From:	Alex Morton
To:	Morel, David P ENV:EX
Cc:	Xia, Eveline ENV:EX; McGuire, Jennifer ENV:EX; Popham, Lana; Heyman.MLA, George LASS:EX; Meggs, Geoff PREM:EX; Tavish Campbell; Tony Allard; Zacharias, Mark ENV:EX
Subject:	Re: Blood Water Testing
Date:	Tuesday, February 6, 2018 09:53:31

David

Thank you,

Alex

On Feb 6, 2018, at 8:34 AM, Morel, David P ENV:EX <David.Morel@gov.bc.ca> wrote:

Hi Alex
Thanks for the email and sharing your research. Will pass your email on to our compliance team and they can forward relevant materials to you.
David Morel
Assistant Deputy Minister
Environmental Protection Division
Ministry of Environment and Climate Change Strategy

From: Alex Morton [mailto:alexandramorton5@gmail.com]
Sent: Tuesday, February 6, 2018 7:59 AM
To: Xia, Eveline ENV:EX; McGuire, Jennifer ENV:EX; Morel, David P ENV:EX; Popham, Lana; Heyman.MLA, George LASS:EX; Meggs, Geoff PREM:EX
Cc: Tavish Campbell; Tony Allard
Subject: Blood Water Testing

Dear Eveline, Jennifer and Dave;
I received a link to an article reporting on your testing of the bloodwater samples from Tofino and Browns Bay.
https://www.desmog.ca/2018/02/05/bloodwater-released-b-c-s-coastal-water-contains-deadly-fish-virus-government-tests-confirm
Can you forward a copy of your report to me?
Attached are two papers that I co-published in December, one on the spread of this virus through BC wild salmon and the other a Formal Comment published in PLoS One a paper stating they had ruled out that any strains of PRV found in BC came from Norway. The authors of Siah et al withdrew that statement in a correction, but we also present further information that at least one strain of PRV found spreading in wild salmon and causing HSMI in farm salmon is most likely from Norway.
The concern with PRV is not that it is outright lethal, but rather that it exists in fish in a low-grade chronic state which means that infected fish can travel with it. The evidence in my work below, and in Miller et al 2014 suggests this blood virus is impeding fish's success in reaching their spawning grounds. Research in Norway suggests that the high presence

of the virus in the fish's red blood cells may reduce the cell's ability to transport oxygen to muscle tissue and thus reduce fitness required to catch prey, evade predators and ascend rivers. As well there are reports of jaundice associated with the virus in Pacific salmon and so HSMI may only be the final outcome of infection with this virus, which only occurs in farms where predators are unable to remove fish during the earlier stages of the disease.

This is certainly a pathogen of concern as it is durable and thus contagious and over 95% of farm salmon sold in markets are infected.

I am available to discuss this further, thank you for your investigation. I look forward to receiving your report.

Alexandra Morton

From:	Alex Morton
To:	Morel, David P ENV:EX
Cc:	Tavish Campbell; Xia, Eveline ENV:EX; Tony Allard; Zacharias, Mark ENV:EX; Graham, Tessa ENV:EX; Buttman, Ashley ENV:EX
Subject:	Re: Enterococcus Urgent Questions
Date:	Monday, February 19, 2018 13:06:45
Attachments:	Enterococcus.pdf ATT00001.htm

Dear David

Attached is a briefing that may be of assistance. In particular, it would be very helpful if you could investigate the current state of the work being done on feeding bacteria such as enterococcus to farm salmon, see attached.

Thank you for your efforts. The openness of your ministry is admirable.

Alex

Enterococcus

When the province of BC tested the blood water effluent of two farm salmon processing plants, one in Campbell River and one in Tofino, they confirmed what the lab at the Atlantic Veterinary College reported – that the samples were infected with the salmon blood virus, piscine reovirus. However, they also detected extremely high levels of the human pathogen enterococcus.

Both water samples taken by the BC provincial government from the Tofino and Browns Bay processing plants reported >60,000 enterococci/100ml, noting there were more bacteria than they had the ability to count. The samples reported by the BC Ministry of Environment were not taken in the ocean, so we don't know what these very high output levels may have diluted down to in the marine waters where people are at risk of coming into contact, however both processing plants are in areas frequented by people.

The enterococcus level considered safe by the US Environmental Protection Agency in marine waters is 104 – 501 cfu/100mL[1] and ≤70 enterococci/100 ml is the Canadian marine recreational water quality guideline[2] recommending further action if this guideline value is exceeded. Minimum action should consist of immediate of the ocean near these outfall pipes. A swimming advisory may required.

In addition, since the fish being gutted in these plants come from farms throughout Clayoquot Sound and the waters between Vancouver Island and the mainland, testing has to be done around these farms because there are commercial, sport, food and ceremonial fisheries in these regions. Species like shrimp and prawns are bottom feeders and thus are ingesting farm waste.

There needs to be an investigation into how such high levels of this bacteria are in farm salmon processing effluent because surprisingly research is underway on feeding enterococcus to farm fish to achieve a probiotic effect. When Enterococcus was introduced to rainbow trout feed, fish growth accelerated.[3] The FDA has approved no enterococcal feed additive. However, a DFO webpage entitled "**Thinking Out of the Box: Exploring Strategies to Reduce Sea Lice Infestations in Salmon Farms**[4]" dated 2017-01-19 reports that DFO is exploring the use of beneficial bacteria to feed to increase resistance to sea lice.

Background

Enterococci are not always considered harmful to humans, but their presence in the environment may indicate that other disease-causing agents such as viruses, bacteria, and protozoa may also be present. Significant amounts of enterococci in a water body can negatively affect the recreational and economic value of the aquatic resource.

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[1] https://www.epa.gov/sites/production/files/2015-09/documents/ecoli.pdf

[2] https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-recreational-water-quality-third-edition.html

[3] http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2095.2006.00408.x/abstract

[4] http://www.dfo-mpo.gc.ca/science/publications/article/2016/09-14-16-eng.html

Overabundance of fecal bacteria in the water can cause beach closures, swimming and boating bans and closures of fishing and shell fishing areas[5].

While enterococci are used simply as an indicator species to alert regulators to fecal contamination of marine waters, i.e. to provide warning that other pathogens are likely present, the bacteria itself can also cause serious and often life-threatening disease.[6] Enterococci are the second leading cause of bacterial blood infections.[7]

Many studies correlate increasing concentrations of environmental enterococci with gastrointestinal and dermatological illnesses. As a result, the Environmental Protection Agency suggests it is urgent to more thoroughly define ecological reservoirs for this bacteria, understand host and bacterial traits that promote colonization, and clarify mechanisms for transmission that enhance the spread of multi-drug resistant enterococci[8]. The Province of BC testing raises the question – are the salmon farms throughout BC enterococcus "ecological reservoirs."

Treatment of enterococcal infections can be difficult because *Enterococcus* species are intrinsically resistant to many antimicrobial agents and have the capacity to acquire resistance genes and mutations. Use of antibiotics in the BC salmon farming industry is second only to Chile[9] with BC using an average of 1.75 antibiotic treatments per grow out cycle in 2014. Sixteen percent of enterococcus isolates from farmed salmon were found to be resistant to the antibiotic tetracycline[10]. Release of antibiotic resistant strains of enterococcus would pose additional threat.

Questions for BC regulators:

1. Given the very high levels of this bacteria in the blood waste pouring from farm salmon processors into the marine environment what testing has been done around the plants to ensure the water is safe for recreational activities?
2. What species of Enterococcus was detected?
3. What is the antibiotic resistance profile of the bacteria?
4. Are BC farm salmon being fed enterococcus bacteria in an effort to reduce the BC salmon farming industry's large consumption of antibiotics, or to reduce sea lice populations which have been escalating again in Musgamagw territory since 2015[11]?

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[5] https://www.epa.gov/national-aquatic-resource-surveys/indicators-enterococci
[6] https://www.ncbi.nlm.nih.gov/books/NBK190429/
[7] https://www.ncbi.nlm.nih.gov/pubmed/18947320
[8] https://www.ncbi.nlm.nih.gov/books/NBK190429/

[9] https://www.undercurrentnews.com/2015/10/27/bc-salmon-antibiotic-use-second-highest-in-world-further-reductions-planned/
[10] http://jfoodprotection.org/doi/pdf/10.4315/0362-028X.JFP-15-463?code=fopr-site
[11] http://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2016-0122#.WnzLcIJG3OQ

5. What is the explanation for the astronomical levels of the bacteria, i.e. more than could be counted?

Alexandra Morton
Alexandramorton5@gmail.com
250-974-7086

On Feb 19, 2018, at 12:30 PM, Morel, David P ENV:EX <David.Morel@gov.bc.ca> wrote:

Hi Tavish

It was good to meet you on Friday and thanks for the email. I will ask our Regional Operations Branch to put together answers to your questions as soon as possible.

David Morel
Assistant Deputy Minister
Environmental Protection Division
Ministry of Environment and Climate Change Strategy

From: Tavish Campbell [mailto:tavishcampbell@gmail.com]
Sent: Monday, February 19, 2018 11:32 AM
To: Morel, David P ENV:EX; Xia, Eveline ENV:EX; Tony Allard; Alex Morton
Subject: Fwd: Enterococcus Urgent Questions

Hello David, Eveline and George,

Thank you for meeting with me on Friday. I appreciate your response to the seriousness of this situation.

Please see below the email from Alex regarding Enterococcus levels in your samples.

Here are the questions again:

1 - have you tested the beach areas adjacent to the Browns Bay and Tofino packing plants?
2 - what species of enterococcus was detected?
3 - what is the antibiotic resistance profile of the bacteria collected?
4 - are BC salmon farmers feeding this bacteria to the fish in their pens?
5 - what is the explanation for these high counts?
6 - what are the enterococcus levels found around salmon farms where people are fishing?

Thank you for looking into these questions and I look forward to hearing from you soon.

Tavish

Tavish Campbell
250-203-2903
tavishcampbell.ca | Skype: tavishcampbell
Box 30 Heriot Bay B.C. V0P 1H0

---------- Forwarded message ----------
From: **Alex Morton** <alexandramorton5@gmail.com>
Date: Fri, Feb 9, 2018 at 11:33 AM
Subject: Enterococcus Urgent Questions

To: "Heyman.MLA, George LASS:EX" <George.Heyman.MLA@leg.bc.ca>
Cc: "Popham, Lana" <L.Popham@leg.bc.ca>, s.22
s.22

s.22 , Tavish Campbell <tavishcampbell@gmail.com>, s.22 , "Meggs, Geoff PREM:EX" <Geoff.Meggs@gov.bc.ca>, s.22
s.22

Dear George Heyman;

In follow-up to my last email on this issue, attached please find a short briefing on the extremely high enterococcus counts that were detected by the province of BC at the fish farm processing plants in Tofino and Browns Bay. This is in addition to the confirmation of PRV in these samples as originally reported by the Kibenge lab at the Atlantic Veterinary College.

As you will see in my report, 30 - 501cfu/100ml is considered the safe level of enterococcus in marine waters, however the plants are discharging in excess 60,000cfu/100ml. They report there were too many bacteria to count. This discharge is going into water frequented by people and raises the concern that this bacteria of human health concern is also being discharged from individual salmon farms coast-wide where people are exposed in a variety of ways.

From a brief review of the literature I find that t**he salmon farming industry has been experimenting with feeding this bacteria to their fish** to produce a probiotic effect, increase growth, and increase resistance to sea lice. Is the high enterococcus count in the blood water a result of this practice?

There are urgent questions that arise from these test results:

1 - have you tested the beach areas adjacent to the Browns Bay and Tofino packing plants?
2 - what species of enterococcus was detected?
3 - what is the antibiotic resistance profile of the bacteria collected?
4 - are BC salmon farmers feeding this bacteria to the fish in their pens?
5 - what is the explanation for these high counts?
6 - what are the enterococcus levels found around salmon farms where people are fishing?

Can you let me know who will be taking the lead in answering these questions? In the meantime I will initiate testing for enterococcus around salmon farms.

Thank you so much for performing these tests,and alerting us to this concern.

Alexandra Morton
250-974-7086

On Feb 7, 2018, at 1:23 PM, Alex Morton <alexandramorton5@gmail.com> wrote:

Dear Ministers George Heyman and Lana Popham

I forwarded the results of your very thorough farm salmon bloodwater testing to a marine toxicologist who has expressed concern (below) at the high nitrogen content in regards to stimulation of algae blooms, which we have seen increase over the duration of salmon farming in BC, but also the elevated presence of enterococcus, a human pathogen of concern. Both of the Tofino and Browns Bay plants are discharging this pathogen into areas people frequent.

You must know that the salmon farming industry has achieved an exemption from freezing their product prior to serving as sashimi, as well, the BC salmon farming industry has increased their use of antibiotics due to winter ulcer (see attached picture of this disease in the Marine Harvest Glacier Falls salmon farm in Musgamagw Territory).

Drug resistant enterococci are a growing human health concern.

If this bacteria is in farm salmon bloodwater, it seems likely it came directly from the farm fish, which are raised throughout southern BC. People are fishing for prawns, crabs, and wild fish near salmon farms, and people are swimming in water near the processing plants, as well as, washing their boats down etc.

I have focused on pathogens of concern for wild fish, and my work has driven the increased understanding and research into farm salmon viruses and sea lice, however now I am wondering - do I need to extend my work to include pathogens of human concern in farm salmon?

Are we comfortable with people eating raw farm salmon straight from the farms, with this level of enterococcus in the offal? Should people be warned about thoroughly heating seafood caught in salmon farm effluent? Should people be guided to wear gloves when handling farm salmon while preparing to cook it, if they have an open scratch or cut?

Wild salmon are culled continuously by predators and so fish even slightly impaired by a pathogen are removed, this is why studying disease in wild fish is so difficult - the predators get them first! However, as we see in the hours of video taken by First Nations in farms from Campbell River to Alert Bay, there are hundreds of slow swimmers in each pen of each farm, meaning there is much greater risk of pathogen content in farm salmon and elevated exposure to consumers.

Can you tell me what response your ministry has mounted in response to finding the bacteria enterococcus in the effluent from the Lions Bay and Browns Bay processing plants, so I can consider what steps I should take? Perhaps the presence of enterococcus is of no concern, but I believe it needs to be identified to species and tested for drug resistance as this came from a product destined for human consumption.

Thank you both for the very thorough work by your team and the transparency of sharing the results. This is such a positive and unprecedented step. There is the unfortunate problem that the more you look at farm salmon, the more uncomfortable discoveries are made. As always this and the other problems would be resolved by getting the industry out of the ocean into tanks.

I will leave it to you to share this Premier Horgan as he continues to decide whether to renew the expiring salmon farm tenures in the Broughton. Browns Bay is processing fish from Musgamagw and Namgis Territory and so as always I have shared my results with them.

All the best,

Alexandra Morton
250-974-7086

"From first glance, I can see that the "Brown's Bay effluent" is much more contaminated with total nitrogen

and enterococcus than the 'Lions gate process water", which is still contaminated. For Brown's Bay, Total nitrogen is 116 mg/L and enterococcus > 6000 which is much higher than what I understand as normal seawater with up to 0.7 mg/L total nitrogen. For Lion's gate, the total nitrogen is 36.5 mg/L, still much higher than normal seawater. This seems like very bad news. Excess nitrogen will promote algae growth that then depletes oxygen, promoting red-tides and eutrophication in the area. The enterococcus are oportunistic pathogens, dangerous for humans as the can promote disease and are a sign of fecal contamination (human and/or other species).”