BC SALMON FARMERS

# Written Submission to the Standing Committee on Fisheries and Oceans

# State of Pacific Salmon Study

May 7 2021

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## Introduction

Thank you for the opportunity to provide input into your committee's work on the State of Pacific Salmon. This document is comprised of contextual industry information, as well as a review of scientific literature on pertinent issues, heard by the committee through witness testimonies. There are also several references provided throughout this document and attached as appendices that we hope will assist in your study.

## SUMMARY OF KEY CONSIDERATIONS

***Clarification on the Discovery Islands Farm Closure Decision***

- All DFO CSAS risk assessments (including PRV) indicated a less than minimal risk posed by farmed salmon in the Discovery Islands to migrating Fraser River sockeye.
- The decision made by the Minister to close the farms was not based on the outcome of these risk assessments, but on the outcome of subsequent consultations with First Nations in the Discovery Islands region[1],[2].

***Pathogens & Disease***

- ***BC farmed salmon are healthy.*** Evidence presented from fish farm data (through DFO reporting) indicates that "mortality events" are overwhelmingly (nearly 100% in 2019) due to environmental and mechanical (handling) incidents, rather than disease; and about 80% of "fish health events" (where disease is known to be a factor) were due to the prevalence of three diseases historically common and managed in populations of BC farm-raised salmon.
- Given that there have been no major die-offs, or significantly high numbers of uncontrollable fish health events on farms, it does not stand to reason that BC farmed salmon are spreading highly infectious and harmful diseases to wild populations. In perhaps a clear example of the impact of social distancing, crowded populations, as those in a farm setting, would be the first to display problems due to a contagion event.
- ***Pathogen detection does not equate disease.*** Pathogen detection alone is insufficient to allow inferences of the overall health status of wild fish populations and requires the context of host susceptibility, virulence of pathogen strains, and environmental conditions (Jia et al., 2019). Therefore, it is inaccurate to assume that because pathogens or their DNA are detected in proximity to a salmon farm that they are causing disease issues for wild salmon who swim in proximity to a farm. This has been a common assumption of Strategic Salmon Health Initiative (SSHI) work, but further research has never been conducted to verify assumptions that pathogen presence is causing disease. There is an absence of evidence to indicate the assumption is correct.
- ***Incorrect to assume salmon farms have introduced "novel viruses".*** Recent Strategic Salmon Health Initiative (Miller-Saunders et al.) studies have noted that a finding of PRV

[1] News Release – Discovery Islands consultations Sept. 2020.
[2] News Release – Discovery Islands Decision Dec. 2020.

in archived samples from 1977 was not repeatable and had not been confirmed by genetic sequencing. Since the time of those publications, it ***has*** been confirmed by genetic sequencing, with references found in GenBank (1)(2). This indicates that PRV was in BC waters prior to Atlantic salmon farming.

- The SSHI authors fail to acknowledge that it is also possible that PRV, or any other viruses with origins in the North Atlantic, could have been introduced to BC waters when more than 8 million wild Atlantic salmon were introduced to BC rivers and streams over a century ago between 1905 and 1935, under the federal government to establish populations of the Atlantic salmon in BC as part of an angling program.
- ***Risk from BC isolate of Piscine Orthoreovirus (PRV).*** There is a weight of evidence that indicates that the PRV isolate found in BC does not cause disease in wild or farmed salmon in the Pacific (Garver et al., 2016, Polinski et al., 2019, Zhang et al., 2019) and Heart and Skeletal Muscle Inflammation (HSMI) (associated with PRV elsewhere) has not been diagnosed by licenced veterinarians caring for fish in British Columbia.
- Importantly, Norwegian researchers, Wessel et al., 2020, in a lab study to compare the onset of PRV infection between different isolates confirmed that high virulent (Norwegian) isolates induced cardiac lesions consistent with HSMI. The low virulent isolates (three historical Norwegian isolates, and one Canadian (BC) isolate) induced only mild cardiac lesions.
- ***Risk from Tenacibaculum maritimum.*** There has been much speculation raised recently in the media and during testimonies at this committee that Tenacibaculum maritimum associated with fish farms is having detrimental effects on wild salmon populations.
- A recent study through the SSHI (Bateman et al., 2020) indicated elevated loads of T. maritimum on dead and dying fish in BC farmed populations. This is an expected finding as it has been a known fish welfare issue which results in economic losses due to mortality and antibiotic treatments (Frisch et al., 2018).
- Tenacibaculosis is considered a farmed smolt disease in B.C, with few cases in farmed fish detected after six months at sea.
- No outbreaks of Tenacibaculosis have been reported in wild salmon.
- Detection of Tenacibaculum species in the environment does not equal presence of disease, as these bacteria are ubiquitous and environmental studies have detected it in diverse substrates and organisms, in absence of clinical disease.

***Sea Lice***

- ***Annual variation.*** The rate of sea lice infestation changes from year to year on both farm-raised and wild salmon. This is directly linked to annual changes in wild host populations and environmental conditions (saltier, warming waters).
- ***Integrated Pest Management.*** The industry manages sea lice through an integrated pest management approach. This is a multi-pronged approach, taken collaboratively, while also adhering to rigorous regulation and meeting globally certified standards such as the Aquaculture Stewardship Council (ASC) standard.
- ***Expanded treatment strategies.*** Industry has expanded treatment strategies to include alternative, non-chemotherapeutic options, following globally developed and accepted,

cutting-edge technologies. These new investments allow the industry to diversify treatments away from a reliance on the sole use of in-feed chemotherapeutants treatments (SLICE®) for sea lice.

- ***Out-migration.*** A precautionary approach has been adopted during the out-migration of juvenile salmon. Extra precautions taken during this period include increased monitoring to provide early detection of increasing numbers and increasing capacity of new non-medicinal treatments and adopting responsible medicinal treatments to shorten response times to increasing lice levels.
- ***Wild monitoring.*** An independent and third-party company (environmental consultants (Mainstream Biological Consulting (MBC)) is engaged to monitor wild juvenile salmon for the presence of sea lice on out-migrating juvenile salmon. Sampling stations provide data before and after they swim past salmon farms during the spring out-migration period. These initiatives are conducted in several regions of coastal BC.
- The effectiveness of industry's sea lice interventions is reflected by observations of sea lice abundance on wild juvenile salmon in all farming operating regions. A point of note, sampling in the mid-coast region in 2020, approximately 30 km from the nearest salmon farm, MBC found historically higher numbers of lice on wild juvenile salmon. These high counts are likely due to optimal ocean conditions and higher sea lice numbers on wild hosts in the region[3]. Further, their report from the Discovery Islands region[4], shows that the number of sea lice on pink and chum salmon (the species actively out-migrating during the sampling period) were similar in both the pre- and post- farm location samples – in some cases rising slightly, in other cases declining. Some of the highest levels of sea lice were found in the Broughton area where salmon farms have been removed[5].

***Status of Wild Salmon.***

- ***Complexities in stock assessment and changing environment***. In considering the potential impacts of Atlantic salmon aquaculture in BC on wild stocks, it is important to consider the much larger picture of the complexities surrounding Pacific salmon stocks and the extensive resources that have been applied to understanding population dynamics. Significant work has been done by DFO to understand the variations in stocks over time, and to understand the changing environment. Research has also shown that the decline of wild Pacific salmon is likely most influenced by broader oceanic factors rather than local inputs. Consecutive years of warm water intrusions from the south are effectively making the west coast of Vancouver Island like the nearshore California Current, with a high abundance of species such as jelly fishes, and low abundance of crustaceans, and marine heat waves appear to be the new normal (2019 State of the Pacific Ocean technical report).

[3] Wild Juvenile Salmonid Monitoring Program 2020 – Quatsino Sound. Mainstream Biological Consulting.
[4] Wild Juvenile Salmonid Monitoring Program 2020 – Discovery Islands, BC. Mainstream Biological Consulting.
[5] Wild Juvenile Salmonid Monitoring Program 2020 – Broughton Archipelago, BC. Mainstream Biological Consulting.

Document Quick Links

## The Discovery Islands Decision

We wanted to first provide information concerning the recent decision by the Minister of Fisheries and Oceans Canada to close farms within the Discovery Islands region by June 2022 (within 18-months, without allowance of restocking during that time).

These sites were slated for licence renewal in December 2020. As a result of recommendation 19 of the 2009 Cohen Commission Inquiry into the decline of Fraser River Sockeye, in September 2020, the Minister was to consider all available science to indicate the risk that farms in the region posed to Fraser River Sockeye at that time. If a greater than minimal risk was perceived, the farms were to close. The farms in this region were operating on annually renewed licences since the completion of the Cohen Commission. In order to ensure science was available to make this decision, DFO nationally, over the past several years, led nine risk assessments through the Canadian Science Advisory Secretariat, with a focus on pathogens of potential harm that could be shared between farmed and wild salmon in the region. All risk assessments[6] indicated a less than minimal risk (including PRV). The decision made by the Minister to close the farms was not based on the outcome of these risk assessments, but on the outcome of subsequent consultations with First Nations in the Discovery Islands region[7],[8].

There are ongoing judicial reviews surrounding this decision. However, of note, a recent injunction was won by Mowi Canada West and Saltstream Engineering to implore government to reconsider the decision to not allow the restocking of three farms in the region. [9]

## Disease; Pathogen and Parasite Interactions

### Bacterial and Viral Pathogens on Fish Farms

Evidence presented from fish farm data (through DFO reporting) indicates that "mortality events" are overwhelmingly (nearly 100% in 2019) due to environmental and mechanical (handling) incidents, rather than disease; and about 80% of "fish health events" (where disease is known to be a factor) were due to the prevalence of three diseases historically common and managed in populations of farm-raised salmon (Mouthrot, Salmonid Rickettsial Septicemia, and Winter Ulcers).

Through health management plans, salmon farmers invest significant time and resources in ensuring healthy stocks. Farmers assess feed rates, water quality and behaviour; conduct routine sampling and regular veterinary care. For fish health challenges with a sudden onset, mortality and morbidity are often the leading indicators. However, for longer term health challenges, production based data, routine sampling and observations are often early

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[6] CSAS Discovery Island Risk Assessments.
[7] News Release – Discovery Islands consultations Sept. 2020.
[8] News Release – Discovery Islands Decision Dec. 2020.
[9] BIV. April 5 2021.

indicators. Few farmed fish die of infectious disease, indicating that these strategies are effective. Beyond a concern for fish welfare, it is not financially feasible to farm diseased fish. Simply put, it is important to farmers to maximize growth, survival, fish welfare and environmental sustainability.

It has been clear that when farm-raised salmon become sick with a highly virulent disease-causing pathogen, the effects to stocks are devastating (e.g. Saksida, 2006 (IHN epidemic in farmed Atlantic salmon); Qviller et al., 2020 (ISA management in Norwegian farmed Atlantic salmon)). Given that there have been no major die-offs, or significantly high numbers of uncontrollable fish health events on farms, it does not stand to reason that BC farmed salmon are spreading highly infectious and harmful diseases to wild populations. In perhaps a clear example of the impact of social distancing, crowded populations, as those in a farm setting, would be the first to display problems due to a contagion event. Of interest, Rechisky et al., 2021, in a wild salmon tagging study to investigate the time spent by an average juvenile salmon near a salmon farm in the Discovery Islands found that "the median time near individual farms was 4.4 min in 2017 when farms were fallow and 10.9 min in 2018 when farms were stocked." This would imply that the time a juvenile wild salmon spends near a population of farmed salmon is relatively minimal.

Concerning the most common on-farm diseases noted by DFO through fish health audits and their causative agents, as mentioned previously DFO has completed Canadian Science Advisory Secretariat Risk Assessments on three of these diseases, and six others (including PRV). In each case, it was found that the risk posed by each is minimal to Fraser River sockeye (see footnote 1 on page 1).

## Salmon farms as reservoirs of pathogens

Pathogen detection or detection of DNA associated with a pathogen does not imply the presence of disease. As cited from Jia et al., 2019, "pathogen detection alone is insufficient to allow inferences of the overall health status of wild fish populations and requires the context of host susceptibility, virulence of pathogen strains, and environmental conditions." Therefore, it is inaccurate to assume that because pathogen eDNA or active or inactive pathogens may be detected in the marine environment in and near farms, they are causing disease issues for wild salmon who swim in proximity to a farm.

For example, recently referenced in discussing this research area, Shea et al.,2020, assumed that the presence of genetic material is indicative of active viruses which will cause disease. Based on an increased amount of viral genetic material near farms, the authors speculated that the probability of a wild salmon encountering a pathogen was significantly higher in the vicinity of active salmon farms when compared to inactive sites, and that fish farms increase the likelihood that juvenile salmon will encounter an infectious agent during their outward migration. This paper does not explore evidence to show that the detected genetic material was causing disease either in farmed or wild fish. Further, the presence of genetic material of

potential pathogens in the marine environment is not indicative of viable viruses. Viruses are among the most abundant biological agents in the sea and their genetic material (DNA or RNA) can be detected everywhere. Further, Shea et al., 2020, noted sampling near active farms and fallowed farms but did not sample away from farming areas to show a true representation of eDNA found in the marine environment. And so, the authors draw several conclusions based on the assumption that the eDNA present in the samples collected were there due to salmon farms, and then made assumptions that the presence of viral sequences of eDNA could potentially mean that infection pressure for wild salmon near farms was high.

The authors disclose that pathogenic genetic material can be found even if the pathogen is non-infectious. Further, the authors include that it is unclear where the genetic material that they found came from or whether it indicated viable pathogens infectious to wild salmon. The authors state "…*this study relied solely on eDNA and, therefore, we cannot explicitly relate the occurrence of pathogens to infection risk*". They also note that "… *the extent of dispersal and the duration of viability for each pathogen species remains to be characterized. In the marine environment, pathogen survival is highly variable ranging from the rapid decay of some RNA viruses to the weeks-long viability of some bacteria outside their host*".

### Origins, infectivity of "novel" viruses, and the example of piscine reovirus (PRV)

There is also significant speculation associated with the origin of some of the "novel" viral material in relation to BC salmon farms, detected through the Strategic Salmon Health Initiative (SSHI) studies. Mordecai et al., 2020 states that it seems plausible that Atlantic salmon calicivirus (ASCV) originated from Norwegian Atlantic salmon that were introduced to BC for aquaculture. Similarly, for PRV, there is an assumption that it was brought to the region by Atlantic salmon from Norway, for the purposes of aquaculture. Previous studies have indicated PRV had been found in archived samples from the West coast of North America. The earliest on record was from a wild steelhead trout in 1977 (Marty et al., 2015), prior to the establishment of Atlantic salmon farming in BC. Recent SSHI studies have noted that this finding was not repeatable and had not been confirmed by genetic sequencing. Since the time of those publications, it has been confirmed by genetic sequencing, with references found in GenBank (1)(2).

Regardless of this, the SSHI authors fail to acknowledge that it is also possible that PRV, or any other viruses with origins in the North Atlantic, could have been introduced to BC waters when more than 8 million wild Atlantic salmon were introduced to BC rivers and streams over a century ago between 1905 and 1935, under a federal government program. This was done in a plan to establish populations of the Atlantic salmon in BC as part of an angling program[10].

In terms of the new and novel viral genetic material detected by the SSHI work, (particularly ASCV and Cutthroat trout virus (CTV-2)) there has been no evidence that these cause disease in

[10] Vancouver Sun, 2017.

salmon, either farmed or wild. As mentioned, viruses are among the most abundant biological agents in the sea and their genetic material (DNA or RNA) can be detected everywhere (Suttle, 2007). As indicated by Fisheries and Oceans Canada's audit data, farmed salmon are tested for a number of pathogens before being introduced to ocean pens and must be certified as healthy before being transferred.

In further considering the PRV example, it is important to separate scientific fact from speculation. As previously noted, there is now genetically sequenced evidence that PRV has existed in BC waters since at least 1977 when it was found in a wild steelhead archived sample. This would place PRV in BC waters before Atlantic salmon farming. Therefore, naming PRV as an "emerging" virus related to aquaculture is an inaccurate statement. The other important fact concerning the BC isolate of PRV-1 is that it is not causing disease in BC farmed salmon as is seen in the Norwegian Atlantic salmon farming industry (see pg.56 of "The Health Situation in Norwegian Aquaculture", 2019), where it has been indicated as one of the top three most important diseases to affect the industry in the past several years. Although PRV-1 has been shown to be highly infectious both among and between salmonid species, there is also a weight of evidence that indicates that the strain found in BC does not cause disease in wild or farmed salmon in the Pacific (Garver et al., 2016, Polinski et al., 2019, Zhang et al., 2019) and HSMI has not been diagnosed by licenced veterinarians caring for fish in British Columbia. Importantly, Norwegian researchers, Wessel et al., 2020, in a lab study to compare the onset of PRV infection between different isolates confirmed that: "there are virulence differences between PRV-1 isolates in Atlantic salmon regarding induction of histopathological changes typical for HSMI. The high virulent isolates, that is, two Norwegian field isolates (NOR-2018/SF, NOR-2018/NL), induced cardiac lesions consistent with HSMI. The low virulent isolates, that is, three historical Norwegian isolates (NOR-1997, NOR-1996, NOR-1988) and one Canadian isolate (CAN 16-005ND) induced mainly mild cardiac lesions".

See Appendix A for further information on PRV and HSMI provided by the DFO Regional Director of Science, Carmel Lowe, on September 30, 2020, in response to a group email from Alexandra Morton to the Fish Health Technical Working Group, concerning recent findings on PRV.

### *Tenacibaculum maritimum* (and Mouthrot, or Yellow Mouth)

Mouthrot, or bacterial stomatitis, is a disease which mainly affects farmed Atlantic salmon, (Salmo salar, L.), smolts recently transferred into salt water in both British Columbia (BC), Canada, and Washington State, USA (Frisch et al., 2018). Frisch et al., 2018, through lab challenge studies, confirmed that Tenacibaculum maritimum is the causative agent of this disease.

There has been much speculation raised recently in the media and during testimonies at this committee that Tenacibaculum maritimum associated with fish farms is potentially having detrimental effects on wild salmon populations. A recent study through the SSHI (Bateman et

al., 2020) indicated elevated loads of T. maritimum on dead and dying fish in BC farmed populations. However, this is an expected finding as it has been a known fish welfare issue which results in economic losses due to mortality and antibiotic treatments (Frisch et al, 2018). Tenacibaculosis is considered a farmed smolt disease in B.C, with few cases detected after six months at sea. No outbreaks of Tenacibaculosis have been reported in wild salmon.

Detection of Tenacibaculum species in the environment does not equal presence of disease, as these bacteria are ubiquitous and environmental studies have detected it in diverse substrates and organisms, in absence of clinical disease.

There are no current vaccines for *Tenacibaculum spp*. Outbreaks are treated using the antibiotic Florfenicol to limit mortality until natural immunity is achieved by the fish, usually 4-6 months after entering salt water.

Isolates are obtained from fish during different stages of the outbreak and monitored for antimicrobial resistance. To date, no loss of Florfenicol efficiency has been detected. There is on-going research into vaccines and ways to boost natural immunity.

## Emerging diseases and novel research techniques – the SSHI

The Strategic Salmon Health Initiative initially showed great promise in its beginnings. It was meant to significantly improve the understanding of the potential impact of farmed salmon on wild salmon populations by first identifying and discovering viruses infecting fish and then importantly, ***determining the impacts of these viruses and their ability to cause disease.*** However, this 10-million-dollar program has not moved beyond viral discovery, the second of four planned phases. This is in despite of running years past the original end date, with consultations and collaboration being extremely limited.

For further context around the SSHI and BCSFA's involvement, please see Appendix B. BCSFA SSHI Letter to the Minister June 25, 2020.

### *Validation of technologies*

The SSHI studies are based on the use of novel technology - the Fluidigm BioMark$^{TM}$ Platform and Viral Disease Development (VDD) technology. It is important to note that there has not been a full (peer-reviewed) validation of the diagnostic accuracy of the VDD approach across a range of salmon species and important viruses.

High throughput molecular screening is important, and host gene activation is interesting, but needs context. However, it is premature to suggest that these would be appropriate for fish health diagnostics. The investment in the investigation of molecular diagnostic tools for human health is far greater than that of fish health. And yet, we are still at very early stages of the utilization of host gene activation in human medicine.

The fundamental pathogenesis or disease progression and susceptibility in each species for each agent is not known. There is agreement that there is merit in this work. However, there is not enough research and evidence to indicate that host gene activity could be used in this way.

With a lack of technique validation to reference, it would be important that the researchers fully describe limitations in their methodology, and exercise full transparency with their data. However, SSHI publications do neither.

*Detecting disease mediated mortality in wild fish*

One of the key assumptions made by the body SSHI research is that diseased fish, even minimally symptomatic, would be more likely to be preyed upon or otherwise drop out of the general population due to poor fitness and condition, and therefore it would be difficult to find diseased wild fish for the purposes of studying disease in wild populations. This statement is negated by evidence from studies on disease in wild fish both locally and globally. If a novel disease was having significant impacts on a fish stock, so much so that it significantly affects a population, it is likely that diseased fish at various stages would be discovered in the environment. Though dated, as an example, Olivier and MacKinnon (1998), and references there in, discuss epizootic events that have impacted wild salmonid species globally, in the context of wild and farmed associations and fish transfers. Additionally, through the national aquatic animal health surveillance program, the Canadian Food Inspection Agency monitors for aquatic animal diseases and functions as the focal point for the collection, analysis and dissemination of surveillance data.

*The Precautionary Approach*

SSHI research also often cites the importance of taking a “precautionary approach” or applying the precautionary principle, in the management of salmon aquaculture with regards to the unknowns on how precisely the sector is impacting upon the health of wild Pacific salmon in BC. That is to say, they imply that there is more than minimal risk of harm from farm to wild salmon, and they advocate for the elimination of BC salmon farming from the coast out of an abundance of caution. However, it is interesting to note other ways in which this term has been applied elsewhere, including by the Canadian federal government.

For example, in a recent news release concerning the opening of the herring fishery in the Georgia Strait, the Minister of Fisheries and Oceans was quoted as saying:

> *"Our government understands the need to protect the health and sustainability of coastal British Columbia's herring stock, which is a forage fish vital to the entire ecosystem. After rigorous scientific stock assessments, the results demonstrate a healthy and stable herring stock in the Strait of Georgia, which has been consistent for the past decade. We are applying the*

> ***precautionary approach*** *to ensure the long term viability of herring for our ocean ecosystems and harvesters alike".*

That is to say, it is important that evidence be equally contemplated across all available peer-reviewed research when considering the level of risk and taking precautions to respond to those risks in resource management decisions.

Considering this in terms of the impacts of farmed to wild salmon in the environment, the DFO CSAS risk assessments, as referenced previously, should play an important role in indicating that the risk of harm is less than minimal (footnote 6, pg.6).

## Conclusions – Viral and bacterial pathogens

Despite the impressive number of publications from the SSHI on this topic, it could be argued that the program has created more speculation than answers on the impacts of salmon farms to wild salmon. As noted in the 2017 Seafood Watch review of the BC net pen Atlantic salmon farming industry, "there is currently insufficient evidence to conclude that population-level impacts to wild salmon are occurring due to pathogen and/or parasite transfer from salmon farms" (pgs. 6, 57, 84).

## Parasitic Sea Lice

The following sections are meant to provide further context on sea lice management in the BC salmon farming industry and to supplement the committee's information concerning sea lice and wild salmon.

## Sea lice ecology

Sea lice have lived in BC's coastal and ocean waters for thousands of years[11] and are common parasites on Pacific salmon in the marine environment off BC's coast. There are two species of sea lice found on salmon, *Caligus clemensi* and *Lepeophtheirus salmonis. C. clemensi* affects many species of marine fish and is considered transient, while *L. salmonis* is found only on salmon and related species.

It is well documented that adult Pacific salmon migrating from the open ocean and aggregating in coastal areas, prior to entering their natal rivers to spawn, carry large numbers of sea lice. For example, a 2005 *Beamish et al.* study[12] concluded that lice had infected adult wild salmon long before they approached the coastal salmon farming areas. In that study, virtually 100% of all the adult Pacific salmon sampled carried sea lice prior to entering areas with salmon farms.

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[11] Sea lice management at BC salmon farms, Fisheries and Oceans Canada.
[12] Beamish, R.J., Neville, C.M., Sweeting, R.M., Ambers, N. 2005. Sea lice on adult Pacific salmon in the coastal waters of central BC, Canada.

The average number of lice carried by those wild salmon was 3-fold higher than the threshold level permissible on salmon farms in BC (3 motile/fish of *L. salmonis*).

The offspring of sea lice carried in from offshore by spawning salmon elevate the number of sea lice in coastal waters, where they infect juvenile Pacific salmon that have not yet migrated. Although farm-raised salmon are lice-free when they go into ocean pens, they are susceptible to sea lice infestations, particularly caused by *L. salmonis*. Farmers will often see a surge in the number of sea lice on a farm after large numbers of adult wild salmon swim past during migration. It is the industry's responsibility is to keep levels of sea lice on farms low, so they don't transfer back to wild salmon. See the BCSFA Performance Dashboard – Sea Lice Indicator, for more information and a visualization of annual sea lice trends.

### Challenges

The rate of sea lice infestation changes from year to year on both farm-raised and wild salmon. This is directly linked to annual changes in wild host populations and environmental conditions (saltier, warming waters).

Factors such as high numbers of Pacific herring, for example, can be correlated to elevated lice counts of *C. clemensi* on farm-raised salmon in the same region, at that particular time. Fraser River sockeye (a population of concern) is mainly parasitized by the generalist sea louse *C. clemensi*, and it is not possible to attribute the impacts observed by studies such as Godwin et al. (2017) solely to salmon farms given the range of hosts for this sea lice species (Seafood Watch, 2017). Additionally, an increase in wild salmon returns in the autumn months of one year can be correlated to elevated lice counts of *L. salmonis* in the following spring, for wild and farm-raised salmon in the same region.

Higher-than-average water temperatures and salinity are conducive to sea lice reproduction. Years with low snowpack or winter precipitation can create high temperatures paired with high salinity (due to decreased freshwater mountain run off), which is an optimal breeding environment for sea lice.

### Solutions

High sea lice levels on farms threatens the health and safety of cultured fish and poses the potential to transfer lice from farms back to wild fish. It is a goal of the BC salmon farming industry to manage sea lice levels and ensure both farmed and wild stocks are kept safe. Science has shown that this goal is achievable (Rogers et al., 2013). The industry manages the risk of sea lice transferring back from farms to wild salmon with an integrated pest management approach, meaning a multi-pronged approach is taken, collaboratively, while also adhering to rigorous regulation and meeting globally certified standards such as the Aquaculture Stewardship Council (ASC) standard. See Appendix C for the BC Salmon Farmers IPM Memorandum of Understanding (MOU).

Integrated Pest Management means:

- **Prevention** – Farms are managed to minimize lice levels and use good animal husbandry to keep numbers low. This includes applying an area-based management approach where companies coordinate management of all farms in an area together. BC salmon farmers have signed a Memorandum of Understanding in agreement on the measures companies will take in an integrated pest management approach, island-wide, and specifically in the Discovery Islands. Management practices such as production timing (stocking and harvesting), having a single year class of fish on farms, fallowing between production cycles contribute towards more effective management of *L. salmonis* on farms.
- **Monitoring** – Industry monitors the presence of sea lice as part of a farm's routine operations. With some exceptions, regulations require biweekly (every two weeks) sampling frequency. The majority of farms now comply with the Aquaculture Stewardship Council's requirement by increasing the frequency of lice monitoring during wild salmon migratory periods to weekly. Some companies may also elect to continue with weekly sampling during non-outmigration periods.
- **Response** – Industry applies multiple tools[13] to keep sea lice numbers low and respond when they increase. Fisheries & Oceans Canada's regulatory oversight is rigorous and requires salmon farmers to maintain the numbers of sea lice below three motile sea lice (*L. salmonis*) per fish. Levels above this threshold require mandatory actions to reduce the levels below the 3.0 motile level within a specified time-frame. There are no management thresholds in place for Caligus. Treatment options include freshwater and medicinal (Interox-Paramove 50) baths (in wellboats), mechanical delousing), the oral therapeutant SLICE® (emamectin benzoate (EB)) and full harvesting of farms.

In the case of freshwater baths, medicinal baths and mechanical delousing, the sea lice that are removed from the fish are captured in the effluent water and disposed on land.

## Technological Innovations and Investments to Respond

The sector is committed to doing the work described in the Integrated Pest Management MOUs effectively. They have expanded treatment strategies to include alternative, non-chemotherapeutic options, following globally developed and accepted, cutting-edge technologies. These new investments allow the industry to diversify treatments away from a reliance on the sole use of in-feed chemotherapeutants treatments (SLICE®) for sea lice.

- **Mechanical Delousing:**
  - This technology uses pressurized water to detach sea lice from salmon, allowing sea lice to be collected separately and composted on land. In 2018, Mowi Canada West launched a $2.7-million Hydrolicer, and spent another $35 million on the Aqua Tromoy de-licer in 2019. Over the past two years Cermaq Canada has also spent over $25 million on mechanical delousing technologies.

[13] Vancouver Sun, November 2018. Hydrolicer.

- **Bath Treatments:** All bath treatments in BC use wellboats. These are large vessels that can be deployed for many purposes related to salmon aquaculture, including transporting fish. They are also useful for bath treatments. Bath treatments for the purpose of removing sea lice can either be in the form of freshwater, or a dilution of Interox ® Paramove ® 50 (hydrogen peroxide).
    - **Freshwater treatments:** Exposure to freshwater causes sea lice to detach from salmon, allowing sea lice to be collected separately and composted on land.
    - **Interox ® Paramove ® 50 (hydrogen peroxide**): A dilution of hydrogen peroxide causes the lice to detach from the salmon. Sea lice are collected and composted on land. The water in the well is released into an appropriate part of the ocean – where currents disperse and dilute the solution, which rapidly breaks down into water and oxygen. When done properly with a wellboat to contain the treatment, tests show there is no lingering chemical in the ocean afterwards. This is a cautious, responsible approach approved by the Aquaculture Stewardship Council (ASC) and regulatory agencies.
- **Other Containment Measures:** Several innovative research and development projects are underway, including investigations of potential applications of semi-closed containment (SCC) and floating, fully-closed containment (CC) systems, as well as off-shore systems. For example, Cermaq Canada has assembled and deployed a floating semi-closed containment system in Clayoquot Sound within the traditional territory of the Ahousaht First Nation. Grieg Seafood has also installed SCC systems for testing at two of its Sunshine Coast farms and at one site in Esperenza Inlet. SCC systems are equipped with technological barriers to protect farm-raised fish from sea lice but to also inhibit the transfer of fish and potential pathogens to the outside environment during the ocean grow-out phase.

## A note on the efficacy of Slice® and other treatments

A publication of Living Oceans Society, (Wristen, 2020) implies that: "…resistance to EB is developing in many regions of BC despite the relatively low frequency of use of EB with approximately half the sites treated each year, and at an average frequency of less than once per production cycle" but recognizes that the data showing this has not been independently verified. In considering the effectiveness of treatment methods, it is important to understand the mechanisms by which these treatments work. Non-therapeutant methods do not offer residual protection like EB. Therefore, total number of overall treatments may increase. The following insight on treatment efficacy was provided by Mowi Canada West (MCW).

- From a performance perspective, analysis of MCW freshwater interventions at pen-level in 2020 demonstrated over 90% decrease in lice abundance in the two weeks following freshwater treatment.
- Analysis of MCW Hydrolicer® interventions at pen-level in 2020 demonstrated over 60% decrease in lice abundance during the intervention, and over 70% decrease after a week.

- Analysis of MCW H2O2 treatments at pen-level in 2020 demonstrated over 90% decrease in lice during treatment.
- Analysis of MCW EMB treatments at farm-level (because the whole farm is treated at the same time) in 2020 demonstrated there is an interval following the onset of treatment for the concentration of EMB in tissue to attain therapeutic dose, then from 2 weeks post initiation of treatment onwards there is a continual decrease in lice inventory following the onset of EMB treatment for many weeks.
- Overall, the three externally applied interventions demonstrate fast-acting knockdown approaches to reducing the number of sea lice on farms. In contrast, EMB/ SLICE® has a slow uptake but reduces lice numbers over a longer term.
- The duration of any of these interventions is influenced by environmental conditions affecting the biology of the sea lice (and host) described above.

### Sea Lice Monitoring during Pacific Salmon Out-Migration

The BC salmon farming industry acknowledges the challenges that come with high lice levels on wild returning adult salmon and applies management of stocks to reduce impacts prior to the out-migration period. This includes pre-migration sampling in February to identify responses to levels of concern prior to the outmigration period. It is industry's intention to enter the out-migration period with low average lice levels.

A precautionary approach has been adopted during the out-migration of juvenile salmon. Extra precautions taken during this period include increased monitoring to provide early detection of increasing numbers and increasing capacity of new non-medicinal treatments and adopting responsible medicinal treatments to shorten response times to increasing lice levels.

Each year in February, immediately prior to the wild juvenile out-migration, each farm is required to sample all cages for sea lice levels. Sampling on each farm is split over two periods – once in the first-half of the month and second in the second-half of the month. If the threshold of 3.0 motiles/fish is exceeded, the farm is required to report the findings to DFO within 48 hours and indicate the measures that will be taken to ensure the lice levels are below the threshold prior to the start of the out-migration period (starting March 1). Monitoring and reporting are also to continue at least once every two weeks following March 1 for the term of the migratory period, and many farms sample weekly.

During the out-migration period (March 1 – June 30), sea lice counts are required over the first week, and every two weeks following for the extent of the out-migration window. If the threshold of 3.0 motiles/fish is exceeded, the company is required to report findings to DFO within 48 hours and notify the Department of the operator's management measures that will be activated to reduce sea lice levels below threshold within 42 days (based on the activation time for maximum protection of Slice®). Following discovery of a threshold exceedance event, a follow-up count is conducted one week later.

### Transparency in reporting

Committed to transparency, salmon farmers publish sea lice data on their websites. Sea lice data can also be found through DFO's website (see links below).

Mowi Canada West: CLICK HERE
Cermaq Canada: CLICK HERE
Grieg Seafood BC: CLICK HERE
DFO Audits: CLICK HERE

### Wild salmon and sea lice

While it has been demonstrated that salmon farms can be a source of lice infection for wild salmon (e.g., Marty et al., 2010), quantifying the impact of that transmission to wild salmon individuals and populations has been heavily debated, particularly given the existence of confounding factors, such as multiple sources of mortality, complex wild salmon population dynamics, environmental stochasticity, and observation errors in both salmon and sea lice data (Peacock et al., 2013). Nevertheless, it is important that measures be taken to monitor and manage the pressures of sea lice on wild stocks where possible.

BC salmon farmers support ongoing scientific investigation of sea lice population dynamics to better inform their management practices. An independent and third-party company (environmental consultants (Mainstream Biological Consulting (MBC)) is engaged to monitor wild juvenile salmon for the presence of sea lice on out-migrating juvenile salmon. Sampling stations provide data before and after they swim past salmon farms during the spring out-migration period. These initiatives are conducted in several regions of coastal BC.

The effectiveness of industry's sea lice interventions is reflected by observations of sea lice abundance on wild juvenile salmon in all farming operating regions. A point of note, sampling in the mid-coast region in 2020, approximately 30 km from the nearest salmon farm, MBC found historically higher numbers of lice on wild juvenile salmon.  These high counts are likely due to optimal ocean conditions and higher sea lice numbers on wild hosts in the region[14]. Further, their report from the Discovery Islands region[15], shows that the number of sea lice on pink and chum salmon (the species actively out-migrating during the sampling period) were similar in both the pre- and post- farm location samples – in some cases rising slightly, in other cases declining. Some of the highest levels of sea lice were found in the Broughton area where salmon farms have been removed[16].

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[14] Wild Juvenile Salmonid Monitoring Program 2020 – Quatsino Sound. Mainstream Biological Consulting.
[15] Wild Juvenile Salmonid Monitoring Program 2020 – Discovery Islands, BC. Mainstream Biological Consulting.
[16] Wild Juvenile Salmonid Monitoring Program 2020 – Broughton Archipelago, BC. Mainstream Biological Consulting.

Salmon farmers have also recently invested in the development of a large database, led by Dr. Crawford Revie, University of Strathclyde & University of Prince Edward Island, which houses hundreds of thousands of data points on all sea lice data from farmed and wild salmon sampling activities in BC, collected as far back as the early 2000s. Going forward, this will be a powerful and predictive tool providing information to compare trends of sea lice on wild and farmed salmon in shared regions historically and into the future. It will also be an important basis for modelling research assessing trends in sea lice on wild and farmed fish in correlation to changing environmental conditions.

## Status of Wild Salmon

In considering the potential impacts of Atlantic salmon aquaculture in BC on wild stocks, it is important to consider the much larger picture of the complexities surrounding Pacific salmon stocks and the extensive resources that have been applied to understanding population dynamics.

As an example, each year, since 1999, an annual State of the Pacific Ocean meeting has been held by DFO scientists and external researchers to present the results of the most recent year's monitoring in the context of previous observations and expected future conditions. The 2019 technical report[17] (resultant from a workshop held on March 10-11, 2020) is an important reference in providing context around the current state of the BC coastal and adjacent open ocean environment, and fish stocks in the region. Some key considerations affecting wild Pacific fish stocks from this report include:

- Marine heatwaves appear to be the new normal (chapter 7).
- The observed changes at the base of the food web during and after "the Blob" could have ecosystem-wide implications (chapter 15) and phytoplankton and zooplankton were both biased towards communities indicating warmer waters for the sixth successive year (chapter 16).
- Consecutive years of warm water intrusions from the south are effectively making the west coast of Vancouver Island like the nearshore California Current, with a high abundance of gelatinous taxa and low abundance of crustaceans (chapter 17).
- Section 20.4. The relative abundance of juvenile salmon in coastal regions reflects cumulative impacts, including but not limited to spawner-egg-fry productivity in freshwater, in-river mortality for out- migrating smolts, and ocean conditions coupled with trophic impacts (prey quality and availability, predation) in the first few months in the ocean. Basin-wide climate and ocean patterns (e.g., Pacific Decadal Oscillation and North Pacific Gyre Oscillation) have been linked through coastal processes, to coherency in broad-scale patterns in Pacific Salmon marine survival (Malick et al., 2017). Adding to this complexity is the occurrence of recent extreme ocean warming events, i.e. marine heatwaves. The continued low juvenile salmon abundance observed in these surveys off the west coast of Vancouver Island (WCVI) provides some support for the concept of a

[17] State of the Physical, Biological and Selected Fishery Resources of Pacific Canadian Marine Ecosystems in 2019

> new ecosystem base-line in this region following the 2015 marine heatwave. Juvenile salmon survey catch-rate anomalies throughout the northeastern Pacific and the Bering Sea continue to exhibit highly variable responses across regions after the 2015 marine heatwave (King et al., 2020).

There is no mention of disease as a concern or significant consideration in the decline of wild Pacific salmon stocks in the State of the Pacific Ocean 2019 Report. Yet, there continues to be a high variability by stock and species as seen in data on wild salmon returns provided by Fisheries and Oceans Canada (DFO) through their New Salmon Escapement Database System. Many stocks are in decline.

Aligning with reports from the State of the Pacific Ocean meeting, Welch et al., 2020 provides further evidence that the decline of wild Pacific salmon is likely most influenced by broader oceanic factors rather than local inputs. In an examination of smolt-to-adult return rate (SAR) data for Chinook salmon from all available regions of the Pacific coast of North America, the authors showed that declines experienced in near-shore environments considered to be pristine (northern BC and SE Alaska) have been similar to those of more urbanized regions.

Further, research programs such as the extensive Gulf of Alaska Expeditions, organized by DFO Emeritus Scientist, Dr. Richard Beamish and Dr. Brian Riddell of the Pacific Salmon Foundation, will continue to be important in understanding the mechanisms and environmental factors that could determine the annual abundance and condition of Pacific salmonids in the Gulf of Alaska, and more broadly in the Pacific ocean. This program also seeks to establish greater international research capacity for understanding the consequences of future environmental conditions and is being used to study the impacts of extreme climate events and ocean conditions.

## List of Appendices

Appendix A – Carmel Lowe Email – September 30, 2020.
Appendix B – BCSFA SSHI Letter to the Minster, June 25, 2020.
Appendix C - BC Salmon Farmers IPM MOU.

# Appendix A.

# Fw: PRV is from the Atlantic Ocean

**From:** Lowe, Carmel <Carmel.Lowe@dfo-mpo.gc.ca>
**Sent:** September 30, 2020 10:19 AM
**To:** Alex Morton
**Cc:** Fish Health Technical Working Group (emails removed for privacy purposes)
**Subject:** RE: PRV is from the Atlantic Ocean

Hello Alex,

I am writing today to address a number of points in your email of September 17, 2020 concerning the Siah et al. 2020 manuscript recently published online in the peer-reviewed journal *Virus Evolution*.

First, DFO scientists have not asserted PRV is native to BC and so your statement they have retracted from such a stance is inaccurate.

DFO scientists (and others) have stated that PRV is endemic in BC – meaning that it is present and maintained within the geographical region of BC without the need for additional external inputs (see Garver et al. 2016, Polinski and Garver 2019). As to when and how PRV came to be present in BC, this remains an area of active research by the science community, with as yet non-definitive answers. Nonetheless, as the body of evidence has grown, the possibilities have been refined.

Further, the basis for the statements in your email "*This paper offers two dates when PRV arrived in BC. The two estimates are 194 years apart, a large discrepancy. The industry/government authors pick the earlier date over 100 years ago. However, the second date offered, supported by the larger number of genetic sequences, is concurrent with the arrival of salmon farms in BC.*" is not supported by the information contained in the paper. The dates reported in this manuscript are results obtained from a series of thorough and clearly documented phylogenetic analyses and supported by all of the contributing authors, including experts from the BC Centre for Aquatic Health Sciences, the University of Washington, Washington State Department of Fish and Wildlife and the US Geological Survey.

By way of context, the Kibenge et al. 2013 study was an important contribution to our early understanding of the timing and evolution of the strain of PRV-1 found in BC. As you know, the authors (of which you are one), proposed that PRV-1 was recently introduced into BC from Norway sometime between 2006 and 2008. However, since this publication, there have been confirmed molecular detections of PRV-1 in archived samples dating back to the mid-1980s in Pacific salmon (Marty et al., 2015). The Siah et al. (2020) study includes a genome sequence from an archived WA Coho Salmon ca. 1993 with confirmed PRV-1 and, while the manuscript associated with this study was in review, partial PRV-1 S1 and S3 sequences from a 1977 Steelhead Trout collected in BC were submitted to and assigned accession numbers in GenBank. Thus, there is now a larger body of evidence supporting a longer term presence of PRV-1 in the northeast Pacific than your initial study.

Specifically, key findings of the new Siah et al. 2020 study which included samples from a broader spatial and temporal distribution of Pacific and Atlantic salmonids than the earlier studies are: a) confirms the strain of PRV-1 in the northeast Pacific is genetically distinct from strains of PRV-1 found in the North Atlantic; b) confirms the strain of PRV-1 found in the northeast Pacific shares a common ancestor with PRV-1 strains from Iceland, Atlantic Canada and Norway; c) acknowledges that the analyses are inconclusive with respect to the timing as the models predicted a descent from a common ancestor between 1986 and 1993 (median 1990) for the S1 and between 1900 and 1975 (median 1950) for the full genome; d) predicts, based on both the S1 and genome analysis, introduction of PRV-1 into the northeast Pacific from the North Atlantic, but reports inconclusive results with

respect to whether the introduction occurred from eastern North America or European waters of the North Atlantic. As such, your and your co-authors proposal that PRV-1 was introduced into BC waters from Norway remains a viable hypothesis.

Editors in *Virus Evolution* finalized their peer-review and subsequent publication of this manuscript after the FH TWG had completed its mandate and so your assertions that some of the authors and other departmental scientists deliberately contrived to withhold information on this study from FH TWG members and others are untrue. I note that prior to its publication, the contributing scientists presented their preliminary findings at regional and international fish health meetings which were open to the public – and aspects of this research were verbally reported by participants in the FH TWG meetings.

Evidence-based and respectful critiques of research findings are an important part of the scientific process – within the global scientific community this is what drives scientists to innovate and within DFO they are also considered as part of our adaptive management and regulatory regimes. I have every confidence in the professional integrity of the DFO scientists and their collaborators in the Siah et al., 2020 study and, as I have described in the preceding, your critique of their findings and associated reporting are based on some inaccuracies and seeming misunderstandings.

Sincerely,

*Carmel*

Carmel Lowe, Ph.D.
Regional Director Science | Directrice régionale des sciences
Fisheries and Oceans Canada | Pêches et Océans Canada
Pacific Biological Station | Station biologique du Pacifique
3190 Hammond Bay Rd, Nanaimo, BC, Canada V9T 6N7
Carmel.Lowe@dfo-mpo.gc.ca
Telephone | Téléphone 250-756-7177
Facsimile | Télécopieur 250-729-8360
Government of Canada | Gouvernement du Canada

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**From:** Alex Morton <>
**Sent:** Thursday, September 17, 2020 10:12 AM
**To:** E-mails removed for privacy purposes
**Cc:** E-mails removed for privacy purposes
**Subject:** PRV is from the Atlantic Ocean

Dear Fish Health Committee members and others,

Finally, the fish farm government/industry stance that PRV is native to British Columbia has been retracted in the attached paper.

In this paper, MOWI West's managing director, DFO and BC CAHS finally accept what Dr Kibenge first published in 2013 - the PRV found in BC is from the Atlantic.

This paper offers two dates when PRV arrived in BC. The two estimates are 194 years apart, a large discrepancy. The industry/government authors pick the earlier date over 100 years ago. However, the second date offered, supported by the larger number of genetic sequences, is concurrent with the arrival of salmon farms in BC.

All scientists working on impact of salmon farms know how aggressive the industrial aquaculture industry is and so I have to wonder which date Siah et al would have picked had MOWI not been a co-author?

I want to state my outrage that MOWI did not inform us of this work at the Fish Health table. Neither did the CFIA or DFO. Perhaps it was distributed at a later date, but I have not seen it arrive from the DFO/CFIA chairs of this committee.

This leads to the question, what else were we not told at the Fish Health table? In particular, how do we know that information regarding the diseases caused by this virus in BC salmon was not also withheld? Is this why the Vet Workshop had to be held behind closed doors?

The fact that DFO/industry united in withholding the highly significant information that the PRV now found in Fraser River sockeye, and wild salmon throughout BC is from the Atlantic Ocean, is a profound threat to the survival of Pacific salmon. Fraser sockeye are on the verge of extinction. How did our DFO regional director of science and other DFO staff at the table not know this? Or did they?

I have two recommendations:

1. Any who knew this information while sitting at the Fish Health table should resign immediately from DFO.
2. DFO should appoint a regional Director of Wild Salmon so there is someone who can work on behalf of wild salmon interests to balance the unethical behaviour which appears in support of industrial aquaculture. I would like to nominate Bob Chamberlin to this position.

Alexandra Morton

# Appendix B.

June 25, 2020

The Honourable Bernadette Jordan
Minister's Office, Fisheries and Oceans Canada
200 Kent St., Station 15N100
Ottawa, ON K1A 0E6

**Re: The Strategic Salmon Health Initiative and the Engagement of the BC Salmon Farming Industry**

Dear Minister Jordan:

On behalf of the BC Salmon Farmer's Association (BCSFA), I would like to raise awareness and concern over deficiencies in process management of the Strategic Salmon Health Initiative (SSHI). Since the federal government has been the primary funder of this project, industry anticipated that DFO would assume a leadership role in project oversight, management, and communication. However, DFO's contribution to project management has been perceptibly minimal.

In the 2018 Report of the Independent Expert Panel on Aquaculture Science, the Chief Science Advisor of Canada recommended that science should be done mindfully, follow a peer-reviewed vision and a corresponding multi-year research plan that considers regulatory priorities. Within this recommendation is an implicit caution against allowing research projects to become unhinged from their pre-determined process. Given this caution, DFO's lack of management is particularly surprising.

**Failure to Complete Research Project**

The SSHI was established 8 years ago through a funding partnership between Genome BC, DFO, and the Pacific Salmon Foundation (PSF), and has cost $10 million plus (with at least 64% from DFO). The overall objective of this project was to investigate potential relationships between variability in the survival of juvenile salmon during early ocean migration and the microbes they carry. As presented on the DFO website, the initiative was to consist of four phases:

- **Phase 1**: Collection of samples and development of consultation process
- **Phase 2**: Validation of novel genomic technology and identification of microbes (viruses, bacteria and parasites) currently carried by BC's wild and cultured fish
- **Phase 3**: Determination of the prevalence of identified microbes and investigation of their potential effects on wild and cultured salmon
- **Phase 4**: Integration and interpretation of findings to support managers and stakeholders in decision-making

Had the SSHI been managed according to the timing and objectives of its original research plan, by 2017 the SSHI could have:

- Significantly improved the understanding of the potential impact of farmed salmon on wild salmon populations by identifying and discovering viruses infecting fish and importantly, determining the impacts of these viruses and their ability to cause disease.

- Created a new and innovative tool for management to use in monitoring fish health of both wild and farmed salmon.
- Supported development of extensive collaborations between industry and federal fisheries scientists in an effort to improve regulatory decision-making based on certainty about fish health.

Each of these outcomes is essential in building certainty around ensuring that your Department is taking appropriate measures to protect wild salmon and to manage the salmon farming sector in BC. However, this 10 million dollar program has not moved beyond viral discovery, the second of the four planned phases. This is in spite of running years past the original end date. Moreover, recent communications from PSF have signalled that the project will be ending in 2020—before completing Phases 3 and 4.

*In other words, the project will be terminated without achieving any of the above outcomes.*

To the team's credit, there have been a significant number of publications to date related to the SSHI. However, these publications largely focus on viral discovery; the investigations have not moved on to the logical, and consulted upon, next step of examining whether the viruses discovered are actually threatening wild or farmed stocks. This last piece of information is vital to regulation of both wild and farmed salmon.

Science such as this, with such important outcomes, and where a regulator is involved so significantly, should be accountable to its originally defined plan. Coastal communities and First Nations who rely on wild fish and aquaculture resources expect this to be the case. Research projects that do not follow through on initially consulted upon objectives serve to damage DFO's reputation, destroying public confidence, and in this case, introducing more questions than answers on regulated and important local resources.

**Lack of Engagement and Collaboration**

In addition to failing to complete the project, the SSHI partners also failed to fulfill their clearly stated commitment to broad and ongoing engagement with stakeholders. An early joint Genome BC/PSF communication stated:

> *"…, the development of a stakeholder consultation process that enhances understanding and dialogue about the health of our Pacific salmon is paramount. The stakeholder group will provide input to information needs, public engagement and communications and on ways to integrate research on microbes and disease on BC salmon. This group of stakeholders will encompass a wide cross-section of BC citizens with an interest in British Columbia's salmon (including wild, hatchery, and farm raised salmon), including regulators, managers, harvesters, Environmental Non-Governmental Organizations (ENGOs) and farmers." (Genome BC/PSF news release, March 11, 2013).*

The partners also struck a Public Interest Panel that was meant to meet at least twice annually. A presentation given at the April 2013 Stakeholder Panel meeting by Genome BC outlined a consultation process to be used over the entirety of the project, with the focal point being bi-annual reports generated and circulated by a project Executive Scientific Committee. DFO's Department Management Steering Committee was to be engaged, receiving these reports to inform senior management in all relevant sectors. The Public Interest Panel was also to receive these reports.

Given that the BC salmon farming industry is one of the largest stakeholders, industry assumed that the SSHI partners and research team would establish and maintain significant ongoing engagement. However, despite granting access to thousands of samples for analysis early on in the process, and

despite the great potential for collaboration towards a shared goal of investigating wild and farmed interactions, the salmon farming industry has been isolated from all aspects of the project. For example:

- While the industry was initially engaged in the project through the Public Interest Panel, over time the engagement of this group waned and became one-sided. The last meeting on record was held on May 8 2018.
- Industry repeatedly sought to engage the SSHI and DFO management requesting progress updates, research results, publication of research, and the return of the industry-owned samples. Communications ceased for over two years from 2018 to February 2020.
- A 'Microbe Ranking' workshop was to be held at the culmination of Phase 2, to "rank microbes by their *potential* to cause disease in wild salmon, using data on microbe load and prevalence over space and time, histopathology and host response". This important meeting has never materialized.

**Proposed Next Steps**

Given the SSHI's failure to fulfill its stated commitments, the BC salmon farming industry feels that it is time to take a step back from its engagement with the SSHI and will therefore no longer engage with or endorse the project in its current format. As a final communication, we have recently provided two sets of comments to the project authors on two recent manuscripts (Bateman et al., and Mordecai et al.) involving industry data. We hope that the comments provided are seriously considered. We also encourage DFO to conduct an evaluation on the communications and expenditures of the SSHI to-date against its originally intended objectives.

Despite this decision, the BC salmon farming industry would like to emphasize its support of the intent of Phases 3 and 4 of the SSHI. There is great importance to ground truthing findings on microbe prevalence, determining their effect on fish health, and integrating this information into management measures. To move forward, in the short term, we would like to propose a meeting between industry and DFO Science senior management to explore future research funding and collaboration options around an extensive program to document health and disease in BC farmed salmon. Industry would hope to involve DFO's world class fish health expertise in this project.

Now more than ever, during this critical time of economic recovery, coastal communities rely on DFO to provide responsible and judicious oversight to the use of public funds for important science directly linked to regulation and management of their aquatic resources. We look forward to meeting with you and your staff as the first step in establishing the greater cooperation and collaboration necessary to bring the debate on farmed and wild salmon interactions to a close in BC, generating answers to questions at the core of both regulatory and management uncertainty, and the precautionary approach.

Sincerely,

John Paul Fraser
Executive Director

Cc. Timothy Sargent, Deputy Minister, DFO
Dr. Carmel Lowe, Regional Director of Science, Pacific Region, DFO
Dr. Jay Parsons, Director, Aquaculture, Biotechnology and Aquatic Animal Health, DFO
Dr. Kristina Miller-Saunders, Research Scientist, DFO

Michael Meneer, President and CEO, Pacific Salmon Foundation
Dr. Brian Riddell, Science Advisor, Pacific Salmon Foundation
Dr. Pascal Spothelfer, President and CEO, Genome BC
Dr. Lisette Mascarenhas, Sector Director, Agrifood and Natural Resources, Genome BC
Tim Kennedy, President and CEO, Canadian Aquaculture Industry Alliance

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# Appendix C.

# Salmon Farming Industry Integrated Pest Management Memorandum of Understanding

**THIS MEMORANDUM OF UNDERSTANDING ("the MOU")** is entered into this first day of December, 2020 between:

**Mowi Canada West**, a corporation existing under the laws of the Province of British Columbia

ADDRESS: #124-1334 Island Highway, Campbell River, British Columbia, V9W 8C9, Canada

AND

**Cermaq Canada**, a corporation existing under the laws of the Province of British Columbia

ADDRESS: 203-919 Island Highway, Campbell River, British Columbia, V9W 2C2, Canada

AND

**Grieg Seafood British Columbia Ltd**., a corporation existing under the laws of the Province of British Columbia

ADDRESS: 106-1180 Ironwood Street, Campbell River, British Columbia, V9W 5P7 Canada

Hereinafter referred to as the Parties:

**Whereas** it is recognized that it is of benefit to the Parties to manage sea lice in British Columbia under integrated pest management agreement (the "IPM MoU");

**And whereas** the Parties agreed to respect and use the Guiding Principles ("the IPM Guiding Principles") previously agreed for the purpose of the "IPM MoU";

**Now therefore**, the Parties agree that the production farms in operation in British Columbia will be managed according to the following principles and "Actions to Achieve":

**Furthermore**, the Parties agree to comply with the standards as set out above and it is mutually understood and agreed to by and between the Parties that:

1. This IPM MOU takes effect upon the date of the signature of the Parties and shall remain in full force and effect for two (2) years from the date of execution with automatic renewal unless notified in writing by one or more Parties at least 90 days prior to the renewal date. However, if all Parties agree in writing, this IPM MOU may be terminated.
2. This IPM MOU may be extended or amended upon written request of any of the Parties and subsequent written concurrence of the other parties.
3. This IPM MOU and information contained herein is confidential and no press releases or other public or official announcements will, under any circumstances other than required by law or stock exchange regulations, be made with respect to this MOU or any other matters set out herein unless mutually discussed and unanimously agreed upon in writing by the Parties (the consent of each Party not to be unreasonably withheld). After publication of an agreed upon press release or other public announcement, the Parties may discuss the contents of such announcement with any other third party, so long as such discussion does not otherwise breach the confidentiality of this MOU and the documents and information developed pursuant to this MOU.
4. The Parties intend for coordinated communication of this IPM MOU, to the Federal Regulatory authorities and First Nations rightsholders, based on preapproved messaging related to topics outlined in this MOU. No Party will make such communication without the prior unanimous agreement in writing of the other Parties.
5. This IPM MOU in no way restricts the Parties from participating in similar activities with other public or private agencies, organizations or individuals so long as such participation is transparent to the other parties to this MOU and does not conflict with the spirit and intent of this MOU.
6. The Parties shall manage their own fish health management practices and utilize their own recourses in a manner that is consistent with the objectives of the IPM MOU and the standards and protocols in the Industry Practice.
7. The Parties will make their best efforts to ensure that inter-company management communications with respect to this IPM MOU and the Industry Practice shall be honest and transparent. Meetings to review this MOU will be held quarterly.
8. Should any of the provisions of the IPM MOU be or become fully or partly invalid or unenforceable, the remainder of the IPM MOU shall remain valid and enforceable. The Parties will make their best efforts to develop valid and enforceable replacement provisions that approximate as nearly as possible the spirit and intent of the provisions found to be invalid or unenforceable.
9. This document will be reviewed by December 31 of even years.
10. The primary contacts for this MOU are the following persons or their representatives as appointed in writing from time to time:

    Mowi Canada West – Meghan Mills, 250-203-2167, Meghan.mills@mowi.com
    Cermaq Canada – Name, telephone, email
    Grieg Seafood British Columbia Ltd. – Name, telephone, email

11. THE PARTIES HERETO have executed this instrument.

December 1, 2020

Mowi Canada West — Date

***Dr. Diane Morrison, Managing Director***

December 1, 2020

Cermaq Canada — Date

***David Kiemele, Managing Director***

December 1, 2020

Grieg Seafood British Columbia Ltd. — Date

***Rocky Boschman, Managing Director***

## Memorandum of Understanding: Guiding Principles

1. IPM GUIDING PRINCIPLES

   1.1. The Principles of Integrated Pest Management (IPM)

- The industry recognizes the importance of integrated pest management to achieve good fish health and welfare. The use of long-term integrated strategies for managing sea lice is important to the sustainability of the industry's operations and the environment in which it operates.
- IPM provides an overall management strategy that uses all necessary techniques to suppress pests effectively and sustainably. The key steps in IPM involve prevention, monitoring, thresholds for action, and control. By using a combination of prevention, monitoring and treatment strategies, the industry should achieve more consistent long-term control. This approach will maximize the effectiveness of control measures and extend the useful life span of therapeutants by avoiding reduced efficacy.

### PREVENTION

Proper management of sea lice requires ongoing preventive activity, with defined and practical steps. Several measures can be taken to reduce the likelihood of sea lice becoming a problem.

The industry manages prevention through the following:

- Appropriate husbandry practices to keep fish thriving and healthy (e.g. fallowing between stocks, single year class stocking, net cleaning, removal of moribund fish and poor performers)
- Area based management – already practiced in areas of shared location; work is ongoing to develop modeling and implementation as new information is obtained.
- Developing and evaluating management tools to keep pests out of sites

### MONITORING

Monitoring of sea lice and thresholds for action at saltwater sites in BC are set by the Finfish Aquaculture License (CoL) under the Pacific Aquaculture Regulations (Fisheries Act). The industry aims to meet and exceed the CoL regarding the monitoring of sea lice.

### THRESHOLDS FOR ACTION

Thresholds for action at saltwater sites in BC are set by the CoL. The industry strives to proactively take action in response to increasing sea lice levels prior to reaching regulatory threshold levels (see Process Map).

## CONTROLS

To avoid the potential reduced efficacy of controls, the industry aims to use control measures in combination and/or rotation.

**Bioassays**: To prevent the potential reduced efficacy of a treatment, bioassays are performed to ensure that the sea lice to be treated are susceptible to the compound (i.e. hydrogen peroxide, emamectin benzoate, freshwater).

Below is a list of control measures currently available to the salmon aquaculture industry in BC that fit the need for effective and sustainable sea lice control. The industry will continue to work with partners to develop, evaluate and implement new control measures as they become available. Rather than replace, the use of control measures should supplement preventive measures, as one part of the overall IPM process.

Control measures in defined Areas will be coordinated between the farms in operation to improve the management of sea lice.

**Emamectin benzoate** (SLICE) – Emamectin benzoate is an in-feed therapeutant that is prescribed by a registered BC veterinarian. This control measure provides a residual protective period after the treatment. Due to the prolonged effect of SLICE, the industry's policy is to use it as the preferred treatment immediately prior to the wild juvenile salmon outmigration. The industry aims to only use emamectin benzoate after bioassay results indicate that lice are sensitive..

The industry participates in the SLICE Sustainability Project (Merck Animal Health) that monitors feed and tissue emamectin benzoate levels as part of each SLICE treatment.

**Freshwater Management**: Freshwater baths are administered in a wellboat, where the fish are contained and immersed in freshwater for several hours. Freshwater is effective against all stages of lice, including chalimus. The industry aims to only use freshwater in wellboats that are capable of collecting all dislodged sea lice from discharge water for disposal.

**Mechanical Delousing Technology** – Most mechanical delousing technologies use turbulence and differential pressure, or water pressure to remove sea lice from fish. The process of mechanical delousing requires sophisticated plumbing and pumping equipment to move fish through the system. The industry agrees to only use mechanical delousing technologies that are able to collect all dislodged sea lice from discharge water for disposal.

**Hydrogen peroxide** (Paramove 50) – The application of hydrogen peroxide requires a Pesticide Use Permit issued by the BC Ministry of Environment and Climate Change and licensed pesticide applicators. Hydrogen peroxide treatments are administered using a well boat to contain the fish while the pesticide is applied. The industry aims to only use hydrogen peroxide after performing a bioassay.

**Harvesting** – Depending on the stage of production of the fish, harvesting may be an option to lower the sea lice load on site and surrounding area. The aggressivenesss of harvest will be dependant on time of year – e.g. outmigration months vs. threshold compliance. A plan for harvest needs to be determined through input from all stakeholders.

**Sealice Capture** – All technology used in treatments or harvest will aim to use sealice recapture filter sizes of 150 micron or less.

## Memorandum of Understanding: Actions to Achieve

2. SEA LICE MANAGEMENT

2.1 Prevention

2.1.1 Good husbandry and management practices are employed to aid in reducing and preventing sea lice infestations

2.1.1.1 If a site is experiencing a higher than expected level of poor performers, management actions must be considered to reduce this subset of the population.

2.1.2 Aim to achieve the principles of Area Based Management regarding single year classes and fallowing in areas with shared connectivity.

2.1.2.1 In areas with shared connectivity, local agreements must be in place and attached in Annex 5 to this MOU, outlining principles (e.g. fallow period)

2.1.3 Invest in existing and future technology (e.g. sea lice tarps, semi-closed systems, etc.) and practices that may advance the prevention of sea lice recruitment.

2.2 Monitoring

2.2.1 Perform sea lice counts weekly Jan 1 – June 30.

2.2.2 Perform sea lice counts at minimum bi-weekly (every two weeks) July 1 – Dec 31.

2.2.2.1 If sea lice levels reach 50% of the regulatory threshold, the frequency of sea lice counts (define count as per DFO COL) will increase to weekly, until sea lice levels return to less than 50% of threshold.

2.2.3 If extenuating circumstances prevent the industry standard from being met, the regulatory conditions must be satisfied.

2.3 Thresholds for Action

| Windows | Time of Year | Threshold & Action |
|---|---|---|
| Pre-migration (see process map) | Jan 1 – Feb. 28 | Mitigation action is completed such that the farm enters the out-migration window under DFO threshold.<br>For action trigger – see process map |
| Out Migration | March 1- June 30 | See additional monitoring requirements in CoL. By December 31, agree to be below 3 motile |
| Non-Migration | July 1 – Jan. 31 | During this time sea lice numbers often increase due to in-migrating adult wild salmon. As a result, careful management is critical. Management threshold shall be at the discretion of the attending veterinarian who shall consider factors including but not limited to; fish health and welfare, site and treatment history, environmental conditions and stage of production, in line with Annex 2 Process Map. |

2.3.1 The Process map (Annex 2) will provide a guide by clearly defining proactive management actions. Companies agree to adhere to the Process Map (Jan 1 – June 30) to be proactive in meeting the CoL.

2.3.2 Management action for *Caligus* spp. will be at the discretion of the company, as they deem appropriate.

2.4 Management Actions/Control Measures (Annex 2 Process Map)

2.4.1 Industry will control sea lice levels year round,

2.4.2 Industry will further focus attention on reducing numbers during the in-migration period of the year. Additional resources, including more preventative and non-medicinal tools and new technology will facilitate this goal.

2.4.3 Selection of appropriate treatment will be based on a number of factors including sea lice population dynamics with the intent to be proactive as per the Process Map decision-making matrix.

2.4.3.1 All actions will be taken to minimize usage of SLICE

2.4.3.2 Communication regarding efficacy of all treatment forms will take place amongst the Parties on an as-needed basis between quarterly meetings.

2.5 Area Based Management

2.5.1 See Prevention 2.1.2.

2.5.2 Regional MOU’s (e.g.Okisollo) superseds IPM MOU – see Annex 5.

2.5.3 Industry will commit to working together on an area by area basis to reduce sea lice levels.

2.5.4 As the biophysical and hydrodymanic modelling currently underway is completed shared areas will be reviewed and updated; any changes will be reflected in this MOU. (ID 3, biannual report, which may then change ID 2, risk matrix). Link to D2/ID2 in the Process map; see Appendix with regional maps.

2.6 Bioassays

2.6.1 All coordinated use of chemotheraputants (SLICE) should be preceded by a favourable bioassay, with all companies aiming to conduct a bioassay if possible. If results indicate reduced sensitivity, SLICE should not be used, however if SLICE is to be used it must be used in combination with second modality.

2.6.2 The industry will participate in the SLICE Sustainability Project (Merck Animal Health), including an annual meeting, that monitors feed and tissue emamectin benzoate levels as part of each SLICE treatment.

2.6.2.1 SLICE Sustainability Reports will be designed to ensure anti-competition laws have been respected.

2.7 Capacity Matrix

2.7.1 Industry will maintain a complete resource list to identify: existing resources, speed of treatment, optimization of treatments, rate of reinfection, assessment of

gaps and future resources required. See Annex 3. (Suggest index of resources in a chosen standard metric – e.g. kg for well boats, fish/minute for Hydrolicer, and considering limitations for each area)

2.7.2 Even when operating at capacity, each company may still be able to share resources

2.7.3 Industry will commit to sharing existing and future resources to maximize effectiveness of sea lice management by area

2.7.4 Industry will commit to investing in tools/new technology to address gaps (see 2.1.3), in an effort to achieve maxiumum capacity

2.7.5 Industry commits to directed research to advise on ecosystem-based management and strategy.

2.8 Sharing of Control Measures

2.8.1 Management Committee to explore the opportunity/feasibility of an equipment supply vendor to provide access to shared sea lice management equipment for salmon farming in BC.

2.8.2 Management committee agrees to maintain an open dialogue for the sharing of existing management tools in order to allow for increased capacity of control rotation.

2.8.3 Management as a group will continually be explored (through capacity matrix, sea lice sustainability project, area based management etc.)

2.9 Wild Fish Monitoring

2.9.1 Industry will continue to participate in wild juvenile fish monitoring within the areas that it operates.

2.9.2 Industry aims to further collaborate with Rightsholders and Fisheries and Oceans on in-migration monitoring.

3.0 Research and Development

3.1 Industry commits to ongoing investigation, research and investment (in novel and proven sea lice managmenet options, sea lice dynamics, as well as sea lice genetics to determine source of lice)

3.1.1 Specifically, companies agree to participate in research and development of the following areas: new control measures, new preventative measures and innovation/new technology regarding current management tools, area based management pilots in cooperation with DFO. Additional emphasis will be given to research that focuses on in migration period of the year.

# Annex 1 - Management Committee

MOU Management Committee

- Structure: Industry veterinarians, operational/production/fish health Directors, BCSFA Executive Director, or representative
- Responsibilities: Management (day to day operation) and Annual Review of MOU. If areas or significant disagreement occur, decision would go to Managing Directors.
- Function: Decision making authority
- Independent council to assist in decision making/creative solutions/resolving disputes as needed
- Semi-annual sharing of data or as needed

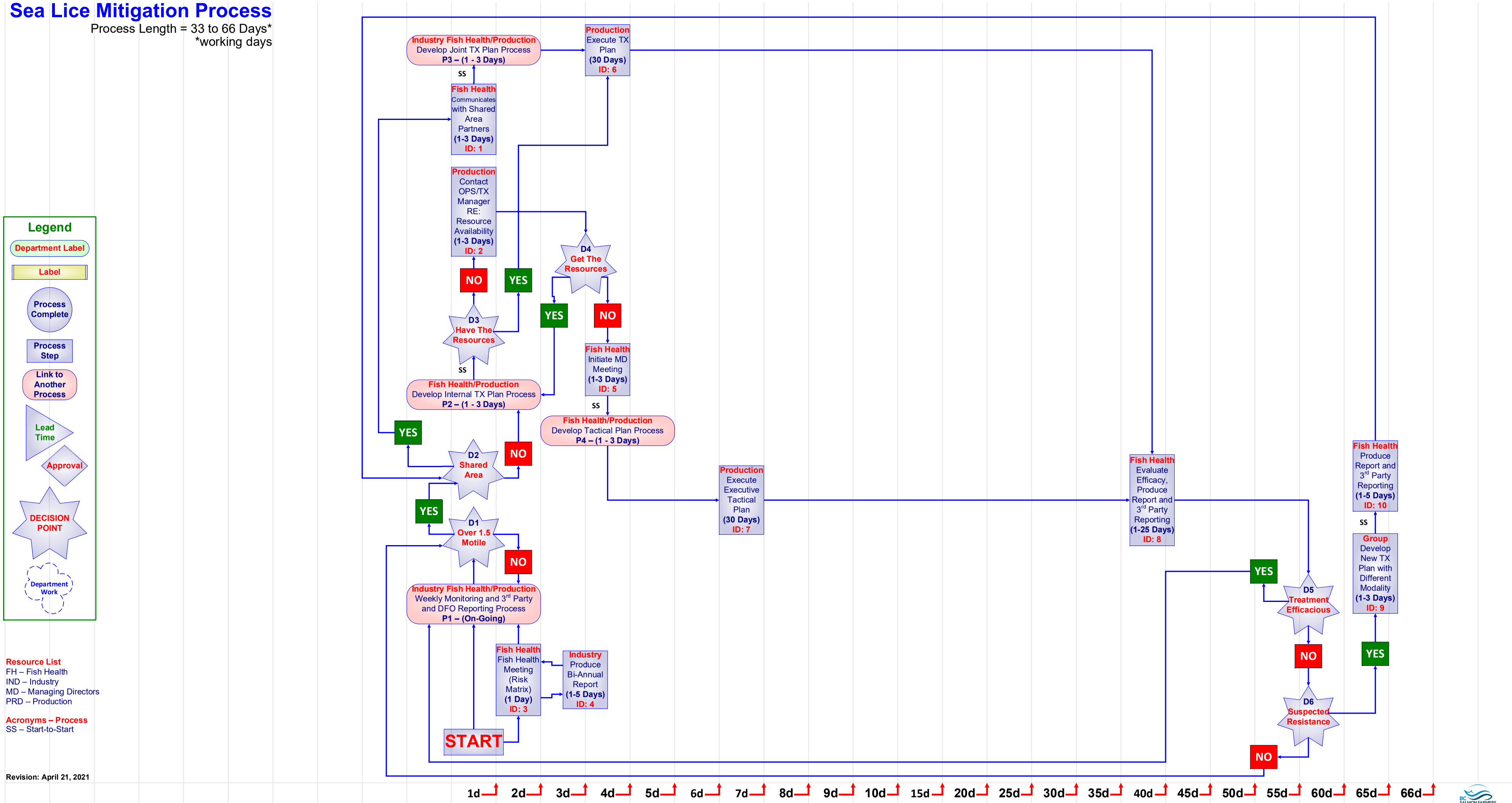
Responsibilities and Actions

- MOU to be reviewed annually by Management Committee, at December meeting
- Document to be shared with Government: DFO, MOE, VDD (Health Canada) and First Nations partners for information

## Annex 2 – Process Map

# Sea Lice Mitigation Process

Process Length = 33 to 66 Days*
*working days




**Resource List**
FH – Fish Health
IND – Industry
MD – Managing Directors
PRD – Production

**Acronyms – Process**
SS – Start-to-Start

Revision: April 21, 2021

## Notes / Comments

Name:

Department:

Local:

E-mail:

## Annex 3 – Conditions of License

**4.11** For Facilities growing Pacific salmon, in a situation where Mortalities exhibit Gross Signs of Jaundice in >0.03% of the Stock Inventory within a one week time period, the Licence Holder must do the following the first time it occurs in a Production Cycle:

(a) notify the Department within seven days using Appendix V-D; and

(b) take a sample of 10 Fresh Silver Mortalities, of which half (if available) must show Gross Signs of Jaundice; and

(c) submit these fish for diagnostic testing at the direction of the Department; and

(d) submit the results of the diagnostic testing to the Department as soon as they are available.

**4.12** The Licence Holder must record "Mortality by Category" for fish within the Containment Structures. The reports must be submitted to the Department, not later than March 15, 2020 and every three months thereafter for the term of this licence, using Appendix V-C. A report is required for all Facilities in operation.

**4.13** Starting March 1, 2020 and quarterly thereafter for the term of this licence, the Licence Holder must maintain and submit to the Department, records of all wild or enhanced fish Mortalities collected during routine carcass recovery, following the template set out in Appendix VII-B.

## 5. Fish Health Records

**5.1** The Licence Holder must keep at this Facility, unless otherwise indicated, complete, up-to-date and accurate written or electronic records of stocking and fish health activity for the Facility. Records must include the following:

(a) stocking and fish health activity for the Facility as set out in Appendix V-E; and

(b) the use of all therapeutants, pest control products and anaesthetics as set out in Appendix V-F.

**5.2** The Licence Holder must ensure that Fish Health Event and carcass assessment records, in written or electronic form, are reviewed by the Licence Holder's veterinarian and/or Fish Health Staff to assess patterns in fish health and to facilitate reporting of Fish Health Events as per Section 4.8 and Mortality by Category as per section 4.12.

## 6. Sea Lice Management

**6.1** The Licence Holder must follow all area-based and site-specific sea lice monitoring Windows listed in this licence. If the licence does not list this information, the following generic dates will apply:

(a) Non-migration Window: July 1 – January 31;

(b) Pre-migration Window: February 1 – February 29;

(c) Out-migration Window: March 1 – June 30.

**6.2** The Licence Holder must follow all area-based and site-specific sea lice thresholds listed in this licence. If the licence does not list this information, the following generic threshold will apply:

(a) sea lice by fish threshold: an average of 3.0 motile *Lepeophtheirus salmonis*.

**6.3** For Active Facilities growing Atlantic salmon (*Salmo salar*), the Licence Holder must conduct sea lice monitoring following protocols in Appendix VI, and report data from Counting Events and threshold exceedances to the Department as described in Sections 6.4 - 6.13.

**6.4** During the Non-migration Window, the Licence Holder must:

(a) conduct a Counting Event on a minimum of three stocked Containment Structures once per month; and

(b) submit the results to the Department by the 15th of the following month, using Appendix VI-A; and

(c) Upon Discovery of threshold 6.2 being exceeded, the Licence Holder must:

(i) notify the Department within seven days using Appendix VI-B; and

(ii) conduct Counting Events on a minimum of three stocked Containment Structures every two weeks thereafter so long as the exceedance continues and submit the results to the Department within seven days of each Counting Event, using Appendix VI-B; and

(d) conduct and report additional sea lice counting as per Section 6.10.

**6.5** During the Pre-migration Window, the Licence Holder must:

(a) ensure all stocked Containment Structures are assessed at least once by conducting two Counting Events, each of which includes a minimum of three Containment Structures:

(i) the first on half of all stocked Containment Structures within the first two weeks of the month; and

(ii) the second on the other half of all stocked Containment Structures (a duplication is only allowed for the index pen and if there are less than six stocked Containment Structures) within the last two weeks of the month; and

(iii) submit the results to the Department within 48 hours of each Counting Event and prior to March 1, using Appendix VI-B; and

(b) within 48 hours Upon Discovery of threshold 6.2 being exceeded, notify the Department using Appendix VI-B, and describe the measures that will be taken to ensure that the sea lice levels are below the threshold by the start of the Out-migration Window; and

(i) conduct Counting Events on all stocked Containment Structures once every two weeks thereafter so long as the exceedance continues; and

(ii) submit the results to the Department within 48 hours of each Counting Event, using Appendix VI-B; and

(c) conduct and report additional sea lice counting as per Section 6.10.

**6.6** The Licence Holder must ensure that sea lice numbers are below threshold 6.2 at the time of the first Counting Event of the Out-migration Window.

**6.7** During the Out-migration Window, the Licence Holder must:

(a) conduct Counting Events on a minimum of three stocked Containment Structures within the first week of the Window, and once every two weeks thereafter throughout the Window; and

(b) submit the results to the Department by the 15th of the following month, using Appendix VI-A; and

(c) if the sea lice threshold set in 6.2 is exceeded:

(i) within 48 hours Upon Discovery and prior to any Sea Lice Management Measure being taken, notify the Department of the planned Sea Lice Management Measures, including harvest, to reduce sea lice levels below the threshold within 42 days using Appendix V-B; and

(ii) within 7 days Upon Discovery, conduct a Counting Event on all stocked Containment Structures; and

(iii) submit the results to the Department within 48 hours of the Counting Event, using Appendix VI-B; and

(d) conduct and report additional sea lice counting as per Section 6.10.

**6.8** Within the Out-migration Window, the Licence Holder must bring the sea lice levels below the threshold set in 6.2 within 42 days Upon Discovery of an exceedance.

**6.9** The Licence Holder:

(a) is not required to count sea lice in an individual Containment Structure if:

(i) the Containment Structure(s) will be Harvested within the next 10 days; or

(ii) fish are being medicated or otherwise managed for a Fish Health Event which precludes handling; or

(iii) an ongoing environmental issue would reasonably lead to additional fish stress or harm if handled; or

(iv) written approval was sought and received from the Department's veterinarian for reasons other than prescribed in 6.9(i), (ii) and (iii); and

(b) must note if any Containment Structure(s) were missed in a required Counting Event for the reasons set out in 6.9(a) in the required reporting to the Department; and

(c) must notify the Department if an entire Counting Event could not occur for the reasons set out in 6.9(a) within 24 hours Upon Discovery.

**6.10** At any time of the year, if Sea Lice Management Measures are undertaken, the Licence Holder must:

(a) Using Appendix V-B; notify the Department what the Sea Lice Management Measures will be:

(i) within 48 hours Upon Discovery of an exceedance of the threshold set in 6.2 during the Pre-migration and Out-migration Windows (as per 6.5 and 6.7); and

(ii) if there was no exceedance during the Pre-migration or Out-migration Window preceeding Management Measures, and during the Non-migration Window, at least 24 hours in advance of undertaking the Measures; and

(b) conduct a Counting Event on all stocked Containment Structures in the seven days prior to the Sea Lice Management Measure; and

(c) conduct Counting Events on all stocked Containment Structures following Sea Lice Management Measures as follows:

(i) for in-feed treatments, conduct Counting Events every two weeks until at least 42 days post-treatment or until sea lice counts are below the threshold set in 6.2; and

(ii) for all other treatments, conduct at least one Counting Event within seven days of Sea Lice Management Measure completion; and

(d) submit the results of (b) and (c) to the Department within 48 hours of each Counting Event using Appendix VI-B; and

(i) based on these results, if a sea lice Treatment Failure is detected, notify the Department within 48 hours Upon Discovery.

**6.11** If a sea lice Treatment Failure is detected as per 6.10(d)(i), the Licence Holder is prohibited from further use of that treatment at the facility during the current production cycle without prior written approval from the Department.

**6.12** By March 1, 2020, the Licence Holder must ensure that all mechanical treatment options have technology in place to capture sea lice, and sea lice that are removed through mechanical treatments are not returned to the marine environment.

**6.13** By June 1, 2022, the Licence Holder must complete and submit a scientific analysis, to the satisfaction of the Department, regarding the viability of sea lice that are captured before, during, and after sea lice bath treatments.

**6.14** For Active Facilities growing Pacific salmon, the Licence Holder must:

(a) at least quarterly, conduct sea lice monitoring during fish handling events; and

(b) make sea lice count data available for review by a Fishery Officer or Fishery Guardian upon request; and

(c) notify the Department within 48 hours Upon Discovery if threshold 6.2 is exceeded using Appendix VI-B.

**6.15** All data from sea lice monitoring on wild salmon conducted under a DFO scientific permit must be submitted to the Department annually or upon request of a Fishery Officer or Guardian.

## 7. Escape Prevention, Reporting and Response

**7.1** The Licence Holder must have in place and follow an Escape Prevention and Response Plan, including all elements outlined in Appendix X, to prevent the escape of cultivated fish.

**7.2** If an escape or a suspected escape of cultivated fish from the Containment Structure Array occurs, the Licence Holder must take immediate action to prevent further escapes.

**7.3** The Licence Holder must notify the Department of any escape or Evidence of Escape of cultivated fish from this Facility within 24 hours Upon Discovery. The notification must include the date and time of escape and any therapeutants administered through feed as set out in Appendix XI.

**7.4** The Licence Holder must submit to the Department a complete follow-up report, as set out in Appendix XI, not later than seven calendar days after the escape or suspected escape.

## 8. Interactions with Wild Fish and Megafauna

**8.1** The Licence Holder must design and use nets and equipment and conduct operations in a manner that causes the least amount of harm to Incidental Catch or the residence of the individuals of any species listed as threatened or endangered under the *Species at Risk Act* or its critical habitat, and does not jeopardize the survival and recovery of these species.

**8.2** The Licence Holder must have mitigation in place to sort farmed fish from wild fish during Transfer between Facilities, Harvest, and net removal, and take reasonable efforts to minimize the Transfer of wild fish between Facilities and to processing plants.

**8.3** Unless otherwise directed by the Canadian Food Inspection Agency or the Department, the Licence Holder must ensure that any live Incidental Catch are immediately returned to waters outside the aquaculture Facility in a manner that causes the least harm.

**8.4** The Licence Holder must retain all dead Incidental Catch and dispose of them in the same manner that cultivated stock carcasses are disposed of, as set out in Section 4.3.

**8.5** The Licence Holder must maintain Incidental Catch records using Appendix VII-A and must submit to the Department in the following manner:

(a) for Facilities that have fish continuously on site, a report must be submitted on January 15, 2021 and annually every January 15th thereafter for the duration of the licence. Records from the previous calendar year must be included; or

# APPENDIX VI: SEA LICE MONITORING PROTOCOLS

(Protocols applicable for Atlantic salmon and trout only)

Definitions

**Lice life stages**

| | |
|---|---|
| *Lepeophtheirus salmonis (Leps)* | Adult female<br>Includes adult female lice, with egg strings (i.e. gravid) or without egg strings<br>Motile Lice<br>Includes all 'not permanently attached' free-moving life stages:<br>Adult females (as above)<br>Adult males<br>Pre-adult male and female lice |
| *Caligus* sp. | Total numbers of motile *Caligus* species |
| Both of the above | Chalimus<br>Attached early stages of both *Caligus* and *Lepeophtheirus* species. Both species are categorized simply as chalimus since louse identification at these early life stages is not practical at the facility. |

**Year class 1 and 2 – see definitions in Part A of this licence.**

| | |
|---|---|
| Broodstock | Broodstock may initially enter saltwater directly into designated broodstock pens, or be entered to a production farm and later become designated broodstock populations, yet remain at the production farm or be relocated to broodstock facilities. |

1. Sea Lice Sampling Protocols – Production Year classes 1 and 2

   1.1. Other than the exemptions of COL s.6.9 sampling at each facility shall be conducted in a minimum of three containment structures, i.e. pens. Pens chosen for a counting event shall include:

   (a) one "reference" or "index" pen (i.e. first pen entered in the system, or the pen with the highest probability of having lice burden based on historical facility information). The fish from this pen are assessed EVERY counting event; and

   (b) additional pens selected at random for each counting event.

   (c) not withstanding COL s. 6.9 (a), a counting event must occur within a 5-calendar-day period, that is the time between conducting lice counts from the 1st pen to the last pen.

   1.2. In order to ensure a random sample of fish are collected from the pen:

(a) numerous fish shall be initially captured using a seine net (or alternate method provided it ensures a crowding and representative collection of the pen's entire population).
(b) a minimum sub-sample of 20 live fish (i.e. 5 groups of 4 fish) shall be randomly collected using a dip net.

1.3. Fish shall then be placed in an anaesthetic bath (i.e. 'tote') or humanely euthanized (e.g. in cases where biological sampling is lethal).

1.4. Physical handling shall be minimized to protect the fish and avoid dislodging lice.

1.5. All sampled fish shall be examined for the presence of lice regardless of the health status or size (i.e. robust, moribund or runt).

1.6. Sea lice on each selected fish shall be discriminated, counted and recorded for reporting in the following four categories:

- Adult Lep females (with or without egg strings) } Motile
- Other motile Leps (including adult males, and preadults) } Motile
- Chalimus (non-motiles, regardless of species), and
- *Caligus* (combined totals of adults and preadults)

1.7. When sampling of each pen is completed, water in the anaesthetic tote shall be examined for detached sea lice. Lice dislodged and found within the handling totes must also be counted and categorized in the manner above, recorded as the 'tote count,' and included in the calculation of the total lice number (per pen) and average abundance (per fish).

2. Sea Lice Sampling Protocols for Broodstock

2.1. Broodstock shall be sampled in the same manner as production fish until their second winter at sea (i.e. the broodstock pens may be selected in the normal course of selecting three pens on the farm during the month for sampling including bi-weekly counts). If a broodstock pen is randomly selected, 20 fish shall be sampled.

2.2. In January/February of their second and subsequent winters at sea:
a) a broodstock population on broodstock facilities shall be selected for sampling. Twenty broodstock from one pen shall be assessed.
b) a broodstock population at production facilities, that are of a different year class than the production fish at that same location, shall be selected for sampling. Twenty broodstock from one pen shall be assessed.

2.3. After January/February of the year in which those brood are anticipated to spawn as two-winter brood, and to reduce handling-related injuries and stress on broodstock:

(a) all sea lice monitoring shall be conducted opportunistically (or via other husbandry sampling). In other words, all sea lice monitoring shall be coordinated with other routine broodstock handling procedures, such as sorting, moving or medicating.

(b) broodstock shall be subject to a visual inspection twice per month for the presence of sea lice and any associated grazing blemishes and observations recorded.

3. <u>Licence Holder Recording and Reporting Requirements</u>

3.1 Licence holder's records shall contain the following information for reporting as per Condition of Licence, Section 6 and Appendix VI-A and VI-B. The records shall contain the following:

a) date and details of the most recent use of anti-sea louse treatments;
b) sampling date of each pen count;
c) year class of the sampled fish;
d) unique pen identifier;
e) number of fish sampled for each pen for each counting event;
f) sampling method used;
g) total number of lice counted, per pen (including the detached lice in the anaesthetic bath);
h) lice counts separated into four categories as described above (at a minimum); and
i) action taken if calculated trigger abundances are reached.

3.2 Calculated Pen averages, Counting Event averages, and Farm Abundance records shall be stored at the facility and made available upon request by the Department.

3.3 Reporting "null" (0) in Appendix VI-A and an explanation is required if no lice monitoring was undertaken at an active production facility.

# APPENDIX VI-A: SEA LICE REPORT

**Licence Holder Name:** ____________________ **Reporting Year:** ____________ **Reporting Period:** ____________

**Facility Name:** ____________________ **Facility Reference Number:** ____________

| Sampling Done This Month (Y/N) | If No Sampling, Explain | Sampling Event Start Date | Pen ID | Reference Pen (Y/N) | Final Sea Water Entry Date | Pen Sample Date | Number of Fish Sampled | Sampling Method | Adult Females L. salmonis | Motile L. salmonis | Chalimus | Motile Caligus | Action Taken | Start date (if Rx or PC approval) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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## Pick Lists:

**No sample:**

Harvest ongoing, Fish < 4 pens, Fallow, Recent transfer, Emamectin <21 d, H2O2, Meds ongoing, Environmental, Pathogen threat, Other - explain

**Sampling method:**

Box seine, Full seine, Dipnet-feed, Weights, Harvest, Brood sort, Visual estimate, Fresh carcass, Cull/Mort event, Other - explain

**Action taken:**

None required, Bi-weekly counts, Harvesting, Harvest Pending, Treatment Ongoing, Treatment Pending, Culled, Cull Pending, Other -explain

# APPENDIX VI-B: SEA LICE EVENT

Licence Holder Name: ______________________
Facility Name: ______________________

Facility Reference Number: ______________
Fish Health Zone ______________

| Incident Date | Occurrence Category | Pen ID | Reference Pen | Pen Sample Date | Number of Fish Sampled | Sampling Method | Adult Females L. salmonis | Motile L. salmonis | Chalimus | Motile Caligus | Current Inventory | Over Threshold | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Input format: YYYY-MM-DD* | *Pick List* | *Specify* | *Y/N* | *Input format: YYYY-MM-DD* | *input format: 0-9999* | *Pick List* | *input format: 0-9999* | *input format: 0-9999* | *input format: 0-9999* | *input format: 0-9999* | *input format: 9999999* | *Y/N* | |
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**Pick Lists:**

Occurrence Category
- Over Threshold Notification
- Over Threshold Follow-up Sampling
- First Pre-migration Sampling
- Second Pre-migration Sampling
- Pre-treatment Sampling
- Post-treatment Sampling

Sampling Method
- Box Seine
- Full Seine
- Dipnet-feed
- Weights
- Harvest
- Brood sort
- Visual estimate
- Fresh carcass
- Cull/mort event
- Other - explain