PLACENTIA BAY ATLANTIC SALMON AQUACULTURE PROJECT
ENVIRONMENTAL EFFECTS MONITORING PLAN (EEMP):
GENETIC AND ECOLOGICAL INTERACTIONS BETWEEN WILD LUMPFISH AND ESCAPED CLEANER LUMPFISH

GRIEG NL

March 2020

Placentia Bay Atlantic Salmon Aquaculture Project Environmental Effects Monitoring Plan:

Genetic and Ecological Interactions between Wild Lumpfish and Escaped Cleaner Lumpfish

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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) on 5 September 2018 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 between Wild Lumpfish and Escaped Cleaner Lumpfish component is presented in this document. This EEMP is designed to monitor the potential effects of genetic and ecological interactions on the wild lumpfish in Placentia Bay and vicinity. The EEMP is largely based on ongoing consultation with Fisheries and Oceans Canada (DFO) in St. John's, Newfoundland and Labrador (NL), as well as scientific information provided in peer-reviewed literature.

Grieg NL is committed to implementation of this EEMP, 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 ongoing basis and updated as needed throughout the life of the Project.

2.0 Objectives and Scheduling of Monitoring

The objective of the EEMP for 'Genetic and Ecological Interactions between Wild Lumpfish and Escaped Cleaner Lumpfish' is to evaluate potential genetic and ecological effects on the wild lumpfish population in Placentia Bay and vicinity as a result of interactions with escaped cleaner lumpfish. Grieg NL plans to stock its cages with juvenile lumpfish from the Department of Ocean Sciences at Memorial University of Newfoundland (MUN) broodstock derived from wild lumpfish collected along the northeast coast of Newfoundland.

The deployment of cleaner fish in salmon cages represents a promising alternative to chemical therapeutants to manage parasitic sea lice in sea cage aquaculture. The Ocean Science Center (OSC) began in 2013 to collect cleaner fish for broodstock for the salmon industry in Newfoundland. Since 2015, the OSC has successfully domesticated and maintained five successive year classes. Juveniles from this program have been utilized in Newfoundland's salmon industry since 2015 (D. Boyce, Memorial University of Newfoundland, pers. comm., September 2019). Grieg NL currently has broodstock from this program being held at the OSC for use once sea cage operations begin.

Monitoring is designed to ensure that effects of interactions between the cleaner and wild lumpfish do not exceed thresholds such that effects on the wild lumpfish in Placentia Bay and vicinity are minimized to the extent possible. Grieg NL will employ proactive measures to minimize the potential of escapes of cleaner lumpfish from Grieg NL sea cages. While Section 7.1 of the EIS provides assessment of routine activity effects on the Fish and Fish Habitat Valued Environmental Component (VEC) which includes wild lumpfish, EIS Section 7.7.1 assesses the potential effects of accidents and malfunctions on the wild lumpfish, specifically escape of cleaner lumpfish from a sea cage that could potentially result in interaction between escapees and wild lumpfish in Placentia Bay. The EIS predicted that the reversible residual

negative effects of the escape of cleaner lumpfish on wild lumpfish in Placentia Bay would be not significant.

Genetic analysis will be conducted on lumpfish tissue collected at numerous locations around Newfoundland in 2019 and 2020 (see Section 3.1 below). The analysis will provide resolution as to whether or not lumpfish collected at different locations along the Newfoundland coast are from the same population (i.e., have the same genetic signature). These results will determine whether a monitoring component that focuses on genetic introgression between Grieg NL cleaner lumpfish and wild lumpfish is required.

Monitoring for ecological interactions between escaped cleaner lumpfish and wild lumpfish is problematic. DFO has not yet been able to provide any advice regarding monitoring of wild lumpfish for ecological interactions with escaped cleaner lumpfish (M. Simpson, DFO, pers. comm., 8 July 2019). Discussions with DFO will continue on this matter. A letter of support from DFO supports the idea that this EEMP is evolving and cannot include more details regarding approaches to monitor ecological and genetic interactions between cleaner lumpfish and wild lumpfish until the results of ongoing research are available (see Appendix 1).

3.0 Monitoring Design/Methodology

3.1 Proposal to Aquaculture Collaborative Research and Development Program

There is currently a proposal submitted to the Aquaculture Collaborative Research and Development Program (ACRDP) to conduct research on lumpfish and cunner population genetics to assist with the continued development of broodstock lines and estimation of any potential genetic effects on the local wild populations due to genetic interaction between escaped cleaner fish and the wild populations of these two species. The overall goal of the proposed research is to provide analysis and characterization of the population genetics of both wild and broodstock lumpfish and cunner from different areas around Newfoundland and Labrador. Grieg NL is proposing to use lumpfish as cleaner fish in its sea cages. The proposed research would be a close collaboration between government scientists (DFO), aquaculture industry partners (Grieg NL Seafarms Ltd., Mowi Canada East, Cooke Aquaculture Inc.), the Newfoundland Aquaculture Industry Association (NAIA), and the Department of Ocean Sciences at MUN.

Specific objectives of the proposed study include the following:

- Identify stock structure among wild populations of lumpfish and cunner in waters around NL;
- Directly compare wild and domestic aquaculture strains (lumpfish); and
- Provide science advice on the geographic scale and nature of population structure in both species.

This study will directly inform the aquaculture industry responses to concerns regarding the potential of genetic interaction between escaped cleaner fish and their wild counterparts.

In 2019/2020, lumpfish samples, and associated metadata will be collected, followed by DNA extractions and quantification for all samples. Work will include sequencing, assembly and annotation of lumpfish genome.

Study tasks during 2020/2021 will include:

- lumpfish individual genome resequencing and Single Nucleotide Polymorphism (SNP) calling;
- lumpfish SNP genotyping with 60K SNP array;
- spatial analysis of lumpfish population structure;
- sequencing, assembly and annotation of cunner genome; and
- preparation of lumpfish spatial genetic paper.

Wild lumpfish samples have been collected through targeted DFO research vessel sampling and collaboration with fish harvesters during 2018 and 2019. Sample locations have extended from as far south as Massachusetts and Maine to the Northern Peninsula of Newfoundland with additional lumpfish samples collected from two locations in Iceland and a location in Ireland. Of the 1,653 samples collected, more samples were collected around Newfoundland (i.e., Fortune Bay extending counter-clockwise to the tip of the Northern Peninsula) and north of the Cabot Strait (i.e., Gulf of St. Lawrence) than in areas to the south.

If the genetic analysis indicates that there is no significant genetic differences between lumpfish collected at various locations around Newfoundland, then the potential for adverse effects of genetic interaction between escaped Grieg NL cleaner lumpfish from the Ocean Sciences broodstock and wild lumpfish will not be an issue. If analyses indicate otherwise, then it may be necessary to design a program to monitor for genetic introgression between escaped Grieg NL cleaner lumpfish and wild lumpfish or ensure broodstock are from the same area. This monitoring design and/or broodstock collection would be done in collaboration with DFO.

3.2 Preventative Measures

Grieg NL will proactively implement preventative measures to decrease the potential for escaped cleaner lumpfish to interact with wild lumpfish. These measures include the following:

- 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 Remotely Operated Vehicle (ROV) or diver 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, the ROV will conduct immediate repairs to the net. 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 the 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).
- As already indicated, Grieg NL will use juvenile lumpfish from a genetically described broodstock as cleaner fish to control sea lice in the sea cages. The cleaner lumpfish are not expected to reach sexual maturity prior to harvesting (see Section 2.5.2.2 of EIS (LGL 2018) for details). Grieg NL will stock the sea cages with lumpfish once they reach 20–50 g (~5–10 months old) and harvest them 12–16 months later at 17–26 months of age. The age at which lumpfish reach maturity can vary depending on location and occur as early as two to three years of age for males in Norway and as late as five years of age for wild females in Newfoundland (Simpson et al. 2016). Based on observations of lumpfish held in captivity in Newfoundland,

sexual maturity typically occurs at about three years of age (D. Boyce, OSC, pers. comm., 20 March 2018). In the event of an escape event, the sexually-immature lumpfish will not be able to immediately genetically interact with wild lumpfish, and ecological interaction with wild lumpfish would likely be negligible.

- In the event of a detectable acute escape event, Grieg NL will immediately contact DFO seeking permission to commence recapture efforts in the marine environment. While the recapture effort would focus on escaped farmed salmon, there would also be potential to recapture escaped cleaner lumpfish. 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 as per Condition 'l' of the Government of Newfoundland and Labrador's Project release letter). Acquiring permission from DFO to commence recapture efforts will depend on the timing of the escape. If wild salmon 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 cleaner fish recovered.

4.0 Frequency, Duration and Geographic Extent of Monitoring

If monitoring is deemed necessary after completion of the genetics study on wild lumpfish, then the frequency, duration, and geographic extent of monitoring for potential interaction between escaped cleaner lumpfish and wild lumpfish will be determined through consultation with DFO scientists.

4.1 Frequency

To be determined.

4.2 Duration

To be determined.

4.3 Geographic Extent

To be determined.

5.0 Reporting and Response Mechanisms

Grieg NL will adhere to all reporting requirements as per Aquaculture Policy (AP 17; DFLR 2019). For all escape events, Grieg NL will immediately provide verbal notification of the escape to the Assistant Deputy Minister of Fisheries and Aquaculture, DFLR, 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.

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 that would be included in the annual report will be determined through consultation with DFO. As already stated, details of monitoring programs for potential genetic and ecological interactions between escaped Grieg NL cleaner lumpfish and wild lumpfish will be developed once results of the ACRDP genetics study are available

6.0 Approach to Monitor Cumulative Effects

If deemed necessary by results of the ACRDP genetics study, an approach to monitor cumulative effects will be determined through consultation with DFO.

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

If deemed necessary by results of the ACRDP genetics study, procedures to assess the effectiveness of monitoring and follow-up programs, mitigation measures and recovery programs will be determined through consultation with DFO.

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, if deemed necessary by the results of the ACRDP genetics study, present the findings of this EEMP in its annual EEMP report. The report will be made available publicly on Grieg NL's website. If deemed necessary based on the results of the ACRDP study, the annual report will include details of monitoring programs for potential genetic and ecological interactions between escaped Grieg NL cleaner lumpfish and wild lumpfish; an approach to monitor potential cumulative effects; and procedures to assess the effectiveness of monitoring and follow-up programs, mitigation measures and recovery programs if required.

9.0 Literature Cited

DFLR (Department of Fisheries and Land Resources). 2019. Aquaculture Policy and Procedures Manual. 135 p. Available at https://www.fishaq.gov.nl.ca/licensing/pdf/Aquaculture_Policy_Procedures_Manual.pdf.

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Appendix 1. Letter of Support from Fisheries and Oceans Canada

Fisheries and Oceans Canada | Pêches et Océans Canada

October 21, 2019

Re: Cleaner fish genetic study

To whom it may concern:

I am writing to confirm my collaboration with Greig NL on an ongoing study of the genetic structure of wild cleaner fish populations in Atlantic Canada to directly inform their Environmental Effects Monitoring Plan. The effective management of sea lice continues to be a top priority for the Atlantic Salmon aquaculture industry, and our collaborative project directly addresses the need for research on cleaner fish (lumpfish and cunner) population genetics to assist with the estimation of any potential ecological genetic effects on local populations of Cunner and Lumpfish around Newfoundland and Labrador. We expect data from this project to be available within 12-24 months to inform the Environmental Effects Monitoring Plan. Please do not hesitate to contact me if I can be of assistance.

Yours sincerely,

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