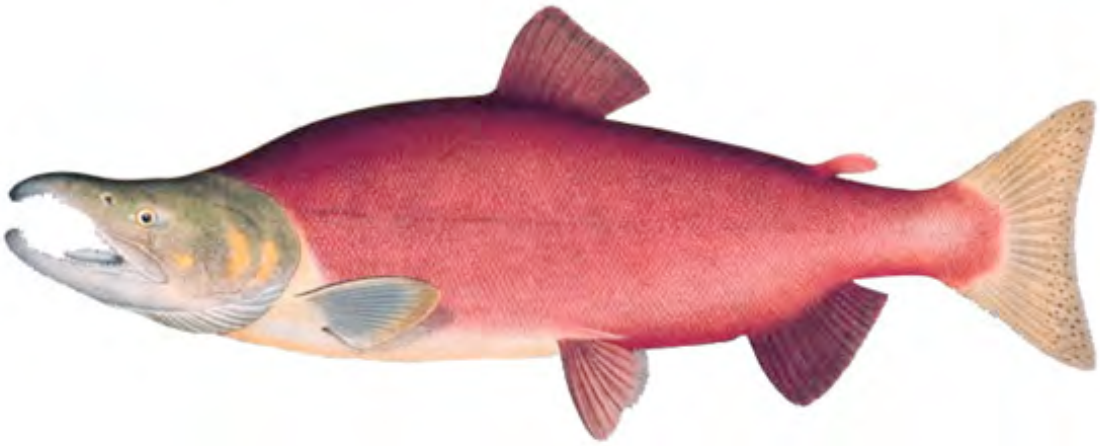
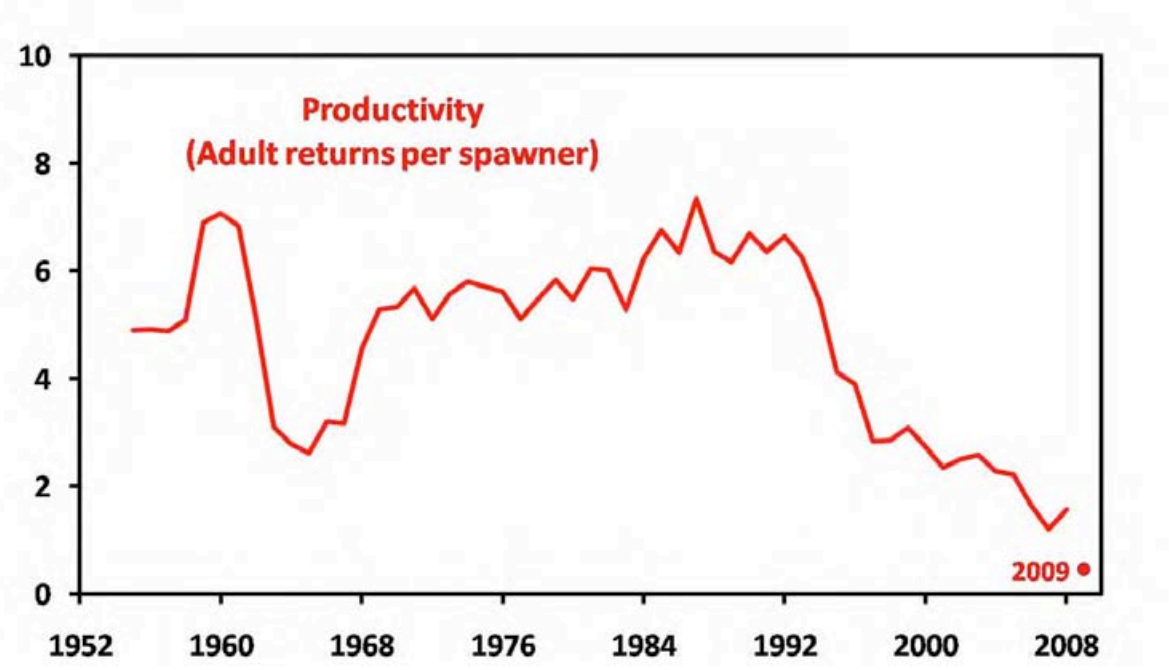
What is happening to the Fraser sockeye?

Aquaculture Coalition
Based largely on documents submitted to the Cohen Commission
August 14, 2011



What is happening to the Fraser sockeye?

After reviewing the documents submitted to the Cohen Inquiry, it is clear something has been increasingly negatively impacting the Fraser sockeye since the early1990s. Some runs are entering the river too early and many runs are suffering massive losses just before spawning, called pre-spawn mortality. Then in 2010, an unpredicted, very large run returned. The 2011 run has been good enough to date that several fishing openings have been allowed. Pre-spawn mortality has been rising as the number of sockeye produced per spawner has declined. Whatever is happening to the Fraser sockeye needs to account for 18 years of decline, only in specific runs, as well as, the large 2010 return. At the Dec 2009 Fraser Sockeye Think Tank, scientists who are tasked with predicting run sizes reported their models have become increasingly inaccurate over the past ten years. This suggests variable/s unaccounted for. There must be factor/s exerting such significant influence on survival of individual sockeye as to be having a population affect. Fisheries scientists from Alaska are not reporting this difficulty. This is not just about the 2009 crash. It is the entire pattern of enormous unpredictable fluctuations.



The Geographic Pattern of the Fraser sockeye collapse

The pattern of south coast British Columbia sockeye runs is important to the question of what is happening to the Fraser sockeye. It is only the runs that have been observed migrating to sea between Vancouver Island and the mainland that are in decline. The Harrison sockeye leave the Fraser River and appear to migrate around southern Vancouver Island (Tucker et al 2009). The Discovery Islands is the region of greatest contact between farm salmon (Chinook and Atlantics) and Fraser sockeye due to a high concentration of salmon farms in the narrowest passages of the sockeye migration route. The wild salmon traversing this area are the reason the Cohen Commission was struck.

Pre-spawn Mortality

It is unusual to find dead wild fish, generally they sink out of sight or are consumed. But in the case of pre-spawn mortality the rare opportunity exists to count and examine them. Fisheries and Oceans (DFO) and Pacific Salmon Commission (PSC) scientists have communicated frequently about what they have been seeing in the escalating pre-spawn mortality (PSM) afflicting the Fraser sockeye.

100% of the Cultus Lake sockeye run died of PSM in 1999, 2000, 2001 (Lapointe, 2003, presentation 2003 Georgia Basin/Puget Sound Research Conference, pg 3)

Cultus "acute" concern since 1996 due to early entry, PSM and en-route losses (643-page report 2007 . Record of Management Strategies [RMS] - Salmon - 2007 - Fraser River - Sockeye and Pink) CAN007959

Since 1995, an average of 58% and up to 95%of the Late run sockeye have died in PSM. (Genomics and the Mystery of the Fraser Sockeye) CAN139298

2006 85% of **Cultus Lake** sockeye died before spawning. Only 2 out of 85 females spawned "very disturbing," different pattern, with later run fish more affected than earlier fish, in contrast with the leading hypothesis. (Email from Timber Whitehouse Dec. 8, 2006 to Riddell, Laura Richards etc) CAN108807

"By 2001, the en-route mortality was as high as 90% in some stocks and pre-spawning mortality ranged from 10 to 30% "The high levels of mortality prior to spawning have already threatened the viability of small late-run populations. (Lapointe, 2003)."

Early Entry

Late-run sockeye typically held in saltwater at the mouth of the Fraser River for a period of weeks**,** but beginning in the mid-1990s these fish began entering the Fraser River 4 -6 weeks earlier. This put them in the river at higher temperatures and so at first people thought it was the high water temperatures killing the sockeye.

"Since 1995, the Cultus sockeye have migrated upstream earlier showing a similar pattern to Adams stock. In fact, the same pattern of early river entry in recent years has been observed in all late-run stocks for which monitoring data are available"… "By 2001, the en-route mortality was as high as 90% in some stocks and pre-spawning mortality ranged from 10 to 30% (Lapointe 2002). In contrast, prior to 1995, *total* freshwater mortality for late-run stocks rarely exceeded 20%." Early river entry is associated with "extraordinarily high mortality rate." "We estimate the cost in lost fish production/harvest was approximately 7.2 million fish in 2002. Using a very conservative estimate of the ex-vessel price of $10 per fish, the losses just to fishermen associated with this problem likely exceeded $72 million dollars last year. And this figure does not included added losses to processors and others involved in the salmon industry." (LaPointe, 2003)

At first in-river losses appeared correlated with high water temperature

Jan 2009, Historically pre-spawn mortality was "system wide," occurring throughout the river when water temperatures were high (2008 Pre-Spawn Mortality Update, , Environmental Watch Program, DFO) CAN207345

I**n 1992, the pattern of in-river die-offs of adult Fraser sockeye changed radically.** Not only were some sockeye entering the river much earlier, mass mortality events began

occurring nearly annually and they were not river-wide events. There seemed no pattern to the large proportions of individual runs dying here and there throughout the Fraser drainage. These die – offs were no longer associated with high water temperatures.

> Jan 2009 "Historically PSM has been correlated with en route river temperatures to the spawning grounds. The normal pattern of PSM within a year is to see higher proportion of the initial carcasses (*when water temps were higher*) examined to have a higher probability of high egg retention." (Pre-Spawn Mortality: Patterns, Physiology and Timing, report Patterson et al DFO/UBC) CAN246413
>
> Lapointe reports early migration is also affecting pinks, chum and Chinook salmon. They do not know what caused this. (Lapointe, 2003)

In some years the sockeye that entered the river at peak summer high temperatures spawned more successfully than the ones that entered the river when the water was cooler. This did not fit the high-water temperature theory.

> "This decline in PSM with sample recovery date has been inconsistent in recent years….. Controlled experiments at Weaver Creek channel have confirmed that prespawn morts can be recovered at any time….This pattern is important when considering modeling PSM and temperature." (Pre-Spawn Mortality: Patterns, Physiology and Timing, report Patterson et al DFO/UBC) CAN246413
>
> Dec 8 2006 "…we are experiencing very high levels of pre-spawning mortality (PSM) in 2006. ….PSM rates for females exceed 85% at present….The pattern being seen in PSM for late run sockeye in 2006 is much different from that observed since 2001. Prior to this year, where PSM rates have been high most of the mortality was weighted on the front end of the spawning distribution, with later timed fish exhibiting higher spawning success. In 2006, however, data at the Adams and from Cultus indicate that later arriving spawners are exhibiting much higher rates of PSM…. These observations stand in direct contrast to the leading hypothesis with respect to the mechanism responsible for elevated PSM rates – cumulative thermal exposure, resulting in osmoregulatory failure due to Parvicapsula infection…Not real encouraging on the conservation front when you consider exploitation rates for Cultus appear to be double the target agreed to during planning for 2006 fisheries' (Email, Timber Whitehouse to Laura Richards, Brian Riddell, Barry Rosenberger) CAN108807

"Early Entry" became a symptom correlated with high mortality in the late runs. The Summer and Early runs do not hold in the Fraser plume in the ocean, however, they were also affected by PSM. Whatever was causing the Late Runs to leave saltwater as fast as possible, would not be detected in runs that do not typically hold in saltwater.

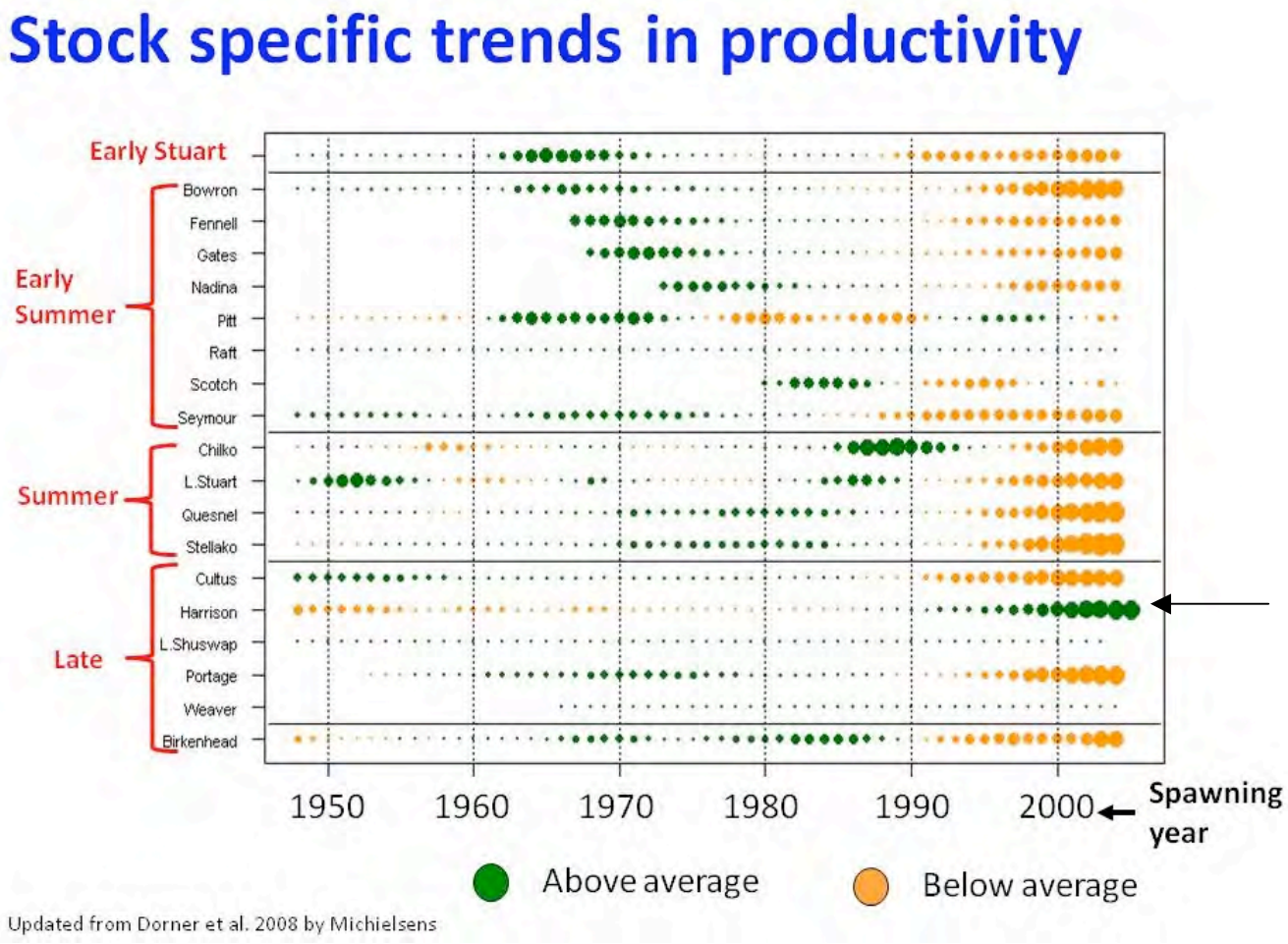
A first the cause of death was attributed to a freshwater parasite *Parvicapsula minicorbinis*

> Nov 10 2006, "The virus results came back negative and bacterial problems were only evident in two of the fish…. The bottom line is that all of the fish sampled were indeed very sick, and a number of organs had pathologies that were consistent across all 10 fish sampled kidney (Parvicapsula), Liver – chronic

infection, Gills, and Heart….there are still a few questions surrounding some gill histology results…" (Email David Patterson to list of DFO) CAN170058

But *Parvicapsula* did not fit any better than high water temperature

In a published paper, Jones et al. (2003) report finding parvicapsula in many Fraser sockeye stocks across the different run timings, including Harrison where prevalence was 76.9%. The Harrison is the one Fraser sockeye stock that has been consistently "above average" during this 18 year- decline, suggesting that even very high prevalence of *Parvicapsula* is not unto itself deadly to salmon. This chart reveals a very stark pattern of most runs in decline, with several have remained unchanged and one increasing – Harrison. Whatever is affecting the Fraser sockeye is not harming the Harrison. Either they are immune or they are not exposed.



2007 "…the severity and incidence of kidney parvicapsula infections are not different among healthy and moribund individuals, suggesting that at least in 2007 it was not the decisive factor in determine PSM…extensive field survey parvicapsula not "decisive factor in PSM" as healthy sockeye had parvicapsula" "…. (Disease and Pre-Spawn Mortality for Late Run Sockeye, Patterson, et al DFO, PEI,) CAN261133

Aug 28 2008 - "definitely something out of the ordinary" **Upper Pitt fish** were dying as they netted them. (Email, D. Willis, DFO) CAN118348

Heavily damaged kidneys became one of the symptoms common among PSM fish.

> 2007, In response, DFO did repeated tests for bacterial kidney disease (BKD), especially on the Cultus Lake sockeye experiencing up to 100% PSM, but the tests kept coming back negative it looked like BKD but was not BKD (Test results from Christine MacWilliams, PBS CAN010901, CAN010860 etc…)
>
> July 7, 2005, Some of the PSM fish were labeled "bleeders" and bled profusely when handled (Email Miller to DFO) CAN108795

The gills of the dying fish were also very damaged, but no one could figure out why.

> Dec 5, 2006 "The gills certainly do present a diagnostic challenge – and they are possible the worst looking (i.e. pathological) gills which I have ever seen….. Additionally, some of the specific lesions are unique and definitely have not been described before ….. severe inflammation…..not consistent with any "as yet" described gill problems. The mystery deepens…. The gill pathology is profound and highly unusual…. I think it is well worth not overlooking the possibility of a viral agent….thus being responsible for a subset of the unusual gill lesions." (Email Dr. David Speares U. PEI to Mike Bradford and others) CAN085251
>
> Dec. 21, 2009 "…despite finding everything but the kitchen sink, there's no smoking gun… The gills of every fish were compromised to some degree….epithelial hyperplasia with no inciting agent identified." Parasites were seen in the kidney: "*Loma….. parvicapsula* …no direct evidence that this infection is harming fish… large colonies of bacteria… further demonstrating the systemic nature of this disease " (Christine MacWilliams Pacific Biological Station, Memo) CAN269763
>
> 2007 "Despite the large loss of future recruits for these high profile populations, we do not have a consistent hypothesis to explain these natural pre-spawn mortalities. Kidney disease induced by *Parvi* sp has been implicated in the recent Late-run pre-spawn mortality events (notably 1996-2001), based on prevalence and severity of *Paricapsula.* However these same levels of infection were present in several sockeye populations (including Weaver, Adams) from 2002-2005 without the accompanying high PSM. …..These results, coupled with the complete absence of *Parvi* spores recently found in Quesnel spawners, suggest that our current understanding of both disease progression and prevalence across the Fraser River is incomplete. The most compelling cause for the 2006 prespawn losses was the discovery of severe gill pathologies observed during a single event of moribund and dead fish from Cultus Lake; the exact cause of the gill disease is still unknown. This raises the spectre of novel pathogen infecting late-run fish. Corroborating evidence of gill pathologies from similar moribund Weaver or Late Shuswap fish has not occurred" (Funding request, David Patterson and Mike Bradford) CAN171270

Despite thirteen years of accelerating loss in the river and declining stocks DFO did not mount a systematic investigation of the fish dead on in the river. Several pathologists do what they can, but are frustrated.

> May 2009 "… a year class of Nadina sockeye died prespawning and all we have are the 11 gill arches and they are virtually useless. This is not a unique situation. There is a poorly defined, inadequately funded response protocol for wild fish kills…..For major PSM like you experienced last year, samples should be taken for bacteriology, virology and histology….might be useful…to put together kits with fixative, laminated instructions…tools, pictures ….in cooler. It is unfortunate that we no longer have the necessary resources to send field crew out to help in these situations….. (Mark Higgins)….bottom line, we are no further ahead in finding out why the majority of the Nadina Channel population died, pre spawning. Our system to try and solve these problems or to least learn from them appears to be very broken….I'm at a loss as to where the money would come from, but I'm hoping it wouldn't stop the process." (Email thread incl. Higgins, MacWilliams, Bennett) CAN085931

DFO did realize, however, that they had to figure out how to predict how many sockeye were going to die in the river or they could not set useful quotas for the various fisheries. While they did not allocate funds to figure out why entire runs of Fraser sockeye were dying in the river, they did task their Genomics Lab at the Pacific Biological Station to figure out how to predict in real-time how many sockeye caught in a test set in Johnstone Strait and elsewhere would survive through spawning. It is useful to note agency does not appear to be engaged in the health of salmon, only the fishery.

Summary

Since the early 1990s so many sockeye were dying in the river that the root cause of this may account for a large percentage of the over-all decline. Even though pathologists were able to examine the dead salmon, they could not figure out the underlying problem because the salmon were not consistently dying of the same thing. The obvious physical symptoms were damaged kidneys and gills, but the cause eluded pathologists from PEI, DFO and UBC. Their work was critically hampered by lack of funds and seeming general disinterest by the department. Finally DFO tasked their Genomic Lab, not because the wanted to know what was wrong with the Fraser sockeye, but to determine how many they could allocate to the various fisheries.

Dr. Kristi Miller's Mortality Related Signature (MRS)

In 2006, DFO tasked Dr. Kristi Miller, head of DFO's Pacific Biological Station, Genomic Lab to conduct genomic profiling in hopes she would find a predictive tool that could be used in real time to determine if sockeye caught in a test set were going to successfully spawn or not. It was expected that Miller would be able to use the condition and fitness to predict if a sockeye had the resources to complete its migration and lay eggs. Her technique, called genomic profiling, records which genes have been turned on and off to make proteins (transcriptional activity). The resulting on/off pattern is called a genomic profile or signature. What Miller found was a "suite of co-expressed genes associated with elevated mortality in the river" (Draft Media Lines Jan. 4 2011) CAN492777 The fish that were dying in the river had a different pattern of genes up and down regulated compared to the sockeye that successfully spawned.

She took a small, non-lethal sample from the fish, then tagging them with a telemetry device so it could be tracked and released it. She eventually named the genomic profile of

the sockeye that died the Mortality Related Signature (MRS). Genomic profiling of fish is cutting edge science, it a new field. Her work has met with the highest scientific accreditation possible – publication in *SCIENCE* (Jan 2011). *SCIENCE* is extremely rigorous journal and that it chose to publish a paper as controversial as Miller et al. 2011 speaks to the quality of her work.

DFO expected her to find the Fraser sockeye were dying because they were running out of energy reserves. But this was not the case. There are many documents written by Dr. Miller in Ringtail; emails, funding applications, reports and power points. There is evidence that she was not allowed to attend non-DFO meetings, under-funded, not allowed to speak to media and not allowed to investigate the genomics of farm salmon. All of this hampered her work and was not beneficial to the public resource. It is difficult therefore to know what parts of her early findings were dropped because they did not withstand further investigation and which aspects she was made to drop, if any. However, it seems worthwhile to examine all of her work because it is so highly significant to the question the Cohen Commission was struck to answer. Miller, by all accounts is a careful scientist, her findings explain the pathology of the dying sockeye and is a perfect match to the geographic and temporal pattern of the Fraser sockeye fluctuations from 1995-2011, including the 18 year decline, the 2009 collapse and the high 2010 retruns. Dr. Miller presents her findings and thinking in two power points:

2008 **"Physiological control of entry timing and fate"** Power Point CAN006139

- Sockeye with the MRS were 16x less likely to reach the spawning grounds
- MRS sockeye were 5.25x more likely to enter the river early
- The pattern within the genes appeared to be "virally-induced"
- 40 genes co-opted by Leukemia viruses
- 40 genes involved in other retroviral infections
- 30 genes linked with cancer
- 3 genes linked with brain cancer
- Genomic evidence that MRS fish enter freshwater faster because they can no longer tolerate saltwater

In the next Power Point by Miller progresses through finding MRS in 90% of the 2009 sockeye, its relation to early entry and pre-spawn mortality, reporting high occurrence of brain tumours and the genomic evidence these were due to infection with Salmon Leukemia virus. She notes Salmon Leukemia virus (SLV) appeared on the Fraser sockeye migration route in salmon farms in the early 1990s, exactly when the sockeye began entering the river earlier and dying before spawning and declining. Salmon Leukemia not only causes ocular brain tumours, it weakens fish so they can die of lesser pathogens. All of this was extremely difficult science for a government agency tasked to promote salmon farms. The first slide is dated Sept 27, 2008, but this document includes 2009 data

> **Epidemic of a Novel, Cancer causing Viral Disease may be Associated with Wild Salmon declines in BC** Sept 27, 2008 CAN006145
>
> - In 2005 75% Fraser sockeye positive for viral signature
> - Viral profiles highly correlated among gills, liver, brain
> - Brain profiles carried tumour-associated signaling
> - 69% of sockeye in 2009 had brain tumours also present in 2006, 2008

- The genes stimulated in these fish were the same as would be associated with retroviral infection in mammals where genomic profiling it better studied
- Retroviruses are often neoplastic (tumour-causing) associated with a wide range of cancers
- 4 pages showing white healthy brains and others with pink and also dark "tumor" masses as well as bleeding.
- Strong linkages between both the MRS in the sockeye genes, the brain tumours and Plasmacytoid Leukemia caused by the Salmon Leukemia Virus
- MRS fish were the ones entering the river earlier and dying of pre-spawn Mortality
- These abnormal behaviours began in 1996, 4 years after salmon farms with Salmon Leukemia Virus arrived in the Discovery Islands
- "SLV infection levels may currently be >09% in Coho, Chinook and Sockeye salmon "

Miller documented her work very thoroughly until 2010. She gives "the accumulating evidence that suggest the disease afflicting our sockeye is retroviral in nature and could be plasmacytoid leukemia:"

- Gene expressions indicate salmon may be responding to a retrovirus
    - Salmon Leukemia is the only suspected retrovirus in BC salmon
- Molecular screening ruled out other viruses ISAv, IHNv, VHSv, Herpes, IPNv
    - Negative for bacterial pathogens and myxosporidian parasite
- Plasmacytoid Leukemia known to infect sockeye
- Plasmacytoid Leukemia fish have pale gills,
    - Pale gills often observed in the dying sockeye
    - Genomics suggest sockeye are low in iron
- Plasmacytoid Leukemia fish generally look healthy
    - The sockeye look healthy externally
- Plasmacytoid Leukemia fish considered temperature sensitive,
    - sockeye in warmer waters had substantially poor survivorship
- Plasmacytoid Leukemia farm salmon losses greatest in transfer from freshwater to saltwater
    - Miller's data indicate sockeye salinity intolerance pushing them into freshwater too soon
- Organisms with leukemia susceptible to secondary bacterial infections
    - Sockeye dying of numerous pathogens
- Leukemia associated with coagulation disorders
    - Field researchers noted heavy bleeding in 2003
    - Coagulation dysfunction noted in expression profiling of liver tissue of these fish
- Retroviruses are neoplastic, hence associated with cancer, Plasmactoid Leukemia in farm Chinook was apparently concentrated from tumours behind the eyes
    - Numerous tumour biomarkers were up-regulated in the brains of afflicted sockeye two of which are markers specific to brain cancer in mammals
- The timing of the first diagnosis of PL (late 1980s, early 1990s) immediately precedes the shift in river entry timing in sockeye salmon, first noted in 1996
  CAN489960

The "unhealthy" sockeye often comprise the majority of runs

> Oct 2009 "So we know that 75% of adults returning to spawn in 2005 carried the viral signature…., with 30% positives in the brain alone. In 2009, we have 70% of the returning adults with tumors, but have not profiled other tissues. Hence, we estimate that infection must be >90%, as brain is a secondary tissue and only a portion of infected fish will actually end up with tumours." (Email from Miller) CAN220802

Now everything began to fit. The pre-spawn fish were indeed sick. With their immune systems damaged they succumbed to many pathogens

> "The profile of the 'unhealthy' fish included evidence of a significant defence response, cell death, inflammation and very clear stress signals indicting the 'unhealthy' fish were, in fact diseased fish." (Conference on Early Migration and Premature Mortality in Fraser River Late – Run Sockeye) CAN145364

The "unhealthy" were entering the river too early for two reasons. 1.) Their brains were no longer in synch with their bodies and 2.) their gills became intolerant to saltwater (SW) as soon as they tasted freshwater on the their return migration

> "perhaps disruption in the transcribed sequence associated with maturation is causing unhealthy fish to "think" they are mature." The data suggest "40 genes co-opted by Leukemia viruses" (2008 power point) CAN006139

> "Unhealthy fish were not only less likely to make it to the spawning grounds, they also entered the river faster than healthy fish, possible due to osmotic disruption in SW." (Conference on Early Migration and Premature Mortality in Fraser River Late – Run Sockeye) CAN145364

> "perhaps FW cues start the "senescence clock"" thus pushing the fish into FW too early. "Do unhealthy fish enter FW faster because they can no longer tolerate SW" (2008 power point) CAN006139

> June 2008, Scott Hinch – "we know the early entry fish are unique physiologically and less healthy, with higher stress, osmoregulatory dysfunction and disease" (Conference on Early Migration and Premature Mortality in Fraser River Late – Run Sockeye) CAN145364

Molecular pathogen screening ruled out many pathogens:

> **Negative** for the RNA viruses: ISAV, IHNV, VHSV, IPNV Picornavirus, DNA viruses Herpes, SPDV, Lentivirus myxosporidia (Parvicapsula), loma etc. (2008 power point) CAN066139

In her early works there are strong geographic references to finding this only in fish traveling past salmon farms

> "Initial analysis showed a strong signal in gill tissue (greater than 400 differentially regulated genes) from fish sampled in Johnstone Strait that was

> associated with in-river fate….the identified signature could be used to correctly classify 88% of Johnstone Strait upper river mortalities and 66% of JS survivors." (Conference on Early Migration and Premature Mortality in Fraser River Late – Run Sockeye) CAN145364
>
> "2 distinct profiles correlate with ocean route taken to reach river" (2008 power point) CAN006139
>
> "We observed profound physiological differences in fish that migrated south along Vancouver Island using the inner (JS) versus outer coastal routes (PR)"

Certain microsporidian parasites might act as co-agents. This could mean a salmon infected with SLV might survive, unless a microsporidian parasite is present. This makes the cause of death a more complicated pattern. Salmon Leukemia and Marine Anemia refer to the same disease.

> "If this is Marine Salmon Anemia, is the brain profile linked with the virus and the gill the microsporidian parasite, if so the virus may have been resident in the salmon for months or years (could be vertically transmitted), with the exposure to the microsporidian upon arrival to the coast" (2008 power point) CAN006139

A salmon infected with this virus might exist in a weakened state until it becomes infected with a microsporidian parasite. The virus might be causing the brain cancer and a microsporidian might be a co-agent causing the extraordinarily degraded state of the gills.

Because the "unhealthy" fish exhibit early entry + massive mortality, both of which began in approximately 1995, Miller suspects that "purported virus" began infecting Fraser sockeye in 1995. Below is a remarkable email.

> OCT 5, 2009 "…I did discuss these data with Mike Lapointe…..from the PSC last week. They are extremely interested in these results and have agreed to keep it quiet for now…They were most interested in the timeline (too bad I did not get a chance to show that slide at the meeting) and tracking where and when the disease may have originated…. In talking to Mike Kent [who first described the virus in Chinook salmon in 1988], it is clear that while they did find a low incidence (6%) of the disease in wild Chinook at the time (1991/1992), they did not observe it in wild sockeye (screened 175 SOG/lower Fraser fish), although they showed that it was infective to them. I found one report that suggested that when they tried to culture sockeye with Chinook salmon, that some did become infected, indicating the potential of horizontal transmission. (Email from Miller to Mark Saunders) CAN088642

Laura Richards Regional Director of Science for the Pacific Region (DFO) limited where Miller could appear

> Nov 4 2009 Kristi Miller to Mark Saunders, " FYI, in case you do not already know, Laura does not want me to attend any of the sockeye salmon workshops

that are not run by DFO for fear that we will not be able to control the way the disease issue could be construed in the press. I worry that this approach of saying nothing will backfire." CAN088697

December 2009, SFU held an invitational scientific think tank into the 2009 sockeye crash and while there were scientists present aware of Miller work no one mentioned it. As a result, we told the public no one had any idea what caused the 2009 crash. This was inaccurate

Nov 4 2009 email cont'd.. Mark Saunders to Kristi Miller " Which Laura, The information is going to be out there and the best thing is to have you, as the expert there. We will need to work with Terry on a communications plan…." Miller replies to Saunders "Laura Richards. Agreed and very frustrated! It will be interesting to see how Brian reacts. Laura also clearly does not want to indicate to the PSC that the disease is of strategic importance. ….." CAN088697

Summary of Miller discovery

From the mid-1990s to present, the Late-run Fraser sockeye have been entering the river weeks earlier and dying before spawning. When vets looked at their tissue, they found an array of afflictions with no clear indication of cause of death or if the fish were dying of the same cause. When genomic profiling began in 2006 it revealed a strong retrovirus signal, resembling Salmon Leukemia. This virus has not been sequenced so no confirmation of this diagnosis was possible. Retroviruses can work to depress the immune system leaving their host vulnerable to other pathogens. Retroviruses can be difficult to detect because they enter the cells they attack. They can cause immunodeficiency, as in AIDS. Retroviruses also cause tumours. The fish with this "unhealthy" MRS genomic profile are precisely the fish entering the river too early and dying before spawning. The scientist who made this discovery suspects that whatever is infecting the "unhealthy" sockeye of today, began infecting sockeye in approximately 1995 and she believes it is the virus Salmon Leukemia. There is strong evidence that the loss of spawners carrying billions of eggs is due to a virus that appeared in salmon farms on the Fraser sockeye migration route one generation prior to the Fraser sockeye decline. Dr. Miller was not allowed to attend an international conference on the collapse of the Fraser sockeye and so the public was not fully informed. There is not evidence she was allowed to examine farm salmon genomics.

Salmon farmers call Plasmacytoid Leukemia, Marine Anemia

- Kent and Dawe (1990) published in *CANCER RESEARCH* Plasmacytoid Leukemia is highly transmittable to sockeye and can infect Atlantic salmon.

- Eaton and Kent (1992) report Plasmacytoid Leukemia called marine anemia by salmon farmers "has caused extensive mortality at numerous seawater netpen facilities," in BC.

- Stephens and Ribble (1995) "Evidence supporting the hypothesis that marine anemia is a spreading, infectious neopplastic disease could have profound regulatory effects on the salmon farming industry"

- But in the Provincial Salmon Aquaculture Review Stephens who co-authors the disease sections scarcely mentions the disease.

- Craig Stephens Carl, Ribble and Micheal Kent (1996) report that marine anemia was "widely distributed throughout the major salmon farming regions in British Columbia," and that "peak occurrence of the disease was associated with a peak in the occurrence of other infectious and inflammatory diseases. Farmers reported that once marine anemia was detected on a farm it was repeatedly diagnosed in subsequent years.

Marine Anemia has distinctive symptoms

- Stephens et al (1996) and Stephen and Ribble (1997) give us the case definition by which marine anemia can be diagnosed **hyperplasia of the interstitial cells of the caudal kidney.**

- Marine Anemia is associated with a microsporidium parasite and Bacterial Kidney Disease (Eaton and Kent 1992)

Scientists suggest salmon farms caused the "emergence" of marine anemia and that financial considerations to the industry may have hindered containment of the virus

- Stephen, Ribble and Kent (1996) report "The environmental conditions created by intensive aquaculture may have facilitated the emergence of marine anemia. Rearing systems used in seapen aquaculture represent a substantial change in the ecology of Chinook salmon. … They suggest marine anemia is a "disease of confinement."

- Stephen (1996) "The lack of regulations that provide for the financial compensation of farmers whose fish have been destroyed in disease control programs suggest that attempts to depopulate salmon farms to control marine anemia would result in strong opposition form the aquaculture industry and a corresponding under-reporting of the disease. "

- Stephen (1996) "… restricting the movement of fish on farms where marine anemia is diagnosed has been suggested as a means to restrict the spread of the disease …Although quarantine may provide for physical separation of "positive" and "negative" farms, the quarantine of pens or year-classes on a farm would be virtually impossible. The intimate interaction of fish with their aqueous environment, the shifting tidal flows of water, the crowded conditions of seapens, and the frequent movement and mixing of groups of fish on a farm, dramatically reduce the probability of preventing the horizontal transmission of pathogens on salmon farms …… the use of quarantine to prevent the spread of a pathogen would effectively force farmers to leave sites fallow for a year in order to break

the cycle of transmission. Once again the potential financial hardships such a program would impose on the industry would result in poor compliance…."

Ultimately the industry switched to Atlantic salmon in the 1990s but Stephens warns:

> "…the susceptibility of Atlantic salmon to experimental replication of marine anemia (Newbound and Kent, 1991) and the finding of marine anemia – like lesions in farmed Atlantics as well as in apparently wild stocks of Chinook suggest that we should not dismiss marine anemia…. Instead attempts should be made to synthesize new and existing information to develop potential intervention strategies not only to service the remaining Chinook producers in the province, but also in **preparation for the possibility of marine anemia becoming a problem for other farmed and wild species**" (Robert Craig Stephen, Thesis Spring 1995 Department of veterinary Microbiology U. Saskatchewan, Saskatoon, A Field Investigation of Marine Anemia in Farmer Salmon in British Columbia, National Library of Canada 0-612-23929-2).

While considered an endemic virus Plasmacytoid Leukemia was tested for during quarantine of eggs imported from the Atlantic

- RPC Aquaculture Diagnostics tested Atlantic salmon fry from imported eggs during their quarantine period for Plasmacytoid Leukemia every month using a Gram stain/Diff Quik/Leishman's test, the same test that Kent and Dawe used in their 1993 paper. (2000 Fish Health, 2001 Fish Health, 2004 Fish Health)

Given that Miller suggests Plasmacytoid Leukemia is weakening and killing the majority of Fraser sockeye and the timing suggested onset of this began at the same time the salmon farming industry, it would seem obvious that sockeye be tested for Plasmacytoid Leukemia and farm salmon, both Chinook and Atlantics be tested for the genomic mortality related signature but there is no evidence in Ringtail that either of these occurred

- April 23, 2010 Kristi Miller **requests** item #3 "Establish whether or not aquaculture fish (Atlantic salmon) could also be affected by the purported viral disease, and could thus be carriers…..COST $18,750" CAN166765

- Questioning of Dr. Laura Richards on the stand March 17, 2011 at the Cohen Inquiry suggests these line of research did not take place

There are several references to a lack of funding for Miller's work to identify the agent causing the distinctive profile of the sockeye that are dying before spawning

- 2008/2009? "While we have not yet identified a virus of other pathogen associated with this signature, we have also not had sufficient funding or technical capacity to pursue this identity with any rigor in the past year (we discussed re-prioritizing our research to focus more on this result at our SAC last year and this was not favourably received)." CAN491506

- Jan 2011 in a congratulatory note to Dr. Miller from a colleague for publishing in the top journal *SCIENCE* "Unfortunately the funding model that enabled the use of funds…. has recently been found to be noncompliant with DFO policy, possible jeopardizing the future involvement of DFO science Staff in this type of innovative research. " (Ruth Withler) CAN493044

On the same day as Miller requests funding to test Atlantic salmon Dr. Sonja Saksida, BC Centre for Aquatic Health Sciences informs local DFO that Marine Harvest has met with the Minister of Fisheries to offer boats and cash to help with a "baseline" juvenile sockeye study around the salmon farms of the Discovery Islands.

baseline /*base·line*/ (bās´līn) a value representing a normal background
*medical-dictionary.thefreedictionary.com/**baseline***

Given the circumstances, that a virus that emerged in salmon farms in the Discovery Islands has been scientifically suggested as an infective agent weakening and killing the majority of Fraser sockeye, it is highly erroneous to suggest that baseline data could be collected in the region of greatest interaction between farm salmon, both Chinook and Atlantics and Fraser sockeye. However, the Minister of Fisheries thought this would be "valuable."

From:	Sonja Saksida <sonja.saksida@cahs-bc.ca>
Sent:	Friday, April 23, 2010 4:01 PM
To:	Saunders, Mark <Mark.Saunders@dfo-mpo.gc.ca>; Brown, Laura (Pacific) <Laura.L.Brown@dfo-mpo.gc.ca>; Mark Sheppard <mark.sheppard@gov.bc.ca>; Keith, Ian AL:EX <Ian.Keith@gov.bc.ca>; Marty, Gary D AL:EX <Gary.Marty@gov.bc.ca>; Hargreaves, Brent <Brent.Hargreaves@dfo-mpo.gc.ca>; Jones, Simon <Simon.Jones@dfo-mpo.gc.ca>; Beamish, Richard <Richard.Beamish@dfo-mpo.gc.ca>; Thomson, Andrew <Andrew.Thomson@dfo-mpo.gc.ca>
Cc:	Backman, Clare <Clare.Backman@marineharvest.com>
Subject:	Sockeye salmon health program

Hello Everyone

Earlier this week I met with Clare Backman, Director of Environmental Relations of Marine Harvest Canada (MHC). He indicated that MHC is interested in seeing some baseline juvenile sockeye salmon health work be conducted in and around the salmon farms in the Campbell River area. Clare mentioned that he met with Minister Shae in Ottawa and that she agreed that this would be valuable considering the current level of interest in the subject. He approached BC CAHS because our involvement in co-ordinated the collection and evaluation of health of juvenile pink salmon in the Broughton Archipelago in 2007 and 2008, our fish health expertise and diagnostic capacity (i.e. virology and molecular diagnostic techniques) and our independence (as a not for profit NGO). He indicated that MHC is willing to provide both in kind (boats) and a cash contribution to help with such a project.

BC CAHS would be very interested in participating in such a program however we recognize for such a program to be successful it needs to be a done in collaboration with others with expertise in fields we lack strength. I feel that the model used in the Broughton Pink Salmon health project was a very good one - it involved DFO who provided logistic and wild fish expertise and BCMAL who provided expertise in field collection and histopathology.

I think a similar multi-disciplinary, multi-year program would also work to improve our understanding of health in our wild sockeye salmon and BC CAHS can provide needed fish health expertise to such a project. I would be very interested in meeting with you to discuss this further and in hearing your thoughts on the subject.

All the best
Sonja

Sonja Saksida DVM MSc
Centre for Aquatic Health Sciences
ph: 250 286-6102 f: 250 286-6103
web: www.cahs-bc.ca

CAN088756

This email was sent at 4:01 pm on the same day after Miller asked to test Atlantic salmon. There is no reference I have found to anyone else speaking directly to the Minister about the problem with the sockeye

Summary of Plasmacytoid Leukemia

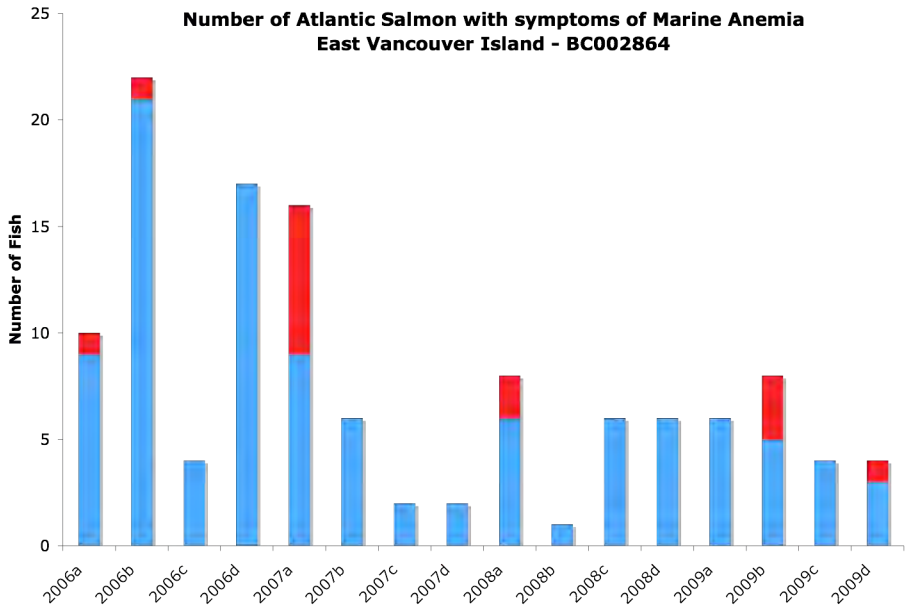
Plasmacytoid Leukemia is considered a salmon farm disease. It became a threat to the industry first in Sechelt Inlet area and then spread with the industry in the early 1990s to

the Discovery Islands – which form the narrowest waterways of the Fraser sockeye marine migration route. It is a retrovirus that may not kill the fish unless a co-agent such as bacterial kidney disease, a microsporidian parasite, or perhaps stress also affect the fish. Salmon Leukemia does spread through water and can infect sockeye and to a lesser degree, Atlantic salmon. It is vertically transmitted from parent fish to young. Quarantined eggs from the Atlantic are tested for this disease, but there is no record anyone applied this test to the Fraser sockeye to confirm Miller's genomic work, nor is there evidence Miller was allowed to read the genomic signature of farm salmon of either species. On the day Miller proposes genomic profiling of Atlantic salmon, an email is sent to DFO saying Marine Harvest has met with the Minister and wants to help study juvenile sockeye in the Discovery Islands to collect baseline data. They do not include Miller in the email and suggest a team of BCMAL and BC CAHS. There is evidence further on that this research went forward.

Marine Anemia symptoms in Farm Salmon on Fraser sockeye migration route

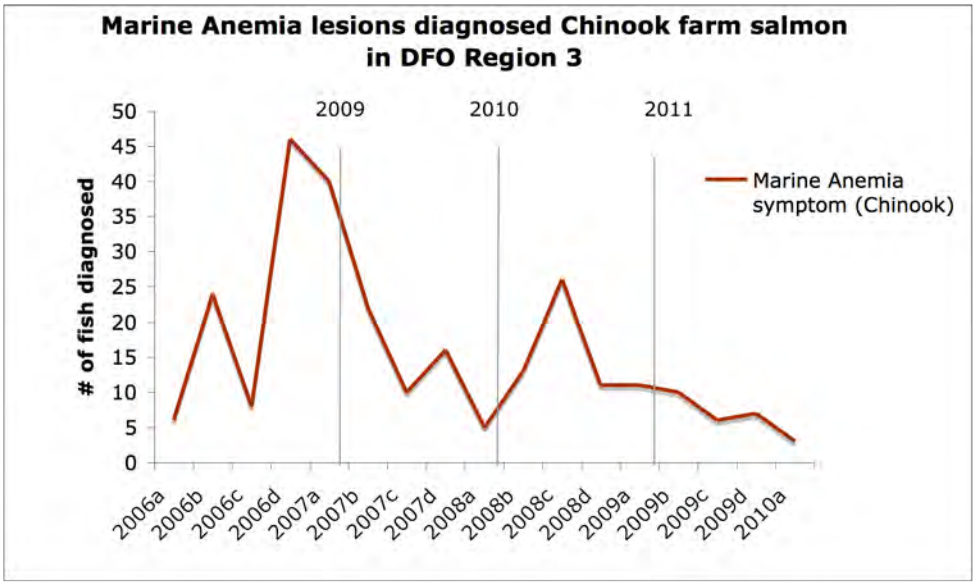
As noted above Stephens et al (1996) and Stephen and Ribble (1997) give us the case definition by which marine anemia can be diagnosed **hyperplasia of the interstitial cells of the caudal kidney.** Dr. Gary Marty of the BCMAL Animal Health Centre in Abbotsford, BC does the histology on farm salmon sampled during the BCMAL audits. He calls these symptoms "ISH" and reports it in every quarter of every year in both Chinook and Atlantic salmon.

- "Interstitial (hematopoietic) cell hyperplasia (kidney); **ISH** is evidence of increased demand for erythrocytes or white blood cells somewhere in the body. In Chinook salmon, this lesion is often associated with the clinical diagnosis of "Marine anemia"."

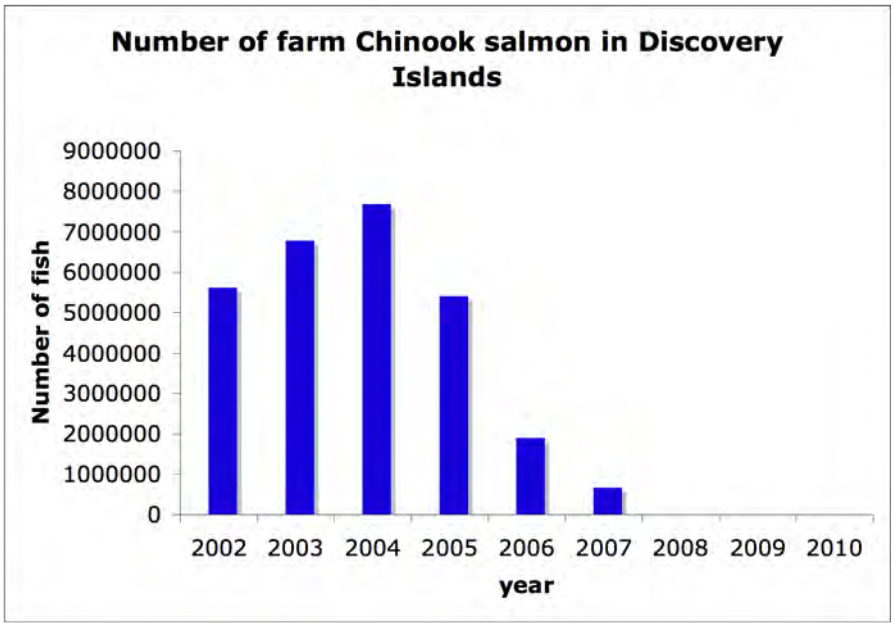


Blue=less severe, red=more severe

Dr. Marty never reports on any further testing to confirm if this is Marine Anemia or not in Atlantic salmon.



Marine Anemia symptoms in Chinook salmon are more likely to be the disease. Region "3" includes Sechelt Inlet, east Vancouver Island and the central coast. There are no farm site designations in this data so this includes data for a larger area than below. The dates 2009, 2010, 2011 mark when sockeye that returned to spawn in those years went to sea. The largest number of farm Chinook with Marine Anemia symptoms were collected in the BCMAL audits in the months when the Fraser sockeye that crashed in 2009 were passing these farms smolts. Miller found the highest rate of Mortality Related Signature, >90%, in this generation and Marine Anemia (Plasmacytoid Leukemia) is the suspect cause of MRS. (database BCP002864 BCMAL Audits)



This is salmon farm stocking data, by farm, from spreadsheet CC1001187 and includes only the sites in the narrow waters of Discovery Islands. There are no Chinook farms along eastern Vancouver Island north of this area. There are some on the Central coast and Sechelt Inlet. The low number of Chinook in 2007/vs high Marine Anemia in above graph suggests an acute

outbreak of the disease somewhere in Region 3. If this was an experiment to test for population effect of exposing sockeye to Chinook farm salmon with symptoms of Plasmacytoid Leukemia you would expect an increase in Fraser sockeye in 2010 and 2011, as they were not exposed to effluent from Marine Anemia suspect Chinook farms as the left and returned to the Fraser river.

Miller does not appear to have access to the salmon farm records so she cannot know a very large potential reservoir for Plasmacytoid Leukemia existed or that it has been has been removed. She finds much lower occurrence of the MRS in the sockeye that were not exposed to Chinook salmon farms

- Feb 2, 2011 "…livers of the 2010 out migrating smolts and returning adults were far 'healthier' (as judged by our specific signature) than we have seen in other years " (Email from Miller to Johnson) CAN491389

In an email Simon Jones seems aware of Dr. Marty's acronym for marine anemia symptom "ISH" and Miller wants to get the sockeye examined for it. There are no records in Ringtail that this was ever done. CAN489814

Brain Tumours

The literature on Plasmacytoid Leukemia reports ocular tumours

- Found ocular tumors. Eaton and Kent 1992
- Causes ocular tumors submitted to Registry of tumors in Lower Animals Smithsonian. Kent and Dawe 1990

In Miller's power point "Epidemic of a novel, cancer-causing viral disease may be associated with wild salmon declines in BC" she has seven photographs of Fraser sockeye brains. Some are all white "healthy" and the others she suspects have tumours as they have relatively large attached growths. She identifies every suspected tumour as being in the "optic lobe." If these are tumours they are *Ocular tumours*.

The year after Miller found the tumours BCMAL ordered Dr. Marty to examine farm salmon brains during the audits.

- In BCP002957 AHC CASE# 07-1564 Dr. Marty writes "I recommend sampling of brain in cases like this one were the cause of death is unknown. At beginning of 2007, brain was added to the list of organs to sample for histopathology as part of the Provincial government's Fish Health Auditing and Surveillance Program. Of the 168 Atlantic salmon examined during the first quarter of 2007…. Addition of brain histopathology allowed me to

determine the cause of death of another 20% of the fish." Gary Marty

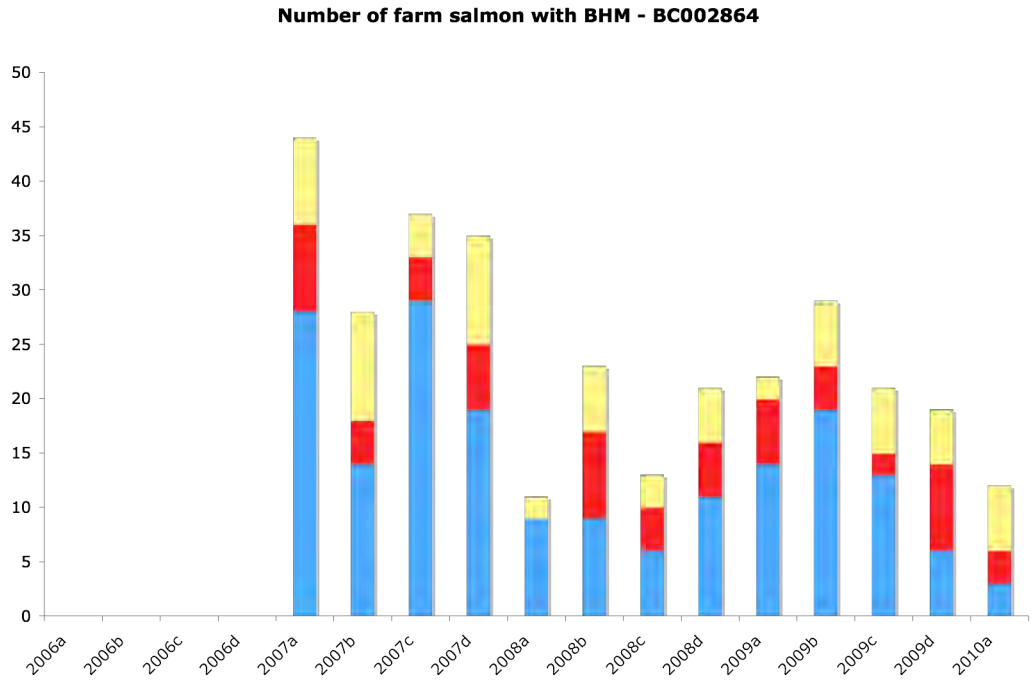
In 2009, Miller took brain samples from Fraser sockeye and sent them to BCMAL and Dr. Michael Kent and got very different diagnoses

- Oct 23, 2009 Animal Health Centre, BCMAL Gary Marty reports they not brain tumours, just damage from blow to head required to kill the fish – did Miller hit the organ she sent for structural analysis? CAN096137 Case#09-4176 Animal Health Centre report
- There is a record in Ringtail of Miller sending Dr. Kent the brain samples, but no report, however in the 2011 Kent Technical Report to Cohen Commission he reports "no significant pathological changes" even though there are large dark structures attached to the brain.
- Nov. 16, 2010 in preparation for the launch of her *SCIENCE* paper Miller changes her mind and calls them "brain aneurisms" in explanation regarding the tumours. CAN492753

Nov 16, 2010 email from Miller to Diane Lake regarding media for her upcoming paper in SCIENCE, Miller states,

> "As for the brain lesions these data came from a briefing note to the Minister dated Dec 2009, at which time we merely speculated that there could be a link, as we observed this signature also in brain tissue. We have since conducted studies that showed that there is no link between this signature and the lesions, and have determined that the lesions are hemorrhagic (aneurisms), not tumours." CAN492753 The research mentioned here does not appear to be in Ringtail

With such a difference of opinion, sending samples to a cancer lab would seem the next step. There is no record in Ringtail to the research Miller refers to above.



Summary

Marine Anemia/Salmon Leukemia virus/Plasmacytoid Leukemia symptoms are commonly reported in the BCMAL audits done by Dr. Gary Marty at the BCMAL Animal Health Centre in Abbotsford, BC. In 2007, following Dr. Miller’s finding tumour-like growths attached to the ocular lobes of Fraser sockeye brains, BCMAL requested that Dr. Marty examine the brains of farm salmon. He finds anomalies in these brains that he describes with the same language he used to describe the sockeye brains. There is a range of seemingly inconsistent diagnosis of the sockeye brains, suggesting a cancer lab might be required to provide confirmation of diagnosis. When farm Chinook salmon are removed from the Fraser sockeye migration route, Miller’s MSR declines and Fraser sockeye productivity rises to historic levels in 2010, and numbers are high enough to date in 2011 to have allowed several commercial fishing openings.

There are no reports of genomic profiling of farm salmon in the Cohen documents and no reports of further work to identify or confirm Plasmacytoid Leukemia in Fraser sockeye.

Parvovirus?

In approximately, March 2011 Miller reports evidence of a parvo-type virus in liver samples from some number of 2010 sockeye salmon smolts. This has not been reported in fish before. She gets to work to find out more about this, collecting sockeye smolts from the Okanagan River that drains into the Columbia River. They do not have this virus there are plans to test the infectious ability of the Parvo-type virus on them in August 2011. CAN490130.

- March 14, 2011 Email from Stewart Johnson to Laura Richards to prepare her to be on stand at the Cohen Inquiry “In a meeting last week Dr. Miller informed us that she had obtained parvovirus sequences from livers of fish showing the genomic signature….. In attendance was Brian Riddell as well as representatives of BCSGA and Marine Harvest. You may be asked about this new development by their lawyers as there is no implication of salmon farms” CAN491470 *Note: I suspect BCSGA is a typo and should read BCSFA BC Salmon Farmers*.

It is noteworthy that the scientist who is not allowed to present at meetings not run by DFO, or test Atlantic salmon, and prevented by privy council from speaking to the media about her research, is briefing the salmon farmers on breaking scientific results. Perhaps Marine Harvest did contribute cash funding and this work is for them? It also appears the Pacific Salmon Foundation may be a partner to this work. This work does nothing to confirm or deny Plasmacytoid Leukemia, which Miller appears to no longer be working. However, she does note the symptoms of PL, MRS has declined substantially.

To understand salmon farm disease reporting in BC the background influence of international trade has to be considered

World Trade Organization

In 1995, the WTO agreement on the Application of Sanitary and Phyosanitary Measures (SPS Agreement) was negotiated setting constraints on member-states' policies relating to food safety and imported pests and diseases. The SPS is closely linked to the Agreement on Technical Barriers to Trade and works to minimize the negative effects of health restrictions on international trade (http://www.ncbi.nlm.nih.gov/pubmed/8890392). The SPS calls for transparency, but not so much as to impede trade and it adopted the OIE standards of reporting (Office International des Epizooties). Both Norway and Canada are member nations to the WTO and the OIE http://www.oie.int/about-us/our-members/member-countries/

BCSFA & Ministry's Fish health Audit and Surveillance Databases

In 1995, the Environmental Assessment Office of the Province of BC conducted a lengthy review of the salmon aquaculture industry in BC that included a series of public meetings, technical reports by experts and 49 final recommendations. Dr. Craig Stephens co-authored the technical report on Fish Health. It was called the Salmon Aquaculture Review. http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_20_6045.html From that came recommendation 16 "Strengthen disease surveillance and control programs," which was referenced in a Letter of Understanding signed Jan. 23, 2001 between the Province of BC and the BC Salmon Farmers Association.

Letter of Understanding Regarding Fish disease reporting and Provincial Fish Health Database January 23, 2001 **Signed** by Bud Graham (ADM, MAFF) and Odd Grydelund (President, BC Salmon Farmers Association) mandates 2 salmon farms disease databases. One for BC Salmon Farmer data, another for BCMAL's audit data.

This LOU navigated SAR Recommendation #16, the SPS Agreement (WTO) and the salmon farming corporations explicit requests for confidentiality in creating the **BCSFA Fish Health Database**

- $70,000 provided to the BC Salmon Farmer Association from BCMAFF to create a "firewalled," strict security, "encrypted," "web-enabled database" ensuring individual companies confidentiality by a Nondisclosure agreement.
- "owned" by the BCSFA and receive site-by-site information on inventories, percent mortality, cause, infectious diseases and provincial and federal enhancement hatchery data.
- the BCSFA must report their data quarterly to BCMAL
- this data would be aggregate into zones so the public could not trace disease outbreaks to a specific farm and posted on the MAL site

The LOU also establishes protocol for the second database BCMAL's **Fish Health Audit and Surveillance Database**, which contains fish health reporting on the samples taken by BCMAL staff during inspections of salmon farms during quarter audits. It specifically mentions:

- **Exotic Diseases of significance** "Any finding of an exotic disease recognized as Notifiable to the Office International Epizooties (OIE) … must be reported to DFO." *Infectious Salmon Anemia fits here*
- **New Emerging Pathogens** (agents not previously recognized that are determined to have a significant economic or biological impact or risk to wild

and/or cultured fish**)** are required to be reported in a more-timely manner the quarterly reports. *Salmon Leukemia Virus fits here*

- **Endemic Diseases** causing significant mortality or of economic importance must be reported more frequently than quarterly, *IHN and Kudoa fit here*

An affidavit provided to the Office of the Information & Privacy Commissioner by Dr. Mark Sheppard in a dispute over whether salmon farm disease records could be released under Freedom of Information Legislature states:

- "The objective of these inspections is to assess compliance with regulatory requirements and licence terms and conditions, not to make evaluations concerning fish health,"
- "The information is treated so confidentially that it is not even shared with the Ministry's Fisheries and Aquaculture Licencing and Compliance Branch staff not Animal Health Branch veterinarians and technicians outside of the Program offices in Courtney"

The BCSFA Fish Health Database is a "public-private-partnership" that allowed BCMAL to:

1. Fulfill Provincial license requirements
2. Fulfill CEAA requirements
3. Meet section 56 License requirements
4. Protect export markets by documenting freedom from ISA (World Trade Organization agreements). **BCS003361**

In his FOI affidavit Sheppard makes it clear that the fish farmers do not have to allow health data to be collected to be in compliance with their license to operate. "A farm could follow it Fish Health Monitoring Plan (a condition of licence) yet choose to not cooperate with providing the Ministry with fish for its collection of fish samples."

There *are* mandated inspections that are required by the fish farm licenses, but Sheppard explains these are conducted by people called "aquaculture inspectors," who "ensure that the records are kept" as per the **Aquaculture Regulation,** but they "do not concern themselves with the specific content or interpretation of those records."

> "In Canada, we do not yet have a legal right to attend farms to sample…for enzootic (natural, indigenous) disease without permission for the farm operators."

He explains, however, that if the fish farmers prohibit government access to their dead fish it would have "significant implications to access to export markets."

In an email March 31, 2010, from Paul Kitching of the BCMAL Animal Health Centre to Mark Sheppard, Andrew Thomson, Trevor Swerdfager and others:

> "I wanted to let you know officially, that following a letter from the BC Salmon Farming Association indicating they no longer require BC MAL involvement in the fish health audit program, staff from the Animal Health Branch will suspend the collection of farmed fish for diagnostic, surveillance and audit purposes…" CAN288661

Andrew Thomson replies in the same document:

> "We don't have much of a lever with industry…."

It is unclear why the "significant implications to access to export markets" were not a lever. Later in this report there is evidence that when the BCMAL Animal Health Centre withdrew from the public audit process they were receiving an unprecedented number of requests to test for Infectious Salmon Anemia from – Marine Harvest and the salmon farmers joined in an MOU to try and protect their farms from spreading viruses to each other.

Summary

The 1995 Salmon Aquaculture Review called for increased transparency in disease reporting from salmon farms. From this came an LOU between industry and the Province of BC mandating voluntary disease reporting to a confidential database and release of some data in a format that prevented public disclosure of geographic occurrence of diseases.

The Fish Health records released to the Cohen Commission offer perhaps the first ever opportunity for anyone review the disease records produced by the BC salmon farmers and the BCMAL audits, the disease tests done on dying Fraser sockeye, hatchery records and Dr. Miller's findings. Unfortunately, all the datasets are arranged in a different way every few years, making analysis weak.

Disease records submitted to the Cohen Inquiry

Fraser sockeye disease records

The records on condition of the Fraser sockeye are scattered, of highly variable detail, and many contain complaints of the low quality of tissue impeding results. The most complete set of records are identified in Ringtail by Stewart Johnson. He has clearly made an effort to assemble what little is available.

> Dr Stewart Johnson, Nov 13, 2009, Head, Aquatic Animal Health, Pacific Biological Station DFO Nanaimo writes Mark Saunders "Here is a preliminary (starting document) outlining a fish health program to understand factors related to early seawater survival of sockeye." CAN191772 Attached to this email is:
>
> Titled "Health Assessments of Fraser Sockeye" "….With respect to pathogens of Fraser sockeye we have scattered information from approximately 157 diagnostic cases that have been submitted to the Aquatic Animal Health Group since 1975. Unfortunately these data do not allow us to draw any general conclusions about the prevalence of these agents or the role they play in sockeye salmon dynamics. Over the past 30 years members of the Aquatic Animal Health Centre have been surveying returning adults for and fry for culturable-viruses…Although these surveys have focused on viruses other pathogens have been identified…. CAN191773

- Some routine monitoring for "culturable viruses" *Note: Plasmacytoid Leukemia is non-culturable*

- "It is possible that there may be some viruses present that do not culture"
- molecular epidemiology studies provided insights into viral traffic patterns and evolution of viruses within sockeye populations Garth Traxler working on large dataset to correlate presence of pathogens with survival (Email from Stewart Johnson, Nov 3, 2009) CAN088699

The "Health Assessments of Fraser Sockeye" body of work does not appear in the Cohen material. Dr. Johnson goes on to recommend a thorough and "routine" sampling scheme including histology, bacteriology, virology, genomics and parasitiology. It would be good to know if this work as gone forward.

In absence of Kristi Miller's findings there would almost nothing of substance in the disease records on Fraser sockeye. For comparison there are 2,278 BCMAL fish farm health records from 2006-2010 (spring). Given that Fraser sockeye have been dying by the 100,000s for 18 years 157 case reports is an extremely sparse dataset.

Hatchery disease records

We reviewed 667 hatchery disease records in Ringtail. These documents are in many cases difficult to interpret being faded and handwritten. They do reveal cases where diseased stock were approved for released, and contain a single reference to Marine Anemia, Plasmacytoid Leukemia, or Salmon Leukemia virus questioning whether it might be in Coho in the Quinsam Hatchery in 2010 CAN390888. While these records suggest hatchery reforms are in order, the diseases occurring frequently are not any considered to be having a population affect in Fraser sockeye.

Fish farm disease records - BCMAL audits

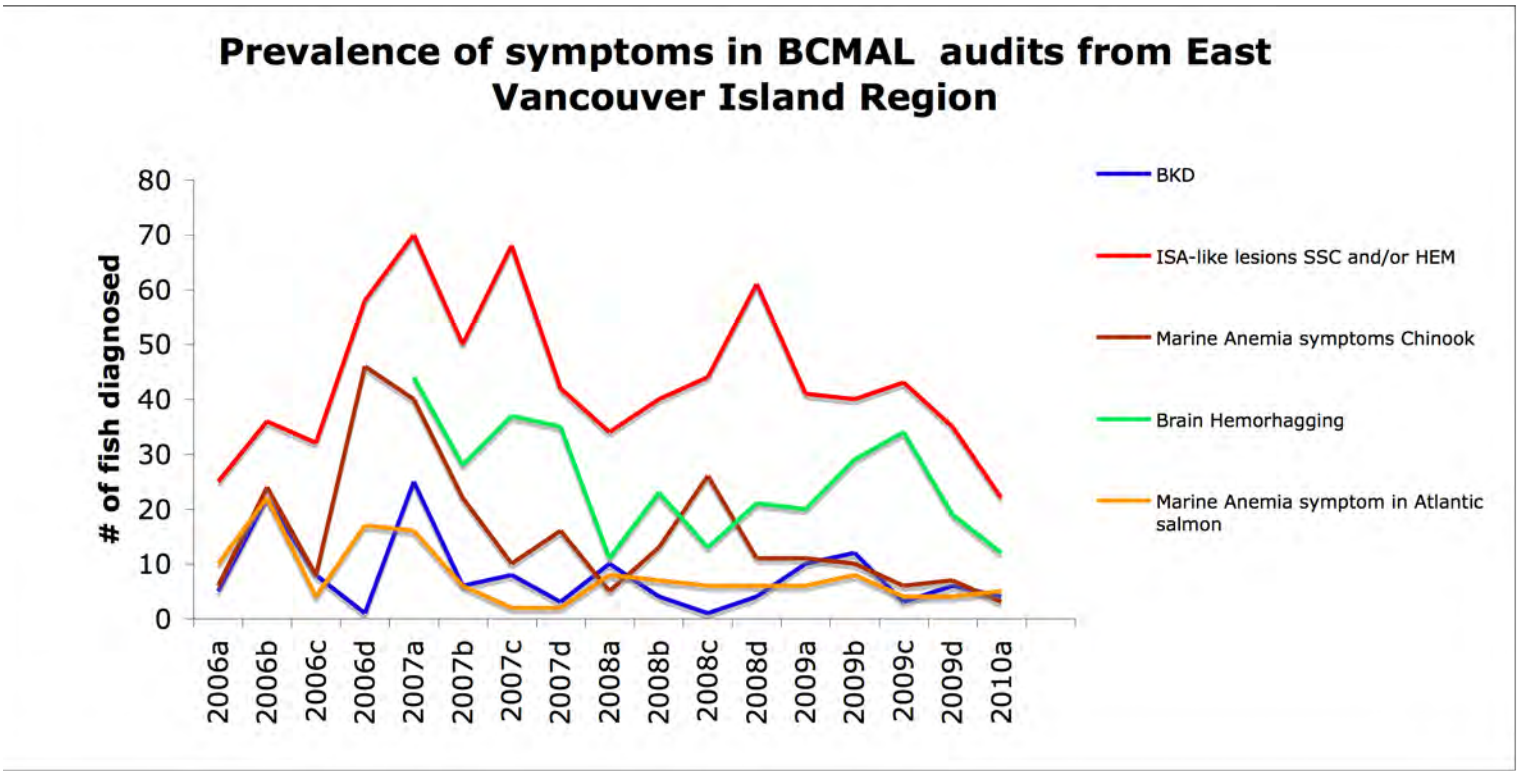
Four times a year BCMAL collected freshly dead salmon from a number of salmon farms including both Atlantic and Pacific salmon. These fish, or samples of these fish were sent the to the BCMAL Animal Health Centre's Gary Marty, for analysis. Reporting on these samples appear entirely contained in BCP002864.

Fish farm disease records - BCMAL reports to salmon farm companies

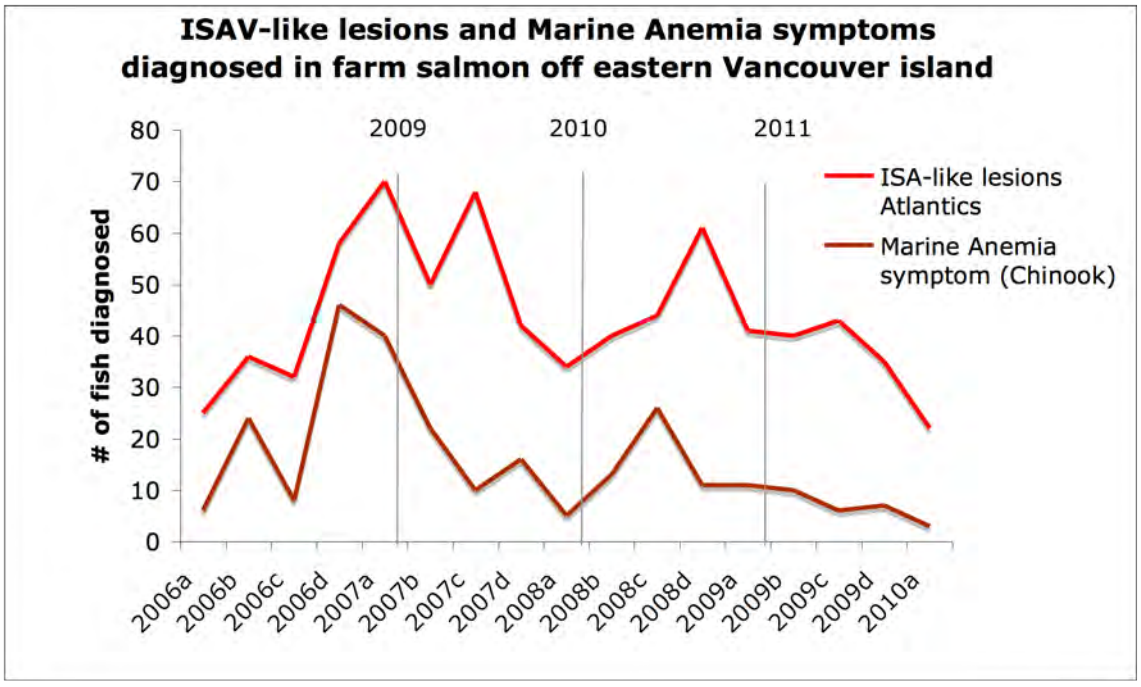
The salmon farm companies, the BC Centre of Aquatic Health and the lab testing the quarantined eggs and resulting fry from newly imported shipments from outside BC all sent Dr. Gary Marty samples beyond the audit process. He reported on these directly to the companies, but also apparently filed copies of these reports to the Province as these are all BCP files in Ringtail. This reporting differs significantly to the audit data because instead of fish being picked up on the day of a farm visit, these are fish the companies sent to Dr. Marty for diagnosis, even though they all have their own vets. They might be considered hard to diagnose fish of concern.

BCP002975 – 2007 Atlantic salmon
BCP002962 – 2008 Atlantic salmon
BCP002971 – 2009 Atlantic salmon
BCP002975 – 2010 Atlantic salmon
BCP002977 – 2007-2010 Pacific farm salmon

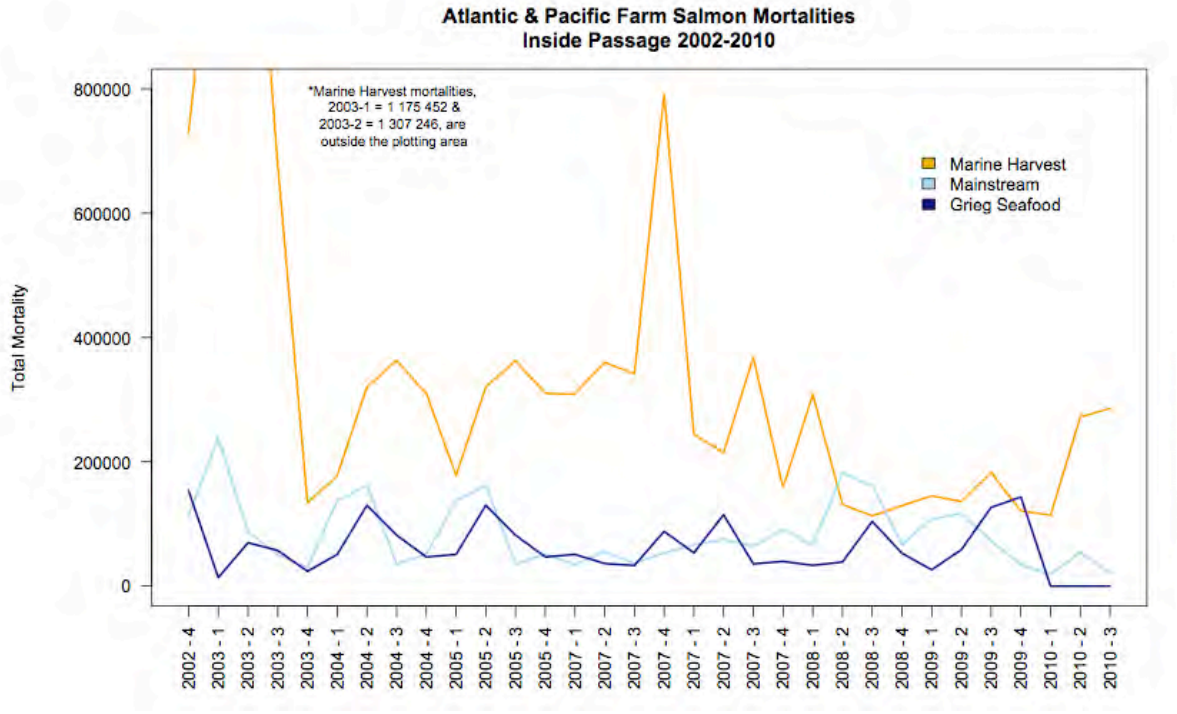
Disease/symptoms in farm salmon of potential significance to Fraser sockeye



These data are the BCMAL audit data recorded in BCP002864. Of note is the suggestion of diagnostic pulses rising and falling in concert with each other. These do not represent prevalence only the symptoms found in farm salmon that were collected on the day of the audits, freshly dead and identified as “silvers” by the industry. Presumably, the methods are consistent across years.



Of note in this graph is the interplay of the data on the symptoms associated with Plasmacytoid Leukemia, a retrovirus with known immunosuppressive qualities, and Infectious Salmon Anemia, an exotic influenza C virus. Note that on three different occasions Infectious Salmon Anemia symptoms spiked in the quarter immediately following a rise in Plasmacytoid Leukemia symptoms in the BCMAL record. Dr. Marty does not confirm either disease, but this warrants further examination, testing and confirmation in particular because occurrence of both of these symptoms were exceptionally high as the 2009 Fraser sockeye were migrating through these general waters. These data include farms from Sechlet Inlet, eastern Vancouver Island and the Central coast.



These data are from BCS000281-9 and describe large losses in the Marine Harvest salmon farms along eastern Vancouver just after the 2009 Fraser sockeye went to sea. Were these farm salmon sick and infectious as the sockeye smolts passing water from these facilities over their gills? This spike follows a spike in Plasmacytoid Leukemia and Infectious Salmon Anemia symptoms. What did they dying of?

Summary

While BCMAL has been posting diseases diagnosed in farm salmon in aggregated form on their website, the above graphs suggest there are significant trends in the symptoms diagnosed of diseases that pose large and unknown threat to Fraser sockeye salmon. There is no record of adequate testing to confirm if these symptoms resulted in disease. That high mortality in the farm salmon belonging to one company, and peaks in two lethal salmon viruses and the out-migration of the sockeye run that crashed all coincide in time and place highlights the need for further investigation.

Infectious Salmon Anemia Virus (ISAV)

ISAV is a virus that has appeared in the salmon farming industry around the world/ http://www.thefishsite.com/articles/598/the-global-spread-of-infectious-salmon-anaemia

The Global Spread of Infectious Salmon Anaemia

As a second wave of Infectious Salmon Anaemia washes up on Scottish shores, the industry holds its breath. Only time will tell what gets upturned in its wake, but on a global scale the severity of the problem is already showing its true face, writes Adam Anson, reporting for TheFishSite.

Almost immediately after the virus was reported in the Shetlands, fish from infected farms were removed and inspectors were making their way around the 42 fish farming sites within the newly established Control and Surveillance Zones. The efficiency of the reaction belies the severity of the problem, and may come to save this industry from the graver impacts that have come to dominate salmon fisheries elsewhere in the world.

Isolation of ISAV in tissue culture.
Photo: Fisheries Research Service

It will take approximately six weeks to culture the samples and establish definitively the presence of the virus, but the first indications of the results should be known much sooner. The Scottish Industry has also initiated an investigation into the source of the outbreak, saying it will be "the subject of a scientific study to determine the source of this new infection, the distribution of the disease in the environment and the risk of further spread."

There has to date been one previous outbreak of ISA in Scotland, which occurred over the years 1998-99. According to figures from the Fisheries Research Service (FRS), the estimated cost to the industry was in the region of £30 million. In this initial incident prompt action succeeded in eradicating the disease, but other countries have been less fortunate.

Since it was first detected back in Norway in 1980's, ISA has posed a number of resilient problems for salmon farmers. To this day, it still hampers the Norwegian industry.

In the same year that Scotland managed to eradicate ISA for the first time, the average annual cost of the epidemic in Norway was US$11 million, while in Canada the virus was estimated to cost an average of US$14 million per year. The Faroe Islands paid the price of their entire industry when the virus hit in 2000, while the Chilean industry currently toils from a particularly severe series of ongoing outbreaks.

Dr Gary Marty reports the Classic lesions associated with Infectious Salmon Anemia 1,100 times in the BCMAL Audit data and the reports he makes directly to the companies. He has acronyms for the symptoms that he defines:

- Hemorrhage/congestion (interstitial, kidney); HEM probably is a nonspecific result of endothelial damage; HEM is often associated with VHSV and bacterial infections. Renal congestion and hemorrhage is one of the classic signs of infectious salmon anemia (ISA), but ISAV has never been isolated from fish in BC.

- Sinusoidal congestion (liver); SSC is a nonspecific result of sinusoidal damage. In BC Atlantic salmon, sinusoidal congestion is an uncommon feature of infection

with viral hemorrhagic septicemia virus (VHSV) and *Listonella anguillarum*. Sinusoidal congestion is one of the classic lesions associated with infectious salmon anemia virus (ISAV) infection, but ISAV has never been identified in British Columbia.

In the reports to the companies Dr. Gary Marty repeatedly states:

> BCP002977 "More diffuse sinusoidal congestion is one of the classic lesions associated with ISAV infection, but ISAV has never been identified in BC"
>
> BCP002975 "More diffuse sinusoidal congestion is one of the classic lesions associated with ISAV infection, but ISAV has never been identified in BC"

He has reported ISAv lesions in Pacific salmon (BCP0002977) and in 100% of the 4 Sablefish he reports on in (BCP002864)

The Regulations concerning ISAv

Every report of ISAv lesions in the BCMAL audits is accompanied by a pooled sample of several fish tested together by PCR. All of these tests have been reported negative for ISAv. Most of the records of ISAv lesions in the fish selected and sent to Dr. Marty by the various companies do not have testing ISAv documentation.

While this amount of testing suggests vigilance, a document written for the OIE (World Organization for Animal Health) contains caveats that must be considered. www.cfsph.iastate.edu/Factsheets/pdfs/infectious_**salmon**_anemia.pdf

> "There is no gold standard test for ISAV, and the confirmation on infection depends on a combination of test results…. ISAV may be difficult to detect…. even if very sensitive techniques are used…. This highly contagious disease can be insidious, with an initially low mortality rate" this means it may not be apparent through the number of losses

The Manual of Compliance Ottawa 1984 (revised 2004) calls for testing of 60 fish if the source population is more than 100,000, which most of these farms are. There are no records of this amount of ISAv testing.

A document produced by the OIE and the College of Veterinary Medicine at Iowa State University titled **Infectious Salmon Anemia** states:

- "The World Organization for Animal Health (OIE) currently defines a suspect case as one that meet any of the following criteria:
    - Either clinical signs or lesions consistent with this disease"

The OIE website lists "suspect cases" but despite 1,100 diagnostics of the lesions in BC consistent with ISAv, which thus meet the OIE criteria for a "suspect" case BC is not listed.

The OIE (World Organization for Animal Health) of which Canada is a member nation considers ISAv a priority. They require reporting to them;

> "*ISA is a disease listed in the OIE Aquatic Animal Health Code (2009) and countries are obligated to report incidences of the disease to the OIE according to Chapter 1.1 of the code"* OIE General Disease Information Sheet – ISA

When Atlantic salmon eggs enter BC they are quarantined and undergo testing. In response to concerns about ISAv entering Canada the Minister of Fisheries has written that there are "measures in place to deal not only with ISAV, but all fish diseases."

Those measures are not visible in Ringtail. To export eggs into BC, foreign hatcheries must sign DFO's **Fish Health Certificate** in the Manual of Compliance, 1984 (revised 2004) (page 51). While this form lists several diseases, ISAv is not on in it. However, on page 53 of the same Manual of Compliance the "Fish Health Protection Regulations Laboratory Report" form *does* have a column for "ISAV." On Page 52 it explains why this second form has more information.

> "The change allows flexibility to use this Laboratory Report form for fish health certification purposes other than FHPR, e.g. for OIE-based trade requirements."

This suggests the form used to protect Canada from Infectious Salmon Anemia virus does not require a hatchery to report ISAv, but the form used to protect international trade of farm salmon products does.

The Canadian Fish Health Protection Regulations also do not list ISAv as a reportable disease. http://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._812/FullText.html
So if it were diagnosed in a salmon farm it would not have to be reported.

On Jan. 5, 2011 the Canadian Food Inspection Agency became involved and made ISAv a reportable disease due to international trade restriction concerns:

> "This federal regulatory intervention allows Canada to meet international trade standards and prevent the loss of aquatic resources due to the introduction or spread of disease and to ensure access to international markets for Canadian exports." http://www.gazette.gc.ca/rp-pr/p2/2010/2010-12-22/html/sor-dors296-eng.html#REFa

In response to concern that Atlantic salmon egg imports into BC could introduce ISAv to the North Pacific, as happened in Chile, the Minister of Fisheries offers assurance that all eggs coming into BC are from a hatchery in Iceland called Stofnfiskur.

However in 2004, Laura Richards wrote a briefing seeking a decision to John Davis: (2004 Fish Health1)

- "Two BC salmon farming companies wish to import Atlantic salmon eggs from Stofnfiskur, an Icelandic company which is not certified under the Canadian Fish Health Protection Regulations (FHPR)"

- "Failure to provide permission for egg importation may trigger a trade challenge under the World Trade Organization …"
- "Additionally, DFO could also be viewed as causing a competitive disadvantage of the aquaculture industry by denying them access to alternate strains"

Laura Richards was successful in her petition to allow eggs from a hatchery that does not meet Canada's Fish Health Protection Regulations. One year later, there is correspondence between Stolt Seafarms and Mark Higgins of DFO asking permission to destroy 150,000 fish hatched from Stofnfiskur eggs.

- March 22, 2005 Email from Judy Knutson Stolt Seafarms to Dorothee Keiser, (DFO) "Fry samples have been collected and being sent away for viral sampling."
- April 15, 2005 Email from Mark Higgins, DFO "Health test results from fish submitted on March 14, 2005 have been returned to me from **Microtek International Inc.** and found to be satisfactory. If all fry from this import have now been destroyed, this letter will serve to end the agreement that was entered into by Stolt Seafarms and Fisheries and Oceans, Canada on Jan 5, 2005. If you wish to import eggs from the facility in the future please contact me for inspections and permits." (2004 Fish Health2)

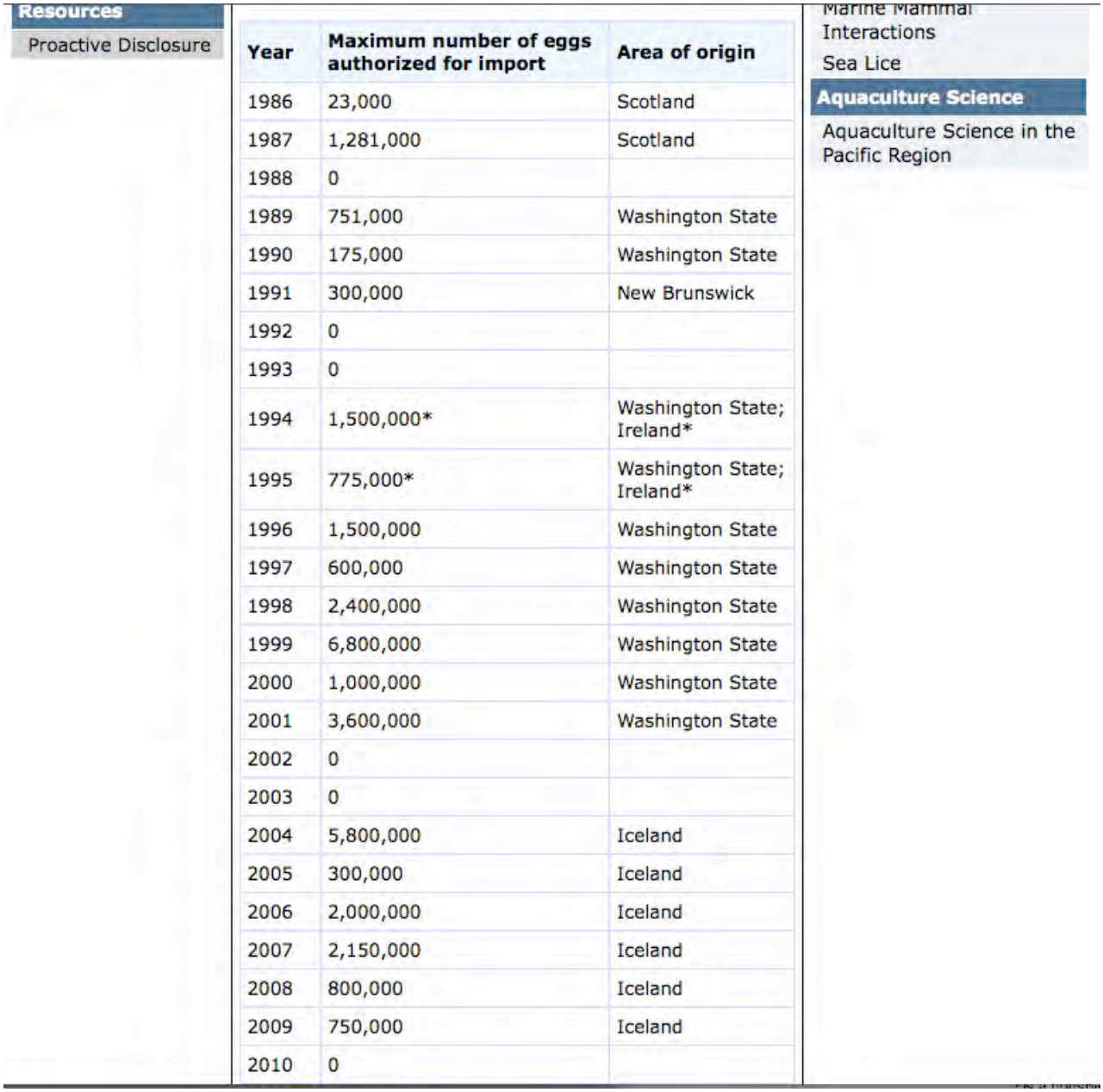
Of concern a shipment of eggs from the same facility went to Mainstream 4 weeks earlier. There is no correspondence to record whether those eggs received the same viral testing as the ones destroyed. (2004 Fish Health1)

While the above incident predates the files received into Ringtail from Dr. Marty on disease testing, there is a diagnosis by Dr. Gary Marty in 2009 of "classic lesions associated with ISAv infection" in a sample from **Microtek International Inc**. Dr. Marty repeats ISAv has not been found BC, however, since Microtek does quarantine work it raises the question, was he examining fish from BC, or fish from Iceland? There is no visible further testing of this sample.

There are no records in Ringtail or the scientific literature reporting ISAv in the North Pacific and it is considered an undesirable virus introduced into the South Pacific. But on August 1, 2007 Dr. Mark Sheppard, Aquatic health Veterinarian with BCMAL wrote a **Confidential Briefing Note for the Minister.**

- "The most likely source for ISA in BC is from migrating wild fishes from other regions of the Pacific Ocean as there is no importation of live Atlantic salmon or eggs into BC" BCP1001938

This is inexplicable, below is the current DFO website on the number of eggs that had been imported to BC by 2007:



Resources

Proactive Disclosure

Year	Maximum number of eggs authorized for import	Area of origin
1986	23,000	Scotland
1987	1,281,000	Scotland
1988	0	
1989	751,000	Washington State
1990	175,000	Washington State
1991	300,000	New Brunswick
1992	0	
1993	0	
1994	1,500,000*	Washington State; Ireland*
1995	775,000*	Washington State; Ireland*
1996	1,500,000	Washington State
1997	600,000	Washington State
1998	2,400,000	Washington State
1999	6,800,000	Washington State
2000	1,000,000	Washington State
2001	3,600,000	Washington State
2002	0	
2003	0	
2004	5,800,000	Iceland
2005	300,000	Iceland
2006	2,000,000	Iceland
2007	2,150,000	Iceland
2008	800,000	Iceland
2009	750,000	Iceland
2010	0	

Marine Mammal Interactions

Sea Lice

Aquaculture Science

Aquaculture Science in the Pacific Region

http://www.pac.dfo-mpo.gc.ca/aquaculture/reporting-rapports/egg-oeuf-eng.htm

ISAV is suspected to travel in eggs in an avirulent form, thought to be the original wild strain. So it does not cause large mortality initially.

"Chilean ISAV isolated from infected Coho salmon was initially classified as the North American genotype. However, comparisons made in 2009 of sequences of segment 5 and 78 sequences of segment 6 from Chilean isolates, obtained from Atlantic salmon since 2007, showed that Chilean isolates have a Norwegian origin. Evidence strongly suggests that ISAV was introduced in Chile as an avirulent strain that mutated into virulent".

(Cottet et al 2010 J. Virol.10:01202 - 10)

Beginning in July 2009, during the in-migration of Fraser sockeye that disappeared and continuing through July 2010, Marine Harvest requested an unprecedented 32 PCR tests for ISAV from Dr. Marty (BCP002971, BCP002975). Prior to this time, back through 2006 Marine Harvest only requested 2 of these tests (BCP002957, BCP002977). In April 2010 not only was Marine Harvest ordering an unprecedented number of tests for ISAv, Marine Harvest, Mainstream and Grieg refused the Province of BC further access to their dead fish, and they signed an MOU regarding viruses between themselves.

- "Whereas it is recognized that it is of benefit to the Parties to work together to manage viral fish disease and to minimize the spread of viral disease between farms, as a disease outbreak at one farm could adversely affect other farms….develop comprehensive Viral Disease Outbreak Management Plan….define minimum standards as well as minimum required capacity for mass mortality removal…The parties may not seek to enforce any aspect of this MOU in Court, including bringing an application for a declaration or injunction" BCS005022

This MOU does not mention sea lice or bacterial diseases, only viruses. If they are concerned about viruses from one farm infecting a second farm, it is reasonable to be concerned about the fate of the wild salmon that swim between these farms. By this MOU and refusing the Province access to their dead fish these companies became self-regulated on the issue of viral contamination of BC waters.

In a project in partnership with Mainstream DFO released particles in the Discovery Island area to mimic viral particles to see where they would spread. In the images here on day 7 and 8 the narrow black passages through which the Fraser sockeye migrate become increasingly grey emanating from the three small circles representing the farms

DFO is also engaged in a study demonstrating that sea lice can spread viruses from fish to fish Vector potential of the salmon louse in the transmission of infectious haematopoietic necrosis virus (IHNV), Jakob, Barker, Garver CAN48973

While the DFO repeats there is no strong evidence that ISAv travels vertically in the eggs, the fish farmers know otherwise. Document from Cermaq PowerPoint

http://www.cermaq.com/portal/wps/wcm/connect/cermaqen/home/press/news/sustainability+presentations

Fish health manager of Mainstream, Siri Vike: Preventive fish health work - slide 28

Severe ISAv-type lesions were reported to the **CFIA** in 2008 in a Pacific salmon. There were also the diagnostic symptom for Plasmacytoid Leukemia in this fish
Case # 2008-2143 Gary Marty CAN185775

Summary

There have been 1,100 reports of ISAv-like lesions by BCMAL vet found in farm salmon of all species and also in sablefish. There is no visible testing as per the Manual of Compliance to demonstrate that BC is ISAv-free. According to the OIE, of which Canada is a member nation, a suspect case of ISAv is defined as presence of the lesions. Therefore, technically, BC appears to be suspect region for ISAV since 2006. While ISAv is recognized as difficult to detect and has appeared in all regions where Atlantic salmon are farmed in netpens, Canada still does not require foreign hatcheries to report the disease on the required certificate. The Director General of Science, DFO Pacific Region petitioned on behalf of two Norwegian fish farm companies to allow eggs into BC from an non-FHPR certified hatchery and now this hatchery is the only source of eggs into BC. One year later an entire shipment from this hatchery had to be destroyed due to what appears to be a viral isse. In 2009 – 2010 Marine Harvest requested an unprecedented number of ISAv tests. At the same time the fish farm companies refused the Province of BC further access their fish and signed an MOU between themselves regarding measures to prevent viruses spreading farm to farm.

There are several other serious exotic pathogens that have been reported by BCMAL's Dr. Marty in farm salmon in BC

Haemolytic anemia

> BCP002977 Case# 08-602 Creative Salmon – Chinook "Clinical signs in this fish are similar to what is thought to be a viral infection in Coho salmon cultured in Chile (Smith et al 2006) Infectious haemolytic anemia"
>
> BCP002977 Case# 10-1347 Sea to Sky Veterinary "The clinical signs in these fish are similar to what is thought to be a viral infection in Coho salmon cultured in Chile (Smith et al. 2006)"

IPNV

> BCP002976 Case# 09-113 The lesion is considered characteristic of IPNV infection (pp. 190, "Systemic pathology of fish"….) but IPNV has never been identified in farmed salmon in BC."

Salmon Alphavirus (SAV)

> BCP002971 Case # 09 1914 Renal eosinophilic granules have also been described in Atlantic salmon naturally infected with chronic pancreas disease in Norway (Salmonid alphavirus subtype 3, SAV3; McLoughlin and Graham 2007), but SAV3 has not been identified in BC salmon. ISAv lesions were also reported for this fish. Submitted to Gary Marty by Peter MacKenzie
>
> McLoughlin and Graham (2007) report "SAVs are recognized as serious pathogens of farmed Atlantic salmon and rainbow trout in Europe. Bratland and Nylund (2009) provide evidence it can be vertically transmitted.

BCP002962 Case# 08-3362 “This pattern of inflammation has also been described with Heart and Skeletal Muscle Inflammation in Atlantic salmon reared in Europe, but this disease has not been identified in BC salmon.” Salmon Alpha virus symptoms are also reported for this fish submitted by Peter Mackenzie to Gary Marty.

Cardiomyopathy syndrome

CAN002976 Case # 07-4778 Membranous glomerulonephritis has been associated with cardiomyopathy syndrome (in Atlantic salmon) in Chinook salmon in 2007

BCP002967 Case# 08-571Membranous glomerulonepritis has been associated with cardiomyopathy syndrome (in Atlantics) in Chinook salmon in 2007

Deadly heart disease found at salmon farm

By Michael McCarthy, Environment Correspondent

http://www.independent.co.uk/environment/deadly-heart-disease-found-at-salmon-farms-715859.html

Tuesday, 2 May 2000

A serious new disease has been found in salmon on Scottish salmon farms. The disease, cardiomyopathy syndrome (CMS), produces heart failure in the fish.

A serious new disease has been found in salmon on Scottish salmon farms. The disease, cardiomyopathy syndrome (CMS), produces heart failure in the fish.

Although CMS presents no threat to humans it is invariably fatal to the fish as there is no known treatment. It has been found in one and possibly two Scottish farms: in the first case, where it has been positively identified, it wiped out 60 per cent of a stock of 27,000 large adult salmon in a west coast sea loch over five weeks, with the remainder having to be destroyed at a cost of many thousands of pounds.

The outbreak of CMS in Britain is reported for the first time in the current edition of *The Veterinary Record*. It is the third of a trio of severe disorders of farmed salmon that have occurred first in Norway, where salmon farming was pioneered, before turning up in Scotland. The other two, sea-lice infestation and infectious salmon anaemia, are now established in Scotland and have caused serious economic and environmental problems.

CMS itself is "probably one of the most serious diseases in some fish farming areas of Norway", where more than 100 farms have been affected, according to the authors of the *Veterinary Record* paper, Hamish Rodger and Tom Turnbull.

Dr Rodger, formerly of the University of Stirling and now at the University of Pennsylvania, and Mr. Turnbull, an aquaculture vet for a big Scottish salmon-farming company, examined eight fish from the west coast sea loch incident, which occurred in December 1997 and January 1998. They found them to have symptoms indicating CMS, including bulging eyes, pitting of the skin, hemorrhaging of the stomach and heart abnormalities.

Tissue samples of fish from a second farm, which was experiencing significant mortalities", displayed similar symptoms, they report.

Dr Rodger said at the weekend that it was too early to say whether CMS presented a serious economic threat to the Scottish salmon farming industry. "But if there were more cases, it would be," he said.

Gordon Rae, technical director of Scottish Quality Salmon, the trade association for most of the industry, said there had been no further reports of CMS since the incidents described. "There is no cause for concern," he said.

Piscirickettisa salmonis at Broughton Archipelago

MAL Memorandum File No. 2005-0594 &95 Jan 3 2006
This is a provincial investigation into how this intracellular bacterium got to the Broughton (Cecil, then Maude and Burdwood) and whether Mainstream breached biosecurity in moving equipment from Tofino. BCMAL reviewed vet records. Fish were from 4 different hatcheries and had BKD when they entered Broughton. Oxytetracycline did not work so used AquaFlor – off label. Not all pens afflicted were treated.
"Questions were asked regarding the potential for a breach in biosecurity measures and BCMAL officials were ensured that this had not happened. …. There was a movement of equipment and nets to these sites; however no records were available for inspection." BCP002848

Drug resistance

BCP002975 Tests by the BCMAL Animal Health Centre appear to be reporting bacteria cultured from the farms salmon that are resistant to antibiotics such as Erythromycin, Tri-Sulfas, Romet 30, Sulfamethoxazole/Trimethropi and Florfenicol.

Summary

Dr. Gary Marty of BCMAL's Animal Health Centre is repeatedly reporting symptoms he seems to think are similar to serious exotic diseases. Dr. Marty is the only government person we know of who is doing these examinations, and so he alone is the second line of defense for British Columbia against contamination by foreign viruses. The first line of defence would be the Fish Health Protection Regulations to certify the source foreign hatcheries, but they have been waived. However, the only response we see in Ringtail by Dr. Marty's to indications of serious exotic pathogens is the statement "but it has not been identified in BC." If he is not taking the steps to identify these pathogens, it seems likely no one is and so this statement might be meaningless and could be repeated

indefinitely. His records appear to go exclusively to the Dr. Mark Sheppard's office or Department. There is no indication that DFO is informed, and yet DFO is tasked to promote salmon farming.

Sea lice

The Pink Salmon Action Plan

When I accurately predicted the 2002 Broughton Archipelago pink salmon collapse across 7 rivers of the Broughton Archipelago due to the sea lice infections I observed in 2001 - DFO and the province came together with a plan. The Pink Salmon Action Plan, widely publicized by the province, included: removing farm salmon from the primary juvenile pink salmon migration route (**fallow**), through the Broughton

The Fallow Plan

In the spring of 2003 farm salmon were largely removed from the primary migration route through the Broughton Archipelago (Tribune Channel through Fife Sound). I co-published a paper that measured lice numbers on juvenile pink salmon on that route in 2002, 2003, 2004. We found sea lice abundance and prevalence were significantly higher in years the farms were stocked and very low in the fallow year - 2003. **Morton, A.B.,** Routledge, R, and Williams R. 2005 Temporal patterns of sea lice infestation on wild Pacific salmon in relation to the fallowing of Atlantic salmon farms. *American Journal of Fisheries Management.* 25: 811-821 describes this finding.

Senior DFO scientist Dr. Dick Beamish also did a study, focusing on the exceptionally high productivity of the pink salmon that had swam through the 2003 fallow. I was chosen by the ICES Journal of Marine Science to review his paper, as part of the publication process. Dr. Beamish's paper reported that pink can flourish among salmon farms and had omitted any reference to the fallow plan that had allowed that generation to go to sea via a largely farm-salmon-free route. I argued with Beamish as an anonymous reviewer for four months and finally had to reveal my identity to him at the suggestion of the journal editor to resolve our difference of opinion. At that point Beamish acquiesced mentioned the fallow in the paper and I recommended the paper be published, below is one of many emails two months into the process. The paper maintained its positive title:

Beamish, R.J., S. Jones, C. Neville, R. Sweeting, G. Karreman, S. Saksida, and E. Gordon. 2006. Exceptional marine survival of pink salmon that entered the marine environment in 2003 suggests that farmed Atlantic salmon and Pacific salmon can coexist successfully in a marine ecosystem on the Pacific coast of Canada. ICES J. Mar. Sci. 63: 1326-1337.)

----Original Message-----
From: Raincoast Research [mailto:wildorca@island.net]
<mailto:wildorca@island.net%5d>
Sent: Mon 27 Feb 2006 22:17
To: peter@phutchinson.net
Subject: Re: ICES JMS - Review

Dear Peter

Attached are my comments. While this paper is much better, there are some things still very wrong.

There is no reasonable reason to refuse mention of the fallow route, even as they discuss another component of the Provincial Action Plan. They even acknowledge the fallow in their response to my review. (See yellow highlighting)

I am also very perplexed about their omitting the five active farm sites. I am at a disadvantage here as the copy I received did not include the Figures 1C and 1B, so perhaps they were included, although it does not appear so from their argument that no sites were omitted. I did research around all these sites in 2003 and 2004 and I saw the fish there myself. The only thing I can think is the study period is somehow confused because the missing sites are among the eleven 2003 fallowed farms.

The fallow worked extremely well, so well the scientific community (government and Universities) has clamoured for it to be repeated. It was such a brilliant success and it did not shut down the industry...If however, it was accepted that removing salmon farms from that migratory corridor was crucial to survival of the wild salmon that would be a big inconvenience to Marine Harvest.

This paper reports on DNA work no one else has repeated or in many cases believes. It must be accompanied with some indication of degrees of confidence.

As it stands this paper is not suitable for publication, which is too bad because it reports on an extraordinary event. In my opinion this is a very political piece.

All the best

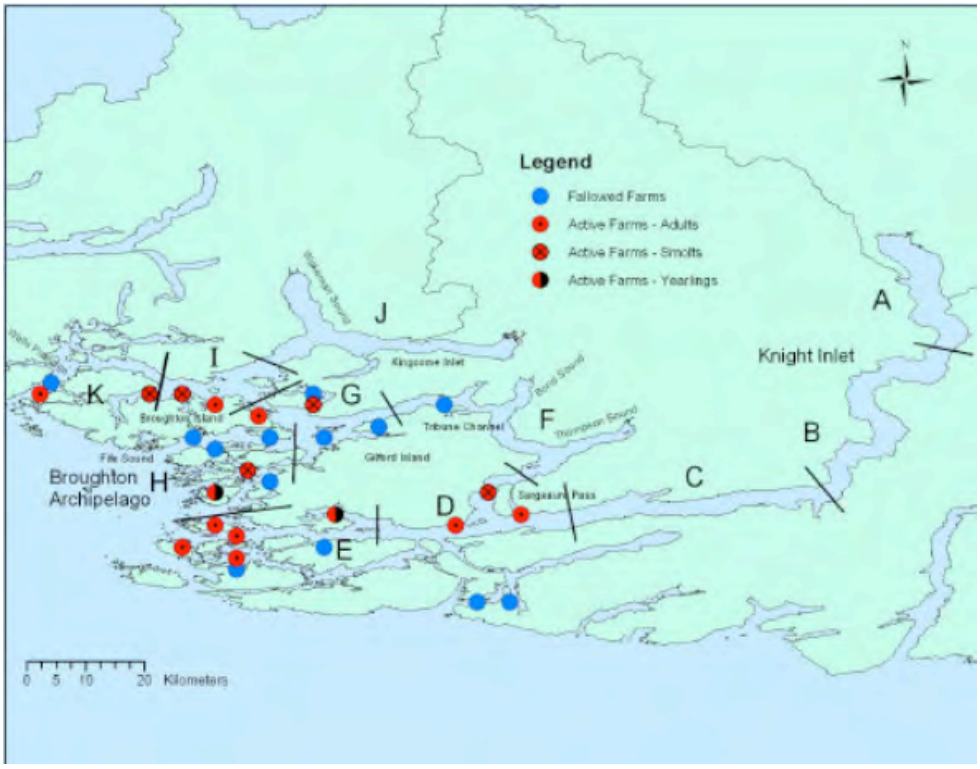
Alexandra

Hargreaves sea lice research methods vs Morton et al.

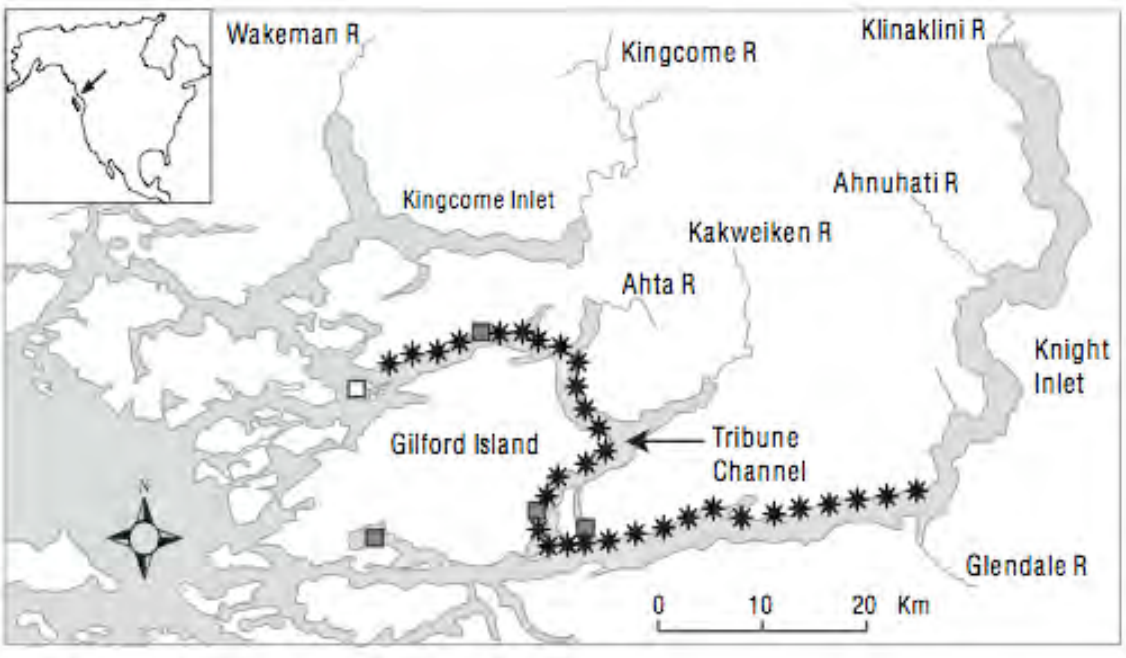
Dr. Brent Hargreaves a senior DFO fisheries scientist, chose methods to count sea lice in the Broughton Archipelago that were different than mine. While did solely shoreline beach seines, he did parallel beach and purse seines to check whether the lice-infested fish were only on the surface and a healthy population deeper. Pink salmon fry are well known to travel on the surface, but this was a good idea to confirm there was not a deeper healthy group of fish. Hargreaves sampled lethally and sent the fish to the Biological Station to have the lice counted. Others and myself counted the lice live and released the fish – but we standardized methods – ran checks with DFO and found when we erred it was that we counted fewer lice than DFO. However the significant difference in our methods was how we grouped locations where we were sampling the fish.

Below is Hargreaves sampling regime. He took fish at intervals between the black lines. The lice were counted all the fish caught between the lines were averaged for a single value. Each of those areas has a letter. If you look at his area “F” you will see, for

example, there are 2 small inlets and one active salmon farm (the blue dot). Fresh water is lethal to sea lice and so we generally find 0 sea lice right at the rivers and for some distance away. By clumping the fry fresh from the river, into the same count as the fish right beside the fish farm, Hargreaves reported there were more lice in his zones as he got further from the rivers. Essentially, he found lice increase with salinity. He did not have the resolution in his data to compare the number of lice on the fish right beside the farm vs. the number of lice on the fish near the river. He did not differentiate between the age classes of lice.



In separate projects Dr. Krkosek and I did it differently. We looked at 100 pink salmon fry at intervals (each of the stars is a sample site) as we approached and passed the farms and we separated out the age of the lice at each one of these sites.



Sea lice change their body shape dramatically through the first 30 days after hatching and so it is easy to estimate how old they are until they become adults at approximately day 30.

What we found was that the most juvenile stages of sea lice peaked at every stocked salmon farm, and that the lice got older as we moved away from the farms in the direction that the fish were migrating. After passing all the farms there were indeed more lice at the ocean end of the archipelago than at the river end, as Hargreaves found, but we were able to see they had been infected at each active farm.

What Hargreaves published said: "The abundance was lowest on fish collected from zones in which the seawater surface salinity was also lowest." (Jones and Hargreaves 2007 J of Parasit. 93:1324-1331)

What Dr. Hargreaves didn't publish is a paper called :

> DRAFT "Detection and distribution of significant clusters of Sea lice infestation from samples of juvenile salmon and stickleback in the Broughton Archipelago, Knight Inlet, B.C. 2003-2006 using a spatial scan statistic (SaTScan ^{TM})" CAN181615

The beginnings of this paper are among the Cohen documents, with no results included, only the methods. I have spoken to Hargreaves about this paper many times over the years and he wanted to published, but felt he needed to know the stocking of the farms and since he could not get that information he has never published it. But it is evident he too found clusters of sea lice, not a smooth gradient increasing from the rivers to the ocean.

Jones vs. Morton Impact of Sea lice on juvenile salmon

In 2004, co-authored a study on the impact of sea lice on juvenile pink salmon. I captured 3000 very juvenile pink salmon, sorted them by how many lice they had, put them in flow through containers in the ocean, fed them all the same and watched which ones lived and which ones died. I ran three trials and multiple replicates within each trial. The results were stark, if a single louse stayed on the fish, until it reached its motile stage the fish died. All of these fish were approximately less than a gram, without scales. (Morton et al 2005 Alaska Fishery Research Bulletin). I invited DFO to visit my research as it was underway and they viewed it.

As part of the Pink Salmon Action plan Dr. Simon Jones of the Pacific Biological Station was tasked to figure out if sea lice killed pink salmon. He undertook this in a lab setting, hatched out sea lice taken from farm salmon in processing plants and put them in the tank with the pink salmon. When I heard that his pink salmon were not dying of lice I made an appointment for Dr. Hargreaves and myself to visit his lab to see these fish, which were infected with sea lice and reportedly showing no ill effects. We arrived at about 3:30 in the afternoon, having made the specific request to view the fish but the lights were off in the lab. Dr. Jones said he was manipulating the daylight hours. So I never actually was able to see these fish. (Jones, et al. 2008. Early development of resistance to

the salmon louse, Lepeophtheirus salmonis (Kroyer), in juvenile pink salmon Oncorhynchus gorbuscha (Walbaum).

Having personally witnessed the affect of sea lice on juvenile salmon I can only believe what I saw.

Sea lice and sockeye

In 2005, I initiated research to count sea lice on pink and chum salmon in the Discovery Islands. We found so many lice on the juvenile sockeye that we looked as many juvenile sockeye as possible, which was not many. The juvenile sockeye are heavily infested with sea lice near salmon farms. (Morton, A.B**.,** Routledge, R. and Krokosek, M. 2008. Sea lice infestation of wild juvenile salmon and herring associated with fish farms off the east central coast of Vancouver Island, BC. *North American Journal of Fisheries Management* 28, 523-532.)

The sockeye were infected with two species of sea lice. *Lepeophtheirus salmonis* is larger and salmon specific, they have only been seen reproducing on salmon. *Caligus clemensi* is smaller and because it is a generalist it tends to jump more easily between hosts. There are now several papers on sea lice infection of juvenile sockeye but there has not been any mortality work done with them. *Caligus* prefer sockeye.

Juvenile sockeye migrate very rapidly, unlike the pink and chum and they are much larger at seawater entry. The impact of the individual lice is likely less because *Caligus* are smaller and sockeye are bigger. But *Caligus* jumps easily fish to fish these lice have a greater potential to spread disease. (Nylund et al 1995 Infectious Salmon Anemia virus (ISAV) in Brown trout J. of Aqua. Animal Health 7:236-240) report that sea lice are potential vector for ISAV. Current work reported in this document by DFO reports sea lice are capable of transmitting IHN virus.

While it is unlikely that sea lice were the cause of the 2009 Fraser sockeye collapse, they are a disease vector of concern and they do physically tax and harm the fish, weakening them. Paul Sprout – Director General, DFO Pacific Region published letters in two BC newspapers (North Island Gazette and Globe and Mail), to assure the BC public that sea lice were not the cause of the 2009 Fraser sockeye collapse, when DFO did not actually have the fish farm sea lice data for the crucial spring 2007 time period when the juvenile sockeye that went "missing" were passing the fish farms. The emails below are from 2009.

Aug 13 Email from Terry Davis (Communications) in reference to the Globe and Mail article on the collapse. "We will be seeking approval from the MO to develop a letter to the editor on the sea lice aspects of this." CAN101482

Aug 19 Email Andrew Thomson recommends saying farm lice not "likely" to explain collapse and adds "If this is the best statement we can make on the subject, we may not want to publicize the letter at all" CAN087854

Aug 19 Email Terry Davis (RD communications) to Laura Richards: "Laura, I spoke to Paul Sprout on this. He is concerned about backing away from the wording we used in the media lines… Are we still comfortable being as definitive as this. The statement we

now propose to use in response to Alexandra Morton is: …returns of sockeye to other rivers…not in proximity to fish farms…were also much lower…management actions that farm operators are taking to minimize the potential for sea lice from their operations to infect wild salmon….our research on the species of sea lice being found on wild sockeye populations….cannot explain the lower-than-expected sockeye runs this year." Earlier this day and in the same email thread Andrew Thomson tells these folks that "I have no data (I'm trying to track it down) on what the levels on the farm were." Email from Andrew Thomson: "I would modify the following as I have no data (I'm trying to track it down) on what the levels on the farm were." CAN139828

Aug 19 Email From Laura Richards "I would be somewhat cautious about again repeating the work that Simon had done on small pink salmon in the lab. This is because the field situation could be quite different with, for example, multiple infection periods, and with sockeye. The stronger message would be poor returns elsewhere on the coast (if the data still suggest this)." *This is remarkable for me to read because my colleagues and I have been trying to get DFO to acknowledge the multiple infections that we take into account with our work, but Jones does not.* CAN139832

Sept 1 all the qualifying statements are removed and the public is told sea lice "are not the explanation…." As well the public is told the species of lice on the sockeye are not typically found on farmed salmon.

Fish farms not the cause
September 01, 2009

http://www.bclocalnews.com/vancouver_island_north/northislandgazette/opinion/letters/56670197.html

Dear editor,

The situation on the Fraser River this year is unfortunate, with returns of summer run sockeye at historic lows (Fisheries catastrophe, Fraser River's salmon stocks beyond a crisis ... Aug. 13, 2009).

There is no question that the low return of sockeye will affect First Nations communities, as well as commercial and recreational harvesters.

There also seems little question that the cause of the low returns has been the poor marine survival of sockeye, which has made the already complex science of forecasting salmon returns even more challenging.

It is also clear that sea lice from fish farms are not the explanation for the extremely poor marine survival of Fraser River sockeye. This is supported by the fact that sockeye returns to the Skeena River in northern B.C. were also significantly lower than anticipated this year, and the migratory route of juvenile sockeye from this river system does not take them anywhere near fish farms.

We also know that the sea lice species found on juvenile sockeye in the Strait of Georgia are not the same species that typically infect farmed salmon.

The Department of Fisheries and Oceans is working closely with commercial harvests, First Nations and the recreations fishery to support the conservation and sustainable use of the sockeye resource.

The right approach under the circumstances this year is to manage fisheries in a

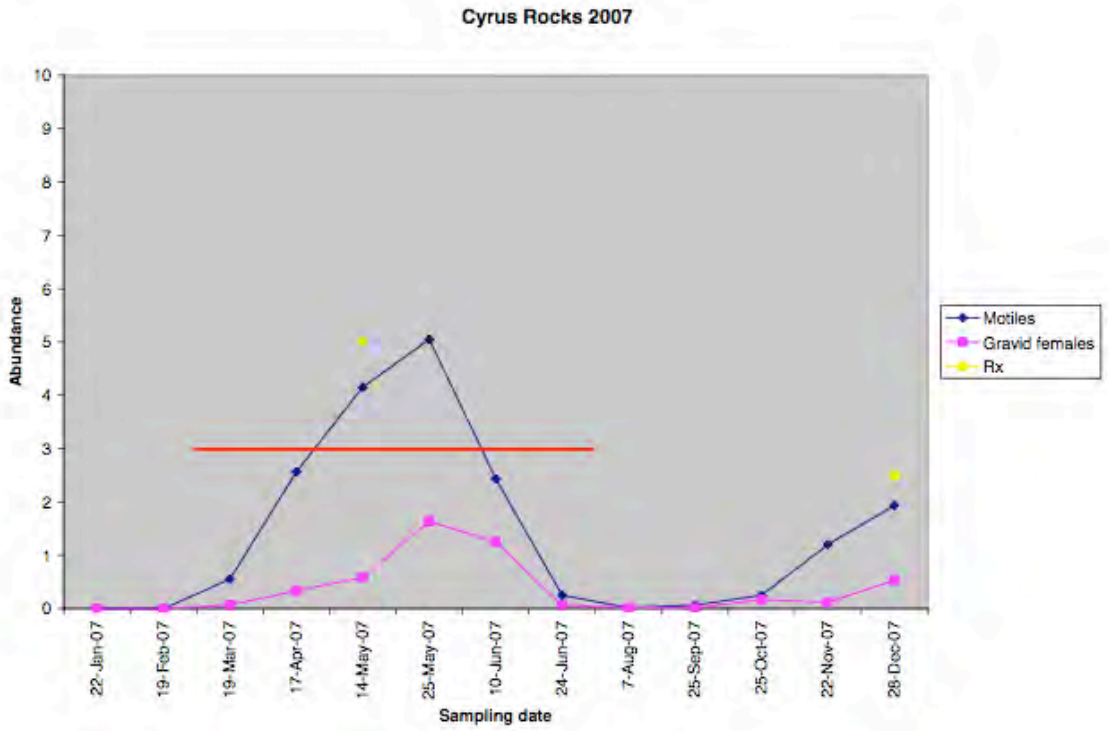
sustainable manner that puts as many fish on the spawning grounds as possible. The conservation and long-term sustainability of sockeye is our first priority in managing fisheries.

Paul Sprout

Fisheries and Oceans Canada

Paul Sprout is incorrect that sea lice on sockeye not typically found on the farm salmon. Marine Harvest has been posting their sea lice data for a few years now. This website used to take you to the data below:
http://www.marineharvestcanada.com/farming_farm_locations.php?area_id=2

At this website you can click on each farm and up comes the data. Every one of these reports, that I have viewed, includes a column for "CALIGUS" and every one reports this species as present on the farm salmon. For example, when the 2009 "missing sockeye" were going to sea they passed this farm in May and June when this farm was reporting levels of Caligus in excess of the provincial limit of three motiles/fish.



DATE	CHALIMUS	PREADULT	ADULT MALE	ADULT FEMALE (w/o eggs)	ADULT FEMALE (with eggs)	CALIGUS	Avg Motiles	# of fish sampled	total lice counted	Site Inventory	Rx	
21-Dec-06	0.93	0.00	0.00	0.00	0.00	0.00	0.00	60	56	322222		
22-Jan-07	1.50	0.00	0.00	0.00	0.00	0.00	0.00	60	90	322055		
19-Feb-07	4.45	0.00	0.00	0.00	0.00	0.02	0.00	60	268	318725		
19-Mar-07	7.80	0.38	0.08	0.02	0.07	1.25	0.55	60	576	318577		
17-Apr-07	11.22	0.80	0.88	0.55	0.33	3.48	2.57	60	1036	317807		
14-May-07	9.20	1.73	1.07	0.77	0.58	5.73	4.15	60	1145	317396	16-May-07	5
25-May-07	13.23	1.25	1.20	0.97	1.63	5.90	5.05	60	1451	317269		
10-Jun-07	2.90	0.42	0.45	0.32	1.25	2.05	2.43	60	443	317700		
24-Jun-07	0.00	0.00	0.05	0.13	0.07	0.05	0.25	60	18	317000		
7-Aug-07	0.00	0.00	0.00	0.00	0.02	0.03	0.02	60	3	316078		
25-Sep-07	0.05	0.00	0.03	0.02	0.02	0.05	0.07	60	10	283885		
25-Oct-07	0.00	0.03	0.03	0.02	0.17	0.00	0.25	60	15	283664		
22-Nov-07	0.42	0.40	0.43	0.25	0.12	0.00	1.20	60	97	283529		
28-Dec-07	0.37	0.13	0.70	0.57	0.53	0.00	1.93	60	138	204458	17-Dec-07	2.5

Sept 16 Email Laura Richards "Also, the line "Despite the views of some, sea lice from fish farms also cannot explain the lower-than-expected returns of sockeye to the Fraser River in 2009." Should have some modification to allow that farms could be responsibility for some portion (albeit perhaps very low) of the overall mortality. In the context of the paragraph, it sounds like we are dismissing farms overall, which I do not think is the intent and will not seem credible to staff. You need to nuance this somehow.

Perhaps something like 'The explanation cannot be as simple as sea lice form salmon farms" Laura." CAN087889

Oct 15 Email Barry Rosenberger (DFO) "There has not been a salmon collapse in the Fraser" CAN088651

Oct 16 Email Brent Hargreaves examines farm lice numbers in his possession and says the data is incomplete and that he needs the numbers of juvenile lice too. CAN115632

Oct 23 Email Brent Hargreaves prepares to ask Mary Ellen Walling (BCSFA) for their complete Discovery Island sea lice data, this is 26 days after RDG Paul Sprout wrote letters to two newspapers saying "clear that sea lice from fish farms are not the explanation for the extremely poor marine survival of Fraser River sockeye." CAN088645

Oct 26. Question Period answers: "Interactions with aquaculture is one of the factors being analysed…. However there does not appear to be anything immediately obvious that would point to that." *Stunning failure to mention that over 75% of the sockeye that past salmon farms appear to have a virus*…. CAN166746

Oct. 26 Dick Beamish tries to figure out why Harrison sockeye did so well and figures it must be lack of predators or "more smaller plankton," completely failing to acknowledge their unique migration route to the south CAN088657

Jan 27 Email although Brent Hargreaves mentions trying to get lice data from fish farms on Oct 23, in a work plan for research needed by the Cohen Inquiry attached to this email Jan 27, 2010 it is still listed as a to do item. CAN166799

Summary

Some of differences in results of sea lice research between DFO and non-DFO researchers can be explained, other cannot.

Immediately following the crash of the 2009 sockeye BC's highest ranking DFO staff, publishes letters in two BC newspapers stating sea lice are not the explanation of the crash even though DFO did not have the sea lice data from the fish farms to support that statement. There was considerable internal dialogue not to soften the statement, but that advice is not heeded. Four months later they still did not have the data to support their statement. DFO was apparently unable to get the sea lice data or stocking data from the salmon farmers.

These documents demonstrate internal conflict over how to portray the role of salmon farming in the decline of the Fraser sockeye, .

Sockeye Okisollo Channel, Discovery Islands May 25, 2010 with sea louse on its eyeball

Atlantic salmon Egg Imports

There exists a history of concern over the risk of importing diseases into British Columbia in Atlantic farm salmon reproductive products

July 13 1991 Dr. Gary Hoskins transplant committee DFO Pacific Biological Station "Numerous examples of the movement of infectious agents, with shellfish as well as finfish, and their severe impact on indigenous species can be found in the literature. In every case, adequate consideration was not given to the potential of infectious diseases to cause serious biological and economic damage." This document goes on to explain exactly how great this risk is from a DFO fish pathologist AQU000023

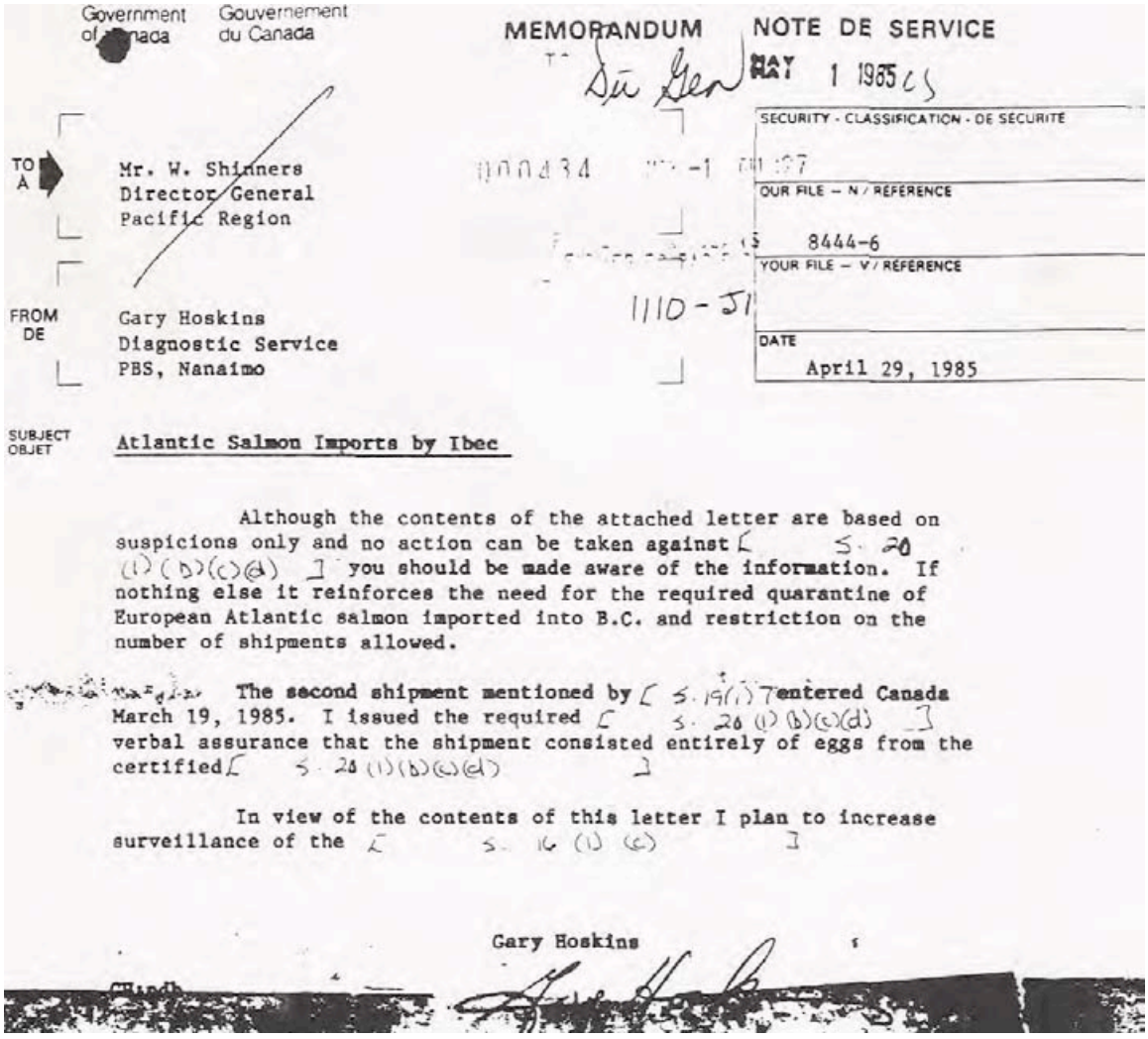
July 9, 1985 "I have discussed with Gary Hoskins, Local Fish Health Officer Pacific Region [omitted] chairperson, Transplant Committee ….It is our opinion that while the risk of exotic disease importation accompanying any single shipment of eggs from abroad is small the cumulative risk from unlimited introductions in the future is large. Therefore, we recommend that Atlantic salmon imports should only be allowed for the next 6 years." AQU000003

July 23, 1987 from John Davis Reg. Dir. Science Pacific Region to Pat Chamut RDG Pacific Region "Quarantine and rigorous testing are only practical for small lots of eggs…. Our experience with Atlantic salmon imported from Scotland has shown these methods to be expensive and their enforcement and monitoring by DFO both expensive and time consuming. Further I am informed…. screening of adults… is not reliable….The massive screening of Chinook broodstock by the BC Salmon Farmers Association at an estimated cost of 0.4 million dollars was only partially successful…..in preventing vertical transmission of bacterial kidney disease (*note BKD is very common the FH records*). Similar detection problems exist for the other diseases listed in Schedule II….. particularly viral diseases. " AQU000033

Date "8/9" Email from Chamut to Davis "While there is a logic to it, we should not knowingly allow smolts into the country if there is a risk. It is one thing to be faced with an imposed risk, quite another to willingly increase the risk" *Were there shipments of live smolts into BC?* AQU000037

Feb 26, 1986 Email Dave Narver Provincial Director Fisheries Branch "I am getting increasingly anxious about our importing of Atlantic salmon eggs…a sub-committee of the Federal-Provincial Transport Committee….developed a live salmonid import policy that closes the door on import of European Atlantic Salmon eggs in 1989….Dick Beamish has approved this draft, as have I. " AQU000139

The memo below suggests problems with imports.



Government of Canada / Gouvernement du Canada

MEMORANDUM NOTE DE SERVICE

To Dir Gen

MAY 1 1985

SECURITY - CLASSIFICATION - DE SÉCURITÉ

TO / A: Mr. W. Shinners
Director General
Pacific Region

OUR FILE – N/ RÉFÉRENCE: 8444-6

YOUR FILE – V/ RÉFÉRENCE:

1110-51

FROM / DE: Gary Hoskins
Diagnostic Service
PBS, Nanaimo

DATE: April 29, 1985

SUBJECT / OBJET: Atlantic Salmon Imports by Ibec

Although the contents of the attached letter are based on suspicions only and no action can be taken against [s. 20 (1)(b)(c)(d)] you should be made aware of the information. If nothing else it reinforces the need for the required quarantine of European Atlantic salmon imported into B.C. and restriction on the number of shipments allowed.

The second shipment mentioned by [s. 19(1)] entered Canada March 19, 1985. I issued the required [s. 20 (1)(b)(c)(d)] verbal assurance that the shipment consisted entirely of eggs from the certified [s. 20 (1)(b)(c)(d)]

In view of the contents of this letter I plan to increase surveillance of the [s. 16 (1)(c)]

Gary Hoskins

CAN356445

In November 2009 I wrote to the Minister of Fisheries, Gail Shea, and cc'd the letter to Brian Riddell about the risk of importing IS virus in Atlantic salmon eggs, in response Brian Riddell, takes an uncharacteristically hard line on the subject of ISAv.

Nov 30, 2009 Brian Riddell to XNCR, Min "…Morton makes a comment that is very serious given the current situation with ISA around the world…if there was ever an application of the precautionary principle…this should be it! The comment in Alex's letter that is very troubling to me was "there is no 'strong evidence' that it travels in the eggs (*this is a quote from Minister's Shea's previous letter to me*)" …assuming the context of this quote is correct then it is clearly contrary to Canada's commitment to the precautionary principle…a lack of 'strong evidence' can not be used as an excuse. …I chose to emphasize Ms Morton's point as the risk to wild Pacific salmon is real and unnecessary" CAN100469

Clearly Brian Riddell, senior salmon scientist with DFO until recently has not seen Gary Marty's 1,100 reports on "classic lesions" associated with ISAV

Nov/2009 This is a thread of emails in response to my query about how many salmon eggs have been imported to BC. From Cindy Wong to Ed Porter "Please note that the database only has information pertaining to the application and does not gather information for the actual numbers imported." CAN138576

From Sharon Ford to Cindy Wong "would it be possible to call the hatchery (*in Iceland*) and ask what they did import for the last couple of years. Are there import restrictions? ... Is there testing for ISA in the country"

Wong to Ford "Attached are the actual numbers…imported from the Iceland hatchery for the past 3 years. According to the Atlantic salmon import policy the limit on egg imports is 300,000 eggs/year/licence….we have made exceptions… As well, applicants are required to follow strict ….disinfection requirements"

Dec 9 Swerdfager to Thomson "…it says that this year they imported 600,000 eggs. I think our QP said zero. We will need to go back and update"

Thomson to Swerdfager " I have already asked Laura (R.) the specific questions about the presence of ISA in Iceland and how confident we are in the position that ISA does not occur in eggs. No response yet."

Porter to Thomson and Swerdfager "….there is a small possibility that ISAV could be transmitted with reproductive fluids…However, surface disinfection of eggs, which is routinely carried out …..provides assurance that ISAV will not be transmitted."

Porter to Ford "Disinfection isn't a regulatory requirement by FHPR, but strongly suggested….."

Stephen (Director Biotechnology, DFO) to Porter "The I&T committees can make this a requirement for import and set any other conditions…. That being said I'm not sure that this is happening in every case, ..."

So with a backdrop of 25 years of strong concern over disease import in eggs, several promises of closing the border and a worldwide epidemic of ISAV DFO does not know how many eggs came in and disinfection is not mandatory.

The Icelandic hatchery MAST writes back:

CAN060446 Dec 8 2009 to Cindy Wong

2004 Jan 21 2004 675,000 First export from this hatchery (Boot Lagoon Hatchery)
2007 – 1,000,000 eggs to West Coast Fishculture (Lois Lake) Ltd in BC
750,000 eggs to Mainstream Canada Ltd., Boot Lagoon Hatchery
2008 – 600,000 eggs to Mainstream Canada Ltd., Boot Lagoon Hatchery
200,000 eggs to Mainstream Canada Ltd., Boot Lagoon Hatchery
2009 – 600,000 eggs to Mainstream Canada Ltd., Boot Lagoon Hatchery

Meanwhile in the recent media in Fish Farming Expert: Article titled:

"Fish Farm Foes not Focused on Fact"

- "The fact is that only a few (3-4) small shipments of Atlantic salmon eggs have been brought in to B.C. over the past 15-20 years, and only from Stofnfiskur in Iceland- one of the few facilities in the world that would meet Canadian requirements for a disease-free status."

Odd Grydelund does not seem to know there have been at least 19 shipments from 5 regions of the world according to DFO and that Stofnfiskur does not meet the Canada's Fish Health Protection Regulations which were waived to allow eggs to be imported from this facility and an entire shipment had to be destroyed with viral testing mentioned. http://www.fishfarmingxpert.com/index.php?page_id=76&article_id=89792

When I asked Laura Richards about egg imports in Dec 2010 she wrote back "all introductions of eggs into BC are closely tracked…."

On 12/3/10 3:24 PM, "Richards, Laura" <Laura.Richards@dfo-mpo.gc.ca> wrote:

> Dear Alexandra,
>
> I would like to respond to your e-mail dated November 15, 2010, regarding causes of pre-spawn mortality of Fraser River sockeye.
>
> With respect to transfers of Atlantic salmon eggs into British Columbia, all introductions of eggs into BC are closely tracked by the federal-provincial Introductions and Transfers Committee which was created specifically to consider potential ecological, genetic and fish health risks associated with moving aquatic organisms into and within the province. Based on their records from1986 to present there have been no imports of eggs from Norway into British Columbia.

From 1995–2001, all Atlantic salmon eggs imported into BC came from a land-based facility in Washington State. This importing company's broodstock program was developed from eggs that originated in the Gaspe' Region, Québec.

For the period 2004-2009, all imports of Atlantic salmon eggs into British Columbia, have come from a single company in Iceland. Fish viral pathogens such as ISAV and IPNV have never been found in Iceland. In addition there are no reports of any clinical signs that might indicate the presence of other viruses in Icelandic Atlantic salmon stocks.

There were no Atlantic salmon eggs imported into BC in 2002, 2003 and 2010.

As has been communicated to you previously, eggs are screened for all known viral agents prior to shipment to BC. For each import into BC the eggs and their resulting progeny are health screened 5 times prior to release to seawater. This screening is conducted by a third party laboratory using diagnostic methods as outline in the Fish Health Protection Regulations (FHPR). There has never been any viral pathogens identified during any of these screenings, nor have there been any physical signs that undiagnosed infectious agents were present. ISAV has never been found in farmed salmon populations in British Columbia.

Using the OIE-recognized diagnostic test for ISAV we have also conducted some screening of wild Pacific salmon and trout for the presence of this virus. This includes hatchery-reared rainbow trout and coho salmon that are routinely screened as part of the FHPR Certification Program. In 2009, 100 sockeye salmon smolts collected from the Strait of Georgia and Johnstone Strait were screened for the presence of ISAV. None of these fish tested positive for ISAV.

With respect to cardiomyopathy syndrome (CMS) of Atlantic salmon there has never been any report of signs of this syndrome in British Columbia. As you have reported in your Salmon Virus Watch Postings "the signs of this syndrome are obvious" so if CMS was present in BC it would not have gone un-noticed. Cardiac deformities that have been reported in BC farmed Atlantic salmon do not match those seen in Atlantic salmon suffering from CMS. This was noted by the two veterinarians who were authors of the report (Brocklebank and Raverty, 2002, CANADIAN VETERINARY JOURNAL43: 129-130).

With respect to Kristi Miller's presentation at the June 2010 PSC workshop, research is ongoing. I intend to give my evidence on this topic before the Cohen Commission rather than through an e-mail exchange.

Laura

Dr. Laura Richards
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

Laura.Richards@dfo-mpo.gc.ca
Telephone | Téléphone 250-756-7177
Facsimile | Télécopieur 250-729-8360
Government of Canada | Gouvernement du Canada

Clearly from the email thread above egg imports are not "closely tracked," by DFO, there have indeed been "clinical" signs of ISAV reported by Dr. Gary Marty as have the "Cardiomyopathy" symptoms.

I don't think Laura Richards has been briefed on what Dr. Gary Marty is finding in farm salmon. I wrote Laura Richards back to ask again about eggs imports:

"The comment below from Pat Chamut suggests that you have left out a large number of Atlantic salmon imports in your email to me. The question is: how many Atlantic salmon eggs have come into BC and from where? Andrew Thomson could not answer this, so I suspect either you guys don't know, or you don't want to say. With a purported retrovirus that remains unidentified in the majority of Fraser sockeye that share water with millions of Atlantic salmon we need complete answers."

On December 3, 1990 Pat Chamut, then Director General DFO writes:
"*Continued large-scale introductions from areas of the world including Washington State, Scotland, Norway and even eastern Canada would eventually result in the introduction of exotic disease agents of which the potential impact on both cultured and wild salmonids in BC could be both biologically damaging to the resource and economically devastating to its user groups.*"

Her reply:

Dear Alexandra - I ask that you direct any further questions related to egg imports to Andrew Thomson.

Best wishes for the holiday season.

Laura Richards
Dr. Laura Richards
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

Summary

There is a 26-year history of opposition and concern from both the provincial and federal government over the importation of Atlantic salmon eggs. This includes senior management and veterinarians. Despite strong requests to close the border it has stayed open and DFO is not currently, if ever, tracking eggs coming into BC, even though they report to the public that this being done. Egg disinfection is not mandatory. There is strong specific concern about the exotic virus ISA and apparently Dr. Laura Richards is not aware that eggs are not tracked by DFO, clinical sign of this exotic disease and others are being reported to the fish farm industry by the provincial vet Dr. Gary Marty.

DFO communication to the public regarding salmon farming matters

In July 2008, I reported oily gas bubbles rising to the surface close to a salmon farm called Cecil Island in the Broughton. In December 2010 I wrote to ask about the outcome of the DFO investigation of my observation and got this reply. Below that is an internal email sent on the same matter by the same person:

On 12/13/10 3:04 PM, "Hoyseth, Kerra" <Kerra.Hoyseth@dfo-mpo.gc.ca> wrote:

> Hello,
>
> The summary of work that was done prior to and following your contact with us is as follows:
>
> DFO partnered with the Ministry of Environment and collectively visited the site on three separate occasions around the time of your observations. Fish had been harvested out of the site in June 2008. The company conducted benthic monitoring within 30 days of peak biomass as required and also submitted additional video monitoring upon request of the Ministry of Environment, which was taken at the location of concern. Staff from the Ministry of Environment went to the site on July 7, 2008 (prior to your complaint) and conducted an audit, where benthic grab samples were taken and results were compared to those generated by industry. DFO Fishery Officers attended the site during the last week of July 2008. Ministry of Environment and DFO staff went to Cecil on September 9/10, 2008 and again took grab samples and video at multiple locations, including locations you provided to Bernie Taekema at the Ministry of Environment.
>
> Video data and benthic grab samples indicated compliance with the Finfish Aquaculture Waste Control Regulations, as did past reports from 2004 and 2006. During the three visits we collectively undertook, there were no further bubbles seen, nor any information we could find to explain your observations.
>
> Sincerely,
> ***Kerra Hoyseth***
> Senior Aquaculture Biologist
> Fisheries & Oceans Canada
> 315-940 Alder Street
> Campbell River, BC V9W 2P8
> (250) 850-5721
> (250) 203-0097
> (250) 286-5852
> Kerra.Hoyseth@dfo-mpo.gc.ca
> www.pac.dfo-mpo.gc.ca <file://www.pac.dfo-mpo.gc.ca/>

From: Alexandra Morton [mailto:gorbuscha@gmail.com]
Sent: December 11, 2010 8:17 AM
To: Jepps, Shelley; Hoyseth, Kerra

Subject: Cecil Island

Hello

In July 2008 I contacted DFO about bubbles rising from just outside the salmon feedlot in Greenway Sound called Cecil.

I was told at the time that it was just bubbling from the mussels falling away from the nets. This seemed unlikely as they were very oily.

I am writing to ask for the report from any investigation you might have done at this site.

Did you determine why there were oily bubbles rising from the sea floor near the Cecil Island farm?

Alexandra Morton

From: Obee, Nicole C ENV:EX [mailto:Nicole.Obee@gov.bc.ca]
Sent: September 24, 2008 9:21 AM
To: Hoyseth, Kerra
Cc: Taekema, Bernie ENV:EX
Subject: Cecil Island - MOE Sampling

Hi Kerra,

I just wanted to give you a quick summary of some sampling that MOE did at the Cecil Island fish farm in early September, because it may be of interest to you from a habitat perspective.

We were sampling the farm due to some concerns raised by a community member about some oil and bubbles seen rising to the surface, and concerns that there were dead fish being disposed of. Peak biomass was in February 2008, fish were still on site in April/May when there was a series of fish kills, and the community members' concerns were from observations in July. We did a regular benthic sediment survey, and did not find anything unusual in the samples. Sulphide levels were moderate. In nearly every grab, we pulled up large sponge fragments. I haven't identified the sponge, but can provide more info if needed.

In one location, where the community member expressed some concern, our vessel's sonar showed three large "blobs" just above the ocean floor. It's unclear what these were.

In another sampling location, at the edge of the feed shed, near where the community member had reported bubbles at the surface, our grab became entangled and we pulled up a mort uplift pipe full of dead fish. The Operations Manager for Mainstream Canada arrived and dealt with the pipe. He was unable to explain how it got to that location, especially full of fish. The pipes are normally inside the net pens and they suck the morts up from the bottom of the pens. Nets were removed in July, so the mort uplift pipes would have been removed as well, and loaded onto a boat in the same place where we were sampling. It's possible the pipe was dropped off the system by mistake.

We have turned this issue over to MAL to investigate with Mainstream Canada. Depending on what action MAL takes, we at MOE may also require Mainstream Canada to do some ROV surveys to determine whether there are other items on the seafloor.

If you would like any more info, or would like to know how MAL/we proceed with this issue, please let me know.

Nicole

Nicole Obee, B.I.T.
Aquaculture Impact Assessment Biologist
Ministry of Environment
Ph: (250) 751-7303 Fax: (250) 751-3103

Summary

I reported bubbles to DFO near a salmon farm, they found a large pipe full of dead fish. They write back they could not find any explanation to explain my observations. There is no evidence within the RT documents that DFO took any actions.

Conclusions

The biology of the fluctuating Fraser sockeye returns is a pattern of exceptional clarity. With healthy sockeye runs occurring in the Columbia River, the sockeye of western Vancouver Island that migrate through Port Alberni Inlet, where there are no salmon farms, and even in the Harrison sockeye which originate from the Fraser River, but avoid the clusters of salmon farms by migrating to sea around southern Vancouver Island, our attention is drawn to the waters off eastern Vancouver Island. It is only the salmon that swim through those waters that are fluctuating unpredictably. The evidence herein suggests the unknown variable/s are salmon farm-origin pathogens.

Massive losses in the river, where scientists could see the fish, led to attempts to isolate a pathogen. But this work was thwarted by a plethora of seemingly unrelated symptoms. The fish seemed to be dying of everything. While DFO did not mount a properly funded investigation into why these fish were dying, they did task Dr. Kristi Miller to find a genetic marker that would allow DFO and the Pacific Salmon Commission to predict whether a sockeye caught in a test set would live to spawn. What Miller found ran deeply against DFO policy. The sockeye appeared to be dying of a cancer-causing virus that originated in salmon farms on the narrowest portion of the Fraser sockeye migration route. The geography, pathology, flutuations and timing all fit perfectly.

What followed was not research it was damage control. There is no evidence Miller was allowed to confirm the identity of the virus in the sockeye. What is abundantly clear is senior DFO had/have no idea what is occurring in salmon farms. There are records of DFO scientists unable to access crucial data from the salmon farms and in the absence of this data, DFO made unsupportable statements.

Biologically, there are two very significant issues for the Fraser sockeye coming from salmon farms – an endemic disease called Plasmacytoid Leukemia that appears triggered by the salmon farm environment and the rising threat of numerous exotic diseases. Plasmacytoid Leukemia is a farm Chinook salmon disease and when the industry quietly removed all farm Chinook salmon from the Fraser sockeye migration route, the sockeye rebounded and the disease symptoms lessened. This is exactly what happened in the Broughton Archipelago. Farm-origin sea lice were infesting juvenile pink salmon. When the Province mandated removal of salmon farms from the primary migration route the pink salmon rebounded. But these results were not acted on.

The diagnostic symptoms of serious exotic diseases are being reported regularly by a BCMAL vet – but no follow is evident to confirm whether these diseases are in BC farm salmon or not and this information does not seem to be reaching Ministers or DFO.

Canada has no mechanism to react to the threat of exotic viruses that are traveling in farm salmon eggs worldwide. Significant farm salmon disease are not reportable, foreign hatcheries do not have to meet Canadian Fish Health Regulations, information does not travel between salmon farm vets and DFO fishery scientists or management. DFO policy is to promote salmon farms, they are being pressure by the salmon farming corporations to do so and field staff seem unable to communicate accurately about salmon farm impacts. The only pressure Canada has responded to is the threat of international trade sanctions so that Infectious Salmon Anemia virus is reportable on the form used for trade and not reportable on the form used to protect Canada's wild fish.

All of this is a pattern DFO has fallen into before. When the North Atlantic cod were collapsing a DFO scientist knew why and he was suppressed. The cod collapsed negatively impacting generations of eastern Canadians. The solution here is simple.

1- Separate the farm and wild salmon completely
2- Separate DFO policy from DFO science
3- Return DFO's single mandate to protection of Canada's wild fish
4- Give Dr. Kristi Miller the Order of Canada and build a team around her to track wild salmon and measure their health, survivorship and environmental variables around them.

In this way we will learn the scope of impact of inevitable anthropogenic impacts and this can be brought to government and the public to make informed decisions about which impacts society wants to remove and which will remain. On the current trajectory it does not matter which pathogen is involved, salmon farms will destroy the Fraser sockeye salmon runs.

In closing I think it is important to read a 2006 email from Georges Lemieux, a senior trade commissioner with the Canadian Embassy in *Oslo.* It could be valuable when evaluating what DFO says publicly about salmon farming This email thread ends up in Andrew Thomson's inbox when his title was acting director for aquaculture management for the Department of Fisheries and Ocean in BC. Were these marching orders? Excerpts of the letter below

From: Lemieux, Georges –OSLO May 2, 2006

On April 27, HOM accompanied by Senior Trade Commissioner and Trade Commissioner, met with Mr. Geir Isaksen, CEO and Mr. Carl Seip Hanevold, Project Director, Cermaq. Cermaq owns two companies in Canada, both located in British Columbia: Mainstream Canada (fish farming) and EWOS Canada Ltd. (fish feeds). With thirty sites in BC Mainsteam makes up approximately 27% of the industry in BC. Together with Pan Fish and Greig Seafood, Norwegian investors account for a total of more than 60% of the production in the fish farming industry in BC. Indeed, it is the fish farming side of the Canadian operations that was chiefly on the agenda for the meeting.
…

Isaksen is a self declared “fan” of Canada – something to keep in mind for investment events requiring testimonials.

The list of “challenges” for Cermaq in Canada is narrowed down to: lack of long term policy and strategy for aquaculture development; lack of skilled labour in remote communities, …. Complexity of negotiations with Fist Nations and difficulty bringing these to conclusion within a specified time frame, lack of insurance to take into consideration BC’s specific environment, and desire for more support from governments in countering myths and disinformation about the aquaculture industry. Cermaq maintains that they have instituted sound environmental and health practices in their BC operations (in contrast to some investors, past and present). It is interesting to note that aquaculture in Norway does not attract the criticism of the environmental groups that is has in Canada. On the latter, we provided Isaksen the link to DFO’s “Myths and realities about salmon farming” which he deemed a good start but would like to see better marketed and publicized to balance NGO’s claims about the industry.

Cermaq is also frustrated that permits to increase production (more sites or increased production in existing sites) in British Columbia are often bogged down in lengthy negotiations involving a confusing number of players without a clear support for the industry from the Government. Mr. Isaksen finds negotiations with First Nations (Mainstream’s 30 sites puts them in contact with 12 different bands) particularly difficult noting “go/no-go” deadlines ….

Mainstream Canada is Cermaq’a largest operation after Norway and, to quote Mr. Iskasen “Canada has the potential to feed the world”…. Especially if the “challenges” above can be removed…. **CAN243705**

Reading this makes it difficult to know, when DFO speaks about salmon farming are they marketing and publicizing, or talking about what they know.