Dear Committee members 17th May 2021

Thank you for the opportunity to express my opinions and answer your questions concerning Pacific salmon on May 12, 2021.

Given that our exchange was necessarily short and not all questions were fully answered or asked, I hope the following written submission will help fill in some of the blanks.

I comment on four topics:

- Known impacts *vs* risk & being overly cautious;
- The science *vs* opinions concerning "diseases" and wild salmon;
- The need for local peoples to be proud of their local activities;
- Salmon hatcheries can have benefits.

I wish you well with your deliberations, which I suspect will have implications beyond Pacific salmon, particularly because other key fish species like Arctic cod and Arctic char will be challenged by a warmer Arctic Ocean.

Tony Farrell, FRSC

## I. Known impacts *vs* risk & being overly cautious

*a) Impacts*

- All forms of fishing are either lethal or potentially lethal.
- Norwegian data are very clear about the impact of commercial fishing on wild salmon, as shown in the following graph (the full 2017 report is appended). When commercial fishing pressure was drastically reduced & recreational fishing pressure kept modest, the wild population stopped declining and started to creep up. During the same period commercial aquaculture greatly expanded.

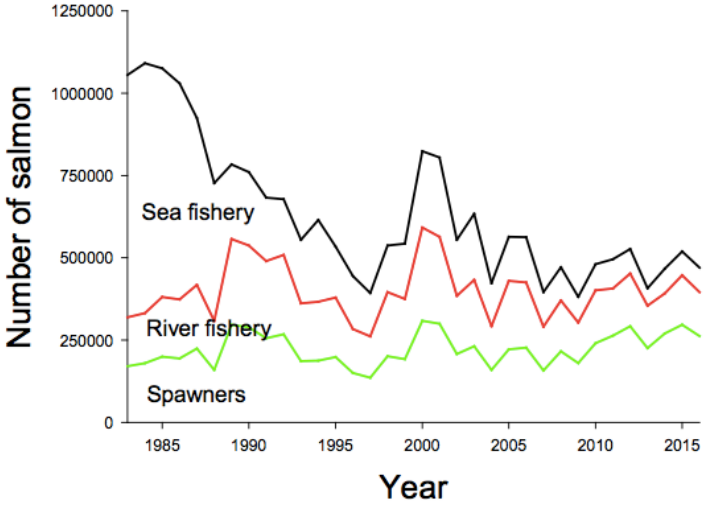


***Figure 1.*** *Estimated number of wild salmon returning from the ocean towards Norwegian rivers (pre-fishery abundance, black line), number of wild salmon entering the rivers (red line, i.e., the number left after catches in sea fisheries), and the number of wild salmon left for the spawning populations (green line, i.e., the number left after catches in sea and river fisheries) during the period 1983-2016.*

- There is no guarantee that a catch-and-released (or a non-retention) salmon can survive after release. Our research suggests that i) silver, marine-phase adult Pacific salmon tolerate capture-and-release better than adults migrating upriver, ii) catch-and-release at high temperature in freshwater causes increases death of adult Pacific salmon and iii) adult female Pacific salmon in freshwater are more susceptible than males to handling stress and hydraulic barriers.
- The natural schooling behavior of adult salmon as they return to rivers increases their vulnerability to the large Pacific seiners (an entire population could be wiped out with one haul). This biological consideration likely was not considered in earlier management decisions.
- Other known impacts to wild Pacific salmon in BC are the massive seal population (which now hunts in packs) and the abundant invasive California sea lions that have an even greater appetite than seals and hunt very efficiently (and cleverly) in packs - I've watched them in action for an entire day decimating schools of juvenile herring and anchovy heading out to the Strait of Georgia.

*b) Risk*

- Life is full of risks. If we were overly cautious, we would never drive a car (the risk of an accident), walk in a city (the risk of having to cross roads), or use aspirin (risk of stomach damage). Therefore, humans are proficient at managing risks.
- Exposure is crucial in risk management. The geographic isolation of New Zealand and Australia has clearly shown us, the risk of a lethal covid-19 infection can be managed and largely avoided with no exposure.
- We actually know very little about the exact exposure of migratory Pacific salmon to open net-pen salmon farms, but it may be quite limited. A recent study (Rechisky et al. 2021; attached) followed (using biotelemetry) juvenile sockeye salmon as they migrated north out of the Strait of Georgia, potentially moving through the Discovery Islands. The results were:
    - Only about 1/3$^{rd}$ of the sockeye salmon went through the Discovery Island channels; 2/3$^{rd}$ by-passed farm activity by migrating directly through Johnstone Strait.
    - Migration rate through the channels was 25-29 km/day and did not differ with or without farming activity.
    - Of the sockeye salmon that migrated through the channels, a maximum of about 50% were detected near one or more farms (Fish detection range was ~80 – 300 m from a farm). Thus about 1/6$^{th}$ came close to a salmon farm.
    - For these salmon, the median time near a salmon farm in Okisollo Channel was 4.4 min in 2017 and 10.9 min in 2018.
- Migrating adult salmon like move much faster than juveniles, thereby reducing their exposure time to farms. They have stopped feeding and are on a mission – to find a mate upriver!

## II. The science *vs* opinions concerning "diseases" and wild salmon.

*a) PRV*

*Opinions*: PRV infects adult sockeye salmon as they migrate passed salmon farms and this infection harms their swimming performance such that they cannot swim beyond the hydraulically challenging Fraser River Canyon.

*The Science:* I analyzed the raw sockeye salmon data presented in Morton et al. 2017 (and the version that was corrected in 2021) and cannot reconcile these opinions with the data.

- None of the 27 adult sockeye salmon sampled a downstream of salmon farms in the Discovery Islands were PRV-positive before they entered the Fraser River.
- 76 adult sockeye salmon sampled in the Fraser River system were either PRV-negative (79%; 60 out of 76) or marginally PRV-positive (21%; 16 out of 76) based on high Ct value (a Ct< 35 is needed to be considered a reliable positive). In fact, six different sockeye salmon populations were PRV-negative (Chilko River; Gates Creek; Stuart Lake; Birkenhead, Selllaquo and Scotch Creek) and only the Boston Bar and Bridge River samples had weak PRV-positive signals.
- Salmon can be carriers of PRV (and possibly many other disease vectors) without impacts.

*b) Sea lice*

*Opinions*: One sea louse kills a baby pink salmon and, as a result, a mathematical model predicted the Broughton population pink salmon would disappear over a couple of generation.

*The Science*: The Broughton population pink salmon did not disappear as predicted. This may be in part because the assumed effect of one louse was incorrect. Our research has shown:

- Baby pink salmon did not die with controlled infections with one to three sea lice.
- 2-3 sea lice had sub-lethal effects on swimming performance and osmoregulation.
- Pink salmon can shed lice, reducing its load.
- As a baby pink salmon grows rapidly, its tolerance of a sea lice load increases.
- In interpreting local monitoring of sea lice on salmon, one louse on a fish is likely not a problem.

## III. The need for local peoples to be proud of their local activities

- Local people should be far more involved in decision making and environmental monitoring. They know the nuances of their locality.
- The risk of aquaculture to wild Pacific salmon can be effectively managed, especially if local peoples are consulted widely ahead of decisions and are then involved in the actions that are specific to their local situation. Such processes can create proud and responsible communities, and sustainable practices.
- The technologies used in aquaculture today are not those of yesterday. The industry has adapted.

## IV. Hatcheries can have benefits

- Hatchery production of Pacific salmon has been on-going in BC for over 100 years.
- Hatcheries can be used effectively to support recreational fishing.
- Hatcheries should not produce salmon that are “couch potatoes”, then release into nature *en masse* (inviting a feeding frenzy by predators) and expect them to easily find food and survive predators.
- Hatcheries can select genotypes and condition phenotypes to improve survival.