STATE OF MAINE

DEPARTMENT OF ENVIRONMENTAL PROTECTION

BOARD OF ENVIRONMENTAL PROTECTION

	IN THE MATTER OF
NORDIC AQUAFARMS, INC.	:APPLICATIONS FOR AIR EMISSION,
Belfast and Northport	:SITE LOCATION OF DEVELOPMENT,
Waldo County, Maine	:NATURAL RESOURCES PROTECTION
	:ACT, and MAIN POLLUTANT
	:DISCHARGE ELIMINATION SYSTEM
	:(MEPDES)/WASTE DISCHARGE
A-1146-71-A-N	:LICENSE
L-28319-26-A-N	:
L-28319-TG-B-N	:
L-28319-4E-C-N	:
L-28319-L6-D-N	:
L-28319-TW-E-N	:
W-009200-6F-A-N	:
ME0002771	

Assessment of the Nordic Aquafarms Permit to Satisfy Clean Water Act Requirements

TESTIMONY/EXHIBIT:	NVC/UPSTREAM 8
TESTIMONY OF:	Bill Bryden
	December 13, 2019
DATE:	

Review of Issues and Flaws with the Application Made by Nordic Aquafarms
by Bill Bryden B.Sc

Alternatives Analysis :

There are several alternative commercial methodologies that are in use and delivering Atlantic Salmon to market in the United States, Canada and worldwide. They represent best practices for Land Based RAS aquaculture.
These commercial methodologies result in zero effluent discharged into public waters and drastically reduced usage of freshwater input. They include both saltwater grow-out of salmon as well as freshwater grow-out.

In Canada, Sustainable Blue has commercialized a licenseable methodology for zero effluent discharge for Atlantic Salmon in saltwater as well as other species. They recycle 100% of all water they utilize, both fresh and salt except for that water that resides in the fish when slaughtered. This is accomplished by utilizing a combination of ozone and advanced filtration methodologies. Their fish is marketed and distributed throughout eastern Canada. Sustainable Blue's CEO and Chief Technology Officer has reviewed the public documents describing Nordic's proposed facility in Maine and have confirmed their methodology can scale to accommodate Nordics proposed volumes of fish. They are prepared to do so under license to Nordic.

In the United States, Superior Fresh has commercialized their freshwater operation in Wisconsin. They have utilized greenhouses to receive their freshwater effluent. They are marketing their salmon and greenhouse produce. While Nordic may only be interested in producing salmon in saltwater, saltwater can be used to grow out eelgrass or saltwater vegetables for human consumption.

In the United States and Europe, there is work underway by commercial Land Based RAS operators like AquaMaof, as well as Universities to achieve zero effluent discharge through the use of tank repositories of microalgaes. These microalgaes produce materials that are used for either producing fish food, bio-fuels or cosmetic ingredients.

So whether by utilizing a licensed technology, or a hybrid of several methodologies, Nordic Aquafarms is able to achieve zero liquid effluent to the public waterways and greatly reduce their freshwater requirements.

Nor did the proponent offer an analysis of an aquifer water only based design using it's existing technology.

Nor did the proponent offer to use only local salmon genetics that have tested virus free and develop a less risky broodstock and eggs source as per the Williamsburg Treaty.

These are viable solutions and mitigation plans to the many risks associated with the current flow through design and its myriad of issues shown by the history of other projects in other jurisdictions.

Summary :

UVc only works if viruses are not shielded by particles in the water. This is affected by the size and the number of particles in the water called turbidity. The proponent assumes turbidity is constant, which it is not, as will become apparent after the first real storms. The proponent assumes that diverting from untreated reservoir water to sea water as an intake source will circumvent turbidity issues. Often, when storm make water turbid it affects both city water turbidity and water in adjacent bays that these turbid streams and rivers flow into. The proponents application shows no data to support the assumptions that diverting to seawater and using city water will nullify turbidity issues due to storms.

Discrepancies Between Intake Water Treatment and RAS/Processing Plant Effluent :

1. Drum filters are 10 micron on intake and 0.4 on effluent. If 0.4 is required to allow UVc penetration of the effluent it should also be required for the intake water.

2. Municipal water is simply carbon filtered without any micron filtration or UVc treatment, this assumes that town water treatment systems are designed to remove and are monitored for fish pathogens. This is a serious design error.

3. 10 micron drum backwash water is dumped in the sewer from the concentrated pathogen laden sludge generated by the intake water (illegal by Maine law). This is collected and disposed of in the effluent treatment.

We Are Still Finding and Learning about Salmon Viruses :

Finfish virology is a new and expanding science. New viruses are constantly being discovered and techniques for monitoring are still being developed for many viruses. Similarly new hosts are being found and many have unknown modes of transmission. One can't control what one knows so little about.

All RAS Systems Have Disease Issues, but Especially Those Using Surface Water :

Most regions have banned surface water use due to the unavailability of effective intake water filtration systems. A recent example is NS Canada after horrendous antibiotic use and disease outbreaks. No RAS system in Atlantic Canada has been recently built or licensed that uses surface water.

Import of Non-Native Fish :

The Williamsburg Treaty states that only local salmon should be used. The USA/Maine signed this treaty. Importing non-native fish often results in importing non-native viruses and other pathogens. Not all viruses are screened for in egg or smolt importation. Once imported and released it can never be taken back.

Lack of Fish Disease Control in the Food Supply System :

USDA, etc are only concerned with human pathogens. Even ISAv, IPNv, PRv, SAv, etc infected fish are allowed to be sold and washed down a sink. As long as the pathogen does not cause extreme mortality of near market ready fish, it is allowable. Effluent from such fish can be washed down any drain and allowed to be amplified in any RAS system. We have no science on the effect of such a disregard for wild fish exposed to fish produced artificially.

Lack of Antimicrobial Testing :

The USA does not adequately test RAS produced fish for antimicrobial resistance at the tank stage of production, nor the effluent.

Lack of Effluent Screening :

No government or independent monitoring of the effluent will be conducted for virus etc shedding.

Other Underlying Issues :

Lack of a pilot project. Issues in pathogen neutralization commonly seen in other semi-closed hatchery and RAS grow-outs such a biofilm issues eg Langsand Laks collapse due to disease, etc could be examined, and seasonal turbidity could be assessed.

What is “good enough” in terms of fish health regarding the stages of intake/import, husbandry, product and by-product is financially and human health driven with little regard to the Precautionary Principle or wild fish and wildlife health, which ultimately we are all dependent on. If a sick fish in a tank can gain weight, chances are it can be sold and washed down a drain.

What is “good enough” in terms of monitoring production. Unknown causes of mortality is the norm in RAS systems. In fact, 22% is a commonly factored-in mortality for fish from egg to just to smolt stage. Often, a further 20+ percent die as post smolts, eg Kuterra in BC Canada, Langsand Laks in Denmark, etc. The proponent has not included these mortality numbers in its effluent discussions.

What is “good enough” in terms of intake and effluent filtration. Again, acceptable levels of mortality is what is important, not fish health or exposure of pathogens via fish sold to the public nor effluent contamination.

When asked by the public about pathogens in the effluent water the company responded with (emphasis added by me):

“ I. Treatment and Containment of viruses and disease.

1. Specifically, how will disease, viruses and sea lice will be managed within the facility and prevented from being transmitted to Penobscot Bay where they could impact wild populations?

One of the major benefits of RAS is the ability to control the culture environment and prevent disease. All egg batches will be sourced from a **reputable breeder** with **a staff veterinarian supervising a routine screening procedure for salmon diseases**. Upon receipt, eggs will be further screened and quarantined in collaboration with **independent fish health experts**. The most likely source of disease risk would be the sea water used. **All water** entering the facility will be treated with **ultra violet (UV) light** (see Attachment F) using technology that is **proven to neutralize parasites, bacteria and viruses**. The internal RAS system will **continuously treat the recirculating water; preventing the growth of any pathogens within the RAS system**. Finally, all water leaving the facility will be treated with **membrane filters and UV as well**. We will also work with a **licensed veterinarian**, who is experienced in aquaculture, to assist us in adapting our established biosecurity measures to **US requirements and conditions**."

The key words here are "reputable breeders". No names are given and most breeders and egg suppliers regularly are caught shipping and amplifying viruses in their fish. This will be discussed below.

The next key phrase is "routine screening procedures" using a "staff vet". This certainly sounds like a made up screening list and protocol that may not include all potential pathogens and may not use the latest techniques and methods. No biosecurity protocols or testing methods are given. This is a huge issue.

Also of note is that "independent fish health experts" means paid staff again, but under contract instead of direct employment.

The company then proceeds to suggest that the UV light technology they will use will neutralize pathogens but does not give any evidence nor the degree of neutralization.
On page 223 of the MEPDES permits see here: https://www.maine.gov/dep/ftp/projects/nordic/applications/MEPDES%20Permit%20Application_Final_Oct%2019,%202018.pdf
the company states:
" The internal RAS system will continuously treat the recirculating water; preventing the growth of any pathogens within the RAS system." This ignores fish to fish transmission within the tank long before the water is hit by any filtration or UVc. Once a pathogen is in the tank the UVc and filters are almost ineffective in preventing the spread of any pathogens. The proponent talks as if their is a filtration system between each fish. This of course is ridiculous.

To actually dismember the viral RNA takes much higher doses of UVc than that required for a mere 3-log reduction, Oye and Rimstad 2001. Skall and Olesen 2011 reviewed all methods of viral inactivity for fish processing plants and were unable to filter the water and disinfect it with UVc. Moreover, they showed just how dramatic turbidity can affect the UVc.

The proposed pathogen reduction system also ignores airborne transmission such as seen with water molds that can devastate RAS facilities (Sakaguchi et al 2019). This was elucidated only months ago despite being a multimillion dollar issue for decades. This speaks to just how little we know about rearing healthy fish in captivity.

Often UVc is only used to determine the 99% - 99.9% reduction in pathogens in the literature, (Torgersen and Hastein 1995). This is referred to a 2-log and 3-log reductions in the percentage of pathogens. Not absolute numbers but percentages, which of course, are relative to how many pathogens are in a system. 100% reduction (ie sterilization) is never seen in an operating RAS system. UVc highly resistant viruses like IPNv (Liltved et al 2006) often cause limited to no mortalities in hatchery RAS salmon but due to this limited financial impact can result in ignoring it in broodstock and in an RAS setting. IPNv resistance to UVc treatment (Liltved et al 2006), is nearing the limit of the proponent's treatment dose under ideal conditions ie 246mJ sec cm2 in seawater vs 300 mJ sec cm2 offered by the proponent. To reduce IPNv by a 6-log reduction (99.9999%) requires >800 mJ sec cm2 (Skall and

Olesen 2011). Viral particles are counted in the billions per liter in some cases in tanked RAS fish. 800 mJ sec/cm2 is two and a half times above the proponents treatment threshold . This is also likely why IPNv is so prevalent in hatcheries at low levels.

Small changes in turbidity can seriously reduce the effectiveness of the UVc treatment.
Moreover, once in the system, pathogens not requiring an intermediary host can be amplified by fish to fish transmission exclusive of the UV treatment restricted to a UV pipe the fish never enter.

The company mentions continuous treatments during the recirculation process but does not mention how this will work nor how effective it is against viruses and other potential pathogens but states it will use membranes and UV. Percent effectiveness of each treatment is not given.

The company then suggest that it will hire a vet and make sure it follows the laws regarding pathogens in effluent. There are no effluent virus laws, nor any monitoring. No company has even been convicted of dumping fish viruses in the ocean via effluent in USA of Canadian history, that I am aware of. This is telling. This is despite that every farmed salmon in the USA is washed down a sink and has a very very high probability of having a heavy viral load. Eg a alck of PRv testing in Washington in Atlantic salmon produced by Cooke (recently banned due to pressure from NGOs).

Any discharge of viruses would be covered, we hope, under Chapter 800 of the Maine State Environmental Protection which covers Hazardous Matter. This could require a complete cessation of the effluent but the system design does not sensibly allow for this. Nor is a “biblical scale” 33,000mt depopulation plan submitted that would handle tens of millions of salmon.

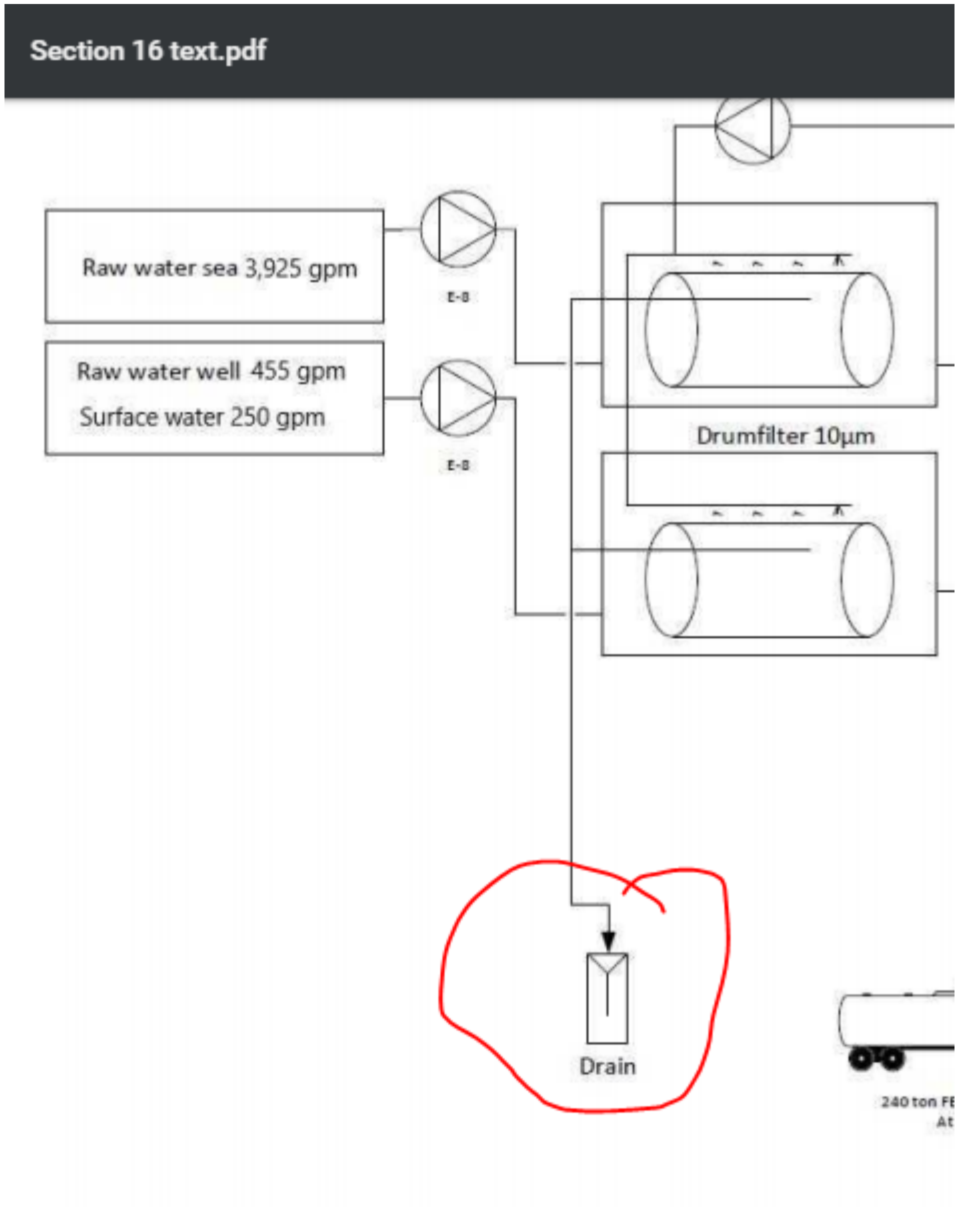
Water Intake Issues :
Right from the outset the proponent demonstrates that impacts to wild fish health are not a priority.

The pathogen concentrate ie the backwash sludge from the 10 micron drum filters on the intake pipes is simply dumped into a drain. This will invariable concentrate pathogens to levels that were not previously at densities that typically allow pathogen transmission in the intake water. This sewer pipe then acts as a major disease vector for ALL pathogens in the entire Little River and Bay water ecosystems. The plant become a disease concentrator.
This is not what the proponent told the public. “Just a final step in terms of the treatment process. So there are solids coming out of various parts of this treatment process. All these solids go through a special dewatering process and what you end up with is a sludge very high and rich in nutrients. And this sludge is in Maine's case going to biogas production. Other cases we see, for example, Norway, it's used for fertilizer, and other types of projects, but in Maine we are sending it to biogas production. And that basically means none of this is going into the ocean.
It's being recycled. “ pg 238 DEPLW1999-19

The design of the intake of surface water and aquifer water is outlined on pages 2 and 3, seen here:https://www.maine.gov/dep/ftp/projects/nordic/applications/SLODA/Section%2016%20-%20Water%20Supply/Section%2016%20text.pdf

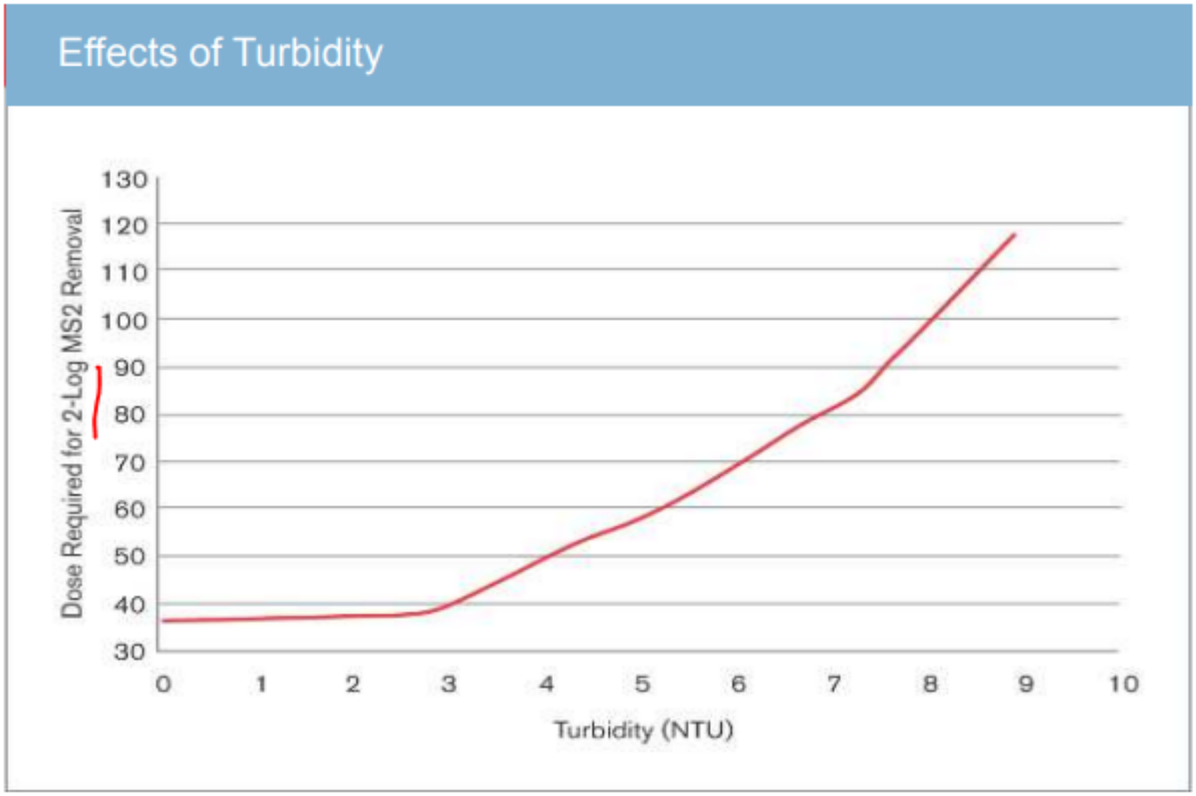
A 10 micron filter is used to remove large solids. This is followed by a brief blast of ozone to bleach some of the solids. UVc is then used at a suggested 250-300mJ/cm2 at 85% transmission rate to kill viruses.

This 85% transmission is totally dependent, as admitted to by the proponent, upon a constant water turbidity as seen under laboratory conditions. This is what the manufacturer and scientists would have used to evaluate the amount of UVc lamps needed. These conditions of course are never the case in a living river with turbidity fluctuations of up to two or more orders of magnitude. The proponent suggests that this will be compensated for by using more seawater. Ironically, typically during times of freshwater extremes in turbidity this added turbidity simply end up travelling for miles throughout an adjacent bay.



The only solution to reduce the turbidity would be to revert to only using aquifer water. Even the town water will increase dramatically in turbidity at times. Note the **log 2 reduction** (only 99%, not 99.9%) in the graph supplied by a competing water pasteurization company. https://www.aquafineuv.com/cms-portals/aqua_com/cms/static/documents/Presentation-Pasteurized-Equivalent-Water-by-Ultraviolet.pdf

The town water is simply carbon filtered by the proponent. This is despite that the town water is not designed nor mandated to be “fish” nor “RAS safe” (Head/Superintendent of Belfast Water District, Keith Pooler per comm. Dec 9 2019) Pathogens that affect fish health are ignored in the town water treatment design (Keith Poolers per comm Dec 9 2019). Moreover, Mr Pooler suggested that neither UVc nor any micro filtration is part of the town water supply treatment. Furthermore, that the town does not guarantee the water quality provided to the proponent, nor, to his knowledge has the town every conducted any long term testing or pilot project to challenge fish with town water. I suggest that this



water supply may, at times of extreme drought and surface water ingress, contain fish pathogens. Mr Pooler stated that at times of severe drought that the aquifer water may increase in turbidity and that this is due to surface water infiltration into the aquifer at high enough rates to cause an increase in turbidity, though this is rare. I would suggest that if turbidity is increasing due to surface water entering the town water system then surface water viruses are also likely entering the system and that this has never been monitored nor tested.

Mr Pooler was also able to confirm that a maximum limit of 262 million gallon of water per year offered to the proponent was the safe limit of the existing pipe system owned by the town. Moreover, that while the aquifer could offer perhaps up to 600 million gallons, that the pipe system would need serious upgrades. The current design and desired production capacity of the proponent is an order of magnitude above what the town can currently supply. >2.81 billion gallons per year vs 262 million gallons per year. About 1/10th. "Right sizing" the project to, as the proponent suggested, "reducing the risk of pathogens entering the system by using the best quality water available in term of pathogen sources" would require the down scaling of the project to 1/10 of the 33,000mt desired by the proponent. Or, the town water supply system getting an upgrade likely via funds/taxes/etc levied on or supplied by the proponent.

Of course only using aquifer water, ie "right sizing the project", is a suggestion the Authorities need to seriously discuss as an option with the proponent.

When asked by the public:
"I. Viruses/disease:

1. "2018, CBC news reported "Virus at 2 Nova Scotia land-based fish facilities results in 600,000

> salmon being killed ... Aquaculture Minister Keith Colwell said Thursday the two facilities are located close to each other but wouldn't name them." If Nordic has a disease outbreak, will it be required by law to disclose the location to the public?

Nordic will follow all reporting requirements in the U.S. and Maine. We cannot speak to the biosecurity measures of these two Canadian facilities. Nordic Aquafarms will install significant upgraded biosecurity measures compared to most of the industry in addition to implementing our best practices for land-based operations, to prevent pathogenic material from entering or leaving the facility. We are not a net pen operation putting fish into the ocean."

What "significant upgraded biosecurity measures" the proponent suggests are unclear at best. Surely not UV light and drum/membrane filters? This is ancient/well established technology. Further statements in the answer to this critical question are vague and uninformative such as "best practices".

The company then makes several serious errors in logic and when asked about viruses when stating:

"*If you have a disease or virus outbreak, will the tanks continue to circulate the disease into Penobscot Bay?*

Pathogenic materials will be unable to enter or leave the facility. ***The primary source of pathogens for RAS facilities is the water source they use.*** *We will use* ***proven disinfection technology*** *at our intake to prevent pathogenic material from entering the facility. The tanks circulate on an internal water* ***treatment loop that has UV disinfection*** *integrated into the RAS for continuous disinfection of system water. Grow-out and processing tanks drain to a waste water treatment system that has micro-filtration to remove particles* ***as small as 0.4 microns*** *(a human hair is 50 microns). This is small enough to remove bacteria. For comparison, rod shaped Escherichia coli bacteria are 1 micron by 2 microns in size. After micro-filtration water is treated with a 300 mJ/cm3 dose of UV light for final disinfection prior to discharge.*"

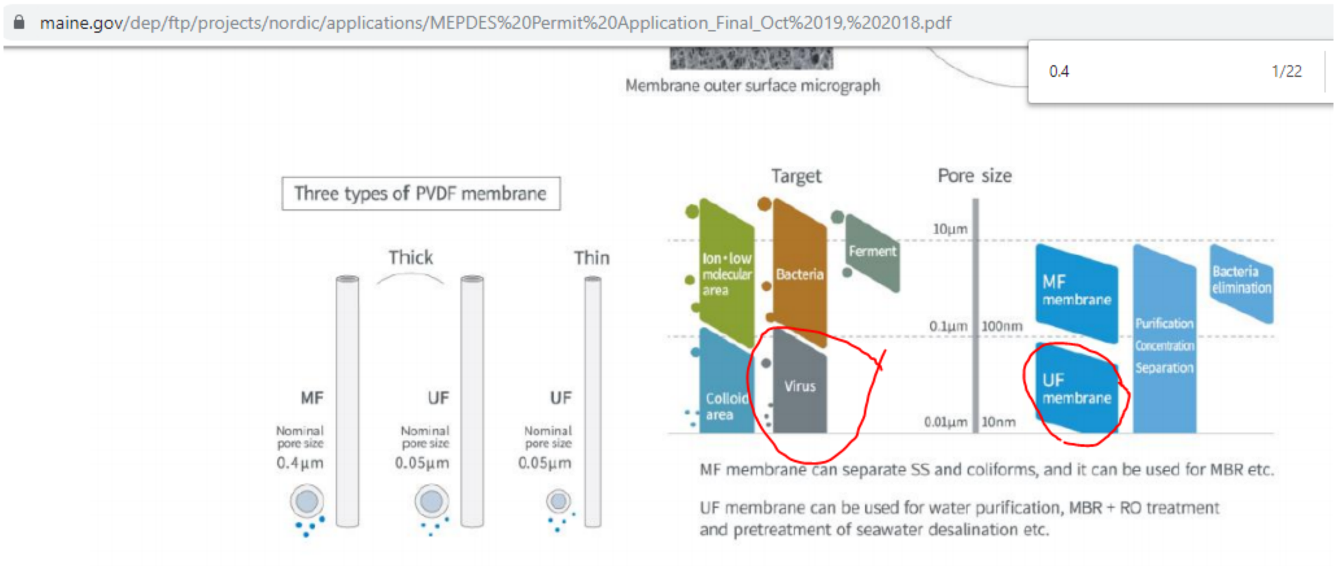
They state that " **The primary source of pathogens for RAS facilities is the water source they use."** This is very true, yet the company ignores a production model that reduces this by simply only using aquifer provided naturally filtered water that is virtually free of viruses. This is truly telling about the managers risk vs profit assessments. Many viruses only cause minor profit losses via protected tanked fish that are sick with a non-OIE reportable disease. This can not be said for wild fish exposed to such viruses from the effluent in a wild/predator environment.

The company then goes on to suggest that drum and membrane filtration down to 0.4 microns will be used and then uses bacteria as a measuring stick but fails to mention that viruses are measured in nanometers (1000 times smaller than a micron). Then, it suggests that a millisecond blast of UV light is effective at eliminating viruses, without discussing those shielded inside particles. This is far from the truth as evidenced by the dozens of hatcheries using UVc globally that suffer from pathogen outbreaks and extreme antibiotic use. It does not state the percent filtration rate at 0.4 micron ie how many particles larger than 0.4 microns will get through per minute, nor suggest evidence of this testing. No filter is perfect.

The company also suggests that the TSS will be 1.5% of input water values, but in reality, this is not constant as the filter becomes fouled and the water turbidity changes. The 1.5% is what the manufacturer observed under constant laboratory ie "ideal" conditions. The first storm that hits Maine will show how much this can change in the real world.
See page 73 of the PDF at https://www.maine.gov/dep/ftp/projects/nordic/applications/MEPDES%20Permit%20Application_Final_Oct%2019,%202018.pdf

While the company admits that a filter from the same supply company is available that is somewhat effective against viruses (see screenshot below), the proponent's design does not use it but instead uses 0.4 microns which will not filter any viruses and instead opts for the cheaper than ozone or membrane filtration - UVc treatment. The problem with virus control in water is that as the system design become more effective it also becomes more expensive regarding filters and or chemical use. It seems that in various discussions with various folks (Dr Dixon, Mr Lannen, etc) people are surmising that a 0.1 micron is the filter they should use to treat seawater coming in (Dixon written submission).

Apparently, when Mike Lannen questioned them on a "circle" that was in their schematic documentation where a filter would be and asked "what is this" the Nordic representative refused to answer. I believe the proponent must supply this info to DEP if asked.



The company then lists mildly or totally unrelated peer reviewed papers on UVc and various parasites that the 0.4 micron filter should remove - among which not one is an original piece of work examining their system on even a bench top laboratory scale. No test of efficacy of their system is offer in any way. Often, expensive blood and bacteria filters fail, become plugged, etc and are bypassed. This is often the case and has been admitted to by facilities in NL via government emails to me.

In fact, 22% mortalities is a common benchmark for ultra modern hatcheries eg Grieg in NL Canada; Cooke Aquaculture hatchery in St Alban's NL, or the Marine Harvest hatchery in Stephenville, NL that are designed to or use aquifer only water, micron scale filtration and UVc treatment - and all suffer from regular pathogen and virus issues. Both of the main hatchery in NL have serious and continual pathogen issues including viruses (eg ISAv), fungi, and bacteria. This is verified by the mortality rate and the following ATTIPA response FLR/75/2018 by the NL government agency responsible an excerpt of which is seen here:

The “no regulatory response required” to ISA HRP0 in the hatchery is telling and normal for NE North American hatcheries. HPR0 is thought to quickly become virulent (see Are Nylund etc quotes below regarding this issue in hatcheries). Moreover, how did a virus get into a land based aquifer only water hatchery? Ans. It was imported. ISA HPR0 and may other viruses are rampant in NE North America hatcheries. See ICES reports on diseases and parasites for examples from 2015-2018.

Site	Company	PCR results	Sequencing	Status	Year
Olive Cove	COS	HPR0	HPR0	No required regulatory action	2017
Grip Cove	COS	HPRΔ	RPC# 23	Quarantine Order - site depopulated	2017
The Matchems	COS	HPRΔ	RPC# 23	Quarantine Order - site depopulated	2018
Spy Glass Cove	MH	HPRΔ	RPC# 11	Quarantine Order - site depopulated	2018
Stephenville Hatchery	MH	HPR0	HPR0	No required regulatory action	2018
Robin Hood Cove	COS	HPRΔ	RPC# 23 and 18	Quarantine Order - site depopulated	2018
North West Cove	COS	HPRΔ	RPC# 25 and 26	Quarantine Order - currently depopulating	2018
Tilt Point	MH	HPRΔ	RPC# 11	Quarantine Order - site depopulated	2018
McGrath's Cove South	MH	HPR0	HPR0	No required regulatory action	2018

Legend

COS	Cold Ocean Salmon
MH	Marine Harvest (Northern Harvest Sea Farms)
HPR0	Non-pathogenic - not known to cause disease
HPRΔ	Pathogenic ISAv

Ultraaqua is a USA leading water disinfection supply company with hatchery clients in 50 states. It admits on its website that only a percent of pathogens are neutralized by any system. That this percentage is proportional to the amount of pathogens in a system, and finally, that turbidity, which can dramatically plug or otherwise negative impact the efficacy of a UV and filter disinfection system, is variable and seasonal in nature.

Disease causing agents can short circuit the system by simply passing from animal to animals without passing through the filtration system. The result is a build up of pathogen production in the tanks. At a theoretical limit the feedback loop reaches a pathogen production value that results in enough pathogens to simply pass through the system and infect significant number of animals through the disinfection treatments system. Spotti and Adams 1981 reviewed this mathematically.

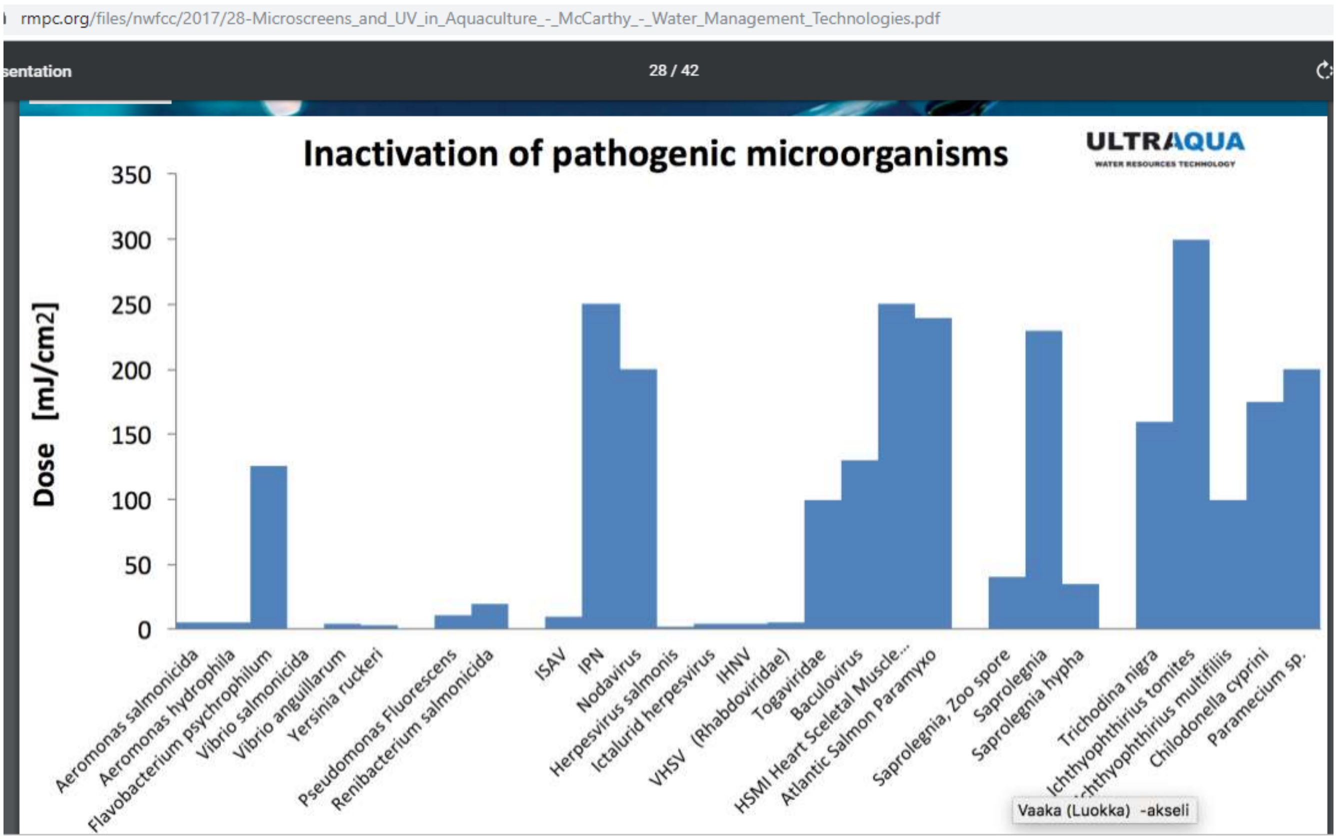
UVc would be used by the proponent at an ideal rate suggested at 250-300mJ/cm2 at 85% transmission rate to kill viruses and other pathogens. This is very close to the limit for many known and common hatchery viruses as seen in the table below. It is also not nearly enough treatment for highly resistant pathogens like whirling disease which require a minimum of 1300 mJ/cm2 (Hedrick et al 2000). Four times that of the proponent's design. Most town water treatment systems will also not neutralize cryptosporidium. This pathogen is also at about the water intake filter limit in spore size ie 10 microns.

Similarly, even higher doses (400mJ/cm2) have been shown to be insufficient to sterilize intake water against water molds (*Saprolegnia spp*) that cause serious losses in hatcheries (Heikkenin et al 2013).

Disease thought to only be transmitted in saltwater are also being discovered in freshwater. Systems and their resulting monitoring are generally not designed to consider anything beyond what is currently known to exist in freshwater hatcheries. SAv, a leading cause of marine salmon losses in the aquaculture industry, was only recently recognized to be an issue in freshwater hatcheries (Soares et al 2019). Note that the hatchery was breeding this disease for a unknown time and was unable to diagnose the pathogen.

The suggested UVc needed for pasteurization varies highly between companies and often is not supported in the scientific literature. This is a serious issue mentioned in many peer reviewed publications eg Liltved 2006, Skall and Olesen 2011.

Eg of the limitations of current testing and models for a leading UVc based system, only a small percentage of pathogens are listed and many are near the upper limit of the proponents UVc dosage:



Recently, after spending circa $250 million dollars trying to prevent ISAv from entering the food chain the CFIA (Canadian Food Inspection Agency) gave up on containing ISAv. It was found repeatedly in hatcheries throughout Atlantic Canada, and the open net pen industry had gobbled up more than 98% of all taxpayer funded "crop insurance" provided to farmers for any and all types of food produced in Canada – two years in a row. This was decidedly unpopular and unsustainable. Instead of shutting down the open net pen production of salmonids in Canada, the CFIA then removed finfish aquaculture from this taxpayer funded "crop insurance" program and suddenly produced evidence that the fish were safe for human consumption. The finfish aquaculture industry was no longer a crop but a fishery. Ironically, or sadly, the Federal agency responsible for protecting wild fish, the DFO, had washed their hands of this responsibility and provided disease oversight solely to the CFIA. Today, and unbeknownst to the public, there is a warning on a buried federal website stating that ISAv infected salmon should not be washed down a drain. https://www.inspection.gc.ca/animals/aquatic-animals/diseases/reportable-diseases/isa/fact-sheet/eng/1327198930863/1327199219511 It may also be of interest to know that ISAv was misdiagnosed in Canada for more than 2 years before it was properly diagnosed for the first time in 1998. Massive industry crippling outbreaks began in 1996. A similar scenario exists for most salmon viruses in aquaculture production. In fact, despite being present for nearly 2 decades, three new crippling viruses were announced to science mere weeks ago. Weeks ago, another thought to be benign was shown to be extremely pathogenic (PRv via HKS with ISA) and a third was found to be able to reproduce in freshwater (SAv). These will be discussed below.

In fact, when I questioned the USDA and Maine government about this issue via Dr Thomas McKenna and Dr David Russell (vets for their respective agencies) in 2018 they referred me to Jeff Nichols of Media relations for the Maine State Marine Resources. I assume the actual questions were answered by Dr Russell. So Jeff suggested that Maine is not concerned about ISAv infected fish being imported from Canada and that Maine has decided this is not an issue at all. See the email response in red in the screenshot below. This, despite two decades of not allowing this to happen. Most notable, this sudden and 180 degree shift in policy occurred *immediately after* to the industry being cut off (2013/2014) the disease compensation for the 5 OIE viruses that includes ISAv. Once cut off the free taxpayer provided (in Maine and Canada alike, using the exact same protocols) "cull insurance" the ISAv infected salmon were suddenly allowed in the USA. The industry was too big to fail at this point it would seem.

Does your government have any studies to show that the risk of consumers spreading the virus via typical consumer practices is extremely low? Or, studies/monitoring that show that current policies and mitigation measures and public awareness is controlling the potential for spread effectively? Seems that having an intensive costly fish health surveillance program and a potentially costly compensation package available due to cull orders is extreme given the protocol is to allow shipping it to 100s of 1000s of drains all over America, including many attached to rivers and estuaries (without any treatment) inhabitated the NOAA posterchild for endangered species - wild Atlantic Salmon. In Maine, most food handling drainage enters septic tanks or publicly owned sewer treatment plants that are not conducive to ISA survival and transmission to a susceptible host at an infective dose. The amount of virus shed from household washing of small amounts of infected product to a private septic system or to a municipal waste water treatment facility, when factoring in dilution, and loss associated with biological and chemical activity results in a negligible risk of transmission to a suitable host at a dose likely to be infective.

https://www.ncbi.nlm.nih.gov/pubmed/24689956

Research has also shown that ISAV does not replicate at temperatures of 25C and above. It is inactivated quickly at such warm temperatures. As such, It is not viewed as a threat for humans.

https://ec.europa.eu/food/sites/food/files/safety/docs/sci-com_scah_out44_en.pdf

I know there is strong interprovincial agreements on how to best manage ISAv in Canada (one crew decides kit all for everyone), and basically everyone in Canada is implementing the same strategy, I am curious to know if Cooke, Cooke's paid consultants, and the USA government ISAv managers are agreeing to work hand in hand with Canadian managers such that both Maine USA and Atlantic Canada are implementing the same protocols and securities? We work cooperatively with the Canadian government to ensure testing methods, response, biosecurity, and fallowing are coordinated between jurisdictions.

The issue with this response is obvious. No studies to prove the statement made about washing it down a drain have ever been completed in Maine or anywhere else. This is telling.

Moreover, the issues with the industry (Cermaq) funded study are many. Industry had provided this study that "proved" that UV light kills ISAv quickly and easily. The issue with the study is that the virus was not IN the fish or even its mucus, it was loose and added to the effluent water. This provided limited protection to the virus from the light. There were also serious issues with media used that destroyed entire sample treatments, tiny sample sizes of 2 fish, and more issues with the study. These flaws in the design of the unnatural study using UVc lamps to simulate sunlight is ignored by governments. Real world tests of fish infected with any of the known viruses that do not require an intermediate vector invariable results in the control fish becoming infected, even under natural UV light conditions in a tank. This UV light experiment cited by the Maine government regarding this issue is Vike et al 2014 and found here:

https://afspubs.onlinelibrary.wiley.com/doi/abs/10.1080/08997659.2013.864720

Norway is now so worried about the recent return of this ISAv to its open net pens that it has reinstated a 10 Km radius around an infected sites whereby all adjacent sites must be culled. This will cost 10s of millions of USD every time it is done. So far, 4 outbreaks have been recently reported and this "stamping out method" is now in force. Salmon are a pelagic species typically found within 2 fathoms of the surface. A salmon gill net is almost never more than 2 fathoms deep. If this virus was so easily killed by UV light, how could it ever be passed from one fish to the next so close to the surface in gin clear open ocean water? Moreover, the last Author of the study above now recommends stamping out all ISAv HPR0 in all broodstock fish. He also suggests, along with the top vets in Norway that this is a serious issue in hatcheries supplying eggs to facilities such as the one proposed by Nordic Aquafarms and has been an issues for decades. This will be discussed below.

The company then suggests that the filtering technology is proven. Where is this proof? Every hatchery in the world to date has contamination issues. Especially those using surface water, drum filters and UV light for pathogen control. On page 207 of the MEPDES application the proponent admits that there are no technical evaluations nor any pilot projects or test data that are available regarding the effluent. Belfast will be the first guinea pig and on an unprecedented scale of 33,000mt of production and 7.7M gallons of effluent a day spilling into the last stronghold of a species supposedly enjoying the protection of the Federal Endangered Species Act in Maine. https://www.fisheries.noaa.gov/species/atlantic-salmon

VI. Engineering Report on Wastewater Treatment

A. If there is any technical evaluation concerning your wastewater treatment, including engineering reports or pilot plant studies, check the appropriate box below.

☐ Report Available ☑ No Report

B. Provide the name and location of any existing plant(s) which, to the best of your knowledge resembles this production facility with respect to production processes, wastewater constituents, or wastewater treatments.

Name	Location
Sashimi Royal	Nordre Strandvej 66, 7730 Hanstholm, Denmark See Attachment 3 for Sashimi Royal water quality results.

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Regarding the proponent using Sashimi Royal as a track record, it's first cohort was just harvest in summer 2018, which hardly gives this very small facility much of a history. I am also lead to believe that extensive antibiotics were also used to rear the fish and mortality rates were extreme. This does not include a likely lawsuit and discouraging remarks from RAS 2020's designer. https://waldo.villagesoup.com/p/two-hours-with-bent-urup/1785347 waldo.villagesoup.com/p/two-hours-with-bent-urup/1785347

Lumsden Academy | Scholastic Canada... | PowerTeacher | myNelson - Your di... | Plickers | Sign In | Masters Cours

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disarray and suffering from poor management.

Urup believes Nordic's Maximus plant is running at only 10-percent capacity. I asked him why. “Because of management,” he said. “You need the right people ... Maximus is complicated to operate.” Urup said Maximus is Sashimi Royal's only source of smolt and that Maximus' production woes are limiting Sashimi's production to half its capacity.

“When you don't really feel you're in control, the typical reaction is ... 'we need to make protocols.' But the thing is if you put 20 tanks up and you did exactly the same trick, they will all behave differently, because of biological factors ...The day you turn into working on a routine, on a fixed protocol, you're lost ... As soon as you see something go wrong, it's too late — you can do nothing. You have to anticipate problems. It's about getting the right qualified people.”

Like a former Maximus worker I interviewed in Denmark Sept. 27, Urup said that Maximus has had problems with fish disease, something Nordic CEO Erik Heim denied to me in his Norway office Sept. 19, and which Nordic Director of Operations Marianne Naess denied in an Oct. 18 Republican Journal op-ed.

Naess's op-ed did not address allegations that a 14-year-old Maximus employee worked with Virkon S, a chemical children that young are not allowed to handle under Danish law. Those allegations appear consistent with Urup's concerns about Maximus management.

“The management (operation) of Maximus is very difficult,” Urup told me, “and if you don't do it right, you will have bacteria growing.” Urup said Maximus has in the past treated its fish disease problem with antibiotics.

But Nordic's problems in Belfast may go far beyond poor management and fish disease.

Bent Urup obtained a patent for his RAS 2020 system, and in 2015 he sold it to Veolia, a French company. But while Urup's RAS 2020 patent was still pending, Inter Aqua, a Danish company, built a fish farm in Australia that infringed on Urup's pending patent. Veolia sued Inter Aqua and won its suit in June 2018. The

The responding affidavit by a company vet is extremely weak, cites extremely high mortality rates of 80-90% post hatching, and does not mention anything about proper genetic virus testing, but instead only far more subjective physical symptoms. Physical symptoms are not always present in viruses and some fish can act as carriers. Moreover, virus shedding is almost always greatest before physical symptoms occur, so all testing done based on symptoms is ad hoc in nature. The speed of immunological response can also not be related to virulence, eg McBeath et al 2014. The litmus test for viruses is not the physical appearance of the fish but rather PCR genetic analysis with appropriate primers. Sadly, there are not even universally accepted primers for most viruses, so avoidance of a positive detection can be done. No explanation of the high mortality rates are given. Fungus are also not mentioned. https://www.cityofbelfast.org/DocumentCenter/View/2297/20181018-veterinarian-affidavit-re-maximus?bidId=

It is also not salmon or even a fish native to the region that is being reared. Instead it is a tropical king fish. This is the nearest comparison the company could make to a new 33,000mt facility the likes of

Veterinary evaluation of Maximus A/S, 7755, Bedsted Thy and Sashimi Royal A/S, Nordre Strandvej, 7730 Hanstholm, Denmark

The facility Maximus A/S produces fish for on-growing at Sashimi Royal, Hanstholm, Denmark.

The survival rates at Maximus A/S are in the same range as other marine hatcheries, and mortality of weak and damaged larvae is not unusual. Survival is usually 10-20% of hatched eggs.

Maximus A/S has been checked by us, macro- and microscopely by DTU-VET (Danish official Laboratory for fish disease, also EU-reference Lab), and no virus was found.

Fish and larvae have been checked by us, macro- and microscopely, monthly since 14. December 2015, and no signs of disease, neither bacterial or parasitic infections has ever been detected.

At Sashimi Royal A/S, the fish has been continuously chekcked for diseases and parasites since the start of June 2017. Similar to Maximus no signs of diseases have been found that are attributable to bacteria, viruses or parasites.

Dr.Med.Vet Thomas Clausen,
Veterinary specialist in aquaculture
Ø.Høgildvej 12
7400 Herning
Denmark

which it has never operated nor tested. This is telling.

Page 210 of the PDF document for the MEPDES permit shows:

Gross / Net Discharge Figures - Belfast, Maine Facility

The table below summarizes our gross discharge of nutrients (before waste water treatment) and net discharge (after treatment).

Discharge Budget: 33 000 MT production of Atlantic Salmon, Nordic Aquafarms, Maine

	TSS	BOD	Total N	Total P	NH3	Unit
Smolt						
before treatment	226,748	198,405	68,248	17,118	2	kg/year
after treatment	2,267	1,984	10,237	171	2	kg/year
Phase 1 PB						
before treatment	3,235,594	2,831,144	778,939	96,535	12	kg/year
after treatment	32,356	28,311	116,841	965	12	kg/year
Phase 2 PB						
before treatment	3,235,594	2,831,144	778,939	96,535	12	kg/year
after treatment	32,356	28,311	116,841	965	12	kg/year
Processing Facility						
before treatment	57,143	62,857	10,400	859	1	kg/year
after treatment	571	629	1,560	9	1	kg/year
Total						
before treatment	6,755,078	5,923,551	1,636,527	211,048	27	kg/year
after treatment	**67,551**	**59,236**	**245,479**	**2,110**	**27**	**kg/year**
	185	**162**	**673**	**5.8**	**0.07**	**kg/day**
Concentration	6.33	5.55	23.0	0.20	0.003	mg/L
WWTP degree of removal	99%	99%	99%	85%	0%	

a 185 kilos a day suspended solids will be created. That is a lot of material to hide some viruses in from UV light treatment. A virus weights circa 0.000000000000001 kilos or there abouts as dry weight.

No land based RAS system, to my knowledge, has actually been successful in rearing salmon using surface water without serious, crippling, and virtually bankrupting in most cases, pathogen introductions. There are reasons microbiological labs autoclave anything they want free of viruses, bacteria, etc and even after that use hepa filtered air in positive pressure air supplied rooms, masks, gloves, etc and yet still have to deal with contamination issues regularly. I manage a “clean room” similar to a surgical room that develops new cultures of microorganism under these types of conditions and can assure the reviewers that the system designed by Nordic Aquafarms will have serious issues with pathogens that are 1000s of times larger than any salmonid virus. This is why they have listed so many antiparasitics and antimicrobial drugs in their project description. They are expecting to have to deal with these microorganisms. Many fish viruses are in the order of 30-100nm. A nanometer is 10^{-7} of a cm (less than a billionth of a 1/2 inch). 100s would fit on the width of a human hair.

There simply is no system that humans have designed that can filter more than 750 gallon per minute of freshwater, nor nearly 4,000 gallons per minute of sea water to the nanometer level at 99.9% efficiency. Physically filtering out viruses requires membranes and pressure and is only available on the desktop scale.

Nor is there a series of systems that will eliminate viral contamination at this pace. The company may be loath to discuss this but is preparing for viral outbreaks in their mortality projections, I assure you. Most RAS systems growing salmon plan for a 22% loss between the egg and smoltification life stages. History shows that moralities from the smolt stage to the time the fish reaches the 4.5 kilos stage range from an absolute minimum of circa 10% to over 90% per cohort or stocking. An example would be the 33,000mt Grieg project being built in NL Canada. This project estimated pre smolt and extra large (1.5kgs) smolt losses at 22% despite using aquifer water and similar UV treatments of intake water that is only aquifer water. From their recently submitted EIS to the NL Canada Government:

Table 2.10. Egg importation schedule during ramp up (Years 2–5) and steady phase (Year 6 onward). Shipments in February will be used for seasonal productions.

Year	Order Month	Planned No. of Smolt to Sea	Extra to allow for mortality (%)	No. of Eggs Received
2	September	1,000,000	22	1,220,000
2	October	1,000,000	22	1,220,000
	Total	**2,000,000**		**2,440,000**
3	June	1,000,000	22	1,220,000
3	August	1,000,000	22	1,220,000
3	October	1,000,000	22	1,220,000
	Total	**3,000,000**		**3,660,000**
4	February	1,000,000	22	1,220,000
4	June	1,000,000	22	1,220,000
4	August	1,000,000	22	1,220,000
4	November	1,000,000	22	1,220,000
	Total	**4,000,000**		**4,880,000**
5	February	1,000,000	22	1,220,000
5	June	2,000,000	22	2,440,000
5	August	2,000,000	22	2,440,000
5	November	1,000,000	22	1,220,000
	Total	**6,000,000**		**7,320,000**
6	February	1,000,000	22	1,220,000
6	June	2,000,000	22	2,440,000
6	August	1,000,000	22	1,220,000
6	October	2,000,000	22	2,440,000
6	November	1,000,000	22	1,220,000
	Total	**7,000,000**		**8,540,000**

[2] One degree-day is the mean temperature, above 0°C, experienced for a period of 24 h. For example, a salmon egg incubated at an average daily temperature of 10°C for 62 days, from fertilization to hatching, is said to have hatched in 620 degree-days.

Physical drum filters combined with membrane filters that reach down into the 0.4 micron range with >99% efficiency will help remove particles, but viruses in these larger none filtered particles will be heavily shielded from the extremely short treatment time (read millisecond aka instantaneous) of a UV blast. UV does not penetrate solids well if at all, Similarly, ozonation has limited effects when viruses are shielded in 0.4 micron and larger particles and treated for a very short duration like that used in the contact tank of the proponents design.

When Dr Fred Kibenge wanted to kill salmonid viruses in his experiments, he increased both the UV and exposure time to 1000s of time above what an industry sponsored study (Vike et al 2014) suggested is effective. He has done this for obvious reasons. He is the author of the benchmark book, Aquaculture Virology, (2016), ran one of only two OIE approved ISAv testing labs in the world, teaches at one of the most prestigious finfish vet universities in the world, and is the Editor of the peer reviewed scientific journal "Aquaculture".

Given these facts, it is only a matter of time before every single virus that is in the ecosystem that the intake water is extracted from, enters the tanks. What happens when each of these viruses enters the bioreactor of a RAS system of this scale will be discussed below with some real world examples.

By far the best method of preventing viral contamination is to reduce to nearly zero the viable viruses in the intake water. Typically this is done by denaturing the virus structure with pressure and heat. This is not viable when millions of gallons a day are needed and so less effect methods are used like using virtually virus free aquifer water and extreme filtration and UVc. This is what virtually all RAS system are now doing globally. Virtually no hatcheries or major RAS project recently or being built are using surface water.

The list of bankruptcies or near bankruptcies is long and successes using surface water are zero. The famed Landsand Laks company in Denmark that is now behind the massive Atlantic Sapphire project in Miami (now projecting >200,000mt of production) used surface and seawater. The result was the near bankruptcy of the company, complete loss of several stocking cohorts, and nearly 18 months of shutdown to redesign the filtration system: https://www.hatcheryinternational.com/danish-salmon-ras-announces-temporary-shut-down-1599/ after 7 years of attempts, and embarrassing bacterial and virus nightmares while expanding into Miami, https://salmonbusiness.com/costly-moon-landing-for-land-based-salmon/ they are finally able to have a profit in 2019. Needless to say, after this experience, the new Miami project is not of a surface water extraction design.
"Johan Andreassen, the CEO of land-based salmon farmer Atlantic Sapphire, said the model in his US expansion would differ from the approach in Denmark, in order to protect the company from the risk of "unexpected mortalities"..." https://www.undercurrentnews.com/2017/07/07/land-based-salmon-farmer-hit-by-die-off-after-securing-funding-for-us-expansion/

Also of note, is that this is the industry leading company's track record. They are currently valued at nearly $1B USD and are yet to produce a single fish. https://www.intrafish.com/aquaculture/atlantic-sapphire-is-now-worth-800-million-really-/2-1-656420

Here is a partial list of major USA and global land based failures: https://www.intrafish.com/finance/analysis-heres-a-list-of-high-profile-land-based-aquaculture-failures/2-1-712748

All of this seems to be lost on Erik Heim who stated recently that he was not aware of many mass mortality events in RAS. Re: https://salmonbusiness.com/is-ras-tech-immature/

There are many reasons beyond excessive antibiotic use and fish mortality and health restricted growth rates and early smaller harvest sizes that NS Canada and many jurisdictions have banned the use of surface water in hatcheries. There are, according to various respected aquaculture project analysts like

Norwegian Development Bank, Rabobank, Parot, etc, more than 70 major land based aquaculture project that have been announced and are either in the planning or building stage. I can not think of one that uses surface water and has been approved and has started construction (Norway has two working on it though), but can name more than two dozen that are strictly using aquifer water and have started construction. Most RAS system that are now being planned or built today are designed around aquifer water for obvious reasons I will explore below.

Discrepancies Between Intake Water Treatment and RAS/Processing Plant Effluent :

1) drum filters are 10 micron on intake and 0.4 on effluent. If 0.4 is required to allow UVc penetration of the effluent it should also be required for the intake water.
2) Municipal water is simply carbon filtered without any micron filtration or UVc treatment, this assumes that town water treatment systems are design to remove and are monitored for fish pathogens. This is a serious design error.
3) 10 micron drum backwash water is dumped in the sewer from the concentrated pathogen laden sludge generated by the intake water (illegal by Maine law). This is collected and disposed of in the effluent treatment.

Brood Stock and Egg Import Issues :

In between intake water sources and effluent issues is another, very troubling source of repeated issues in the salmon aquaculture industry – disease importation and development in the brood stocks. This will be discussed more in depth below.

Every major brook stock supplier globally has had virus issues, including the proponent's supplier - Stofnfisker in Iceland. Chile banned this company in 2015 for producing VHSv infected fish. This virus crippled the entire Norwegian salmon industry for 2 years while shutting borders to their fish. Recently in 2019, they were caught shipping PRv infected fish to Washington for Cooke Aquaculture and 800,000 smolt had to be destroyed when government was alerted by eNGOs. In a recent interview with a leading trade magazine responding to the Washington bungle, the company spokesperson suggested that they sell both PRv infected fish and non PRv infected fish at a higher price. This does not bode well for their reputation in sustainability and transparency.

The proponent does not mention what strain of salmon will be used, but given that Stofnfisker sells Norwegian strain salmon, it is safe to assume the proponent wants, like virtually every salmon farmer in North America, to use this non-native strain. This will almost certainly introduce known non-native viruses to Maine, just as it did mere months ago in Washington. Unknown viruses, yet to be discovered like the many potential candidates that Dr Kristi Miller-Saunders is working on (per comm 2017), will of course also be transferred. There are very good reasons that this industry has been denied access to these fish and the Williamsburg Treaty exists that restricts companies to using local salmon as broodstock.

Certainly the proponent is in such a terrible rush while proceeding without any pilot testing of its design in the given location, thus risking the entire project, it will not take the time to develop St. John River strain broodstock as required by the Williamsburg Treaty, and used by all aquaculture facilities in

Maine currently ge Cooke Aquaculture. This is a Treaty that at all ICES members signed, including the USA, that states that local genetics will be used in all aquaculture developments for salmon. I suspect that EU smolt will be attempted to be brought in. This has never been done in North America despite industry trying for nearly 20 years. Every time this industry moved salmonids from the EU to North or South America they brought a host of viruses with them that to this day are causing serious harm to native fish stocks. Examples will be discussed below.

This serious risk (or imminent occurrence) of virus mutation in the bioreactor of a RAS system or introduction of non-native pathogens such as viruses via the use of non-native St. John River, or even more severe, the use of Norwegian strain salmon would be in contravention to the Maine State Environmental Protection Regulations which state:

Chapter 586: RULES PERTAINING TO DISCHARGES TO CLASS A WATERS

SUMMARY: This rule establishes criteria to define what constitutes effluent quality necessary to ensure the standards for class A waters are met.

1. Scope. Under 38 MRSA section 464 discharges to class A waters must be equal to or better than the receiving water in order to ensure that habitat, aquatic life, and bacteria are as naturally occurs. The following sections define effluent criteria necessary to ensure these requirements are met.

It could be argued that if granted a permit for this design, and importation of salmon, that government is setting the company up to break Maine's laws.

Effluent Treatment and Diversion or Shutdown Issues :

This next response to a public engagement question is also telling.

"*We are going to require you to have, in place, a plan to halt all circulation into the bay should a virus or disease outbreak in your tanks. Please explain in detail the steps that you would take.*

Pathogenic material will be unable to enter or leave our facility. We have extensive standard operating procedures (SOPs) for contingency situations at our European facilities. These SOPs, best practices, and biosecurity measures will be adapted and further expanded for our Belfast facility.

Our modules and tanks are separate entities and do not share water or materials from one module to the next. Materials and water from one module cannot and will not move from one module to another. This separation of modules provides an additional layer of biosecurity for the facility."

I would suggest, based on the design, that no ability to shut off the effluent for any extended period of time is available. Culling 10s of 1000s of fish from one or more tanks is a time consuming venture even if the equipment required is available immediately. Culling millions would be very difficult to get the proponent to do under any circumstances. They may pump air into the tanks but this is a guess as no intelligent response was given. There is no viable plan "b" as to where to put the effluent and I will suggest that effluent will continue to stream from the tank despite a diagnosed viral or other infection that bring pathogen titres to "biblical levels". Hence the list of antimicrobials and antiparasitics in the list of chemicals that may/will be used if the pathogen is not viral. A viral issue could results in a mass die off and serious disposal and contagion issues. I have witnessed 3 industry wide meltdowns in NL since 2012 and can assure you that 7+ million dead rotting salmon of up to 10 pounds each is a serious logistical and environmental nightmare that requires mega infrastructure and planning. To date 17 million plus have died in NL since 2012.

The problem of fish effluent treatment, from processing or RAS plants, is an old one. After nearly 11 years of debate and research a team of EU vets finally produced a document that reviewed all the known available options. The result was that the only known financially viable and tested method for virus reduction to titres (aka dilutions) that were acceptable in terms of risks to wild fish would have to include: extreme filtration and burning of the solids, bleaching and de-bleaching of the effluent liquid (or evaporation and treatment of the solids – often deemed as too expensive), and then geo-filtration in a suitable clay based matrix. Needless to say, this did not go over well for processing plants dumping untreated effluent or hatcheries (Skall and Olesen 2014).

Unknown Viruses and or Hosts :

As suggested in world leading finfish virologist, Dr Fred Kibenge's benchmark 2016 book “Aquaculture Virology”, we are only beginning to scratch the surface of finfish virology. This is evidenced by the large number of new viruses and new hosts for known viruses being found in aquaculture.

Perhaps an excerpt from the ICES Working Group on Pathology and Diseases of Marine Organisms published in 2018 may highlight just how primitive our current knowledge is by listing a number of serious disease issues and trends discovered that year:

“The group produced a report on new disease trends in the ICES area based on national reports from fifteen member countries. **Notable reports for wild fish included observations of salmonid alphavirus SAV6 and Photobacterium damsellae in ballan wrasse, underscoring the need for disease surveillance in wrasse used as cleaner fish in salmonid aquaculture; the first observations of parasites Ichthyobodo salmonis and Desmozoon lepeophtherii in Pacific salmon from western Canada**; high prevalences of Loma branchialis and increasing prevalences of Contracaecum osculatum in Baltic cod from the eastern Baltic Sea; **and increasing prevalence of M74/thiamine deficiency in salmon yolk sac fry in Sweden. The considerable number of new and emerging disease trends in wild fish, all relevant to important fisheries, highlight the urgent need to continue disease monitoring of wild fish populations in the ICES region.**
Reports for farmed fish included the first cases of heart and skeletal muscle inflammation (HSMI) caused by piscine orthoreovirus (PRV) in Atlantic salmon in western Canada; the first report of infectious haematopoietic necrosis virus (IHNV) in Finland, in rainbow trout; the first report of I. salmonis in Atlantic salmon in Canada, in aquaculture in British Columbia; widening geographic distribution and increased effects on younger salmon of cardiomyopathy syndrome (CMS) caused by piscine myocarditis virus (PMCV) in Scotland and Ireland; and increasing cases of complex gill disease (CGD) in Atlantic salmon in Scotland. Complex gill disease is an increasing concern among ICES member coun-

tries, and better understanding and developing strategies to mitigate CGD will be a new focus of WGPDMO effort.“

It goes on to suggest that a pathogen screening list is still in development:
“ Work on additional documents included...a synthesis on amoebic gill disease in salmon, **and a compilation of pathogen screening in wild salmonids.**“

https://www.researchgate.net/publication/326467969_Report_of_the_Working_Group_on_Pathology_and_Diseases_of_Marine_Organisms_WGPDMO_13-17_February_2018_Riga_Latvia

Novel, but very serious disease are still unexplained and new viruses are being discovered at an alarming rate. For many known serious viruses we have no method to culture the virus to amplify it for testing; and for others, testing protocols are of unknown efficacy. Please review the presentation by Dr Kristi Miller-Saunders, she is the lead researcher of the world's largest salmonid virus hunting program, a >$10M CAD venture, based in Nainimo BC Canada at the Federal Department of Fisheries and Ocean lab and has been cited by more than 4,500 peer reviewed papers:
https://youtu.be/qfIGzDrTtJA?t=3011

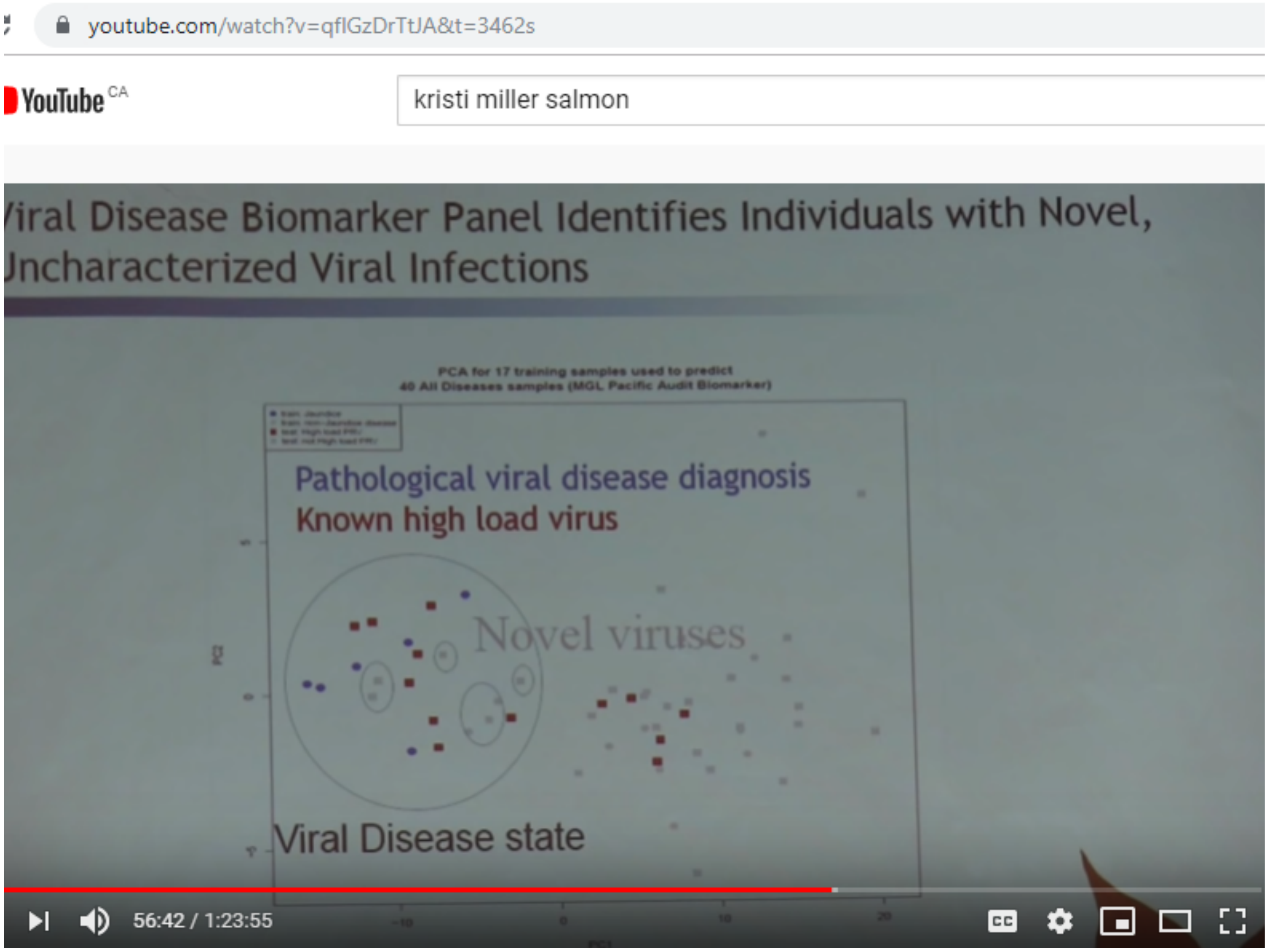
Of critical importance, when describing fish she had sampled recently, is the statement that the fish were in a diseased state (and shedding viruses) without showing any physical symptoms histologically. Often, the peak in virus shedding occurs prior to any physical symptoms.

This statement and situation is important as it suggests that any and all testing that any land based facility is doing, will not likely see or detect a pathogen until long after the disease is being amplified, possibly mutated, and expelled via the effluent. In some cases, depending on the virulence of the virus, this may be days, weeks, months, or even years. A “slightly sick” fish in a protected tank is not a big issue for the proponent, nor the government overseers, as 99% of fish diseases they are not transmissible to humans and thus able to be ignored without endangering public safety, or in many cases, the production of the fish in a tank. The same cannot be said for any wild fish that may become exposed to such effluent. This regulatory dichotomy between what is “good enough” for tanked fish grown for human consumption vs what is “good enough” for wild fish exposed to tank amplified and mutated contagions, will be discussed below.

Dr Kristi Miller-Saunder's presented some of her research in a 2017 presentation in BC. A graph from this presentation is seen showing new to science viruses.

The grey data points on the left of the graph showing fish in a diseased state (ie immunological responses) are all unknown viruses to science. This shows that a good percentage of all individuals in the samples in the graph are sick with unknown to science viruses.

What is also featured throughout her talk, is her use of “high put-through” genetic testing to examine the genes being expressed by the fish to show it is in an immunologically distraught state, ie sick with a triggered immune system. No aquaculture company, nor any USA regulatory agency is using this



cutting edge "high put through" qPCR gene screening for monitoring the health of RAS salmon. Nor do they screen fish or eggs using the methods used in Dr Millers lab. *Moreover, if indeed these methods were used, I think one would quickly see that, virtually no tank of Atlantic salmon held in captivity is comprised of even 50% "healthy" fish, after several months of being in that environment. The objective of a RAS system is not to mimic nature and produce fish fit to survive in nature and breed, but simply to get them to market. It has long been known that hatchery reared fish do not survive well in nature compared to naturally produced fish. Some of the reason this occurs is likely due to viruses in the broodstock intrinsic to the way the fish live and are artificially bred.*

Another telling statement of her talk is the fact that many viruses we know exists, due to genetic testing, science can not culture. This makes development of effective screening methods difficult or impossible as well as learning about vectoring between species, mode of pathology, etymology, (Kibenge 2016, Miller 2017 personal communication – see video).

A single virus in a single egg or broodstock fish is likely to be quiet prevalent in the population after some months in a tank environment. Predators, struggles in environmental challenges, struggles in migrating fast flowing rivers with rapids, waterfalls, etc will ensure that only the fit survive. This is the complete opposite of a stable tank environment where viruses of low and medium pathology can and do flourish. **A mortality rate of 22% is common in RAS hatcheries before the fish reach the smolting stage (circa 2-3oz and 6 to 8 inches)** *but very often only a tiny percent, if any at all, of these* *mortalities can be definitively diagnosed to a single or multiple known pathogens. We simply do not know what we are doing regarding fish culturing.*

Moreover, studies show that for many viruses, the peak in viral particle shedding occurs before the fish become physically sick, exhibits changes in behaviour, or physical histological symptoms. By the time any of these visually detectable conditions are manifested the fish's immune system has started to reduce the virus particle production and shedding. Ie It is too late in terms of prevention of viral management of mutation of the virus, or escape via the effluent. This is the “perfect storm” that Dr Fred Kibenge discusses in the preface of his benchmark book, Aquaculture Virology. Dr Kibenge is a professor in one of only two Universities in Canada that all our aquaculture fish vets are trained in. He is also the editor of the peer reviewed prestigious journal “Aquaculture”.

Regarding the 7 grey data points on the left of Dr Miller-Saunders graph at time 56-57 minutes, she and her colleagues recently published Mordecai et al 2019 which is turning the salmon farming industry on it's head: https://elifesciences.org/articles/47615

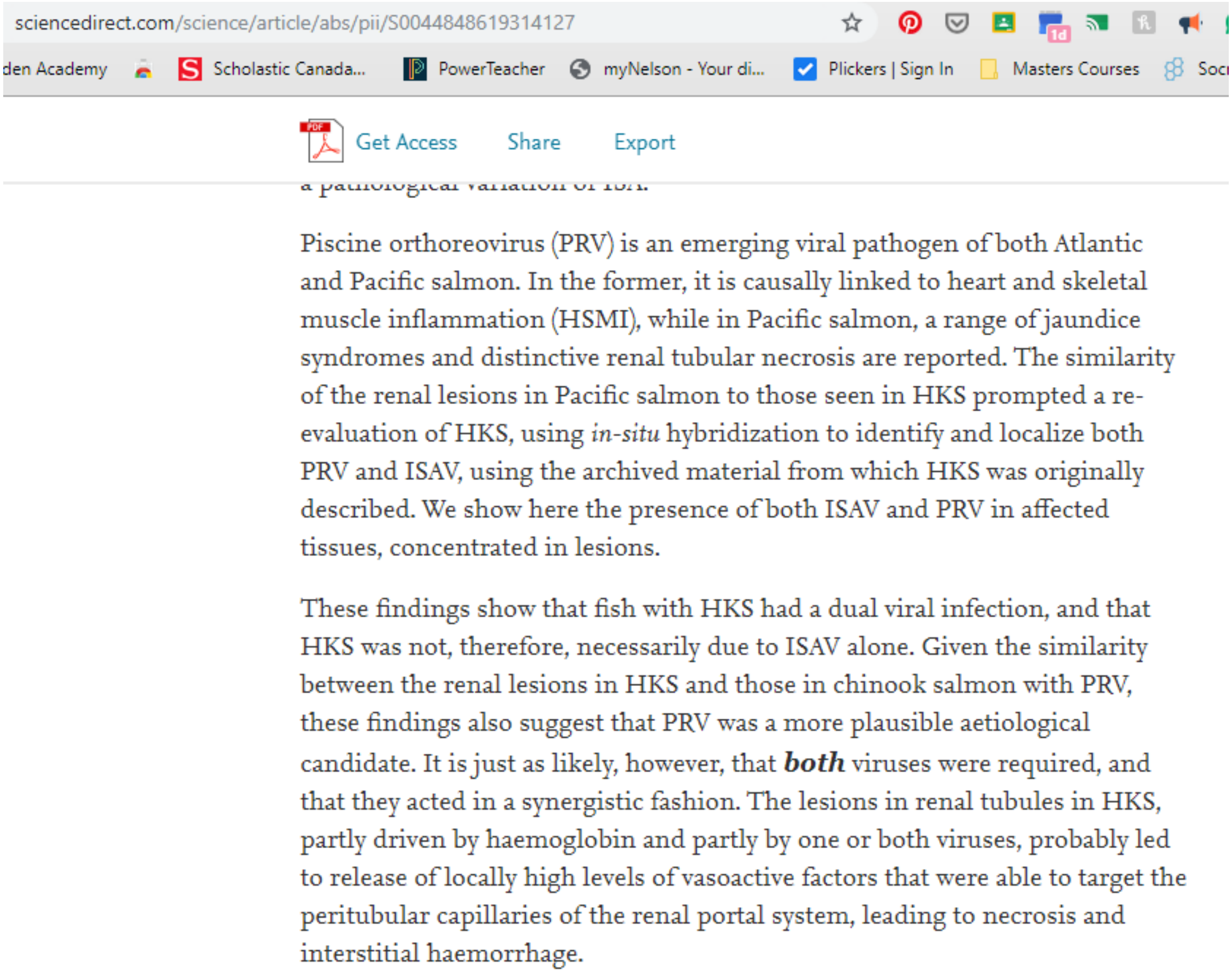
Her team has discovered three new viruses among now decimated and endangered Chinook and sockeye salmon populations. One of the viruses belongs to a group not known to infect fish and thought to have a completely different infection strategy, more similar to its closely related viruses that infect mammals.
In total, scientists sampled DNA from 6,000 salmon. The new viruses were found in hundreds of dead and dying farmed salmon, as well as in wild specimens from stocks that have inexplicably collapsed recently.
"It emphasizes the potential role that viral disease may play in the population dynamics of wild fish stocks, and the threat that these viruses may pose to aquaculture," said UBC virologist Curtis Suttle in an interview by his University.

One of the three new viruses was identified in more than 15 percent of all the tested hatchery Chinook salmon. Another was found present in 20 percent of farmed Chinook.

While such a discovery may seem alarming, and scientists are pointing to this as an example of likely causes to the decline of dozens of stocks of pacific salmon, Atlantic salmon, and trout stocks, it is not unusual or even irregular.

New to science highly pathogenic viruses are being discovered annually. Many of the world's top finfish virologist's think that aquaculture may be a primary incubation point for virus mutation.
Recent examples abound but would include:
PMCv
SAv6
HKS caused by previously thought benign PRv and ISAv together
etc eg

See Ferguson et al 2019 (screenshot above) for an example of brand new to science viral interactions that have been ignored by industry for decades yet are now known to cause severe issues in wild fish. PRv is ignored in Maine. Most hatchery/aquaculture salmon test positive (Morton Unpublished data, personal communication)



a pathological variation of ISA.

Piscine orthoreovirus (PRV) is an emerging viral pathogen of both Atlantic and Pacific salmon. In the former, it is causally linked to heart and skeletal muscle inflammation (HSMI), while in Pacific salmon, a range of jaundice syndromes and distinctive renal tubular necrosis are reported. The similarity of the renal lesions in Pacific salmon to those seen in HKS prompted a re-evaluation of HKS, using *in-situ* hybridization to identify and localize both PRV and ISAV, using the archived material from which HKS was originally described. We show here the presence of both ISAV and PRV in affected tissues, concentrated in lesions.

These findings show that fish with HKS had a dual viral infection, and that HKS was not, therefore, necessarily due to ISAV alone. Given the similarity between the renal lesions in HKS and those in chinook salmon with PRV, these findings also suggest that PRV was a more plausible aetiological candidate. It is just as likely, however, that ***both*** viruses were required, and that they acted in a synergistic fashion. The lesions in renal tubules in HKS, partly driven by haemoglobin and partly by one or both viruses, probably led to release of locally high levels of vasoactive factors that were able to target the peritubular capillaries of the renal portal system, leading to necrosis and interstitial haemorrhage.

Moreover, via the protective "bioreactor" aquaculture provides, new strains are discovered monthly and even weekly. Again, many of the world's top finfish virologists think that aquaculture may be a primary incubation point for virus mutation. Examples would include the
106 new to science strains of ISAv found in salmon open net pens in the NW Atlantic since 2012 as seen here: https://www.inspection.gc.ca/animals/aquatic-animals/diseases/reportable-diseases/isa/locations-infected/eng/1549521878704/1549521878969

For decades industry vets proclaimed that viruses like ISAv could not be transmitted from broodstock to eggs. Once this is proven, it should mean eradication of extremely valuable (100s of millions of USD) broodstock that took decades to develop. Thus industry was determined to make sure that didn't happen. A fight among scientists and vets ensued in peer reviewed journals with industry funding PhDs and Universities and NGOs funding PhDs. Now, today, beyond any question some of the viruses, like ISAv and others, are known to be transmissible to offspring by the parents.

One would think that the industry would then be required to cull the brood stock of these viruses. Instead, nothing has been done. The issue is how healthy must a fish be, if the goal is to get it to market regardless if it carries fish pathogens that are not harmful to humans and not regulated.

Many papers have been published (eg Nylund et al 2007) for more than a decade suggesting that ISAv mutation from a none mortality inducing strain/type called HPR0 in an aquaculture setting ie “fish flu” to a virulent mortality causing strain called HPR-deletion (types 1-6) is occurring in the “bioreactors” used by salmon aquaculture. Proving this and catching the virus “in the act” so to speak is almost impossible. In fact, only recently were scientists able to prove such an event in a net pen whereby a non pathogenic strain of ISA called ISA HPR0 mutated to a more pathogenic form.

Issues with Vectors/Hosts, Transmission, Monitoring, Motivation, and Science :

No complete list of all known viruses have been tested for in the fish present in the intake water supply. Thus, government, nor the proponent has any baseline as to what is present before the project starts.

It also leaves everyone guessing where to focus limited monitoring and testing efforts.

A common criticism of regions with intensive aquaculture is that **not enough money is charge for fees to allow sufficient monitoring for effects.** Norway has tabled a tax that amounts to 62% that is expected to pass. This is a 40% increase. Moreover, compared to Maine, Norway charges 17,000 to 36,000 CAD per mt of fish produced via a licence, Maine charges less than $1 CAD/mt in fees and licenses.

Similarly, science is still piecing together thee most basic understanding of transmission vectors for ANY of the known salmonid and finfish viruses in general, Kibenge 2016. Even some of thee most screened for viruses like ISAv are transmitted from one fish to another or one species to another by unknown means and vectors, McBeath et al 2014. Kibenge et al 2016 found a strain of ISAv in BC that had a mutation in the screening primer section of the virus that made detection using standard techniques impossible.
Industry has limited time and money to focus on virus detection. As such viruses known to cause mass mortality are the only focus of genetic testing. For example, in Canada, the Authority Responsible, the Canadian Food Inspection Agency, not only has no mandate to protect wild fish, it only lists 5 viruses that must be reported if found. These are the 5 listed by the OIE (the United Nations Vet Board responsible for limiting disease spread that may seriously threaten our traded food supply). Ie CFIA lists the bare minimum of protection and then only for our financially significant food supply. Maine does the same.

Even screening of such OIE listed viruses is limited. It is not an issue until it is a serious issue in the tanks. For example. 5 fish every 30-45 days from a tank holding 50,000 fish is a typical genetic screening protocol for even the most deadly of the 5 OIE reportable viruses like ISAv, VHSv, SAv, IPNv, etc. Others like PMCv, PRv ENv, etc are ignored.

Viruses that can be carried by salmon in a RAS system yet do not cause serious financial losses are ignored, especially if the primary host is a different fish species. So while a striped bass virus, for example, might be carried by the salmon without pathological symptoms in the salmon, it would be ignored by monitoring and thus the facility would act as an unnatural year around reservoir that kills striped bass. The vets would simply shrug and suggest, we don't know what is causing it and “we have no evidence” to suggest that aquaculture is to blame. Finfish vets are only employed by two groups:

industry and government departments that rely on industry to do well. Neither have a financial benefit from protecting wild fish.

The principle and secondary reservoir hosts are also not known with new ones constantly being discovered for ALL of the known viruses at an alarming rate eg Di Cicco et al 2018. Virtually every study done results in a lengthening of the list of finfish that can carry and transmit the virus. The same is true for fungal, bacterial and parasite carriers of finfish viruses. Once an amplified contagion leaves the RAS facility – whether it affected the health of the salmon or not, we have no idea what will happen beyond the end of the pipe.

Unintentional Dramatic Virus and Parasite Introductions :

What might be even more alarming is how often and how deadly the aquaculture industry is at transferring pathogens from one biologically isolated region to another via eggs and fish shipments. Examples might include the destruction of 41 salmon rivers in Norway by a skin parasite transferred from a hatchery in Sweden. The river have never recovered even today, nearly 40 years later. A more recent example is the very likely transfer via rainbow trout of VHSv 4a from the Pacific to the NW Atlantic before April 2016 in NL. This never before seen Pacific virus then ravaged through the herring stocks from April 2016 through 2017 through 2017 all along the NW Atlantic ocean. Immediately after, and for the first time in NL history, the entire spring purse seine herring fishery was shut down completely. Occurrences like this, while almost impossible to prove, abound. Another recent 2017/18 example was the amplification, mutation and escape of VHSv in salmonid hatcheries and aquaculture facilities in Alberta. This spread into and throughout local rivers decimating fish stocks and causing unknown ecological cascade effects. In spring 2016 VHSv 4a strain (pacific only virus) was found in herring near NL salmonid net pens. This primarily rainbow trout disease has following aquaculture around globally and is now lose in the Atlantic Ocean. It spread through herring stocks throughout the NW Atlantic during a winter of mass die offs - 2016/17. That spring the NL south coast purse seine herring fishery was shut down for the first time in NL history. It was all over the media. The aquaculture industry claims it was not them. I will not belabour the point but will list a few more recent examples below with concrete evidence.

Viruses in Broodstock and Hatcheries in NE North America and Beyond :

Many known and likely unknown viruses are found in the broodstock of virtually every company. Every year many hatcheries get caught selling virus infected eggs, fry, or smolt. This often includes the proponent's chosen hatchery.

Dartek Nova Scotia. 2017. This hatchery was selling ISAv infected fish and got caught.

Despite this, the salmon sold by this company were stocked in NL - later several massive ISAv outbreaks were detected and the fish were gradually culled or died. The sites held roughly 850,000

Infectious Salmon Anemia reported in land-based aquaculture facilities

Fisheries and Aquaculture
March 2, 2018 9:30 AM

The presence of Infectious Salmon Anemia (ISA) at two land-based aquaculture facilities in Nova Scotia was confirmed in February.

The virus must be reported under federal regulations and the province notified the Canadian Food Inspection Agency (CFIA).

The sites were quarantined in early February once initial tests indicated the suspected cause of infection was the virus. The affected fish have been removed and disposed of in a safe and secure manner.

The virus poses no risk to humans. In these two land-based cases, the risk of the disease spreading to the wild population is considered to be very low to none at all.

Infectious Salmon Anemia has been present in Atlantic Canada since 1996. The disease-causing version of the virus has not been detected in Nova Scotia since 2012.

salmon each when initially stocked. Millions of fish died or were culled. https://www.mae.gov.nl.ca/env_assessment/projects/Y2018/1975/1975%20Appeal%20document%202018%2011%2005.pdf

VHSv Iceland 2015

Caught harbouring and amplifying VHSv infected fish in a supposed biosecure egg production facility used by clients globally. This is the same company that the proponent wants to use to import non-native salmon carrying heaven knows what.

World News

Search by date - Go Search by country All

Salmon eggs. (Photo: Stock File)

Salmon egg import from Iceland suspended

CHILE
Tuesday, October 27, 2015, 22:00 (GMT + 9)

The National Fisheries and Aquaculture Service (SERNAPESCA) decided to suspend Atlantic salmon eggs imported from Iceland, given the health alert issued by the World Organisation for Animal Health (OIE) generated by the notification of the occurrence of viral hemorrhagic septicemia (VHS) virus in that country.

The measure to suspend imports was provided in Resolution 9844 of the agency, under the Supreme Decree 72. This regulation, which establishes the health requirements for import, in its Article 10 the suspension to carry out a new health assessment is considered, given the significant changes in the epidemiological situation of the country of origin.

SERNAPESCA emphasizes that the first detection of this disease is confirmed in Iceland, wild fish used as fish cleaners, and the case is still under investigation.

editorial@fis.com
www.fis.com

PRv from the same hatchery in Iceland caught by Washington in 2018. https://wdfw.wa.gov/news/wdfw-denies-permit-company-place-800000-atlantic-salmon-puget-sound-net-pens

The Washington import of PRv was from the same Icelandic company StofnFiskur (same as the VHSv issue in Chile cited above) that the proponent stated would be used. The company admitted to harbouring broodstock infected with PRv and charging more for eggs that were free of PRv. None of the regulatory agencies caught this ongoing multi-year issue until an NGO forced the issues in Washington.
https://salmonbusiness.com/egg-supplier-responds-to-washington-prv-salmon-cull/

wdfw.wa.gov/news/wdfw-denies-permit-company-place-800000-atlantic-salm...

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Date
May 17, 2018

Contact
Ken Warheit, 360-902-2595

OLYMPIA - Citing the risk of fish disease transmission, the Washington Department of Fish and Wildlife has denied permission for Cooke Aquaculture to transport 800,000 juvenile Atlantic salmon from its hatchery near Rochester to net pens at Rich Passage in Kitsap County.

In late April, Cooke applied for permission to move juvenile non-native salmon from its hatchery into pens in Kitsap County to replace adult fish that were recentl harvested. Washington lawmakers enacted a bill earlier this year that will phase out Atlantic salmon aquaculture by 2022, but Cooke plans to continue to operate until then.

WDFW officials cited two factors in denying the permit that they said would increase the risk of disease transmission within the net pens and possibly to wild an hatchery-raised Pacific salmon outside the pens:

- The population of Atlantic salmon that would have been transported from Cooke's hatchery near Rochester tested positive for a form of the fish virus PRV (piscine orthoreovirus) that is essentially the same as the PRV that occurs at the Iceland hatchery from which Cooke receives Atlantic salmon eggs. The Icelandic form of PRV is not known to occur in the eastern Pacific Ocean or Puget Sound, so WDFW classifies it as "exotic" in Washington.
- Cooke proposed to place fish into pens that have not been empty (or "fallow") for at least 30 days after the most recent harvest of adult fish, and within a farm that still contains adult Atlantic salmon. These actions would contradict the company's own management plan.

"Each of these factors raised an unacceptable risk of introducing an exotic strain of PRV into Washington marine waters," said WDFW fish health manager Ken Warheit. "This would represent an unknown and therefore unacceptable risk of disease transmission."

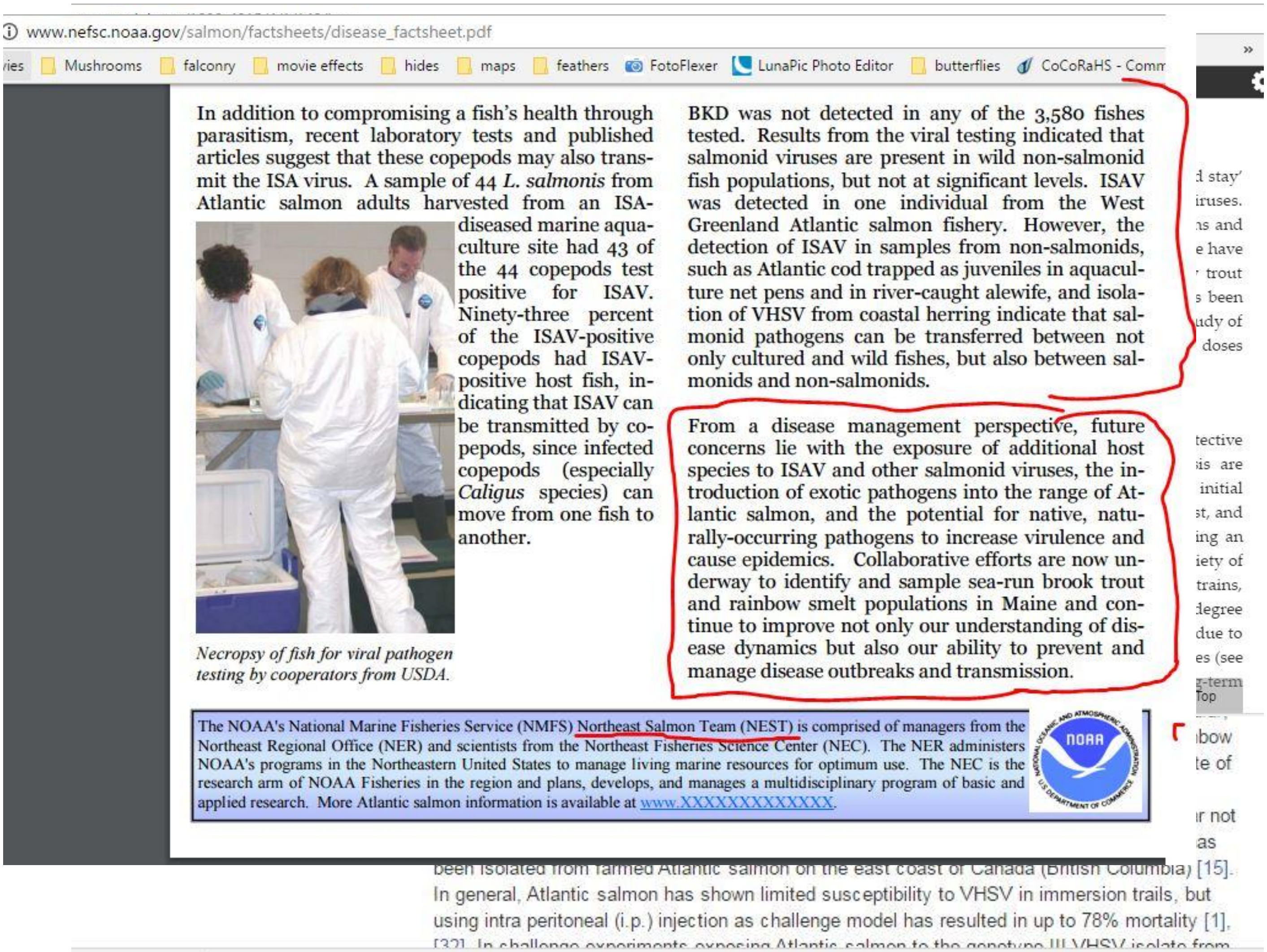
Warheit said samples of the juvenile fish that would have been transported were collected by an independent licensed veterinarian under contract with Cooke. The samples were tested for PRV at the Washington Animal Disease Diagnostic Laboratory at Washington State University. Test results were confirmed at the

New strains, “species”, and pathologies are constantly being found. Hugely important and basic questions about most finfish viruses remain today for our most studied viruses. Two examples are below.

Above from Purcell et al 2012

NOAA admits there are serious and basic information gaps.

ISAv HPR0 Marine Harvest was caught breeding eggs, fry and smolt with ISAv HPR0 in its Stephenville NL Canada close containment strictly aquifer supplied biosecure RAS facility in 2018. Later, marine sites stocked with these fish experienced mass mortality when the ocean warmed to typical peak summer temperatures. More than 3 million net pen fish died. Months later, when pushed



www.nefsc.noaa.gov/salmon/factsheets/disease_factsheet.pdf

In addition to compromising a fish's health through parasitism, recent laboratory tests and published articles suggest that these copepods may also transmit the ISA virus. A sample of 44 *L. salmonis* from Atlantic salmon adults harvested from an ISA-diseased marine aquaculture site had 43 of the 44 copepods test positive for ISAV. Ninety-three percent of the ISAV-positive copepods had ISAV-positive host fish, indicating that ISAV can be transmitted by copepods, since infected copepods (especially *Caligus* species) can move from one fish to another.

Necropsy of fish for viral pathogen testing by cooperators from USDA.

BKD was not detected in any of the 3,580 fishes tested. Results from the viral testing indicated that salmonid viruses are present in wild non-salmonid fish populations, but not at significant levels. ISAV was detected in one individual from the West Greenland Atlantic salmon fishery. However, the detection of ISAV in samples from non-salmonids, such as Atlantic cod trapped as juveniles in aquaculture net pens and in river-caught alewife, and isolation of VHSV from coastal herring indicate that salmonid pathogens can be transferred between not only cultured and wild fishes, but also between salmonids and non-salmonids.

From a disease management perspective, future concerns lie with the exposure of additional host species to ISAV and other salmonid viruses, the introduction of exotic pathogens into the range of Atlantic salmon, and the potential for native, naturally-occurring pathogens to increase virulence and cause epidemics. Collaborative efforts are now underway to identify and sample sea-run brook trout and rainbow smelt populations in Maine and continue to improve not only our understanding of disease dynamics but also our ability to prevent and manage disease outbreaks and transmission.

The NOAA's National Marine Fisheries Service (NMFS) Northeast Salmon Team (NEST) is comprised of managers from the Northeast Regional Office (NER) and scientists from the Northeast Fisheries Science Center (NEC). The NER administers NOAA's programs in the Northeastern United States to manage living marine resources for optimum use. The NEC is the research arm of NOAA Fisheries in the region and plans, develops, and manages a multidisciplinary program of basic and applied research. More Atlantic salmon information is available at www.XXXXXXXXXXXXX.

been isolated from farmed Atlantic salmon on the east coast of Canada (British Columbia) [15]. In general, Atlantic salmon has shown limited susceptibility to VHSV in immersion trails, but using intra peritoneal (i.p.) injection as challenge model has resulted in up to 78% mortality [1],

by the media thanks to whistleblowers, the company was forced by the government to admit ISAv HPR deletion (a mutated deadly strain) was detected at three of the sites after never mentioning it during the die off despite knowing about it for 3 months prior.

In fact, many ?most? of thee top salmonid virologists in the world like Dr Are Nylund, Dr Kristi Miller-Saunders, and thee top government vets in Norway have all been warning the industry that they simply must take the financial hit and clean up their brood stock as it pertains to known harmful viruses and viruses thought or proven to mutate into virulent form in a tank or net pen:

Despite this, virtually no studies exist examining the differences between local wild salmonid and hatchery reared salmonids. The one study that does exist shows massive infection rates in all 13 of the critical government hatcheries in BC Canada as well as seasonal fluctuations and between site differences (Nekouei et al 2019). This is despite a variety of surface and subsurface water usage and state of the art treatment in many cases.

salmonbusiness.com/researcher-warns-of-isa-impact-on-trade/

Tissue samples showed the virus was identical with those in Norwegian aquaculture. Nylund concluded that a Norwegian brood-stock firm had send infected eggs to Chile.

"The virus had moved from Norway to Chile. You might want to believe that God put two identical viruses in two places, but research doesn't operate with God," Nylund asserted.

The price to pay

Nylund said he's documented that the virus spreads down through generations, as opposed to the popular belief that the virus is transferred "sideways". The discovery could lead to a solution, Nylund said, adding that the industry itself needs to seize the opportunity.

"This is an opportunity to do something about it, by going in and screening for the virus in the brood fish. The potential for infection from Norwegian fish should be minute," Nylund said.

"The industry has the opportunity, here, to go in and work with brood fish. We need to ensure the brood is free of infection. It's cost the industry must incur."

and become the ISA virus. HPR0 is found in most hatcheries," he noted.

"We also know that different environmental conditions can cause the virus to mutate."

In addition, if several of the RAS facilities are not shut off, fallowed and disinfected, the virus can build up.

"Land-based facilities can be a part of the future -- they have some advantages, but the technological solutions must not override important infection-hygienic principles," Rønningen said.

Perhaps this lack of monitoring is not surprising, given that the same vets and government departments that run these stocking hatcheries would be culpable for any impacts they caused on wild stocks. What is known, is that hatchery or RAS produced fish generally do not survive well in the wild. The single study done to date examined Pacific salmon and focused on diversity and viral load rather than potential effects from individual viruses, ignored surface water effects on the pathogens in a hatchery, ignored differences in individual pathogens, and seems designed to support the continuation of hatchery based multimillion dollar wild fisheries such as those in BC and Alaska where river stocking is big business (Nekouei 2019). It was also funded and designed by these same agencies, and in many cases individuals, that would be held responsible for the demise of the wild stocks had a link between the hatcheries and the demise of sympatric wild stock been found.

Ironically, despite a conclusion of - its not our fault-, the authors did suggest that: " There is a clear knowledge gap regarding pathogens that can adversely affect the performance and survival of Coho salmon. " The same is true for Atlantic Salmon.

Similar behaviour can be seen by culpable regulatory agencies like Canada's DFO when publishing peer reviewed papers that require full disclosure of funding by a potentially biasing source - yet simply not reporting it: eg https://watershed-watch.org/Scientific_Reports_Polinski_et_al_2019.pdf

In fact, the Cohen Commission uncovered a hornets nest of cover-up, not supplying required papers, emails, and data, that resulted in the lead Government Vet, one Dr Marty, facing a Federal Supreme Court challenge to his practices which was later withdrawn after the Vet Board (whom he helped lead) agreed to investigate his practices.

These are must watch if you think this industry and those managing it are trustworthy beyond being profiteers and industry shills in many cases:

Canada's Commission for Environment and Sustainability audited this industry and suggested it was the most disturbing audit she had ever conducted: https://www.youtube.com/watch?v=f2JZev5oYZ4

The Canadian DFO's own lead salmon virus hunter Dr Kristi Miller Saunders went public about cover-ups within government and regulatory capture: https://www.youtube.com/watch?v=VSIZgWdW0T8

This shocking documentary was a result of the Cohen Commission inquiry into the collapse of BC wild salmon:
https://www.youtube.com/watch?v=fTCQ2IA_Zss

A national TV channel in France produced a documentary which is revealing in several regards and should be viewed:
https://www.youtube.com/watch?v=MgrFXN4d1Jc

https://thetyee.ca/News/2018/01/10/DFO-Deadly-Farmed-Salmon-Disease-Downplay/

Despite strong evidence of similar practices in Atlantic Canada concerning at least two ISAv outbreaks and a VHSv outbreak, the public has been denied access to samples and reports that would incriminate the vets involved. They simply refused to supply the information and samples. Often this is done under the guise of “Third Party Harm” redaction and refusals.

So, even if the public in Maine catch the company, company vets, government vets, etc that are culpable will be in charge of the evidence. Even if a formal inquiry is called to investigate the incident, the public is likely to find they will simply not supply the rope to hang them with.

When asked if the public would have access to take their own samples for testing, the company avoided the question and suggested they would talk to groups about it. See
“*Will you allow the public to view or conduct sampling?*
Sampling will be conducted as required by any final permit in accordance with specific protocols outlined in said permit. We have been contacted by groups with a documented science and/or environmental background that are interested in assisting with this sampling, and Nordic will discuss such future cooperative sampling opportunities.”

The following is an except from the **2016 report by the ICES Report of the Working Group on Pathology and Diseases of Marine Organisms**. I include a large section from the wild fish and farmed fish in an attempt to show just how prevalent disease is in hatchery, how often new diseases follow the aquaculture industry around the globe, how the broodstock and eggs can often not be disinfected by treatments, and finally how often new to science disease are being found. Please remember, a sick wild fish is unlikely to breed. All of the sick wild fish tested were near aquaculture facilities.

Wild Fish
Viruses
Salmon gill poxvirus (SGPV) – Reported for the first time in Canada from **a healthy** adult Atlantic salmon in the Magaguadavic River, New Brunswick (a hatchery stocked river). **The finding was based on cytopathology and high-throughput DNA sequencing.**

Piscine reovirus (PRV) – Reported from Denmark in 2014 for the first time, 6% of 176 Atlantic salmon brood-stock tested positive by qPCR. **The virus was later detected in progeny (fry) from the affected brood fish despite disinfection of eggs. Eight wild brown trout were found to be negative for the virus.**

Infectious pancreatic necrosis virus (IPNV) – In mid-Norway, the virus was detected in gill samples in 7 of 670 of returning Atlantic salmon in four rivers in 2013 and 2014.

Infectious salmon anaemia virus (ISAV) – In mid-Norway, the virus (HPR0) was detected in gill samples in 16 of 670 of returning Atlantic salmon in four rivers in 2013 and 2014, and in 2014, the virus was also detected in 5 of 204 Atlantic salmon and 2 of 18 sea trout caught in marine estuaries in the same region.

Viral haemorrhagic septicaemia virus (VHSV) – A rare observation of Genotype 1b was made in a Baltic cod from Hanö Bay, Sweden (ICES district SD 25). The fish also showed signs of fin rot, purulent exudate, splenic granulomas, endo- and pericarditis, anaemia and peritoneal haemoraging...

5.1.2 Farmed Fish Viruses
Infectious pancreatic necrosis virus (IPNV) – In Sweden, two cases of IPN serotype ab were diagnosed in rainbow trout in a national screening program. One of the farms was in the Baltic Sea, the other in an inland lake. In Norway, the number of cases declined from 48 in 2014 to 30 in 2015, continuing a trend reported previously.
IPNV was found in Atlantic halibut **fry** in Norway on two occasions.

Infectious salmon anaemia virus (ISAV) – The disease was diagnosed in 15 Atlantic salmon farms in Norway, an increase from 10 farms in each of the two previous years. **Only three cases were considered primary outbreaks, one in brood fish, one at a sea site, and the third in a smolt farm.**

Four secondary cases received fish from the smolt farm. The remaining secondary cases were likely caused by horizontal spread from neighboring farms. Two epidemics in northern Norway from 2013 and 2014 are still not declared eradicated. At two sites, rainbow trout were infected following infection of Atlantic salmon at the same site. These cases are the first registered in rainbow trout under ordinary farming conditions. **In eastern Canada, sporadic outbreaks with the North American genotype persist, however surveillance revealed a high prevalence of European type HPR0 strains.** In western Canada, 0 of 2207 Atlantic salmon tested positive by qRT-PCR.

Salmonid alphavirus (SAV) – In Norway, there are two endemic regions with two subtypes of the virus, SAV2 and SAV3, and the northernmost part of the country is surveilled to maintain SAV-free status. One case of SAV2 was seen in Atlantic salmon in this region, and the affected population was immediately culled. During 2014 and 2015, there have been cases of pancreas disease (PD) caused by SAV2 in the SAV3-zone. The number of PD cases in 2015 was 135, close to the historically high number of 142 in 2014. Ireland experienced seven outbreaks of PD, after only three in 2014.

Piscine orthoreovirus (PRV) – Heart and skeletal muscle inflammation (HSMI) was diagnosed for the first time in Ireland at one marine Atlantic salmon site, and detection of PRV was confirmed by qPCR. Mortality was reported to be low. In Norway, the number of HSMI outbreaks in Atlantic salmon was 135, a reduction from the historical peak of 181 in 2014 that coincided with national delisting of this disease. Using qRT-PCR, **the virus was detected for the first time in eastern Canada in all Atlantic salmon from one lot held in quarantine**. **In addition, 6 of 11 salmon originating from another hatchery and held at a government research facility tested positive**. None of the Canadian salmon were examined histologically for evidence of HSMI. Onchorhynchus mykiss reovirus – **A new viral disease in rainbow trout first reported in 2013 from four different hatcheries in Norway was documented in the WGPDMO report from 2015. This disease had also caused mortality in fish transferred to seawater. Sequencing of the new viral agent showed that it is related to PRV in Atlantic salmon. No disease outbreaks have been registered in 2015, however, the virus was detected at 9 marine sites from among 50 farms tested**.

Salmon gill poxvirus (SGPV) – Salmon gill poxvirus disease has been known in Norway **since 1995**. The first genome sequence of this DNA-virus was described in **2015**. SGPV was diagnosed in a total of 18 Atlantic salmon farms last year, 15 marine sites and **three smolt farms**.

Bacteria Aeromonas salmonicida – One case was diagnosed in a marine Atlantic salmon site in Ireland. In Norway, A. salmonicida subsp. salmonicida was isolated in one case of increased mortalities in lumpfish transferred to a sea-site containing vaccinated Atlantic salmon, which were not affected. In Scotland, atypical A. salmonicida has been detected in moribund ballan wrasse being used as cleaner fish for farmed Atlantic salmon. In Norway, atypical A. salmonicida has been diagnosed in lumpfish used as cleaner fish in 51 cases, and in wrasses in 32 cases. Atypical A. salmonicida was found in three cases in Norway, all involving Atlantic halibut fry.
Yersinia ruckeri – Norway had 34 cases of yersiniosis in Atlantic salmon in 2015, eight in smolt farms, 25 in sea farms, and one in brood fish. Detected cases have increased over the last four to five years. As a consequence, smolt farms are increasingly using vaccines.
Moritella viscosa/winter ulcers – Winter ulcer syndrome was diagnosed in Atlantic salmon from three sites in Scotland and three sites in Ireland. In Norway, 57 cases of winter ulcers in Atlantic salmon and

four cases in rainbow trout were diagnosed, compared to 44 cases in salmonids in 2014. Vibrio-infections – In Norway, Vibrio anguillarum has been isolated from diseased cleaner fish used to control salmon lice. The bacterium was detected in lumpfish from twelve farms and wrasses from two. Three cases of V. ordalii have been reported in lumpfish. Flavobacterium/Flexibacter – Three cases of infection with Flavobacterium psychrophilum in rainbow trout were reported in Norway, two from marine sites and the third from an inland farm. Two cases were registered in 2014, and septicemic flavobacteriosis in rainbow trout has been a list 3 disease in Norway since that time. Pasteurella/ Pseudomonas – In lumpfish from Norway, Pasteurella sp. was isolated in 14 cases and Pseudomonas anguilliseptica in four. Piscirickettsia salmonis – The range of salmonid rickettsial septicaemia in Atlantic salmon in western Canada expanded to a new management zone and the disease now occurs throughout the year in some locations. Between 2013 and 2015, the annual number of diagnoses in Atlantic salmon has increased from 8.5% to 29% and in Pacific salmon, from 4% to 38%.

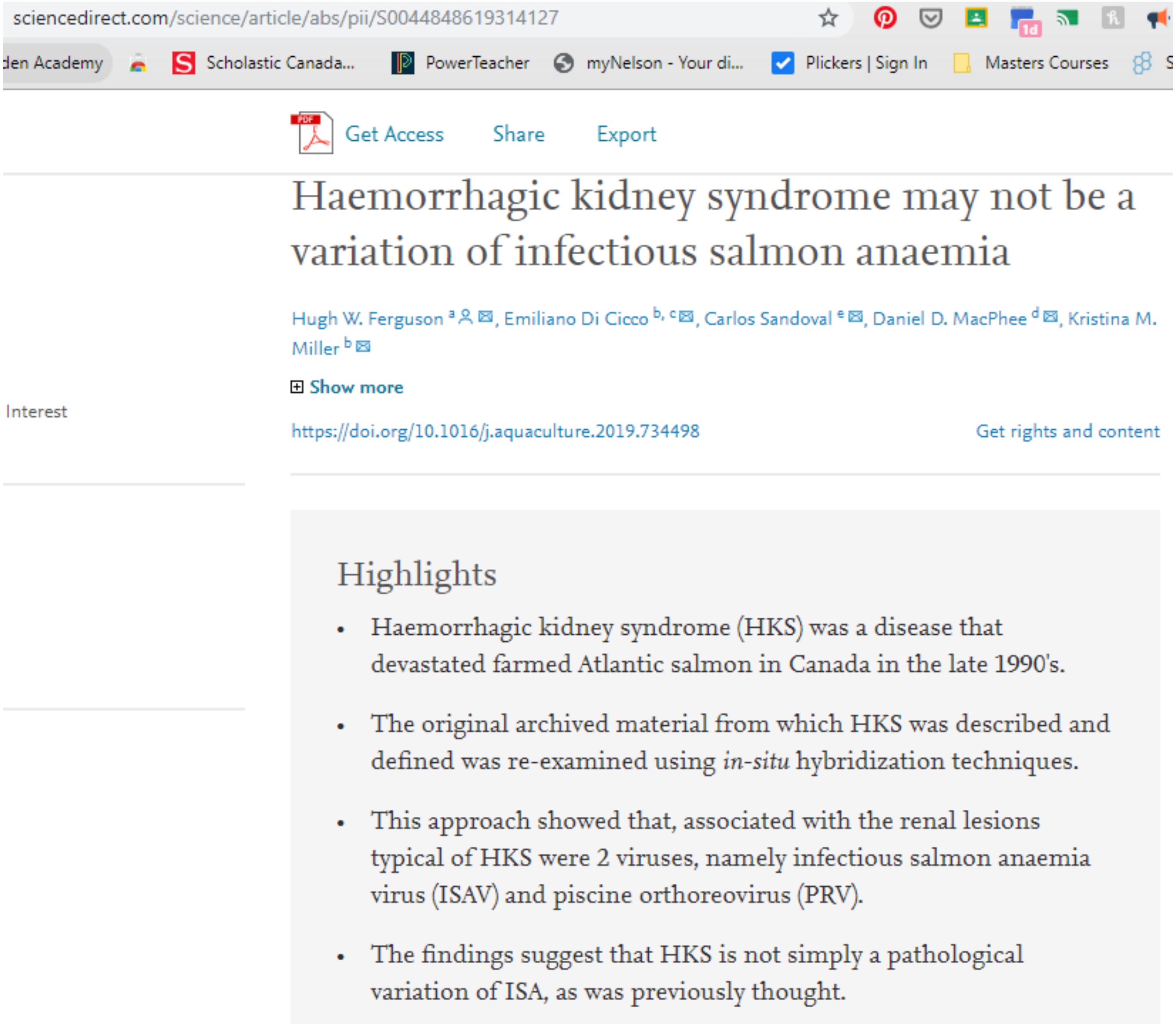
1.

From: http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/SSGEPI/2016/01%20WGPDMO%20-%20Report%20of%20the%20Working%20Group%20on%20Pathology%20and%20Diseases%20of%20Marine%20Organisms.pdf

A similar outcome can be seen in the 2018 report whereby supposedly biosecure hatcheries and government inspection of importation failed to result in eggs or smolt free of OIE reportable viruses: https://www.researchgate.net/publication/326467969_Report_of_the_Working_Group_on_Pathology_and_Diseases_of_Marine_Organisms_WGPDMO_13-17_February_2018_Riga_Latvia Of note is the admittance by the Canadian government that they allowed PRv imports that triggered mild disease in fish yet caused no significant financial losses to aquaculture companies. This is now a huge issue for Canada and BC in particular due to the recent finds by Dr Millers lab that shows that wild fish are seriously harmed by this mis-step. PRv is not screened in Maine, either. We do not known all the hosts of this virus. PRv in concert with ISAv, was only weeks ago, discovered to also cause Hemorrhagic Kidney Syndrome (Ferguson et al 2019)

Viruses from Egg Shipments:

Hatcheries are regularly caught harbouring, amplifying and even mutating fish viruses. The same is true for other pathogens. The industry has a long history of importing new non-endemic viruses to new regions. Allowing non-native salmon into BC Canada has resulted in introductions of EU strains of ISAv, PRv, SAv, (Kibenge 2016) and others we are only now discovering (Mordecai et al 2019). The same was true for Chile where the introduction of ISAv collapsed the entire salmon farming industry (~$2B USD) (Vike et al 2006). It seems little has changed, as more recently, in 2019, Washington State caught Cooke Aquaculture importing eggs from the same supplier that proponent wishes to use, that were infected with an exotic non-endemic EU strain of PRv This is also a huge issue in BC where screening of some strains of PRv infected fish were only just initiated. It took 3 court challenges to force regulatory agencies to do this. More than 80% of all aquaculture salmon in BC have this virus (Morton Unpubl Data). It is also in the broodstock of many major companies. It is not screened for in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Interest

Haemorrhagic kidney syndrome may not be a variation of infectious salmon anaemia

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Highlights

- Haemorrhagic kidney syndrome (HKS) was a disease that devastated farmed Atlantic salmon in Canada in the late 1990's.
- The original archived material from which HKS was described and defined was re-examined using *in-situ* hybridization techniques.
- This approach showed that, associated with the renal lesions typical of HKS were 2 viruses, namely infectious salmon anaemia virus (ISAV) and piscine orthoreovirus (PRV).
- The findings suggest that HKS is not simply a pathological variation of ISA, as was previously thought.

Maine. Recently, the implications of this mis-step became apparent when it was discovered that this virus harms other marine fish severely, specifically Pacific salmon. It has now become an “electric third rail” for the industry and regulators. See Ferguson et al 2018 for a review. Dr Miller's lab in BC is expected to reveal more than the 3 harmful viruses she just published in 2019 (Mordecai et al 2019) that are new to science. While some of these new viruses she is working on may not cause mass mortality in Atlantic salmon they will likely be infectious to other fish with unknown outcomes.

The Fish are Clean Enough Syndrome :
The goal of RAS finfish aquaculture companies is to produce profit through the generation of fish in an artificial setting. Consumers then believe that these RAS fish are the same or similar to their wild counterpart. Nothing could be further from the truth. A wild fish has had to survive in a hostile environment, full of pathogens, predators, extreme weather, migrate past obstacles, etc and breed. A tanked fish simply has to survive in an environment where even a very sick fish can thrive and grow. Even the breeding has been removed from their requirements. A very sick tanked fish, loaded in viruses, unable to jump a waterfall in nature, or escape a predator can still be sold in the USA market.

Conversely, a very sick wild fish is a dead and/or eaten fish and/or unable to migrate and breed. Mixing the two results in what industry calls “spill over” and “spill back”. A pathogen that is at a super low frequency in the wild population, and often can not be found during survey work, due to the “struggle for life” quickly amplifies and/or mutates in a “bioreactor” such as a RAS system. The entire USA regulatory and monitoring system is designed to focus testing on “reportable” diseases that could affect trade. These 5 OIE viruses are but a tiny portion of the non-salmon and salmon pathogens that can and will be amplified in any RAS setting. Similarly, regulatory agencies and operators alike have very short lists of non-viral pathogens in their effective monitoring programs, all others are ad hoc and must result in serious mortality or pathology issues before being noticed. Many are missed.

The goal is to get fish to market, not make healthy fish that will not impact wild fish. The following is from a review of the Maine salmon breeding program:
“ The use of groundwater, reuse culture technologies, and effective biosecurity protocols has resulted in fish health certification for the facility and fish stocks. No mortality events or pathogens of regulatory concern have been reported on any fish health checks. All fish stocks were screened biannually for five viruses (IPNV, IHNV, ISAV, OMV, VHSV), along with Aeromonas salmonicida, Yersinia ruckeri, Renibacterium salmoninarum, Myxobolus cerebralis, and Ceratomyxa shasta. “ from : Wolter et al 2009

The proponent used this as a shining example of what is being done “right”. It is an example of where the bar is set, even for the Maine State salmon breeding program : mass mortality and population collapsing disease outbreaks. Anything above that is a success. Causes of regular mortalities and disease are not worth mentioning. Pathogens not important to financial considerations in an RAS system are basically ignored and flushed. Ironically, when one of the fathers of RAS development in the USA, Dr Steve Summerfelt (4^{th} author on the above paper), finally did leave applied research in an academic setting and join the corporate world, he did so by joining a closed loop system called aquaponics and not any of the larger, semi-closed, or flow through systems being developed in the USA today. He chose what many believe is the best design and not what the proponent is offering to build.

The proponent then suggests that: “There have been no documented negative effects on wild fish stocks from the outflow pipe of these RAS facilities.” What he didn't offer was that virtually no monitoring or studies have been conducted for this facility or any other in North America or in fact the world.

Flow Through Design Issues :
All flow through systems that have ever been tried for rearing finfish suffer from a lack of negating this spill over and spill back effect. They invariable fail financially and/or cause alarming outbreaks of pathogens that end up "ineffectively sterilized" in the effluent. Even more alarming is that the intake and effluent pipes are in close proximity to one another. The UN calls the results of this concept "One Health". If you have sick animals in husbandry you will have sick adjacent wild animals and these will then reinfect the animals in husbandry. The resulting "sick" ecosystem then impacts nearby and distant human health. Examples of the consequence of mixing wild animals and domesticated stocks abound. Disease flourishes due to predator exclusion, breeding non-requirements, less than perfectly effective drug treatments, etc in the unnatural husbandry environment. This then impacts the local wild animals. For example: Wild bison and cattle in Canada's midwest resulting in a Bovine TB epidemic spill-over and spill-back positive feedback loop that results in many endangered wood bison being culled annually and costs Canadian taxpayers millions. A parasite in Sweden was amplified in a hatchery and transferred to more than 40 rivers in Norway. These rivers then had to be Rotenon-ed (read, kill virtually every living thing in the river) and restocked. Even this did not kill every last one of the parasites, and these rivers despite having millions of dollars spent to recover them, have never recovered nor has the parasite been eradicated.

Pathogens in the Feed Pellets :

Annual Norwegian studies show that a significant percent (up to a 10% average) of the feed pellets produced and stored by industry carried human and fish pathogens (eg NIFES annual reports, EU Report 2003). Typically these were bacteria such as salmonella, or molds. Maine and the US Federal government has limited to no effective monitoring system for testing shipments for these pathogens.

Similarly, Chile banned all feed shipments from France (specifically, a major feed pellet plant owned by Sketting, a company the proponent suggested they might use) due to finding fish viruses that were still active and viable in the feed. These had originated from wild fish used to create the pellets.

Shark and Predator Attraction :

This, again, will be unmonitored and be an obvious issue when dumping 7 million gallons of chum a day into a bay where wild salmon will not be protected in tanks. Sharks attracted will be eating local wild fish. Many "salmon" aka porbeagle sharks migrate past the project location. This is a huge issue where I live in NL Canada.

Why So Big? Why Not Reduce the Size of the Project and Just Use Aquifer Water and Reduce the Pathogen Exposure Risks ? :

So, if the risk of pathogen introduction can be significantly reduced by simply using aquifer water, why not simply only use aquifer water as almost all of the recent RAS systems do? Well, it seems that the aquifer chosen was simply not able to supply enough water to satisfy the profit needs of the promoters. So, they decided to risk using seawater and surface water, from of all places, a nearby wild salmonid watershed and the same bay their own effluent will be discharged into. History has shown us this never ever works, if by "works" we mean make profit and provide jobs in a stable fashion and have limited and negligible disease outbreaks and thus reduced: culls, waste, antibiotic usage, etc

Mr Dagan is the CEO of one of the largest land based salmon developers in the World: Aqua MoAF https://salmonbusiness.com/23-months-from-egg-to-harvest-this-salmon-has-grown-30-miles-from-the-sea/

In a recent interview with a major trade magazine (Salmonbusiness.com) “estimates a production cost of USD 3.4 per kilo of live fish.“But remember that there are scale advantages,” he said. How big? “Very big. For 5,000 tonnes it would be USD 2.8 per kilo, and for 10,000 tonnes it would be USD 2.4-2.5 per kilo,” he added.”

So the simple answer is, the majority of risks of disease amplification and mutation due to surface water use, must be, in the promoters mind, manageable and bearable with regard to getting fish to market. What may not have been factored in is the ramifications of the many pathogens that simply make fish sick without causing mass mortalities. Wild fish exposed to the effluent will not live in a predator free tank, have access to antibiotics, etc. Moreover, no one is monitoring the health of exposed wildlife or even testing the effluent for known pathogens. This alarming fact was recently exposed in Canada by the 2018 Spring Reports of the Commissioner of the Environment and Sustainable Development to the Parliament of CanadaReport 1—Salmon Farming found here: https://www.oag-bvg.gc.ca/internet/English/parl_cesd_201804_01_e_42992.html The auditors were “shocked” by the total lack of monitoring of adjacent wild fish health, unlimited use of antibiotics, unlimited use of pesticides”. This is also the case in Maine. The Auditor also suggested that the results of the audit showed the most number of gaps of any audit she had ever conducted. Her expressions of horror when presenting the results to the Federal government need to be seen to be appreciated. https://www.youtube.com/watch?v=f2JZev5oYZ4 Again, the exact same situation exists in Maine.

Biocide Use Issues

Flow through RAS design does not allow compliance with Maine State Environmental Protection Chapter 514 which states:

C. A permit for aquatic pesticide use will be issued only if the applicant provides adequate protection for non-target species.

Incomplete List :

Many chemicals have been ignored by the proponent. These include chemicals banned in the EU such as ethoxyquin which is a common feed additive not banned in the USA but shown to be both carcinogenic and mutagenic. It has traditionally been used in Maine by Cooke Aquaculture. It also has been shown to cross the human blood brain barrier (Bohne unpublished data personal communication 2017). The amounts of this in many feed formulations can be extreme eg 1.5% w/w. The 3 main compounds from the breakdown of this pesticide are all biologically active and persist in the environment. See review by Blaszczyk et al 2013 and Bernhardt 2018. I have also submitted screenshots showing the ban being covered in the popular media.

Amounts Used Incomplete :

Many of the biocides the applicant wants to use have no estimated amounts. Moreover, Maine law does not restrict their use. Examples include: antiparasitics and antimicrobials in general.

The amounts discharged can be quite substantial with serious ramifications.

For example, a Cooke Aquaculture hatchery in St.Albans produces about 3 million 100g to 120 g smolt a year from about 5 million eggs. To do this in 2017 (last year data is available as seen here: http://isdm.gc.ca/opendata/aar/Land-Based%20and%20Freshwater%20Data%202017%20v1.xlsx and cited as DFO Antibiotic Data 2017) it used 180,750,000 milligrams of Florfenicol, 1,290,000 milligrams of Imvixa, 1,040,000 milligrams of Oxyteracycline, and 1,431,720,000 milligrams of formalin (to treat the eggs and not a human use antibiotic). All this ended up in what was once a large pristine Bay and what is now undoubtedly a soupy of antibiotic resistant bacteria.

This is 330,000 kgs or 330mt that required *183 KILOS of antibiotics*. This is typical. It is of special note that this hatchery uses UV and drum filtration of *aquifer only water*...not surface water known to be far more prone to serious pathogen infestation and yet wanting to be used by the proponent.

In contrast, 33,000 mt is what Nordic Aquafarms wants to generate. *100 times more.* Thus, the amount of antibiotics would be 18300 kilos or 18,300,000,000 mg by equivalency using the recently build, high tech, aquifer water only using, Cooke hatchery as a measuring stick. Yes 18.3 billion milligrams. This will, in all likelihood, result in much much more antibiotics being dumped in the bay than all of Belfast currently uses per year. Yet not a single monitoring study has been required nor any legal limits on antibiotic usage put in place. Japan does not allow the use of antibiotics in aquaculture - at all. Antibiotic use in aquaculture is a serious issue and part of the One Health initiative of the UN (One Health, WHO, United Nations, 2015).

What effects and affects this will have on the local marine and wildlife (and humans) is completely unknown. We do know that high usage of antibiotics in the freshwater and marine ecosystems by salmon farming has had dramatic effects in terms of cascade effects and antimicrobial resistance Wang et al 2019. A quick scan of the available scientific literature shows many studies where both human workers and ecosystems are affected.

For example, the province of NL Canada produces about 22,000 mt of salmon per year, yet used 5.9 billion milligrams of antibiotics in 2017, this does not include the hatchery phase of production which further elevates these numbers. See 2017 Marine usage rates in citations as an XL spreadsheet. This is 4 times what the same provinces used during the same year for terrestrial animal production (cows, sheep, pigs, goats, chickens, turkeys, ducks, etc) combined. Despite that in-feed administration is the primary method used during outbreaks, sick fish don't eat and many of these antimicrobials will end up in the feed waste and waste water. Many antimicrobials will not be administer to individual animals that are sick but instead the entire stock in the tank will be treated. This is called Broadcast treatments by some people and has been discouraged by the OIE, WHO, and UN in general. It has also been banned in many countries and the EU for all animals except fish. The reason is obvious. A vet can handle a sick pig, for example, but can't find, let alone treat a single sick fish in a giant tank. So, the entire tank is heavily dosed as a standard practice for many fungal and bacterial infections.

Lack of Monitoring for Antimicrobial Resistance :

Neither Maine nor the Federal USA government has an antimicrobial resistance monitoring program that would monitor the impacts of this project. Nor has the proponent offer any such monitoring program. These are obvious serious issues when one is considering the effects of billions of milligram being dumped in a small area annually thereby exposing *all* the local and migratory wildlife and marine life to such an effluent stream. Many studies have shown not only antimicrobial resistance jumping from freshwater fish tanks to human pathogens in a RAS aquaculture setting, even as close as NS Canada (McIntosh et al 2008), and marine based costal RAS (, Wang et al 2019), but serious impacts on antimicrobial resistance in the marine and freshwater environments (Paoni 2000, Rhodes et al 2008, Saavedra et al 2017, Buschmann et al 2012, Vincent et al 2014, Huang et al 2015, Henriques et al 2016, Bohle et al 2016, VKM Report 63 2016,). Please see Irish, Chilean, Norwegian studies eg Buschmann et al 2012, review by Pridgeon and Klesius 2012, Grant et al 2014. Human pathogens are already being discharged into the bay via the effluent, adding billions of milligrams of these antibiotics will have unknown as well as alarming predictable negative impacts (Gov Canada, The Interdepartmental Antimicrobial Resistance Policy and Science Committees 2002, Chee-Sanford 2009, Heuer et al 2009, Miranda et al 2013, review by Cabello 2013, Ivanova 2015, Done and Halden 2015). Monitoring of these impacts by government or the proponent in the Bay is unlikely as a monitoring framework does not exist within government despite repeated attempt to develop one (Smith 2008, Grant et al 2014), despite growing use and concern (WHO One Health 2012, Van Boeckle et al 2015).

Norway has restricted use to such an extent that 0.1 g/mt is the average antibiotic usage in 2018, while Japan has banned the use of antibiotics in aquaculture altogether. Maine has no legal limits on use and as a result, likely uses >50g/mt and as high as 280g/mt as is seen in Atlantic Canada. No legal limits will be imposed on the proponent. Use of 10s of billions of milligrams per year to produce 33,000mt should be expected based on nearby hatcheries in NB/NS/NL as reported by the DFO in Canada (see 2017 usage rates in DFO XL spreadsheet).

In addition to the effluent, spoiled medicated feed dumped, etc, as the fish move in the food distribution chain, so do the antimicrobial resistant plasmids (Nespolo et al 2012).

Persistent in the environment and passes through the fish still active :

In addition, to simply not being ingested by sick fish that refuse to eat, or otherwise taken up by the fish, many antimicrobials will pass through the fish unaffected and have an extreme half life in cold water. More than 50% of many antimicrobials ingested will simply pass through the fish and be added to the effluent.

Chemicals for the Fish Farm

Note: Annual usage estimates represent approximate quantity required given a product is the only one used for this application. The quantities needed will be dependent on the site-specific conditions experienced which are difficult to establish prior to operations and are indicated as estimates only. Likely a fraction of the estimated annual use of each of these products will be used. All products listed will be used according to label.

Cleaners Detergents

Aqualife® Multipurpose Cleaner. A biodegradable, nonhazardous cleaner that is designed specifically for use in fish hatcheries, aquaculture facilities, fish & food processing plants, & agricultural farms. Active ingredients: sodium hydroxide (1-5%), the product is phosphate free, contains no volatile organic compounds and is NSF certified for use in food processing facilities. Used according to the label at dilutions of 1:20. Approximate annual use: 2232 gallons/year (8449 l/year).

Gil Save®. High-foaming chlorinated, alkaline, liquid detergent, Gil Save is designed for foam and high pressure spray cleaning of meat and poultry plants, breweries, dairies and canneries. It is a complete product containing alkalis, water conditioners, chlorine and high-foaming wetting agents. Gil Save is an effective cleaner of food processing equipment by removing fatty and protein soils, pectin, mold, yeast and organic greases. Active ingredients: sodium hydroxide (7- 9%), sodium hypochlorite (3-4%). Use according to label at concentrations of 0.2-3% (1⁄4-4 oz/gal). Approximate annual use: 678 gallons/year (2567 l/year).

Clean in Place (CIP)

Gil Super CIP®. A heavy-duty, chelated-liquid caustic cleaner for use in CIP, boil-out, soak, spray clean and atomization cleaning systems, Gil Super CIP is formulated to remove protein, fatty and carbonized soils typically found in dairy and food processing. Active ingredients: sodium hydroxide (49%). Used according to label at 0.1-3% (1/8-4 oz/gal). Approx. annual use: 5840 gallons/year (22107 l/year).

Gil Hydrox®. A concentrated organic, liquid acid cleaner, Gil Hydrox rapidly removes milk/beer stone, alkaline/hard water film and stains/protein build-up from dairy and food processing equipment. It is specially formulated for use in CIP, spray and acid rinse operations. Active ingredients: glycolic acid (29-31%). Used according to label at 0.3-1.5% (1⁄2-2 oz/gal). Approx. annual use: 5840 gallons/year (22107 l/year).

Disinfectants/Sanitizers

Bleach. Active ingredient: sodium hypochlorite (8%) in concentrated form. Typically used at 100-1000 ppm for general cleaning/disinfection. Approximate annual use: 1500 gallons/year (5700 l/year).

Ozone. Ozone can be dissolved into water to provide an aqueous ozone solution that is stable, safe, easy to control, leaves no residue and has been granted GRAS approval by both the USDA and FDA for direct contact with food. This water containing ozone can replace chlorine as an antimicrobial agent or be used to supplement existing water rinses and achieve improved antimicrobial intervention. This is now a common application to sanitize fillet machines, cutting tables, knives, and all equipment that may be used in the seafood processing areas. Approximate annual use: TBD. Concentration in discharge = 0 ppm

Virkon® Aquatic. A powerful cleaning and disinfecting solution with efficacy against fish viruses, bacteria, fungi, and molds. Virkon® Aquatic is EPA registered (except in California where registration is pending) for the disinfection of environmental surfaces associated with aquaculture. Active ingredient: Potassium monopersulfate (21.4%). Used in accordance with label as a general cleaner and in footbaths. Working solution strengths normally range from 0.5% - 2.0%. Approx. annual use: 1100 lbs/year (500 kg/year).

Zep FS Formula 12167® Chlorinated Disinfectant and Germicide. A liquid chlorine sanitizer and deodorant for use in all types of food-handling establishments. Authorized as no rinse sanitizer for equipment. Provides deodorizing activity by destroying bacteria which generate many disagreeable odors. Can also be used to sanitize commercial laundry. Active ingredients: Sodium hypochlorite (5-10%) and sodium hydroxide (1-3%). Used according to label, effective at concentrations as low as 0.3% (1 oz/ 2 gallons). USDA applicable and EPA and Maine registered. Approx. annual use: 1980 gallons/year (7495 l/year).

Therapeutants

Compounds Potentially Used:

Note: the quantities needed will be dependent on the site-specific conditions experienced which are difficult to establish prior to operations and so are indicated as estimates only. All products listed will be used according to label use or a licensed veterinarian's prescription.

Parasite-S, Formalin-F, and Formacide-B. (Formalin). Active ingredient 37% formaldehyde. Used periodically according to the label if needed to alleviate fish health issues due to saprolegniasis, external protozoa and monogenetic trematodes. Typical dose rates from 25 ppm to 1,000 ppm. Approximate annual use: 925 gallons/year (3500 l/year).

Finquel® or Tricane-S. (Tricaine methanesulfonate). Used periodically in accordance with the label to reduce stress on the fish when handling small numbers for examination. Typical dose rates of 15-330 mg/L. Approximate annual use: 1.1 lbs/year (500 g/year).

Halamid® Aqua. (Chloramine-T). Active ingredients N-chloro, p-toluenesulfonamide and sodium salt trihydrate. Used periodically according to the label if needed to alleviate fish health issues due to bacterial gill disease. Typical dose range 12-20 ppm. Approximate annual use:
1100 lbs/year (500 kg/year).

Ovadine® (PVP Iodine). A buffered 1% Iodine solution (Iodophor) specifically formulated for use in disinfecting fish eggs. It contains a 10% Povidone-Iodine (PVP Iodine) complex, which provides 1% available iodine. Used according to the label at dose rates of 50 -100 ppm as available iodine solution. Estimated usage: 160 gallons/year (600 l/year).

Compounds Rarely Used Only in Emergency Situations:

Praziquantel. Considered as 100% active. Can be used if fish are suffering from trematode/cestode infections. Typical dose ranges from 5-200 ppm depending on length of standing bath treatment. Used as needed/intermittent or emergency use only,
according to label use or as prescribed by a licensed veterinarian. Approx. annual use: 0 lbs/year (0 kg/year).

Potassium permanganate. Considered as 97% active. Can be used if fish are suffering from certain parasites and fungal infections in younger fish life-stages. Typical dose range 1.5-2.5 ppm. Used as needed/intermittent or emergency use only, according to label
use or as prescribed by a licensed veterinarian. Approx. annual use: 0 lbs/year (0 kg/year).

Terramycin® 200. (oxytetracycline dehydrate, 44% active): Can be used as an in-feed treatment (maximum of 0.08 g active oxytetracycline/kg fish/day) if fish are suffering from certain bacterial infections. Used as needed/intermittent or emergency use only, according to label use or as prescribed by a licensed veterinarian. Approx. annual use: 0 lbs/year (0 kg/year).

Aquaflor®. (florfenicol; 50% active). Can be used as an in-feed treatment (maximum of 15 mg/kg fish/day) if fish are suffering from certain bacterial infections. Used as needed/intermittent or emergency use only, according to label use or as prescribed by a licensed veterinarian. Approx. annual use: 0 lbs/year (0 kg/year).

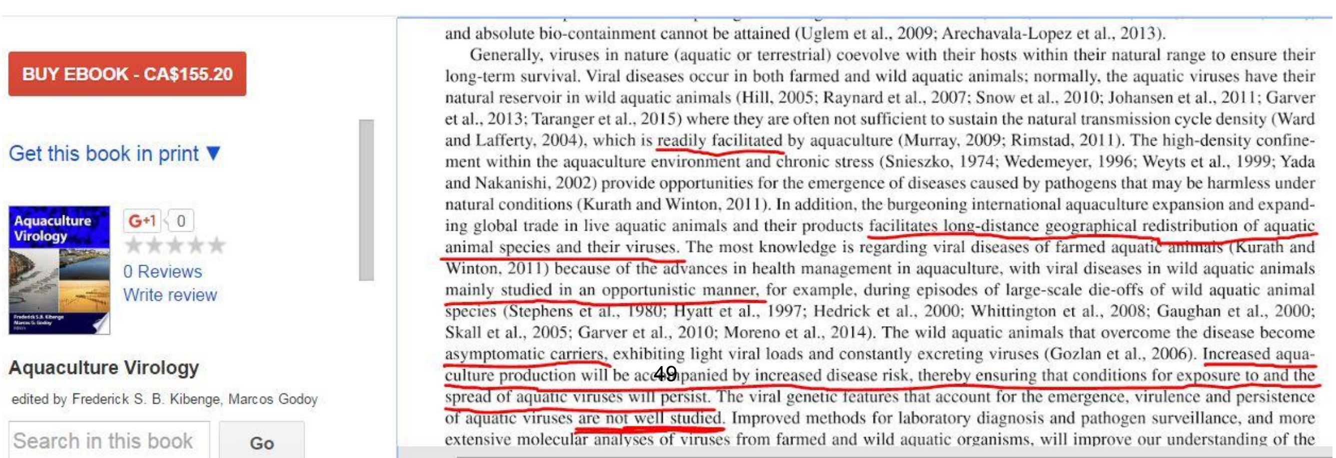
Romet® 30/Romet® TC. (sulfadimethoxine/ormetoprim, 30% active or 20% active, respectively). Can be used as an in-feed treatment (maximum of 50 mg/kg fish/day) if fish are suffering from certain bacterial infections. Used as needed/intermittent or emergency use only, according to label use or as prescribed by a licensed veterinarian. Approx. annual use: 0 lbs/year (0 kg/year).

WasteWater Treatment

Formic Acid (85%). Used for pH correction of fish processing water prior to disinfection with sodium hypochlorite. Approx. annual use: 18200 gallons/year (69000 l/year).

Bleach. Active ingredient: sodium hypochlorite (15%). Used to disinfect water used in fish processing. Applied at a concentration of 50 mg/l. Estimated discharge concentration: 0.4 mg/l. Approx. annual use: 14800 gallons/year (56000 l/year).

MicroC® 2000. (1.1 million mg/l COD). A non-hazardous, green chemical developed specifically for use as an electron donor / carbon source for wastewater denitrification applications. It is used as a supplemental carbon source in wastewater treatment plants to stimulate denitrification processes. Approx. annual use: 1.0 million gallons/year (3.8 million l/year).



and absolute bio-containment cannot be attained (Uglem et al., 2009; Arechavala-Lopez et al., 2013).

Generally, viruses in nature (aquatic or terrestrial) coevolve with their hosts within their natural range to ensure their long-term survival. Viral diseases occur in both farmed and wild aquatic animals; normally, the aquatic viruses have their natural reservoir in wild aquatic animals (Hill, 2005; Raynard et al., 2007; Snow et al., 2010; Johansen et al., 2011; Garver et al., 2013; Taranger et al., 2015) where they are often not sufficient to sustain the natural transmission cycle density (Ward and Lafferty, 2004), which is readily facilitated by aquaculture (Murray, 2009; Rimstad, 2011). The high-density confinement within the aquaculture environment and chronic stress (Snieszko, 1974; Wedemeyer, 1996; Weyts et al., 1999; Yada and Nakanishi, 2002) provide opportunities for the emergence of diseases caused by pathogens that may be harmless under natural conditions (Kurath and Winton, 2011). In addition, the burgeoning international aquaculture expansion and expanding global trade in live aquatic animals and their products facilitates long-distance geographical redistribution of aquatic animal species and their viruses. The most knowledge is regarding viral diseases of farmed aquatic animals (Kurath and Winton, 2011) because of the advances in health management in aquaculture, with viral diseases in wild aquatic animals mainly studied in an opportunistic manner, for example, during episodes of large-scale die-offs of wild aquatic animal species (Stephens et al., 1980; Hyatt et al., 1997; Hedrick et al., 2000; Whittington et al., 2008; Gaughan et al., 2000; Skall et al., 2005; Garver et al., 2010; Moreno et al., 2014). The wild aquatic animals that overcome the disease become asymptomatic carriers, exhibiting light viral loads and constantly excreting viruses (Gozlan et al., 2006). Increased aquaculture production will be accompanied by increased disease risk, thereby ensuring that conditions for exposure to and the spread of aquatic viruses will persist. The viral genetic features that account for the emergence, virulence and persistence of aquatic viruses are not well studied. Improved methods for laboratory diagnosis and pathogen surveillance, and more extensive molecular analyses of viruses from farmed and wild aquatic organisms, will improve our understanding of the

2.1.2. Survival outside the host ISAV has been detected by reverse-transcription polymerase chain reaction (RT-PCR) in seawater sampled at farming sites with ISAV-positive Atlantic salmon (Kibenge et al., 2004). It is difficult to estimate exactly how long the virus may remain infectious in the natural environment because of a number of factors, such as the presence of particles or substances that may bind or inactivate the virus. Exposing cell culture-propagated ISAV to 15°C for 10 days or to 4°C for 14 days had no effect on virus infectivity (Falk et al., 1997). 2.1.3. Stability of the agent (effective inactivation methods) ISAV is sensitive to UV irradiation (UVC) and ozone. A 3-log reduction in infectivity in sterile freshwater and seawater was obtained with a UVC dose of approximately 35 Jm–2 and 50 Jm–2, respectively, while the corresponding value for ISAV in wastewater from a fish-processing plant was approximately 72 Jm–2. Ozonated seawater (4 minutes with 8 mg ml–1, 600–750 mV redox potential) may inactivate ISAV completely. Incubation of tissue homogenate from diseased fish at pH 4 or pH 12 for 24 hours inactivated ISAV. Incubation in the presence of chlorine (100 mg ml–1) for 15 minutes also inactivated virus (Rimstad et al., 2011). Cell culture-isolated ISAV may survive for weeks at low temperatures, but virus infectivity is lost within 30 minutes of exposure at 56°C (Falk et al., 1997).

https://www.oie.int/fileadmin/Home/eng/Health_standards/aahm/current/chapitre_isav.pdf


Legend
Important Anadromous Fish Habitat
Displaying: IncDesc
Multiple Species (Non-Alosid)
Single Species (Non-Alosid)
Top 5% Alosid
Top 5% Alosid plus Non-Alosid Species
Atlantic Salmon Habitat Suitability
Proportion of Habitat > 10%
44.32° N
68.85° W
69.17° W
44.48° N
Stockton Harbor
Sears Island
Long Cove
Searsport
Islesboro Island
Belfast Bay
Belfast
Passagassawakeag River
Belfast Municipal Airport
Little River
Piper Stream
673 ft
Warren Brook
Morrill
LEVENSELLER MOUNTAIN
0 2.6 km (1.6 miles)
N
DATA BASIN
MAINE
Kennebec
Augusta

NOTE - This map contains two datasets: "Important Anadromous Fish Habitat, Northeast U.S." and "Atlantic Salmon Rearing Areas, Maine"

These dataset are part of a suite of products from the Nature's Network project (naturesnetwork.org). Nature's Network is a collaborative effort to identify shared priorities for conservation in the Northeast, considering the value of fish and wildlife species and the natural areas they inhabit. "Important Anadromous Fish Habitat" and "Atlantic Salmon Rearing Areas, Maine" are two input used in developing "Lotic Core Areas, Stratified by Watershed, Northeast U.S." that is also part of Nature's Network. Lotic core areas represent intact, well-connected rivers and stream reaches in the Northeast and Mid-Atlantic region that, if protected as part of stream networks and watersheds, will continue to support a broad diversity of aquatic species and the ecosystems on which they depend. The combination of lotic core areas, lentic (lake and pond) core areas, and aquatic buffers constitute the "aquatic core networks" of Nature's Network. These and other datasets that augment or complement aquatic core networks are available in the Nature's Network gallery: https://nalcc.databasin.org/galleries/8f4dfe780c444634a45ee4acc930a055.

Important Anadromous Fish Habitat:

Intended Uses

This dataset is primarily intended to be used in conjunction with the Nature's Network product "Lotic Core Areas, Stratified by Watershed, Northeast U.S." to better understand the importance of core areas to anadromous fish. It also can be used on its own, or in conjunction with the Atlantic salmon dataset, to identify priority watersheds for anadromous fish.

Description and Derivation

This dataset is a combination of the following two products:

1) Habitat for Atlantic sturgeon, short-nosed sturgeon, and sea-run (salter) brook trout.

Atlantic and shortnose sturgeon are federally listed endangered species. Sea-run or salter brook trout, which undertakes seasonal migrations from the ocean into rivers and streams, is also of conservation concern. Occurrence was compiled by Dauwalter et al. (Dauwalter, Daniel C., Carolyn J. Hall, Jack E. Williams. 2012. Assessment of Atlantic Coast watersheds for river herring and diadromous fish conservation. Trout Unlimited final report to National Fish and Wildlife Foundation. Trout Unlimited, Arlington, Virginia.)

2) Top 5% of watersheds for alewife, blueback herring, and American shad (collectively referred to as "alosids").

This component of the product consists of streams and rivers in the top 5% of watersheds for conservation action for river herring (alewife and blueback herring) and Azmerican shad, based on a prioritization developed by The Nature Conservancy (TNC). The 2015 TNC analysis is intended to identify areas of high anadromous fish conservation potential along the Atlantic Coast. For the analysis, a suite of metrics was calculated in each subwatershed (USGS 12-digit hydrologic units or "HUC12s") of the U.S. Atlantic Coast to measure population and habitat factors which are relevant to these fish. The high priority subwatersheds are areas where conservation activities to support these fish could have the greatest impact. They are intended as a regional-scale screening tool to be used in concert with local-scale information and expertise; they are not a prescription for any particular management action.

The metrics used in the alosid analysis fall under four categories:

1) Population – recent run count or occurrence, or historical occurrence (as compiled by Dauwalter et al. 2012)

2) Habitat Quantity and Access – e.g., wetland extent, percent of stream reaches in the subwatershed with unrestricted downstream access (no barriers) to the ocean

3) Water Quality – extent of impervious surface

4) Water Quantity – potential dam impacts on stream and river flow based on total upstream dam storage capacity

These factors were then weighted by importance for each species based on expert knowledge. The results of the simple weighted ranking prioritization algorithm were then binned into 5% tiers for each species; the top tier is considered to have the greatest restoration potential. The top tiers for each of the three species were also combined to result in a combined Top 5% representing the highest tier for one or more of the three species. The metrics and results can be viewed on the Fish Habitat Decision Support Tool, http://www.fishhabitattool.org/, in the Atlantic Coastal Fish Habitat Partnership section.

Atlantic Salmon Rearing Areas:

Intended Uses

This dataset is primarily intended to be used in conjunction with the Nature's Network product "Lotic Core Areas, Stratified by Watershed, Northeast U.S." to better understand the importance of core areas to Atlantic salmon. It also can be used on its own, or in conjunction with the dataset "Important Anadromous Fish Habitat, Northeast U.S." to identify priority watersheds for anadromous fish.

Description and Derivation

The dataset consists of stream reaches that are predicted to contain greater than 10% Atlantic salmon rearing habitat, based on a GIS-based habitat model developed by the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration (NOAA). The model assesses salmon rearing habitat throughout the range of the Gulf of Maine Distinct Population Segment (DPS) of Atlantic salmon, which is federally listed as an endangered species. The model was developed using data from habitat surveys conducted in the Machias, Sheepscot, Dennys, Sandy, Piscataquis, Mattawmkeag, and Soudabscook Rivers. The model uses reach slope derived from contour and digital elevation model (DEM) datasets, cumulative drainage area, and physiographic province to predict the total amount of rearing habitat within a reach. The variables included in the model explain 73% of the variation in rearing habitat. More details about the model are available at: https://www.greateratlantic.fisheries.noaa.gov/prot_res/altsalmon/Appendix%20C%20-%20GIS%20Salmon%20Habitat%20Model.pdf.

All citations are in these two folders:
https://drive.google.com/open?id=16IRTPpv2wG8wHoZmyaQMX8-aAKZIQXdi

and

https://drive.google.com/open?id=1-I6sR5y-Mzi3RlCk6TQFpE5rG3pHMxa_

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William H. Bryden

SKILLS

Up-valuing existing factories through microbial production, mycoremediation, species cultivation development, ecoponics development and design, customized class 10 biosecure lab design and construction, office/scientific/lab software, culturebank development and maintenance, business plan development, photography, aviation, permaculture land development.

EXPERIENCE

Atlantic Mushrooms Inc, Lumsden, NL — *Director Research and Development*

April 2016 - PRESENT

- Developing new anexic cultures
- Designing and developing biosecure class 10 equivalent labs and microbial factories.
- Directing a team of microbial researchers
- Training lab staff
- Contamination source determination
- Genetic analysis of strains
- Exploring new microbial cultivation techniques
- Liaison with provincial production and research facilities

Consultant, Lumsden, NL

2012 - Present

- Risk assessment for aquaculture facilities.
- Environmental Assessment Review.
- Surveillance and monitoring of aquaculture facilities.

EDUCATION

Memorial University, St. John’s, NL — *B.Sc Ecology and Evolutionary Biology*

1991 - 1996, St. John’s

Honors program. 27 courses at the undergraduate and cross referenced graduate level focused on ecology, parasitology, molecular genetics, physiology

Honors research funded by provincial government, presented at National Zoology Conference.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that the re are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

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Title:

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William H Bryden

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ANNE MARIE HOWELL NEWFOUNDLAND