Fisheries and Oceans Canada / Pêches et Océans Canada
Ecosystems and Oceans Science / Sciences des écosystèmes et des océans

Newfoundland and Labrador Region
Canadian Science Advisory Secretariat
Science Response 2018/045

REVIEW OF THE ENVIRONMENTAL IMPACT STATEMENT FOR THE PLACENTIA BAY ATLANTIC SALMON AQUACULTURE PROJECT

Context

The Proponent, Grieg NL Nurseries Ltd. and Grieg NL Seafarms Ltd. (referred to as Grieg NL), proposes to build and operate a land-based Recirculating Aquaculture System (RAS) Hatchery for Atlantic Salmon (*Salmo salar*) in Marystown, Newfoundland and Labrador (NL), and marine-based farms (11 sea cage sites) located in the northern portion of Placentia Bay, NL. A phased approach will be used to ramp-up production of salmon.

Grieg NL is required through the provincial environmental assessment process to prepare an Environmental Impact Statement (EIS) for the proposed Placentia Bay Atlantic Salmon Aquaculture Project. The EIS documents, including the Component Studies, were prepared pursuant to the NL *Environmental Protection Act* to comply with the EIS Guidelines prepared by representatives from Provincial and Federal government departments, including Fisheries and Oceans Canada (DFO). The purpose of the EIS is to identify and assess the significance of biophysical and socio-economic effects of the Project taking into consideration mitigation measures.

On May 30, 2018, the Fisheries Protection Program of the Ecosystems Management Branch in the NL Region of DFO requested that Science undertake a review of specific sections of the EIS for the proposed Placentia Bay Atlantic Salmon Aquaculture Project. DFO Science undertook a Science Response Process for this review. The information from this scientific review will be provided to Ecosystems Management to help form part of the Department's response to the overall adequacy of the EIS documents.

The objective of this review was to evaluate:

- The sufficiency of baseline data and appropriateness of methodologies to predict effects;
- The mitigation measures proposed by the Proponent;
- The level of certainty in the conclusions reached by the Proponent on the effects;
- The manner in which significance of the environmental effects, as they pertain to DFO's mandate, have been determined (i.e. the scientific merit of the information presented and the validity of the Proponent's methodologies and conclusions);
- The follow-up program proposed by the Proponent; and
- Whether additional information is required from the Proponent to complete the technical review.

The information required for this review can be found in a number of sections throughout the EIS report, and associated Component Studies and Appendices. The EIS documents are available on the Government of NL's Department of Municipal Affairs and Environment website.

This Science Response Report results from the Science Response Process of June 25, 2018 on the Review of the Environmental Impact Statement for the proposed Placentia Bay Atlantic Salmon Aquaculture Project.

Analysis and Response

The comments provided by DFO Science, NL Region are related to the following Sections of the EIS Reports:

- **Executive Summary**
- **Section 2.4 – Project Description**
  - Section 2.4.1 - Project Rationale
  - Section 2.4.3 - Land-based Facility (RAS hatchery)
  - Section 2.4.4 - Sea Farms
- **Section 2.5 – Monitoring and Mitigation Measures**
- **Section 2.7 – Alternatives**
- **Section 2.8 – Accidents and Malfunctions**
- **Section 3.0 – Effects Assessment Methodology**
- **Section 4.0 – Existing Environment**
- **Section 4.2 – Aquatic Existing Environment**
  - Section 4.2.2 - Physical Environment
  - Section 4.2.3 - Fish and Fish Habitat
  - Section 4.2.4 - Wild Atlantic Salmon
- **Section 4.8 – Data Gaps**
- **Section 6.0 – Effects of the Environment on the Project**
- **Section 7.0 – Effects of the Project on the Environment**
- **Section 7.1 – Fish and Fish Habitat Valued Environmental Component (VEC)**
- **Section 7.2 – Wild Salmon VEC**
- **Section 7.7 – Accidents and Malfunctions**
- **Section 7.8 – Follow-up Monitoring**
- **Section 7.9 – Assessment Summary and Conclusions**
  - Section 7.9.1.2 - Wild Salmon VEC
  - Section 7.9.2 - Accidents and Malfunctions
- **Section 8.1 – Summary of Mitigation Measures**
- **Component Study: Wild Atlantic Salmon and Appendices**
- **Component Study: Fish and Fish Habitat and Appendices**

General Comments

Overall, the EIS documents appear to be complete and the topics considered within the relevant sections are generally appropriate, although many references cited in the EIS are missing from the reference list. The elements of the report that focus on the technical basis of the EIS are well developed, clear and easy to interpret. However, the EIS is lacking in the sections dealing specifically with impacts on the local and broader environment. Additionally, the conclusions made throughout the document are not consistently supported by existing information.

DFO Science's assessment of the risks associated with the proposed Project identified a long list of significant uncertainties. Despite significant and numerous knowledge gaps, the report consistently states that there is medium to high certainty of non-significant impacts. This is highly unlikely.

The EIS documents state that triploidy induction has been improved from the industry standard to 100%, and that a sample size of 10 eggs is all that is required to detect failures. This assumes both the success is indeed closer to 100% than previously reported in the literature, and the distribution of failures is non-normal such that small sample sizes are all that are needed. In the absence of published peer-reviewed work describing these findings or inclusion of the actual testing data this cannot be validated. Without validation the reported 98% success rate seems a more reasonable approximation (DFO 2016).

There is no evidence that testing for triploidy following delivery to Newfoundland will occur at multiple points prior to the release of these individuals to sea cages. Differential mortality of triploids is highly likely and could significantly magnify the proportion of diploids in these cages, dramatically increasing the direct genetic threat to wild salmon populations. Repeated testing and verification should be required.

The spatial and temporal variability needs to be considered when using the current information to run a deposition model. As such, the current data to be used to force the model should correspond to the same period as the planned season for high feeding. In addition to the fact that the time-series are too short, they were collected during the winter which does not correspond to the feeding period.

Executive Summary

Page xxix. Sea Cage Sites. *"The crew change sites will have specific areas for embarkation to and disembarkation from the proposed sea cage sites, which is designed to avoid cross-contamination."* It is unclear how avoidance of cross-contamination will be achieved as some of the proposed routes cross Bay Management Areas (BMAs), as shown in Figures 2.52 and 2.53. Specific areas for embarkation/disembarkation within a given BMA are not sufficient as pathogens could be present in a given BMA and then transmitted to another as currently proposed. Additional information is required on mitigation measures to address biosecurity risks associated with the introduction and spread of biofouling invasive species.

Page xxx. Sea Cage Sites. The document states that all sea cages will be attended by a remotely operated vehicle (ROV) and operator in addition to a camera monitoring above and below the water surface. This seems to imply that each cage will be equipped with its own ROV and operator. Clarification is required on the frequency the cages will be monitored (e.g., monthly, daily) and whether the ROV will be shared between BMAs.

Page xxxi. Assessment Boundaries. The EIS states that the boundaries of the Study Area are the Placentia Bay Extension Ecologically and Biologically Significant Area (EBSA) and that this is considered the 'maximum extent' wherein potential effects could occur. Although the Environmental Assessment (EA) Committee determined it was reasonable to use this as the Study Area as this is where most adverse effects would be expected to occur, it was acknowledged that some effects, particularly disease transfer and transfer of parasites, could occur outside this area as salmon are a highly migratory species. Also, there is scientific evidence that wild salmon tagged within Placentia Bay move beyond the bay and non-local salmon have also been caught within the bay. Therefore, it seems inaccurate to state that the 'maximum extent' for impacts is the EBSA.

Page xxxiv. Genetic Integrity and Biological Fitness of Wild Atlantic Salmon. Supporting documentation to demonstrate how 100% triploidy will be achieved needs to be provided and peer reviewed.

Page xxxiv. Based on the figures provided, the statement that the proposed cage sites are more than 50 km from the majority of scheduled rivers is false. In fact, most of the scheduled salmon rivers within Placentia Bay are less than 30 km from the proposed cage sites, and several of the proposed cage locations are at the mouths of known salmon rivers. Please provide a figure that shows all salmon rivers (scheduled and non-scheduled) in relation to location of proposed cage sites and report distance between them. It is important to note that farmed fish show up at DFO's counting fence every year on Garnish River even though the nearest aquaculture site is 40-50 km away, and release studies in Norway have reported farmed salmon occurring in rivers hundreds of kilometers from where fish have been released (Skilbrei 2010).

Page xxxiv. Control of Sea Lice. Please provide a detailed explanation of how proposed mitigation measures such as use of sea lice skirts, administering feed at depths of 6-7 m below the surface, use of formulated feed, etc. will help control sea lice.

Page xxxiv. Effects on Benthic Habitat. *"Proposed sea cage sites were selected based on sufficient current velocity and direction necessary to minimize depositional build-up from sea cages, adequate water depth for deployment of sea cages, and suitable bottom type (i.e., >50% hard bottom)."* The timeline of the currents data used in the study is much too short to determine dominant forcing (e.g. tide vs. wind) and variability and cannot be used with confidence to support the claim that most of the potential effects are "not significant" (see detailed comments re: Appendix A: Fish and Fish Habitat Component Study).

Page xxxiv. Effects on Benthic Habitat. Based on monitoring data collected over the past 10-12 years, it is known that organic wastes (excess feed, feces, and biofoulants) accumulate underneath cages and surrounding areas even if DFO siting criteria (suitable currents, depths and hard bottoms) are adhered to and this deposition remained beyond the one year mandatory fallow period, which was implemented by the Province at that time.

Page xxxv. Fish and Fish Habitat VEC. The document states that there will be cessation of feeding at ~80% satiation. It is assumed this means that the operators will stop administering feed to the salmon once ~80% satiation is reached. This is very subjective and would require constant monitoring of the fish behaviours.

Page xxxvi. Wild Atlantic Salmon VEC. Please provide a reference for the Placentia Bay salmon abundance estimate or describe how this estimate was derived.

Page xxxvi. Studies exist for migratory movements on south coast (see Reddin and Lear 1990, Pippy 1982). These should be included and discussed.

Page xxxvii. In the first paragraph, it states that effects are expected *''to be minor, localized and relatively short-term."* This is not known and the statement does not reflect the large amount of uncertainty. The concluding statement that residual effects were predicted to be not significant is overly optimistic and does not reflect the high level of uncertainty, particularly when the level of confidence is rated as medium to high.

Page xxxvii. Species at Risk VEC. There is no mention of the footprint that will be caused by deposition of organic wastes. Please revisit and provide this information.

Page xxxviii. Sensitive Areas VEC. It is assumed that the medium-term effects would be the accumulation of organic wastes underneath the cages, which will occur despite implementation of the various mitigation measures listed. Clarification is requested.

Page xxxix. Accidents and Malfunctions. Please provide references to support the statement that triploid female salmon do not enter freshwater.

Page xxxix. Follow-up Monitoring. Collecting blood samples from salmon within scheduled salmon rivers following an escape event might not be the best approach for determining whether farmed salmon have entered freshwater. Follow-up monitoring should be determined in consultation with DFO.

Page xli. Summary of Component Studies. Follow-up monitoring does not minimize potential effects. This section should use similar wording as used for the Fish and Fish Habitat Component Study (i.e., mitigation measures intended to minimize the potential effects of the proposed Project on fish and fish habitat and the follow-up monitoring intended to validate the effects conclusions in the EIS).

Section 2.4 Project Description

2.4.1 - Project Rationale

Page 12. Triploids would alleviate most of the concerns associated with direct genetic impacts on wild salmon populations. Recent information suggests that current methodology results in about 98% of the fish being sterile, although on p.17 it states that there will be 100% sterility. Demonstration of 100% triploidy induction is not practical given the requirement to test every individual and the destructive nature of verification methods at embryo-larval stages (DFO 2016). Sterility estimates should be based on careful experimental design and accurately reflect the proportion of sterility based on representative samples. To date, details needed to evaluate these protocols and estimates have not been provided.

Examples are provided whereby small and large companies are transitioning to the use of sterile triploid salmon. While operating revenues are shown, information pertaining to what proportion of farmed salmon production comes from triploids versus diploids for each of these example companies, would provide a better context. In general, how much of the production of farmed salmon in Norway (or Scotland, or Ireland) is now derived from use of triploids?

The document suggests that better nutrition and more optimal growing conditions have alleviated past disadvantages associated with use of triploids, namely reduced or irregular growth, lower survival, increased deformities, suppressed immune system resulting in increased susceptibility to diseases. Thorstad et al. (2008) reported that experiments carried out to evaluate commercial culture of triploids in the Bay of Fundy region were terminated when triploids were found to be highly susceptible to infectious salmon anaemia (ISA).

Page. 14. *“Despite some previous commercial concerns surrounding the use of triploid versus diploid Atlantic Salmon, recent research and industry results show that triploid Atlantic Salmon perform equal or better than diploid salmon.”* This is encouraging, but until triploids are fully investigated in Newfoundland (Placentia Bay), there is no evidence as to whether similar results would occur and hence a cautious approach should begin with a series of pilot studies to evaluate this fully. Accordingly, the sentence on p.17 stating that: “*In the sea, its performance is equal if not better than diploid salmon in cold environments such as Placentia Bay*” is premature. Benfey (2016) has recently noted that triploids tend to perform less well than diploids and their resistance to diseases is still uncertain. Also, while the study is now somewhat dated, triploid Rainbow Trout were not found to perform better than diploids at Bay d’Espoir (Pepper et al. 2003).

Page 16. *“Hansen et al. (2015) also compared performance of diploid and triploid Atlantic Salmon at various temperatures and reduced oxygen concentration (70% O_2 saturation). No* *difference was observed between the diploid and triploid groups with regard to length and weight measurements, but triploids had significantly higher mortality at 70% O_2 saturation compared to diploids. Hansen et al. (2015) concluded that triploid Atlantic Salmon were negatively impacted on important production parameters (feed intake, mortality, etc.) when cultured at high seawater temperatures (19°C) and this was compounded when oxygen saturation levels were lower (70% saturation). In conclusion, triploid Atlantic Salmon are more suited to culture in areas that have temperature profiles that are moderate in the summer months and not subject to periods of low oxygen saturation (hypoxia)."* The dissolved oxygen (DO) values to define potential hypoxic conditions for triploids should be 7.0 ppm, based on current literature data and as stated above. The document reports that the proposed sites in the Rushoon BMA have DO values near or below 7.0 ppm at all depths sampled (see Table 4.11) with no fish at present. This is a concern and use of these sites should be reevaluated.

Page 16. *"Likewise, the oxygen concentration of Placentia Bay over the 2016 and 2017 sampling period indicates that hypoxia should not be a concern."* As stated previously, this may not apply to all BMAs.

Page 17. The Executive Summary (p. xxxix) states that *"triploid female salmon do not enter freshwater."* However, it states here that *"the propensity for triploid Atlantic Salmon to migrate into freshwater following an escape is significantly lower than for diploid Atlantic Salmon escapes."* Revisit and clarify for consistency.

Page 21. It would be helpful to label any scheduled rivers on these maps (Figs. 2.4, 2.5, 2.6) to illustrate proximity to sea cage sites/sea cages.

2.4.3 - Land-based Facility (RAS hatchery)

Page 29. The percentage of the eyed eggs that will be tested and certified for diseases, sterility and all-female prior to being shipped to NL, should be provided here. Testing for sterility should be conducted at multiple time points throughout the production cycle, and most importantly, just before introduction into sea cages.

2.4.4 – Sea Farms

Page 45. Promoting the Aqualine Midgard nets as escape-proof may be a strong statement as accidents may occur. While a number of clients were identified as using these cages, it would be helpful to know the relative production of farmed salmon originating from the Aqualine nets versus other conventional nets in places like Norway, Scotland, and Ireland. As there are still thousands of escapees reported from Norway, Ireland, and Scotland each year, this would suggest these nets are not commonly used by industry.

Page 45. It states that Grieg NL may also use sea lice skirts to assist in controlling sea lice. Skirts work by allowing the exchange of water while keeping parasites (sea lice) out. While they have worked well in some areas (e.g. Scotland), other studies have found that using skirts resulted in low oxygen levels in cages (Stien et al. 2012). Skirts would not be recommended in areas of low oxygen.

Page 52. Regarding the statement that service vessels will assist with net changing, further information is required on whether nets will be routinely changed. If so, how frequently or under what conditions, or is it only in the event that a net is damaged via predation or storm conditions? Please revisit and elaborate.

Page 53. *"Typically once a year, Grieg NL will employ the services of a larger multi-purpose service vessel to assist with operations such as net changes."* This suggests that all nets are replaced approximately every year. Additional detail is requested on net replacement and maintenance.

Page 64. *"If a transfer of fish between sea cages is required for any reason, a response/corrective action will be developed as per the established Standard Operating Procedures (SOP). This would likely involve the use of well boats."* Please clarify under what circumstances a transfer between sea cages would be required and also if there is a requirement/commitment to use well boats for this purpose, as Grieg NL are proposing to use well boats for all fish transfers. Otherwise this may result in a higher risk of escapes, which would need to be discussed in the EIS.

Page 68. Although it is promising to see new initiatives being explored such as the use of cleaner fish for sea lice control, use of Lumpfish may result in additional problems. Published reports (Powell et al. 2017) have shown that it is commonly the smaller, younger Lumpfish that will feed on sea lice. Also, other studies show that only about 30% of the Lumpfish placed in cages may actively feed. Additional details are required on the use of Lumpfish (e.g. size and non-feeding Lumpfish protocols, and transfer of pathogens/diseases from Lumpfish to salmon).

The stock origin of the Lumpfish (cleaner fish) is not clear. This is relevant specifically as a consequence of a potential breach in the cages and subsequent inadvertent escapes of salmon and Lumpfish come into play.

It is expected that sea lice will continue to be a problem both for farmed fish in cages, and most likely for wild salmon in areas proximate to cage sites. As noted previously, sea lice are a major threat to wild salmon in Norway.

Page 73. *"Environmental changes and plankton levels are rated and depending on the results various mitigation responses will be initiated."* Please provide a detailed explanation of these mitigation responses.

Page 75. Transfer of Fish from Sea Cage to a Processing Plant. The transfer process creates a risk in terms of potential for mortality and/or escapes and information on mitigation measures in case of accident/equipment failure, etc. is discussed briefly in the escapee section. Additional information should be provided regarding SOPs used during this process.

Page 76. *"The crew change sites will have specific areas for embarkation to and disembarkation from the proposed sea cage sites, which is designed to avoid cross-contamination."* It is unclear how cross-contamination will be avoided as some of the proposed routes cross BMAs as shown in Figures 2.52 and 2.53. Specific areas for embarkation/disembarkation within a given BMA are not sufficient as pathogens could be present in a given BMA and then transmitted to another BMA. Relatedly, on page 98: "*Service vessels (and the associated movement of equipment, supplies and waste) will not use the Petit Forte or Long Harbour stations. The use of separate resupply sites is designed to avoid contamination."* However, the Proponent will use routes crossing BMAs, as shown in Figure 2.53, thereby not mitigating risk of cross-contamination.

Section 2.5 – Monitoring and Mitigation Measures,

General Comment: Given that the companion text in Section 7.1 does not provide documented evidence of the expected area of influence during Operations and Maintenance, information is lacking to determine if the proposed mitigation measures are appropriate. Some of this research is presented in the Fish and Fish Habitat Component Study, but the pertinent details should be presented within the main document.

Page 91. Inspections. The document states that nets that are over three years old and still in use will be tested every 18 months by a third party, however, on p.53, it states that '*typically once a year, Grieg NL will employ the services of a larger multi-purpose service vessel to assist with operations such as net changes*." Please revisit and clarify for consistency.

Page 92. Other Mitigation Measures. What are the contents of an escape response kit?

Page 96. Genetic Integrity and Biological Fitness of Wild Atlantic Salmon. The statement: *"The majority of scheduled rivers are located more than 50 km away from the proposed sea cage sites"* is not factual as many of the proposed cage sites are less than 30 km from scheduled rivers and some are actually located at the mouths of known salmon rivers (even though they are non-scheduled). The following non-scheduled rivers (Table 1) have been overlooked in the EIS.

Table 1. Non-scheduled salmon rivers near proposed cage sites.

River Name	Latitude	Longitude
Fair Haven Brook	47.541050	-53.891667
Little Barasway Brook	47.180000	-54.035700
Cuslett Brook	46.959817	-54.157450
Lance River*	46.819000	-54.067333
Branch River**	46.886883	-53.967317

*At tip of peninsula next to St. Mary's Bay
**In St. Mary's Bay

Page 99*. "Grieg NL will be using a sea cage net which extends 45 m below the water surface. This relatively deep net has sufficient volume to allow fish to swim to depths that will allow it to avoid unsuitable surface conditions (e.g., water temperature, sea lice, and waves) and thereby decrease stress on the fish."* While true for surface waves, this will not necessarily mitigate potential effects of internal waves that may be present at the sites. A reference to this potential effect on fish health should be given with data collected at sites during the stratified seasons (spring to fall) to determine whether this may be an issue.

Page 99. The statement: *"In addition, the grow-out plan is that fish will only spend one winter at sea; this minimizes the risk of fish mortality"* is unclear as only one intense winter could be problematic. A recent example is the superchill event in 2014, which significantly impacted the industry in nearby Fortune Bay and Bay d'Espoir. A more rigorous analysis of past winter sea temperature variability should be provided to properly assess the risk. For example, are temperatures expected to rise in Placentia Bay? Are any spatial variations to be expected? What are the current expectations with respect to climate change for the (Newfoundland Shelf) region?

Page 100. *"A routine program will be established for monitoring, measuring, and recording water quality at all active sea cage sites on a daily basis throughout the Project. In-situ data loggers will be installed on the barges at each sea cage site as well as on each individual cage. In addition, sensors can be attached to cameras and buoys located at the perimeter of each sea cage site. These in-situ loggers will collect data on water temperature, oxygen levels, current speed and direction, as well as pH and salinity. Data will be wirelessly transmitted to centralized computer stations on the barges and at the control center in Marystown for real-time viewing or logged for historical collections. Plankton samples will be completed weekly, analyzed and levels recorded. This will be one of the information sources used to create net cleaning schedules. Data collection will be used to evaluate the severity of any environmental issues* *such as fouling or changes in physio chemical data, leading to a response. Environmental changes and plankton levels are rated and depending on the results various mitigation responses are initiated."* These data would be highly valuable to industry regulators and should be made available. Consultation and cooperation between the Proponent and regulators to develop appropriate SOPs to ensure data quality is recommended.

Page 101. The use of Aqualine nets and triploids will not prevent the incidence of, and the potential transfer of diseases among farmed salmon, and possibly to wild Atlantic Salmon. The Canadian Food Inspection Agency (CFIA) website indicates the following ISA events reported for Newfoundland: 2012 - three; 2014 - four; 2017 – two; and 2018 – two. In some of these instances, the virus strain was not known to cause disease. However, it should be expected that ISA and perhaps other diseases, resulting in mass mortality events, will continue.

Section 2.7 – Alternatives

Page 111. Alternatives Within the Project. There is reference to Bay St. George and the Codroy Valley area as an alternate location. However, Bay St. George should be protected from any development owing to the unique contribution of multi-sea-winter (MSW) salmon in these rivers.

Section 2.8 – Accidents and Malfunctions

Page 124. Table 2.25. The interpretation of the probability and impact of escapees to the environment lacks detail and seems optimistic that there would be little to no problems.

Section 3.0 – Effects Assessment Methodology

Page 130. Project Area. Potential for runoff from the Marine Industrial Park due to a tank rupture was not included in the evaluation of the project area. This should be revisited.

Page 130. Study Area. It states that *"The boundaries of the Study Area correspond to those of the Placentia Bay Extension EBSA"* and that "*This is considered the maximum extent wherein there is potential for effects of the Project to occur…"* Although the EA Committee determined it was reasonable to use this as the Study Area, as this is where most adverse effects would be expected to occur, it should be acknowledged that some effects, particularly disease transfer and transfer of parasites, could occur outside this Study Area as salmon are a highly migratory species (Reddin and Lear 1990, Pippy 1982).

Section 4.0 - Existing Environment

Page 139. Wind Speed and Direction. While the statistics presented are useful, persistence analyses should be added due to their importance with respect to structure resilience at sea. (e.g. duration of wind speed (storms) >10 m/s, 20 m/s) with the threshold to be determined upon structure tolerance. Wind direction variability (seasonality) is also not sufficiently documented (see detailed comments regarding Appendix D: Fish and Fish Habitat Component Study).

Page 140. Climate Change. More information should be provided regarding future change in storm frequency and intensity, as well as winter intensity that could occur based on latest available science (e.g. Cohen et al. 2014). These are of importance to aquaculture and would better inform risk factors.

Page 140. Wind rose(s) should be added to illustrate the statement *"The prevailing wind direction in Placentia Bay is a southwest to west flow throughout the year. During the winter, west to northwest winds are prevalent, with a counter-clockwise shift beginning in March and April resulting in predominant southwest winds during the summer."* The sentence *"The tropical-*

to-polar temperature gradient strengthens during the fall, returning to prevailing westerly winds by late-fall and into the winter" is unclear. Please revisit and clarify.

Page 141. *"A sea level rise of ~0.6 m is anticipated for the waters off southern Newfoundland, including Placentia Bay, by the 2081–2100 period."* A reference should be provided for this statement.

Section 4.2 - Aquatic Existing Environment

General Comment: The topics presented and discussed are appropriate. However, the material provided within the sections is not adequately researched and inconsistent in the level of coverage within, and too generic with little effort made to incorporate local information or relate to the Study Area. In particular, in Section 4.2.3, Traditional Ecological Knowledge is largely unused (see Community-Based Coastal Resource Inventories in Newfoundland and Labrador). Also, for the components in which Grieg collected their own recent data, a literature review for other available data should be completed to better describe the spatial and temporal variability.

4.2.2-Physical Environment

Page 143. Ocean Currents. This section fails to describe the variability of the currents that has been observed and modelled, and which is considered to be the most important issue with respect to the physical environment assessment. In fact, the only coastal circulation modeling of the area, published by Ma et al. (2012) is not referenced. Appendix D (Fish and Fish Habitat Component Study) states: *"Since the variability due to tides accounts for approximately only 15% of the total variability, other factors are more important."* This should be clearly stated in the main document as it implies a statistical variability of the currents much greater than that of the tides alone. For a system forced by tides only, most of the current variability could be represented with one month of data (i.e. spring and neap cycle in Newfoundland wind forcing and the Labrador Current are variable on timescales of days to seasons [or more]); thus implying the need for a longer time-series. Consequently, the data collected for this study which are 20 hours to seven days in duration, are not representative of the conditions experienced at any given site. This has significant implications for the modeling results presented in this section.

Page 144. Wind and Wave Action. Due to its nature the MSC50 dataset (note: the source/reference is missing from the text and should be added) is unlikely to be realistic for most of the sites of interest. MSC50 was based on a model initially developed for deep water (i.e. not coastal), is of insufficient resolution (0.1 degree for MSC06Min; that is about 10 km within Placentia Bay), and used a rather crude bathymetry and coastline (GEBCO and CHS 15s) which severely limits its applications in coastal areas. Wave climate might be under and/or over estimated at any given site and for any given season. Comparison with available data should be documented, limitations should be clearly stated, and a discussion on how this uncertainty is being mitigated should be provided.

Page 145. Flood and Tidal Zones. *"During storm events in September 2010 (Hurricane Igor) and January 2004, storm surges of ~0.03 m were observed at Argentia, resulting in a local sea level rise to 2.6 m as a result of the combined tidal and storm surge heights."* A surge value of 0.93 m is reported on page 67 of Appendix D. Please revisit and provide the correct value.

4.2.3-Fish and Fish Habitat

Page 154. Water Temperature. There are bay wide long-term data available from other sources that should be included in this assessment (see Bedford Institute of Oceanography's Oceanographic Databases; and DFO's Marine Environmental Data Section).

Page 154. Figures 4.6 and 4.7. Standard deviations to illustrate the variability should be provided in these figures.

Page 160. Corals and Sponges. This section does not make use of DFO research vessel incidental observations as referenced later in the document.

Page 160. Invasive Species. The document states that the primary Aquatic Invasive Species (AIS) concern in Placentia Bay is Green Crab. This is not correct. Although Green Crab are well known and well distributed in Placentia Bay, the primary concern for AIS is the presence of highly invasive tunicates, which are important/(economic and biological) biofouling species, specifically vase tunicate (*Ciona intestinalis*) and golden star tunicate (*Botryllus schlosseri*).

Vase tunicates are highly invasive and economically significant and have been found at both Marystown and Burin. The site of the hatchery and many of the support and supply vessels are from the Marystown area (and those not using this area may find AIS at other smaller harbours). The movement of this species is prohibited by the AIS regulations in the *Fisheries Act*. There are three major reasons for concern that are not addressed in the document:

1. Transport of invasive species (vase tunicate) by supply boats and other vessels (McKenzie et al. 2016). There is no mention of how this will be prevented. This is particularly important if the Proponent does not want to constantly clean their cages, and the weight alone of vase tunicate is a significant problem. More importantly, the Proponent will spread this species around Placentia Bay. It is important for the Proponent to have a plan to avoid spreading it throughout the bay on their vessel.
2. Regarding AIS and Biofouling, Grieg will monitor AIS and report to DFO. It is important to note that in addition to reporting, the Proponent will be responsible for the removal of the invasive tunicate. The Proponent received an experimental licence (2017) to monitor the proposed sites for AIS biofouling. It is not known where these data are or if they were collected, and it was not discussed in the report.
3. Although the document indicates cleaning the nets for biofouling, the Proponent cannot spray wash or clean the AIS species as they will spread in the water and infect other places. This is unacceptable and will cause a great deal more harm/cost for an aquaculture operation. Prevention is key but there are no references to prevent this introduction. This needs to be addressed.

Page 164. Regarding the text that successful restoration of eelgrass beds in Placentia Bay will be dependent on the removal or substantial reduction in Green Crab density, this information is available from studies performed in Placentia Bay (see Matheson et al. 2016).

Information is presented in this section regarding eelgrass restoration only. Eelgrass is considered an ecologically significant species (see DFO 2009; Rao et al. 2014), and information on existing eelgrass sites within the bay should be provided.

Page 166. There is no mention of the threatened designation for Lumpfish from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC*)* in November 2017. This section should be revisited and updated to include a discussion in this regard.

Page 170. Table 4.10. Subzero temperatures can be lethal to salmon. This section should indicate whether this is a concern.

Page 170. Benthic Habitat. This section only comments on habitat immediately near proposed sites. It would be helpful if habitat was discussed at a larger spatial scale using existing information. This is recommended in light of the lease sizes, the proximity of sites to Marine Protected Areas (MPAs), and the overall potential cumulative effect of deposition after stocking. More video data should be gathered to better describe depth related changes, considering the significant depth ranges at sites.

4.2.4-Wild Atlantic Salmon

Page 173. The EIS acknowledges the COSEWIC evaluation on the status of Atlantic Salmon whereby South Newfoundland was designated as “threatened.” COSEWIC uses a standard approach where trends in abundance are examined over a period of 15 years or three generations. The authors of the COSEWIC report also indicated that with respect to south Newfoundland, had the analysis extended back one single year (i.e. over 16 years) south Newfoundland would have met the criteria to be designated as “Endangered.” Several individual stocks in nearby Bay d’Espoir have declined by upwards of 80% (Conne River) and 90% (Little River) and represent the greatest salmon stock declines in NL. A retrospective analysis of salmon returns to Conne River for the years 1976-85 (10-years prior to start of the enumeration project) indicated that Conne River likely had strong returns of salmon similar to those that occurred during the first four years of the fish counting fence operation (1986-89) (Robertson et al. 2013). The recreational salmon fishery at Conne River used to be the third most important (in numbers of fish caught) on the island of Newfoundland (Warren and Dempson 1995). Historically, retained catch of salmon at Garnish River (Fortune Bay) was higher than total returns of salmon to the river in recent years at the fish counting fence (Moores et al. 1978). More discussion of historical and current studies should be provided.

Page 174. Migratory Patterns. Remove reference to Atlantic Salmon spending ‘several months’ in their natal freshwater habitat after hatching as they always spend at least two or more years in freshwater within Newfoundland systems.

Page 175. The document states *"Atlantic Salmon migratory corridors in Placentia Bay have not been identified in the literature"* yet some data exists which is not cited. While specific migratory corridors may not have been identified for the Placentia Bay area, past and current studies clearly indicate that Atlantic Salmon from other regions migrate along the south coast of Newfoundland. In the interception report by Pippy (1982), Maritimes and Quebec origin salmon made up 15% and 11% of the commercial catch of salmon in the Placentia Bay area and recently, genetic analyses of mixed stock fisheries for salmon at St. Pierre and Miquelon (Bradbury et al. 2016) similarly intercepted salmon originating from these other regions. Collectively, both historic and contemporary analyses show that salmon from other regions migrate by and into areas along the south coast of Newfoundland (see: Bradbury et al. 2016; Reddin and Lear 1990; Pippy 1982). Thus, any impacts associated with salmon aquaculture such as disease, parasites may also potentially impact salmon from areas well beyond Placentia Bay.

Page 175. Genetic Population Structure. The text should be updated to reflect that no diploid escapes were found in 2017 either.

Page 175. The genetic structure discussion requires more detail and is missing several references (see: Jeffrey et al. 2018, Bradbury et al. 2015). Placentia Bay is characterized by small isolated regional populations of Atlantic Salmon, making them highly vulnerable to impacts.

Page 176. Abundance. It is noted that recreational fishery data for Placentia Bay are probably the best available indicator of salmon abundance within the Study Area. This is due to the lack of long-term salmon monitoring programs within the Study Area, with the exception of Northeast River, Placentia. The use of angling data, however, can be problematic. Stock assessments are not routinely carried out on rivers for which only recreational catch data are available. Reasons include: numerous changes to management plans over the years, use of daily and season bag limits, split seasons, angling quotas, the change to a licence stub return system and provision for catch and release besides the periodic closure of rivers for environmental reasons (Dempson et al. 2006). In a review of the use of angling data to infer status of populations, O'Connell (2003) concluded that the extrapolation of angling exploitation rates among rivers to determine stock size as used in relation to salmon assessments, for example those carried out by the International Council for the Exploration of the Sea (ICES), "*is potentially quite risky.*"

Section 4.8 – Data Gaps

Page 344. Fish and Fish Habitat. Data gaps exist regarding cumulative effects. The BMAs will not be fallowed simultaneously and therefore potential overall cumulative organic deposition and chemical persistence might occur. Sampling in areas between the BMAs could provide some information on presence of organic deposits, although the water depths may be a limiting factor.

The lack of physical environmental knowledge (ocean currents and water salinity in particular) represents a very significant data gap that should be acknowledged and addressed.

Section 6.0 - Effects of the Environment on the Project

Page 351. Superchill.*"Temperature profiles during winter months in Placentia Bay are negatively correlated with water depth (see LGL 2018b in Volume 3)."* The correlation could not be found in the document cited. Note that superchill events resulting in fish mortalities have previously occurred on the south coast of Newfoundland.

As noted in the EIS, superchill events have already occurred on the south coast of Newfoundland in 2014. These events happen when there is an intrusion of lethal water temperatures. In view of continued climate variability and change, and the occurrence of more extreme events, the likelihood exists for other superchill events to occur again in Newfoundland. Superchill events also occurred in the Maritimes in 2013 and 2015.

Page 352. Currents. *"Ocean currents within Placentia Bay are described in Section 3.1 of Appendix V, with BMA-specific summaries provided in Section 4.2.2.2. The proposed sea cage locations were selected in part due to the presence of adequate current to assist in the removal of organic deposits associated with sea cage operations, thereby minimizing depositional build-up or nutrification."* The time-series presented and used for this Project are much too short to confidently support this statement. Also, the statement is not quantitative; the term "adequate" should be defined in this context.

Page 352. Algal Blooms. This section of the document cites DFO 2010c several times, but is not included in the references. Additionally, the DFO 2010 reference for Figure 6.1 is not known, so this information cannot be fully assessed.

Section 7.0 - Effects of the Project on the Environment

General Comment: In Section 7.1 - Fish and Fish Habitat VEC, the report does not integrate supporting documents with knowledge of existing conditions in Placentia Bay to justify the conclusions regarding the magnitude, extent, and duration of effects. Similarly, Section 7.6 - Cumulative Effects, lists the potential activities that may have an effect but lacks the integration of expected influences or consideration of the existing conditions within the bay to justify the conclusions.

Section 7.1 - Fish and Fish Habitat VEC

Page 354. Fish and Fish Habitat VEC. There is no mention of potential escapes of farmed fish as an effect of the Project on the environment, specifically fish and fish habitat. This should be discussed under operations and maintenance.

Page 359. Table 7.3 (and page 377, Table 7.6). The tables report that the potential for negative environmental effects is not significant, but the Proponent has assigned a medium level of confidence throughout these tables. A medium level of confidence would indicate that the risk of each outcome cannot be in fact "not significant."

Page 360. Feeding of Farmed Salmon. There is no evidence provided to support the predictions made about magnitude and duration of effects.

Page 362. Although it states that the presence of farmed salmon in sea cages could result in increased predators around the cages, there is no discussion of how this could subsequently increase mortality on migrating wild Atlantic Salmon smolts and adults.

Indirect genetic effects and ecological interactions are not adequately described nor are the potential effects of escapees on wild Atlantic Salmon populations.

Page 363. Deposition from the Sea Cages. Due to the limitations of the ocean current time-series (i.e. much too short) the estimated benthic loading of carbon provided in this section is not representative of what will eventually occur (see additional comments re: Appendix A: Fish and Fish Habitat Component Study).

Page 363. *"It is important to consider all of these visual indicators when assessing for impacts of aquaculture since Beggiatoa mats and opportunistic polychaete complexes (OPC) may be absent from sites due to water depth or seasonal hypoxic conditions (Hamoutene et al. 2014, 2016)."* They are likely not *Beggiatoa* mats as reported in Verhoeven et al. 2016.

Page 364. *"Salvo et al. (2017) found that after sites had been fallow for 15 months, the benthic communities at these sites had not returned to a state resembling that of control sites, suggesting slow recovery of benthic communities after production cycles."* As stated above, recovery might not happen within timelines selected for fallowing by the Proponent. However, at this stage only regulatory requirements through DFO Aquaculture Activities Regulations (AAR) will determine compliance.

Page 369. Monitoring of the seabed using ROV, drop camera, and surficial sediment sampling is listed as a mitigation measure that will minimize the effect of further accumulation of organic material on the seabed. Unless there is some action that will be taken based on the results of the monitoring (i.e., a threshold of 'acceptable' organic deposition after which no further net cleaning will occur), then monitoring alone will not reduce the effect of further accumulation of organic material on the seabed. The same comment applies for use of monitoring under Presence of Sea Cages (p.370).

Page 371. Production of Waste Materials. There is no evidence provided to support predicted magnitude of influence over a spatial area. There is no integration of existing information about the local environment, or other aquaculture sites.

Section 7.2 - Wild salmon VEC

Page 372. There is no mention of potential escapes of farmed fish as an effect of the Project on wild salmon. This should be discussed under operations and maintenance in the context of both direct and indirect genetic effects as well as ecological effects.

Page 377. Previous comments regarding migration corridors and proximity of sea cages to salmon rivers apply here as well.

Section 7.7 - Accidents and Malfunctions

Page 434. The document states: *"Recently, there has been interest in using European-origin farmed salmon because of their higher growth rates and other attributes that result in more economic benefit*." It would be useful for the reader if these other attributes were described. It also states that *"since European-origin salmon have never been utilized in Newfoundland, there is no available information concerning the genetic interactions between farmed European salmon and wild Newfoundland salmon."* There are a number of other uncertainties with respect to the use of European-origin salmon in Newfoundland waters that should be also be listed here including their performance, resistance to disease and pathogens, etc. which may affect their survivability, as well as the potential impacts they may have on wild Atlantic Salmon.

Page 435. *"Some studies suggest that the use of sterile triploid salmon in aquaculture will help to prevent genetic and ecological interactions between wild and farmed salmon."* This is an overstatement as it will not prevent the occurrence of indirect genetic interactions such as competition, habitat disruption, parasite/pathogen introduction, etc. (Glover et al. 2016, Madhun et al. 2017). The EIS document references an investigation into the frequency of diploid and triploid farmed salmon escapes in rivers and concludes that there were significantly fewer triploid escapes found in rivers. Nonetheless, indirect genetic and ecological impacts can occur regardless of whether or not triploids escape and regardless of whether they enter rivers.

Page 435. In the statement *"it has been documented that farmed Atlantic Salmon escapes, in this case diploids, <u>sometimes</u> enter rivers that have natural spawning grounds for wild salmon stocks, and mate with wild salmon"* the word 'sometimes' should be deleted (Glover et al. 2016).

Page 435. Keyser et al. (2018) was conducted in Atlantic Canada, not in Norway, as stated.

Page 435. The reference provided states that *"even with the implementation of the best available containment measures to prevent farmed salmon from escaping from sea cages, it is considered a frequent and inevitable occurrence",* nonetheless escapes are only discussed in the context of an accidental event. It is well known that damage to sea cages can occur during severe weather events and predator strikes, which are likely to occur despite implementation of the proposed mitigation measures. It is acknowledged that although these mitigation measures will tend to reduce this from happening, it is not 100% escape-proof.

Page 436. There is a reference to Verspoor et al. (2015), which states that *"smaller depressed stocks (i.e., lower abundances) will be more vulnerable to impacts of genetic contribution (i.e., genetic drift) than larger healthier stocks."* It is important to point out that many of the salmon rivers on the south coast of Newfoundland are small and have low salmon abundances.

Page 436. The EIS document seems to mix-up juvenile and adult surveys. Also, the statement "older individuals" is not correct as these were later stage hybrids and all individuals were young of the year. It should be clarified that there were no escapes captured in Fortune Bay or Bay d'Espoir in the fall 2017 surveys. DFO continues to encounter farmed escapes at its monitoring facility in Garnish, even though the nearest aquaculture site is 40-50 km away.

Page 439. The statement: *"…triploid all female farmed salmon are not expected to interact either genetically or ecologically with wild salmon"* is not substantiated. Although triploidy will greatly reduce genetic interactions, insufficient information exists in the literature regarding ecological interactions as this is largely unknown.

Page 440. The document states that a fish escape resulting from a complete cage breach (i.e., 160,000 farmed salmon and 16,000 Lumpfish cleaner fish) would not have a significant impact on wild salmon. On the contrary, an escape of 160,000 farmed salmon would likely have a significant effect on the wild salmon population (approximately 20,000 fish). Such a statement should have a higher level of confidence than that indicated in the EIS document (medium).

Section 7.8 – Follow-up Monitoring

Page 475. Please clarify why the Environmental Effects Monitoring and Follow-up Program (EEMP) is limited to verifying effects predictions for an accidental escape of farmed salmon on the wild salmon VEC. The EEMP should also monitor effects due to disease and pathogens, sea lice, and ecological interactions.

Page 476. Accidental Events. Collecting blood samples from salmon within scheduled salmon rivers following an escape event might not be the best approach for determining whether farmed salmon have entered fresh water. Follow-up monitoring should be determined in consultation with DFO.

Section 7.9 – Assessment Summary and Conclusions

7.9.1.2 - Wild salmon VEC

Page 478. The document states that: *"Overall, planned Project activities on the wild salmon VEC were predicted to be not significant"*. The Proponent outlined in detail the various mitigation measures that will be implemented, many of which are to be commended. Although numerous mitigation measures have been built into the proposed Project, based on experience where farmed Atlantic Salmon and wild populations of Atlantic Salmon co-occur, there is a strong likelihood that wild salmon populations will be negatively impacted.

There is no mention of the potential effects of farmed escapes on wild salmon. Although there are statements that the cages are escape-proof and that the all-female triploid salmon will be 100% sterile, this has not been demonstrated in Newfoundland waters and therefore potential direct and indirect genetic effects and ecological effects should be discussed.

7.9.2 Accidents and Malfunctions

Page 480. It is unlikely that the residual effects would not be significant. Even in the absence of direct genetic interactions, indirect and ecological interactions (disease, competition, predation, etc.) could be significant and therefore a high level of uncertainty remains. The level of confidence cannot be medium, at best it would be low.

Section 8.1 - Summary of Mitigation Measures

Table 8.1. Under the potential effect '*alter genetic integrity*….' it states that only sea cages in Rushoon BMA are <20 km from scheduled salmon rivers, whereas elsewhere in the document it states that sea cages are >50 km away from scheduled salmon rivers. Please revisit and correct the inconsistencies throughout the document.

Component Study: Wild Atlantic Salmon

Page 1, Para. 2. The potential impacts of disease/pathogens and parasites such as sea lice should also be discussed here.

Page 4, Para. 2. Please correct the statement that "*after hatching, Atlantic Salmon spend several months to several years in their natal freshwater habitat…*" as Atlantic Salmon never spend as little as several months in freshwater in Newfoundland before migrating to sea as smolt. Also, since it reports salmon that spend one winter at sea as grilse, it should then also report that salmon that spend more than one year at sea are MSW.

Page 5. It states that *"Recently, there has been interest in using European-origin farmed salmon because of their higher growth rates and other attributes that result in more economic benefit."* It would be useful if these other attributes were described. It also states that *"since European-origin salmon have never been utilized in Newfoundland, there is no available information concerning the genetic interactions between farmed European salmon and wild Newfoundland salmon."* There are a number of other uncertainties with respect to the use of European-origin salmon in Newfoundland waters that should be also be listed here including their performance, resistance to disease and pathogens, etc. which may affect their survivability as well as the potential impacts they may have on wild Atlantic Salmon. As they have never been used in NL, the level of confidence in many of the predicted effects should be more uncertain.

Page 10, Para. 1. DFO Science has information regarding farmed salmon captured at one of the Department's counting facilities on the south coast, Garnish River. These salmon originated from escape incidents and this information should be reported and discussed in the EIS (DFO 2018b).

Page 15, Para. 2. It is important to point out that the reduction in harvest limits being implemented this year in the Atlantic Salmon recreational fishery are for conservation purposes in response to dramatic declines in Atlantic Salmon returns to many DFO monitored rivers throughout NL over the past two consecutive years, which has not been seen since the commercial moratorium in 1992.

Page 17. Please describe the methodology used for calculating distances between sea cage sites and mouths of scheduled and non-scheduled salmon rivers.

Page 36. It states that *"the deposition of uneaten fish feed can serve to attract wild fish, including wild salmon to sea cages"* and that this could affect migration patterns if wild salmon *"choose to travel between fish farms to eat uneaten fish feed instead of actively seeking natural prey."* This was not mentioned and discussed in the main EIS document.

Page 43. Maintaining Genetic Integrity and Biological Fitness of Wild Salmon. The report states that only the sea cages in the Rushoon BMA are located <20 km from a scheduled salmon river. However, it is also important to note that on p.16 it indicates that sea cage sites in two locations in the Long Harbour BMA are within 20 km of a non-scheduled salmon river and another river where Arctic Charr and Rainbow Trout are known to occur, and sea cage sites at two locations in the Merasheen BMA are within 20 km of another non-scheduled salmon river.

Page 55. Follow-up Monitoring, Planned Project Activities. There should be some discussion about validating predictions made regarding fish health, sea lice, ecological interactions, etc.

Page 56. Follow-up Monitoring, Accidental Events. Collecting blood samples from salmon within scheduled salmon rivers following an escape event might not be the best approach for determining whether farmed salmon have entered fresh water. Follow-up monitoring should be determined in consultation with DFO.

Appendix I – Wild Atlantic Salmon Component Study: Stofnfiskur Certification and Verification (All-Female Triploid)

The document cites improved triploidy induction method but data are not provided nor does it appear to be published. It is difficult to evaluate the accuracy of these claims in its absence. Also sample sizes of 10 eggs per batch make the assumption that failures in induction are not normally distributed (i.e., 100% or high rates of failure). Again, data are not provided.

Appendix T – Wild Atlantic Salmon Component Study: Grieg NL Emergency Response Plan

Page 31. It states that *"if necessary, Grieg NL will collaborate, by sharing recapture gear, or enter into an arrangement with local fisherman to ensure that adequate recapture efforts are implemented*." This should be mandatory and a commitment made by the Proponent to have this in place in the event DFO recommends that recapture efforts be undertaken. Recent evidence has shown that recapture efforts are most successful when implemented within 24-48 hours after an escape event because after this time escapes begin to disperse making it extremely difficult to recapture individuals. To date, past recapture efforts in the NL Region have been largely unsuccessful due to operational and environmental issues which resulted in delays in initiating recapture efforts.

Page 32, Para. 1. The document states that recapture efforts will commence as soon as possible after an escape event. This should be tightened to state: provided environmental conditions (sea state/weather conditions) are safe to do so, recapture efforts should commence within 24 hours following an escape event.

Page 32, Para. 2. It is recommended that an emergency licence should already be in place in the event an escape incident arises, so that there are no delays in initiating recapture efforts. Standard conditions could be specified ahead of time in the licence with input from DFO Science to ensure any adverse effects on wild salmon are minimized.

Page 32, Para. 3. The text should specify where (i.e., immediately adjacent to cage site) and how deep nets will be set.

Page 32, Para. 5. The document states that site staff will immediately assess the sea cage to find the suspected source of the escape and attempt to repair it. Since this is often the first course of action for site staff, there should be separate dedicated staff or an arrangement made with local fishermen who can focus their efforts on recapturing the escapes.

Page 32, Para. 6. Once again there is reference to seeking the assistance of 'third-party providers such as local fishermen' and engaging in recapture efforts 'as quickly as possible.' Again, these arrangements should be in place prior to an escape event such that recapture efforts can commence within 24 hours of an escape provided it is safe to do so. It also states that 'recapture nets will be checked four times daily while deployed.' Depending on time of year when recapture efforts occur, and if it's deemed appropriate to do so by DFO, nets may need to be constantly tended (i.e., during peak salmon migration period in June/July when there is a higher risk of intercepting wild salmon).

Page 33. Appendix 8 appears to be missing.

Component Study: Fish and Fish Habitat

Page 14. The first paragraph has mis-referenced DFO (2017a) as the source for the preceding statements in this paragraph. However, the referenced document has no text in it that provides such information.

Page 49. "*Relative to effects on fish and fish habitat, proposed sea cage sites were selected based on sufficient currents and direction necessary to minimize depositional build-up, adequate water depth for sea cages, and suitable bottom type (i.e., >50% hard bottom)*." However, only measurements at one point for each site are reported, making the above an overstatement as far as selection of location based on currents and direction.

Additionally, the timeline of the current data used is much too short to determine dominant forcing (e.g. tide vs. wind) and variability. A minimum of one month (30 days) is necessary for the tides to be determined with reasonable accuracy, and on the order of one year to get the variability induced by atmospheric forcing (i.e. seasonality). Thus, the statement: *"siting of sea cages at locations with suitable currents and depth to distribute organic waste,"* which is repeated throughout the document and used to support the claim that most of the VEC potential effects are "not significant" is not sufficiently demonstrated in this document.

Appendix A - Fish and Fish Habitat Component Study: Grieg NL Benthic Depositional Modelling Report

The ocean current time-series used for this study are too short to give statistically robust estimates of dispersion. Looping 20 hours to a few days long time-series on itself to make it one month long does not reproduce the spring-neap tidal cycle and, even if it did, would not represent other variability that may take place on longer timescales (e.g., days to seasons). The ocean currents description provided in Appendix D of the Fish and Fish Habitat Component Study states that tide is a minor component of the total variability (~15%) thereby indicating that other processes dominate. Previous studies carried out in the area found large, and broad, peaks at low frequency on the observed currents' power spectrum (<0.5 cycles per day or less) indicating the importance low frequency variability (most likely due to storms or fairly regular strong wind events). These past observations should be stated in order to put modeling results and limitations in perspective. Longer time-series should be used to represent this large variability. One possible option would be to use the current fields published by Ma et al. (2012). While their time-series does not cover a full year (April-November) and their resolution (bathymetry and coastline) is not ideal, it is the best available dataset in absence of long observations and should provide a better order of magnitude. Modeling scenarios should also try to encompass worst cases: high feed, low currents resulting in high concentration; high feed, high currents resulting in lower concentration but larger footprint.

Appendix D - Fish and Fish Habitat Component Study: Metocean Conditions for the Placentia Bay Aquaculture Sites

General Comment. All stated names should be illustrated on a map. There are numerous instances where they are not (e.g. Brine Islands, Red Island, Ship Island, etc.). The quality of the maps is also poor and blurred, and would benefit from a higher resolution. Also, the list of references is quite short and somewhat outdated (the most recent reference is from 2008).

Page 5. Wind Speed. This section does not clearly describe the wind forcing seasonality (i.e. prevailing directions potentially changing seasonally). Monthly wind roses should be provided to illustrate it.

Page 28. *"The positive phase of the North Atlantic Oscillation (NAO) index results in more and stronger winter storms crossing the North Atlantic on a more northerly track, and cold dry winters in Northern Canada and Greenland, while the negative phase results in fewer and weaker storms crossing on a more west-east track."* The report should describe the resulting effect on the ocean/water column, for example, as described in Colbourne et al. (2017).

Page 36. *"In general, the near-surface currents in Placentia Bay have been observed to flow counter clockwise around the Bay."* A reference should be provided here, and also where other such statements are made. For example, the statement that follows: *"Since the variability due to tides account for approximately only 15% of the total variability, other factors are more important."* Information on the tidal analysis results is required.

Page 36. *"Winds in the area are predominately from the southwest during all seasons and this would contribute to a counter clockwise pattern in the near surface waters."* This statement is overgeneralized and misleading. This pattern is only true in steady state (geostrophic balance). While wind might be predominantly from the southwest statistically, that does not mean that it always blows from this direction and that it blows sufficiently long to induce a steady state. In fact, an example of wind forcing from the southwest shows a much different pattern (see Fig. 9 in Ma et al. 2012). Wind relaxation and/or change in direction, which occurs all the time, would also induce much different dynamics. The report provides an annual wind rose (Fig. 2.2) but this does not justify that wind is "predominately from the southwest during all seasons." In addition, the text of Section 2.3 (p. 5) states: *"There is a strong annual cycle in the wind direction. West to northwest winds which are prevalent during the winter months begin to shift counter-clockwise during March and April, resulting in a predominant southwest wind by the summer months. As autumn approaches, the tropical-to-polar temperature gradient strengthens and the winds shift slightly, becoming predominately westerly again by late fall and into winter."*

Page 36. Please provide references for the datasets that have already been documented (e.g. Memorial University data reports: Hart et al. 1999; Schillinger et al. 2000).

Page 36. It is understood that Smart Bay Buoys actually feature a current profiler, instead of a single point. This should be confirmed and the text modified if this is indeed the case.

Page 38. *"At the head of Placentia Bay on the eastern side, the Memorial data showed that the current is consistently flowing into the bay with mean speeds between 11 cm/s and 18 cm/s at a depth of 20 m."* It is unlikely that currents would flow consistently in the same direction anywhere in the bay, although its long-term mean (vector-averaged) might be. The source of this information is unclear (e.g., reference, mooring name). Please revisit and adjust the text accordingly.

Page 45. As stated previously, the MSC50 dataset is unlikely to be realistic for most of the sites of interest. Which dataset was used, MSC06Min? If not, the results presented are even less reliable. The dataset which was used should be clearly stated and described (resolution and limitations).

Page 63. A more recent paper by Ma et al. (2017) on surge in the Study Area would be beneficial and should be referenced and discussed.

Conclusions

Overall, the EIS documents are extensive and the topics considered within the relevant sections are generally appropriate. However, the level of certainty in the conclusions on risk characterization is insufficient and requires additional information and/or sampling.

The objective of this review was to evaluate:

The sufficiency of baseline data and appropriateness of methodologies to predict effects;

- The document cites improved triploidy induction method but data are not provided and thus the accuracy of these claims cannot be thoroughly evaluated. Also, there is insufficient data to validate that a sample size of 10 eggs is all that is required to detect failures.
- Additional physical environmental data should be collected at each site. A longer time-series of ocean currents, in particular, should be collected as well as profiles of water salinity; the former due to its importance for dispersion modeling and monitoring, and the latter due to its importance on sea-lice life cycle.
- A lot of outdated material is cited where more recent material exists. Also, some inaccurate statements are found in the reports.

The mitigation measures proposed by the Proponent;

- The list of mitigation measures proposed are fairly inclusive but do not offer solutions for larger scale effects.
- Crew change sites and resupply sites have been proposed to avoid cross-contamination. However, the proposed routes cross the BMAs which could negate this mitigation.
- There are inconsistencies in siting distances from scheduled and known (non-scheduled) salmon rivers thereby making the evaluation of this mitigation measure unviable.
- There are several sections in which there is a lack of detail to thoroughly evaluate the mitigation measures.

The level of certainty in the conclusions reached by the Proponent on the effects;

- Assessment of the risks associated with the proposed Project identified a long list of significant uncertainties associated with the proposed activities. Despite significant and numerous knowledge gaps, the report consistently concludes that there is medium to high certainty of non-significant impacts. The data do not support this conclusion.

The manner in which significance of the environmental effects, as they pertain to DFO's mandate, have been determined (i.e. the scientific merit of the information presented and the validity of the Proponent's methodologies and conclusions);

- The potential effects of farmed escapes on wild salmon have not been adequately assessed. Although there are claims that the cages are escape-proof and that the all-female triploid salmon will be 100% sterile, this has not been demonstrated in Newfoundland waters and therefore potential direct and indirect genetic effects and ecological effects should be investigated further before conclusions are made.
- The cage siting locations and conclusions regarding dispersion were based on a time-series too short to provide statistically robust estimates to inform conclusions. Related to this, limited sampling (measurements at only one point for each site) was used to make conclusions regarding suitable siting locations.

The follow-up program proposed by the Proponent;

- As the EEMP has not yet been completed, it should consider the comments provided in this review including: verifying effects due to disease/pathogens, sea lice, ecological interactions, etc; additional sampling at each site and in areas between the BMAs to provide information on presence of and potential for organic deposits and chemical persistence; recommendations to improve the Grieg NL Emergency Response Plan.

Whether additional information is required from the Proponent to complete the technical review.

- Please see the many comments provided throughout the review.

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Sources of information

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