained differences in fish count (number of mortalities will be subtracted from total count) will result in a recount and investigation of the potential problem. A count difference exceeding 3–4% may be an indication of chronic escapes which may be addressed through monitoring of proximate rivers systems.

3.3 Traceability of Farmed Salmon

As per Condition 'm' of the Government of Newfoundland and Labrador's EIS release letter, all imported and grown in-province Atlantic salmon smolt will be marked. Stofnfiskur, the Icelandic company that will supply eggs to Grieg NL, will collect a sample fin clip from each broodstock salmon and store it in ethanol. Stofnfiskur currently has 25 years of experience in maintaining genetic material. Stofnfiskur's current protocol is to maintain parental fin clips for five years should the need arise to analyse. Grieg NL has requested that Stofnfiskur maintain fin clips from both parents for all its imported eggs as per its protocol. The Quantitative Trait Loci (QTLs) are mapped by identifying which molecular markers (e.g., SNPs [single nucleotide polymorphisms] or AFLPs [amplified fragment length polymorphism]) correlate with an observed trait. This genetic tagging (or marking) will allow traceability back to each 'batch' of eggs received from Stofnfiskur and ultimately to salmon being farmed in a specific Bay Management Areas (BMA). Traceability may even be possible to one or two sea cage sites within a BMA.

3.4 Recapture of Escaped Farmed Salmon

Grieg NL will adhere to all reporting requirements as detailed in AP 17 (DFLR 2019) and the Code of Containment (COC) for the Culture of Salmonids in Newfoundland and Labrador (DFA 2014). In the event of an escape incident, Grieg NL will immediately provide verbal notification of the escape to the Assistant Deputy Minister of Fisheries and Aquaculture, DFLR and DFO. Written notification will be provided to the Assistant Deputy Minister of Fisheries and Aquaculture, DFLR within 24 hours of the incident. All

suspected and confirmed escape incidents will be reported to the public within 24 hours of the incident. All public reporting will be via public communication acceptable to the DFLR. In addition, all escape incidents will be reported on either the Grieg NL website or the industry association website.

Grieg NL will immediately contact DFO seeking permission to commence recapture efforts in the marine environment. Besides DFO permission, Grieg NL will have all other recapture protocol components in place (e.g., dedicated long liners and fishers, gill nets, emergency recapture licence issued by DFO [see Appendix 2 for 2020 licence]) as per Condition 'l' of the Government of Newfoundland and Labrador's EIS release letter. DFO will be issuing escape recapture licenses on an annual basis, outlining the conditions under which recapture can take place in the event of an escape. Grieg NL will be in discussion with DFO prior to initiating any escape recapture. Acquiring permission from DFO to commence recapture efforts will depend on the timing of the escape. If wild fish are actively migrating in the marine environment at the time of the escape, it is unlikely that DFO would grant permission to commence any recapture effort using gill nets. Grieg NL will document recapture efforts and the numbers of farmed fish recovered.

3.5 Monitoring for Genetic Interaction

As described in detail in the EIS, Grieg NL will farm triploid sterile all-female Atlantic salmon with the intention of greatly reducing the risk of genetic interactions with wild Atlantic salmon. The following methods will be employed by Grieg NL to monitor for genetic interaction between escaped Grieg NL farmed fish and wild salmon in Placentia Bay:

- Operation of counting fences on select Placentia Bay rivers that are known to support wild salmon and are located proximate to operational BMAs; and
- In the event of either a detected acute escape of a large number of farmed Grieg NL salmon or the detection of a Grieg NL farmed salmon in a fence trap during routine monitoring, genetic analysis of river water (i.e., eDNA) may be conducted to monitor for presence of Grieg NL farmed salmon in the particular river above the counting fence.

3.5.1 Counting Fences

For each active BMA, a counting fence will be installed one year prior to initial stocking of sea cages associated with that particular monitoring river. One season of baseline data will be collected on returning wild adult salmon. Each year, counting fences will be installed in late April/early May and remain operational until early October, assuming river flow conditions are suitable. Counting fences will be in place for 10 years during times when associated sea cages are stocked with salmon; a typical counting fence is shown in Figure 3.1. If there is no evidence in the monitored rivers of interactions between wild Atlantic salmon and Grieg NL's farmed Atlantic salmon after 10 years of annual monitoring, then the monitoring program will be reassessed and adjusted accordingly at that time.

The counting fences, which consist of portable weirs and traps, will be constructed as per DFO requirements. The trap component of the counting fence will be large enough to accommodate anticipated numbers of fish in order to avoid overcrowding and scale loss, which could lead to fish mortality. According to Anderson and McDonald (1978), a wooden frame trap is best suited to Newfoundland salmon rivers since it can withstand water level fluctuations and accommodate large numbers of adult salmon.

Anderson and McDonald (1978) describe the three requirements for proper installation of counting fences: (1) site selection; (2) position of traps within the river; and (3) layout and installation of the weir. To ensure that fish are led into the trap, the weir component is laid out in a 'V' shape (see Figure 3.1). This 'V' shape design allows more water to pass through the fence for a given width of river, thus reducing pressure on the fence and lessening the possibility of washout.

Figure 3.1. Downstream perspective of a typical counting fence used to monitor adult wild salmon returns in some Newfoundland and Labrador rivers (Photo courtesy of DFO).

Grieg NL will temporarily employ one or two people who have considerable experience in the installation and operation of counting fences to oversee the installation of the fences and train the local employees to install, operate and dismantle the fences. Grieg NL intends to employ Miawpukek First Nations (MFN) individuals to oversee the construction and operation of the monitoring counting fences. MFN has gained valuable experience through its work on counting fences installed on Conne River.

3.5.1.1 Locations

Through consultation with DFO scientists, two scheduled Placentia Bay rivers with wild salmon stocks were selected for monitoring three BMAs. Come-By-Chance River would be monitored for potential Grieg NL farmed salmon escapes from the Red Island and Merasheen BMAs (Figures 3.2 and 3.3), and the Bay de l'Eau River would be monitored for farmed salmon escapes from the Rushoon BMA (Figures 3.2 and 3.4).

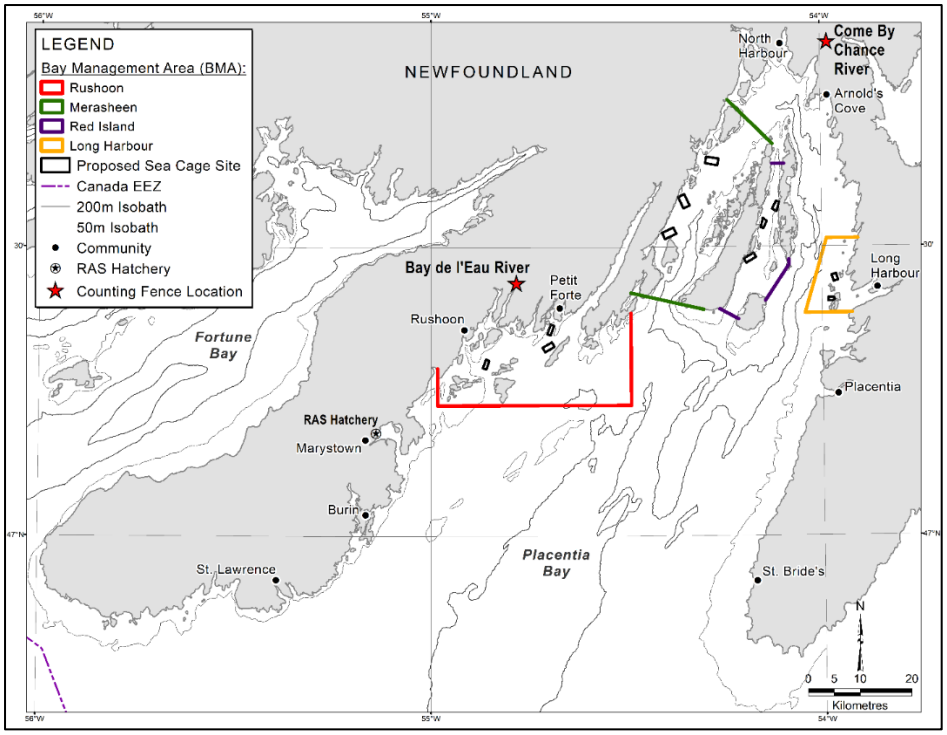

Figure 3.2. Tentative counting fence locations relative to Red Island, Merasheen and Rushoon BMAs.

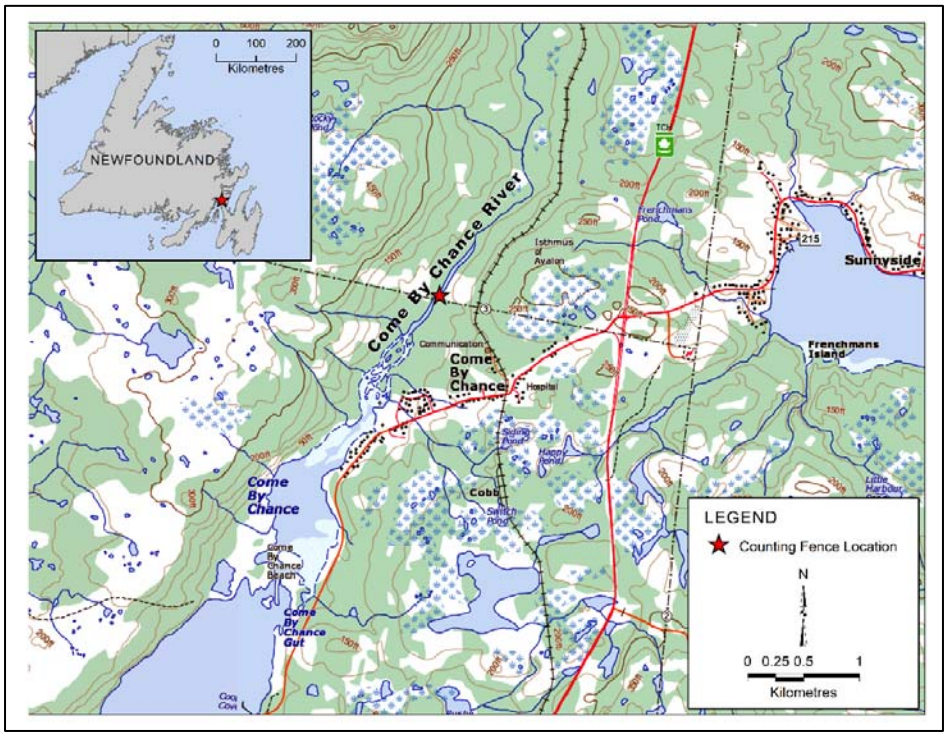

Figure 3.3. Tentative location of counting fence on Come-By-Chance River.

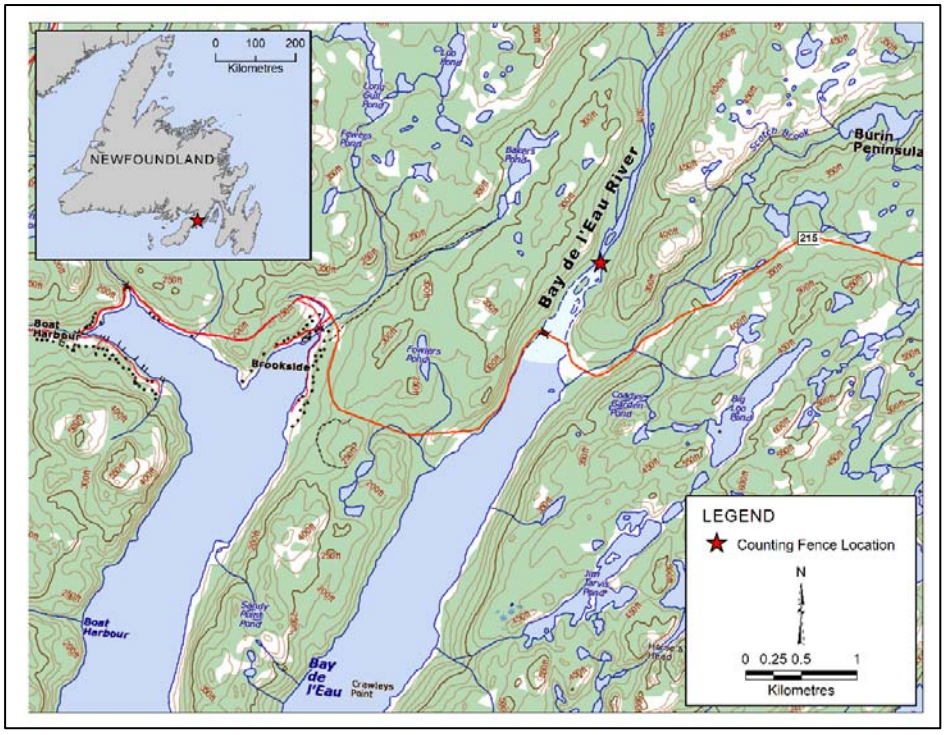

Figure 3.4. Tentative location of counting fence on Bay de l'Eau River.

The Atlantic salmon recreational fishery statistics for 2012-2016 indicate that the Bay de l'Eau River ranks first among all scheduled salmon rivers in Placentia Bay in terms of total number of salmon caught during that period (2,098 fish), while the Come-By-Chance River ranks sixth for that same statistic (927 fish). The Catch Per Unit Effort (CPUE) during that same time period for the Bay de l'Eau River was 0.40, ranking third among all scheduled salmon rivers in Placentia Bay, while the CPUE for the Come-By-Chance was 0.31, ranking seventh among the rivers.

A monitoring river for the Long Harbour BMA (see Figure 3.1) has not yet been recommended by DFO. The Long Harbour BMA will not be operational for several years so the selection of a monitoring river for that BMA will be made at a later date. If the width of the selected monitoring river for the Long Harbour BMA is suitable for a counting fence configuration that can monitor both upstream movement of adult salmon and downstream movement of smolt, and DFO is able to cover the additional construction costs associated with this configuration, then Grieg NL will commit to covering the costs for the monitoring/data collection associated with the smolt. Similarly, if DFO is able to cover the cost of materials and installation for separate smolt counting fences on the Come-By-Chance and Bay de l'Eau Rivers, then Grieg NL will also commit to covering the costs for the monitoring/data collection associated with salmon smolt on these rivers.

In September 2019, Mr. Peter Downton, a former DFO employee with experience installing and operating salmon counting fences, and a Grieg NL employee visited the tentative fence locations suggested by DFO to assess suitability. Based on the site visits, it was concluded that the suggested areas for counting fence installation are suitable. The reports prepared by Mr. Downton after the river site visits are included in Appendices 3a and 3b.

Two potential fence locations are recommended for each river. Coordinates of these locations are as follow:

- Assessed fence locations on Come-By-Chance River

  47.85796° N; 53.97910° W, and 47.85837° N; 53.97884° W

- Assessed fence locations on Bay de l'Eau River

  47.44201° N; 54.77970° W, and 47.43913° N; 54.78154° W

Figures 3.5 and 3.6 are Google Earth images that show the above recommended fence locations on Come-By-Chance River and Bay de l'Eau River, respectively.

Figure 3.5. Recommended counting fence locations (red stars) on Come-By-Chance River, based on a site visit in September 2019.

Figure 3.6. Recommended counting fence locations (red stars) on Bay de l'Eau River, based on a site visit in September 2019.

3.5.1.2 General Operation of Counting Fence and Associated Data Collection

Counting fences will be operated to monitor for Grieg NL farmed salmon potentially entering the rivers as a result of both chronic escapes (i.e., routine monitoring) and acute escape events that typically involve large numbers of escapees. Grieg NL will employ MFN individuals and other local residents, preferably from communities in the immediate vicinity of the monitoring rivers, to assist with fence installation, fence operations, and fence dismantling at the end of each monitoring season. Once installation is completed and a counting fence is operational, the trap will be checked three times daily (early morning, mid-afternoon, evening), and the weir will be cleaned of debris and checked for any holes/gaps daily. Accumulation of debris during high water could result in increased velocity, thereby increasing the possibility of fish mortality in the trap as well as washout of the fence.

Enumeration and size categorization (i.e., <63 cm fork length [FL] or ≥63 cm FL) of fish will be conducted during all daily trap checks but fish in the trap will only be handled during the early morning check when air and water temperatures are typically lowest. Measurement markings on the inside of the trap will allow size categorization without removing a fish from the water. The only salmon that would be removed from the water during the afternoon and evening trap checks are those suspected of being escaped farmed salmon. Fish will be removed from a trap using a sewn dip net since a knotted net could damage the fish. The eyes/head of each fish will be covered during data collection to lower a fish's stress level. Hands will be wetted prior to handling the fish.

If escaped farmed salmon are relatively large and occur in a fence trap shortly after escape, there is potential to use external morphological differences between farmed and wild salmon to identify escaped farmed fish at a counting fence. Adult farmed salmon typically have smaller heads, shorter opercula, different pigmentation, thicker bodies, more fin erosion/splitting, and more tail erosion/splitting (C. Hendry, DFO, pers. comm., March 2019). See Appendices 4 and 5 for characteristics to distinguish farmed salmon from wild salmon, and the 'Escaped Aquaculture Salmon Sampling Protocol', respectively, both provided by DFO. If farmed fish are small at the time of escape, then external morphological differences between the escaped and wild fish may not be obvious. Initial examination of fish for morphological differences during the afternoon and evening trap checks will be conducted without removal of fish from the water.

Collection of tissue samples from a subsample of adult salmon (maximum of 200 adult salmon subsampled during entire season of fence monitoring; actual number will depend on size of salmon run) for genetic analysis will only be conducted during the early morning trap check. Data that will be collected from each fish of the subsample include the following (J. Meade, DFO, pers. comm., June 2019):

- Species;
- Enumeration;
- Fork length (FL) (to nearest 0.1 cm);
- Size categorization (<63 cm fork length [FL] or ≥63 cm FL);
- Enumeration by size category;
- Whole weight (to nearest 0.1 kg);
- Sex (based on external examination);
- Maturity;
- Number of sea lice;
- Scale sample collected 3-6 scale rows above lateral line immediately behind dorsal fin;
- Fin clip sample – 1 cm x 1 cm sample removed from dorsal tip of caudal fin, placed in vial with 95% ethanol and stored in cool, dark location; and
- Presence of external tags and ID information.

The scale samples that will be collected from subsampled salmon can be examined at the river with a dissecting microscope to analyze the growth rings on the scale. Wild salmon growth rings are typically irregularly spaced while growth rings associated with farmed fish would have a more regular spacing. Thus, scale examination is another method that could potentially allow the differentiation between wild salmon and escaped farmed salmon.

If an adult salmon caught in a counting fence trap is suspected to be an escaped farmed fish, the following data will be collected:

- Enumeration;
- Fork length (FL) (to nearest 0.1 cm);
- Whole weight (to nearest 0.1 kg);
- Gutted weight (to nearest 0.1 kg);
- Sex (based on internal examination);
- Number of sea lice;
- Photographs;

    - Left side of whole fish on measuring board;
    - Close up of tail on measuring board showing FL;
    - Fin wear;
    - Eye bulges or other irregularities;
    - Gut intact in body cavity; and
    - Dissected stomach and contents.
- Scale sample collected 3-6 scale rows above lateral line immediately behind dorsal fin; and
- Fin clip sample – 1 cm x 1 cm sample removed from dorsal tip of caudal fin, placed in vial with 95% ethanol and stored in cool, dark location.

Any salmon in the trap identified as farmed escapees in conjunction with DFO, will be euthanized and returned to the Northwest Atlantic Fisheries Centre (NAFC) for disposal. Photos of salmon suspected to be farmed escapees will be sent to DFO for confirmation prior to euthanasia. Euthanasia will be accomplished via complete spinal severance, or a sharp blow on the top of the head ensuring a result of fish that are permanently unresponsive to stimuli. The procedure will be determined based on size and life stage of the Atlantic salmon as recommended in The Canadian Aquaculture Standards (DFO 2004). All wild salmon will be released as quickly as possible after data collection, minimizing time out of water and the potential of damage/injury to the fish. No wild salmon will be euthanized however, if any wild salmon mortalities are found in the trap, they will be properly tagged and returned to NAFC for disposal.

All data will be recorded in waterproof books. Grieg NL will also use the DFO 'Fishway and Counting Fence Data' sheet to record environmental data (e.g., water temperature, air temperature, water level, water conductivity) and fish specific data (e.g., enumeration, species, recaptured tagged fish). An example of this data sheet is included in Appendix 6. Data related to water levels, water and air temperatures, and weather will be recorded every four hours.

3.5.2 Genetic Analysis of Water Samples for eDNA

Environmental DNA (eDNA) analysis is an emerging molecular approach for species identification from samples containing cellular DNA and extracellular DNA sloughed off living organisms (Bohmann et al. 2014). eDNA analysis has been successfully employed to detect and monitor eukaryotic micro- and macrobial communities and populations (Ficetola et al. 2008; Thomsen et al. 2012) and is a useful tool for early monitoring systems as it allows for more accurate and standardized detection of species that are cryptic, inaccessible (Thomsen et al. 2012) and of low abundance (Ficetola et al. 2008). DFO in St. John's is currently working to develop genetic markers for eDNA analysis and hope to have these markers finalized within two years. The markers will differentiate between 'European' and 'non-European' strains of farmed salmon.

In the event of an acute salmon escape from a Grieg NL sea cage or the detection of an escaped Grieg NL farmed salmon in a trap during routine monitoring, eDNA water sampling and analysis may be conducted at the appropriate time to check for the presence of escaped Grieg NL farmed salmon in the relevant monitoring river (see Appendix 7 for eDNA sampling protocol (A. Messmer, DFO, pers. comm., May 2019)). Water samples would be collected upstream of the counting fences. The locations, frequency and duration of eDNA sampling would be determined through consultation with DFO.

3.5.3 Genetic Analysis of Salmon Tissue

The unique genetic signature for Placentia Bay wild salmon has already been determined (Bradbury et al. 2014, 2015; Watson et al. in prep). Fin clips from the parents of Grieg NL fish will be archived and can be used to determine genetic signature of Grieg NL fish, if required (as per condition 'm' of the Government of Newfoundland and Labrador's EIS release letter). Genetic analysis is intended to determine whether escaped Grieg NL farmed salmon have entered the monitored rivers (from analysis of salmon tissue samples collected at counting fence traps and perhaps eDNA samples). The genetic analysis of salmon tissue will be conducted as described in Bradbury et al. (2015).

3.6 Monitoring for Ecological Interaction

Currently, the only viable way to monitor for potential ecological interaction between Grieg NL farmed salmon and wild salmon in Placentia Bay and vicinity is through analysis of adult salmon return data collected at the counting fences.

Counting fence adult salmon return data, both baseline and those collected after sea cage stocking, will be collected by Grieg NL and shared with DFO for its database. While baseline data will likely be collected during one year only, time-series of data will eventually be gathered given that Grieg NL will monitor select rivers for at least 10 years, providing an opportunity to observe inter-annual variability. Specifics of this approach will be developed in consultation with DFO. As indicated in Section 3.5.1.1, if the river selected to monitor for escaped farmed salmon from the Long Harbour BMA is large enough to accommodate a counting fence configuration that can also monitor downstream movement of smolt, and DFO can cover the extra construction costs associated with the fence, then Grieg NL would also collect data on smolt moving through the fence. Grieg NL is also willing to collect data on smolt migrating downstream on the Come-By-Chance and Bay de l'Eau Rivers if DFO is able to cover the cost of materials and installation of separate smolt fences on those rivers. These data would also be important additions to the DFO database and serve as a component of monitoring for ecological interactions between escaped farmed salmon and wild salmon.

4.0 Frequency, Duration and Geographic Extent of Monitoring

The current frequency, duration, and geographic extent of monitoring for potential interaction between Grieg NL farmed salmon and wild salmon have been determined through consultation with DFO scientists (Table 4.1). Note that some of these parameters are tentative and will require further consultation with DFO.

Table 4.1. Summary of frequency, duration, and geographic extent of monitoring genetic and ecological interactions between Grieg NL farmed and wild salmon.

Monitoring Type	Frequency	Duration	Geographic Extent
A. Genetic Interaction			
River monitoring-counting fences	Three times daily during period of counting fence operation (i.e., May to October)	Seasonally for 10 years [a]	Selected monitoring rivers located proximate to active BMAs
eDNA sampling/analysis	Following either the detection of an escaped Grieg NL farmed salmon or an acute escape of farmed salmon from a Grieg NL sea cage site	Will be determined on a case by case basis	Upstream of counting fence
B. Ecological Interaction			
River monitoring-counting fences	Three times daily during period of counting fence operation (i.e., May to October)	Seasonally for 10 years [a]	Selected monitoring rivers located proximate to active BMAs

[a] If there is no evidence in the monitored rivers of interactions between wild Atlantic salmon and Grieg NL's farmed Atlantic salmon after 10 years of annual monitoring, then the monitoring program will be reassessed and adjusted accordingly at that time. This reassessment will be done in consultation with DFO.

4.1 Frequency

For potential genetic interaction, there will be daily monitoring (three checks per day) at counting fences installed on river systems located proximate to operating sea cage sites (i.e., active BMAs). Counting fences will be operational during May-October, depending on water flow conditions. In the event of either the detection of a Grieg NL farmed salmon at a counting fence or an acute escape of a large number of farmed salmon, eDNA sampling may be conducted above the counting fence. Table 4.2 indicates the years during which counting fences will be operational on the Come-By-Chance and Bay de l'Eau Rivers.

For potential ecological interaction, there will be monitoring at the counting fences that includes enumeration and size categorization of all adult salmon in traps three times daily during fence operations. Once a day, data related to disease and external parasites on adult salmon in the fence traps will be collected. In combination with the disease/parasite monitoring at the fences, Grieg NL will monitor its farmed fish in sea cages for disease and parasites at least weekly when water temperatures are above 5ºC and weather permits.

Table 4.2. Annual schedule for counting fences on the Come-By-Chance and Bay de l'Eau rivers.

	Counting Fences Active	
Years	**Come by Chance**	**Bay de l'Eau**
2020	Active	Inactive
2021	Active	Inactive
2022	Active	Active
2023	Active	Active
2024	Active	Active
2025	Active	Inactive
2026	Active	Active
2027	Active	Active
2028	Active	Inactive
2029	Active	Active

4.2 Duration

As recommended by DFO, the counting fences will be operated during the May to October period for at least 10 years (i.e., two generations of Atlantic salmon). If there is no evidence in the monitored rivers of interactions between wild Atlantic salmon and Grieg NL's farmed Atlantic salmon after 10 years of annual monitoring, then the monitoring program will be reassessed and adjusted accordingly at that time. This reassessment will be done in consultation with DFO. The duration of potential eDNA sampling would be determined on a case by case basis, in consultation with DFO.

Disease and parasite monitoring of Grieg NL farmed salmon in sea cages will continue throughout each operational phase.

4.3 Geographic Extent

Counting fence monitoring will be conducted in river systems located proximate to operating sea cage sites. Counting fences will be installed as close to the mouth of these rivers as possible. Selection of locations in the river systems for potential eDNA sampling, following either the detection of a Grieg NL farmed salmon in a fence trap or an acute escape of a large number of Grieg NL farmed salmon from sea cages, would be determined on a case by case basis in consultation with DFO. Disease and parasite monitoring of Grieg NL farmed salmon will be conducted at the sea cages.

5.0 Reporting and Response Mechanisms

Grieg NL will adhere to all reporting requirements as detailed in AP 17 (DFLR 2019) and the COC for the Culture of Salmonids in Newfoundland and Labrador (DFA 2014). For all escape events, Grieg NL will immediately provide verbal notification of the escape to the Assistant Deputy Minister of Fisheries and Aquaculture, the Department of Fisheries and Land Resources and DFO. A written notification to the Assistant Deputy Minister (DFLR) will be sent no later than 24 hours after Grieg NL becomes aware of the escape. All suspected and confirmed escape incidents will be reported to the public within 24 hours of the incident. All public reporting will be via public communication acceptable to the DFLR. In addition, all

escape incidents will be reported on either the Grieg NL website or the industry association website. As per AP 17 (DFLR 2019), Grieg NL will report sea lice abundance numbers to DFLR on a monthly basis and post these numbers on the industry association or corporate website.

Grieg NL will present the findings of this EEMP in its annual EEMP report as per condition 'c' of the EIS release letter. The report will be made available publicly and the monitoring results will include, at a minimum, the following:

- Counting fence data related to salmon returns, including the number of escaped Grieg NL farmed salmon and associated morphometrics, the number of wild adult salmon (and perhaps juvenile salmon as well should DFO be able to cover the cost of materials and installation of fences specifically directed at smolt monitoring) and associated morphometrics. These data will be provided to DFO;
- A map showing locations of counting fences and stations for eDNA sampling, should eDNA sampling be necessary; and
- Data related to post-escape eDNA sampling, should eDNA sampling be necessary.

With respect to criteria for response mechanism, Grieg NL, in consultation with DFO and DFLR, will adjust the protocols for sea cage system inspections should there be evidence of escaped Grieg NL farmed salmon entering the monitored river systems.

6.0 Approach to Monitor Cumulative Effects

Monitoring will be conducted in three river systems located proximate to the Grieg NL BMAs, two of which have been selected through consultation with DFO, to monitor for occurrence of Grieg NL farmed salmon that have escaped from the Red Island, Merasheen and Rushoon BMAs. The third monitoring river, which will be associated with the Long Harbour BMA, has not yet been selected. Data collected on the monitoring rivers for may help to monitor for any cumulative effects of the Project on the wild salmon stocks in Placentia Bay, and will add to the DFO database for upstream migration of adult salmon in the monitoring rivers.

7.0 Procedures to Assess Effectiveness of Monitoring and Follow-up Programs, Mitigation Measures, and Recovery Programs

If monitoring of the river systems indicates that there is either occurrence of escaped Grieg NL farmed salmon in the rivers or rigorous evidence to support genetic introgression between Grieg NL farmed salmon and wild salmon, then follow-up measures will be required. These measures will include but are not limited to more intensive inspection of the sea cage systems, and a re-evaluation of the protocol intended to ensure that all farmed salmon are sterile triploid females.

8.0 Communication Plan to Describe the Results

As per Condition 'c' in the Government of Newfoundland and Labrador's EIS release letter, Grieg NL will include the results of monitoring potential interactions between escaped Grieg NL farmed salmon and wild salmon in its annual report on the EEMPs. This report will be publicly available on the Grieg NL website. The report will include, at a minimum, the following:

- A map showing locations of counting fences and stations for potential eDNA sampling;
- Counting fence data related to adult salmon upstream migration, including the incidence of escaped Grieg NL farmed salmon and their morphometrics, and the incidence of wild salmon and their morphometrics; and
- Data resulting from any required genetic analysis of counting fence salmon tissue samples and eDNA samples, if eDNA sampling is required.

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9.1 Personal Communications

Hendry, C. DFO Regional Aquaculture Coordinator, March 2019.

Meade, Jim. DFO Senior Biologist and Section Head for Salmonids, June 2019.

Messmer, Amber. DFO Aquatic Science Biologist, May 2019.

List of Appendices