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Road Salt and Salmon

Restoration for Resilience Conference
February 14, 2018

Alan James, BSc, MA

Alan James has been a volunteer with the Stoney Creek Environment Committee in Burnaby for 17 years. He had a long career as an exploration geophysicist in the Alberta oilpatch followed by several years as a computer consultant. He has a BA in Physics and Chemistry from UBC, and an MA in Geophysics from the University of Toronto. He now advocates for changes in how we deal with toxic road salt in Canada.

[Member: American Association for the Advancement of Science, Ecological Society of America, and Society for Ecological Restoration]

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Me at age 7

I grew up in Vancouver. We spent summer vacation on Gabriola Island where I caught my first salmon.

This afternoon, I'd like to tell you about what our **volunteers** do, why Road Salt is so **toxic** to salmon, and what we can **do** about it.

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Last year, 46 volunteers put in more than a thousand hours protecting and enhancing Stoney Creek and its wildlife.

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In the spring, they count small juvenile salmon.

In the fall, they count the returning fish that struggle upstream to spawn.

Imagine seeing big fish in the city, like this Coho that Alan Russell is holding.

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GREAT SALMON SEND-OFF

Our fish release, The Great Salmon Send-Off, attracts around 2000 adults and children every spring.

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Our volunteers also do a lot of riparian restoration. They remove English Ivy and replant with native species.

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But my personal passion are the **salmon**.

Fernando Lessa, who is doing a project about Salmon in the City, took this photo of Coho fry in Stoney Creek.

see http://www.fernandolessa.ca/

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Stoney Creek is a small urban salmon creek with its headwaters on Burnaby Mountain

My creek begins up here on the SFU campus and it drains into the Brunette River and then into the Fraser.

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The creek is a great place to watch for fish and listen to nature in the city.

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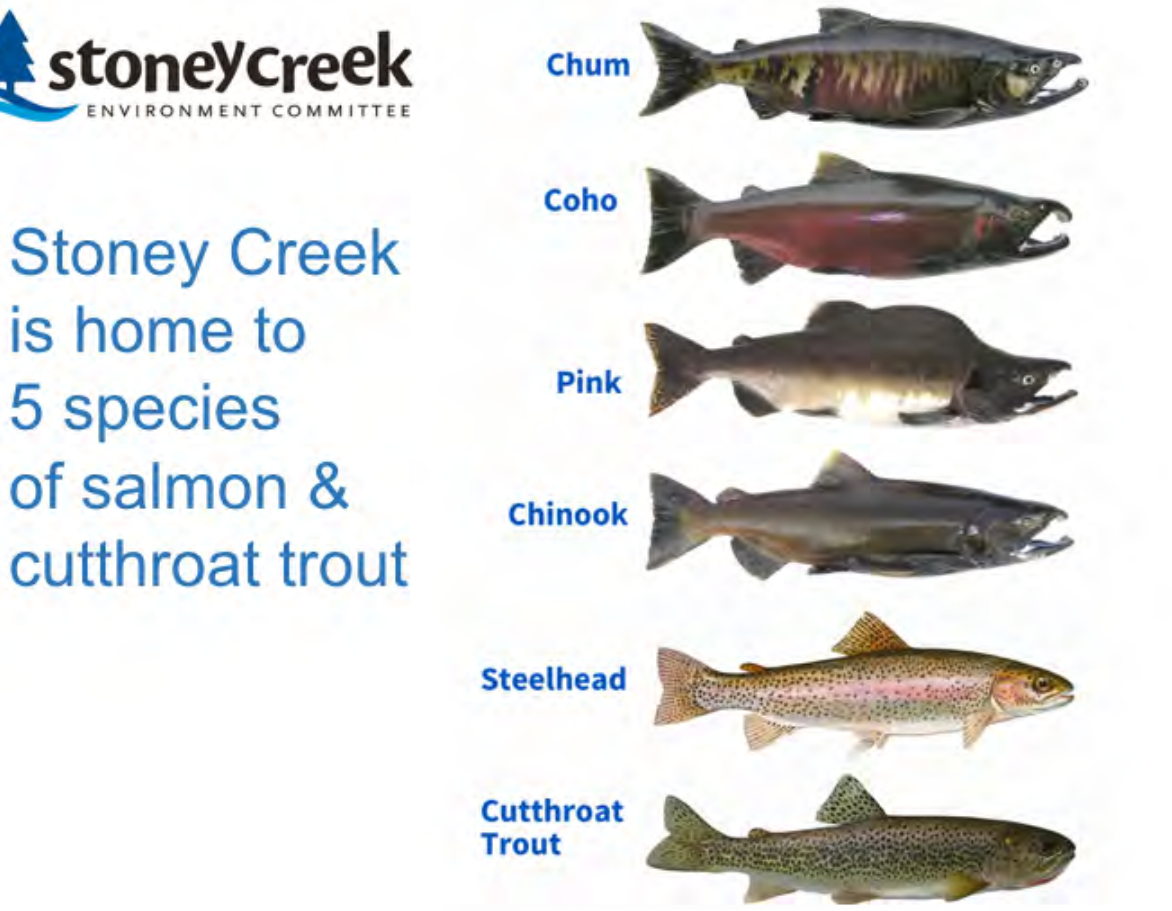

Stoney Creek is home to 5 species of salmon: Chum, Coho, Pink, and a few Chinook and Steelhead. Also some resident Cutthroat trout.

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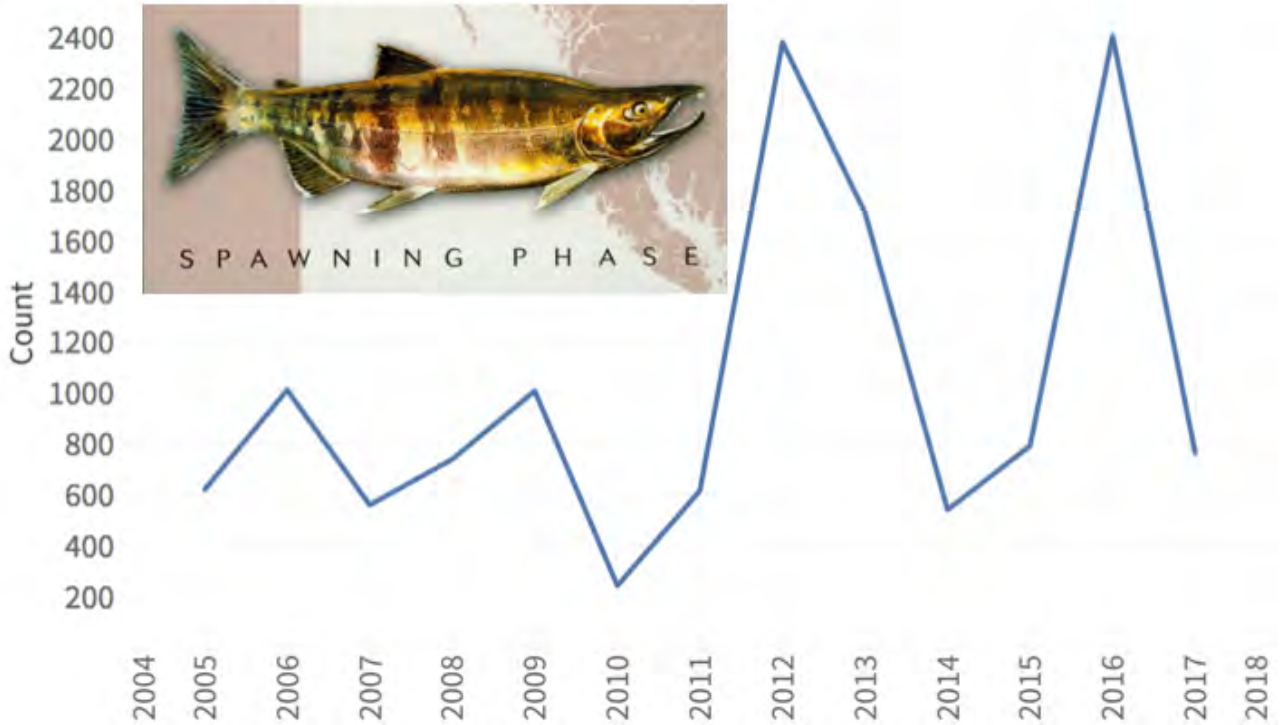
Stoney Creek Chum Spawner Counts



Chum are the most common salmon in Stoney Creek.

- They leave for the ocean soon after hatching.
- They stay in the open ocean for 3 or 4 years.
- The annual returns are highly variable and unpredictable.

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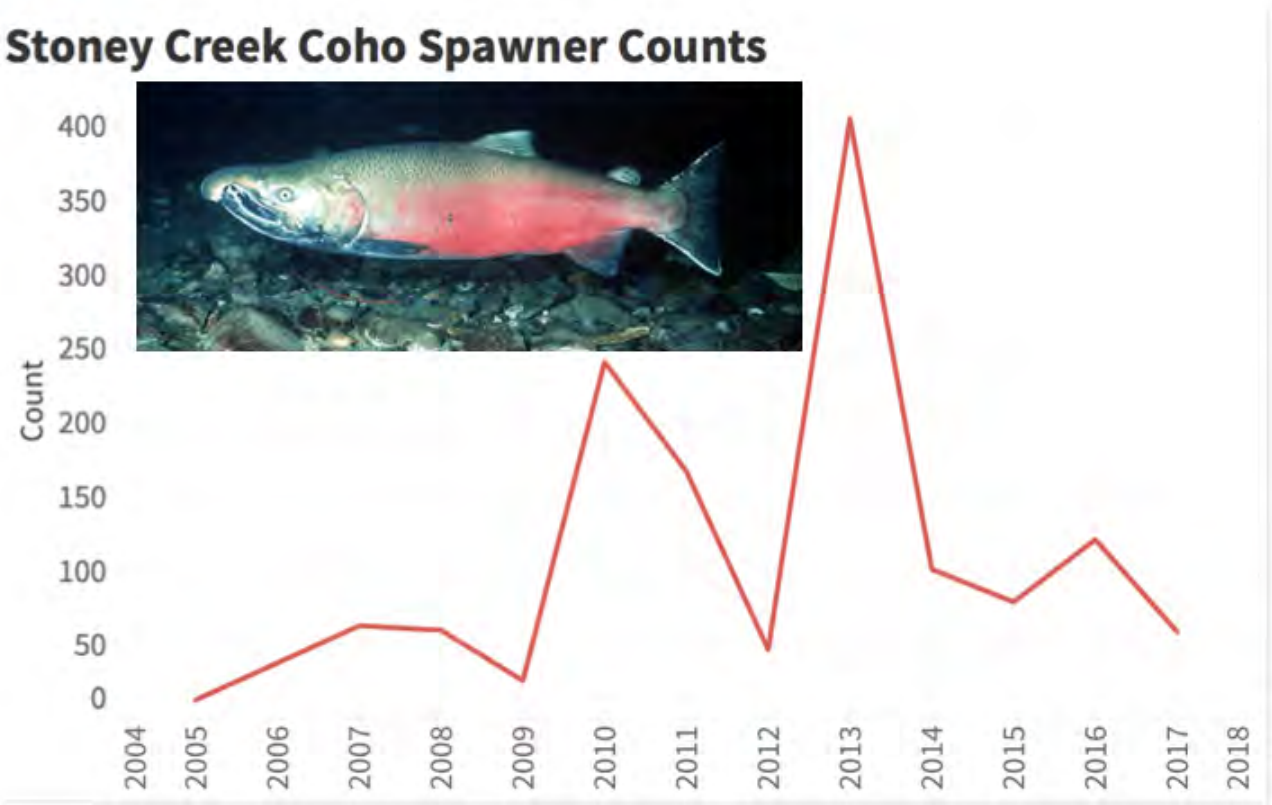

Coho returns are the ones we watch most closely.

As Coho stay in the creek for their first year, they are most affected by the creek's water quality.

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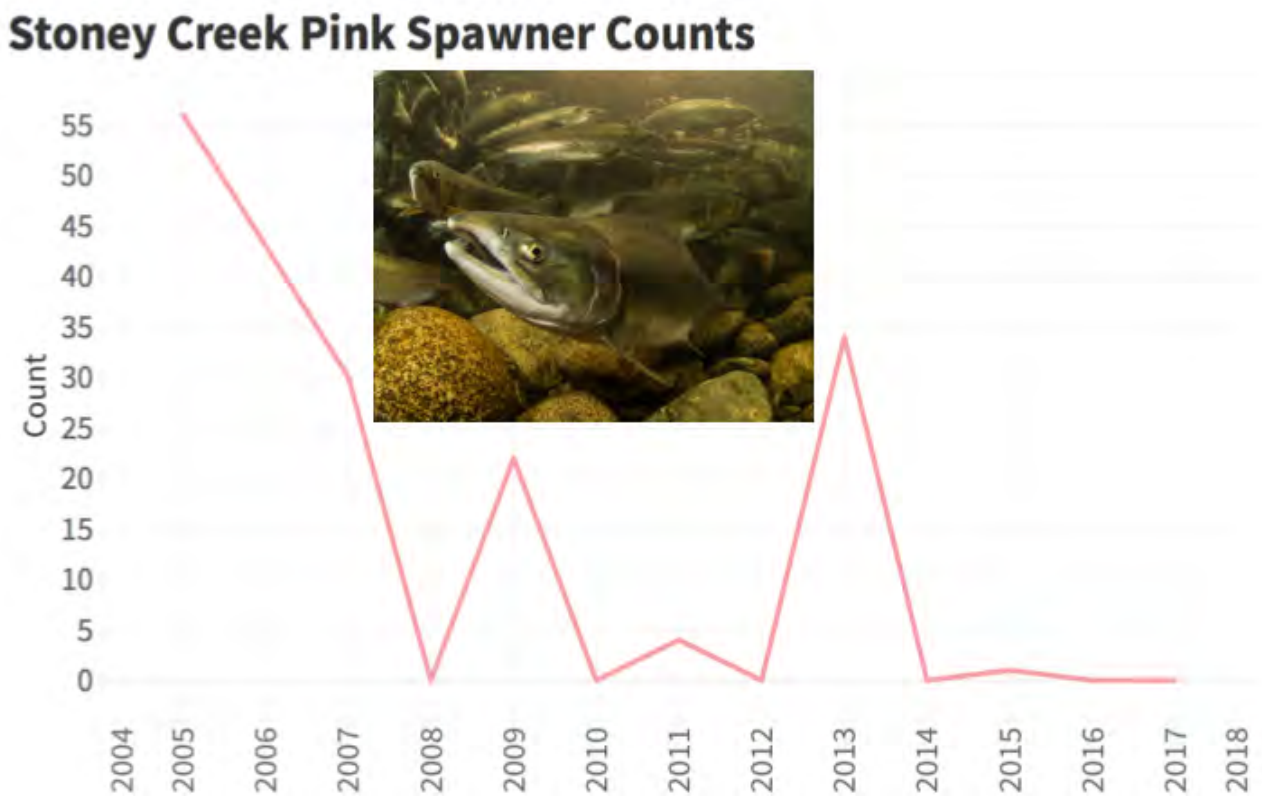

Pinks have a two-year cycle, returning only on odd-numbered years.

In the last few years, low water has prevented them from entering Stoney Creek.

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Endangered Nooksack Dace

Stoney Creek is also home to the tiny endangered Nooksack Dace, which is red-listed in the Species at Risk Act.

To survive, all these fish need water that is:

clean (no silt or chemicals)

and **cool** (lots of trees for shade).

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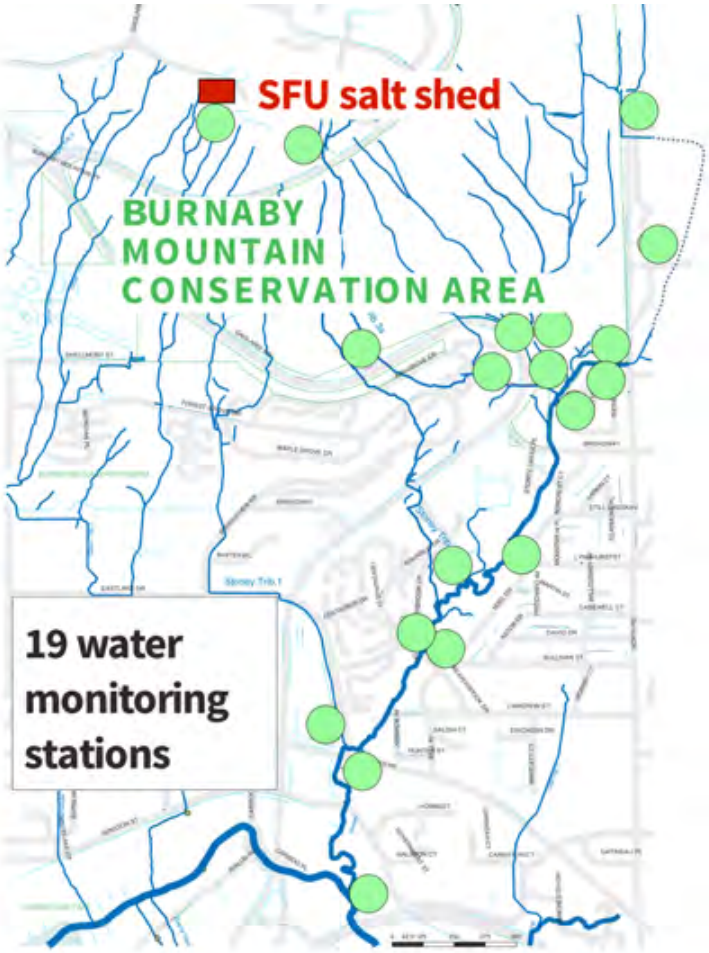
Volunteer water monitoring



Vladimir Soukhatchev is a Stoney Creek volunteer.

He is a fisheries biologist, and in 2003, he wanted to record the health of the creek.

He collected water samples at 19 locations, spending 4 hours a week over several months.

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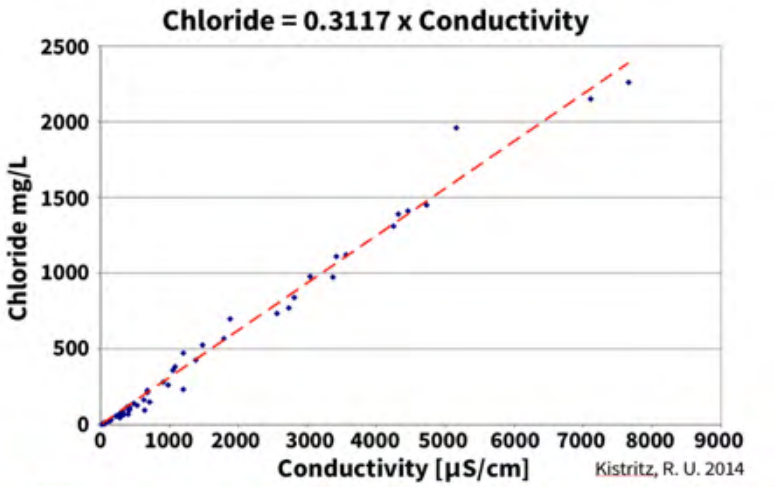

He measured Dissolved Oxygen, pH, turbidity, and conductivity.

Conductivity has a straight line relationship to chloride concentration.

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water monitoring led to SFU salt shed

His work traced some chloride contamination to the SFU road salt storage area.

This open structure had been in use since the early 1980s and the ground around it was saturated with salt.

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Whenever it rained, the salt found its way into the groundwater through cracks in the apron.

Vladimir pointed this out to SFU for several years without success.

How could we convince SFU to take our concerns **seriously**?

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In-stream study begins in December 2008

With an in-stream study, perhaps?

Here on the right, Vladimir puts chum salmon eggs into incubation trays.

He enlisted help from Maurice Coulter-Boisvert, our Fisheries and Oceans Community Coordinator and Jennifer Atchison, one of Stoney Creek‘s founding members.

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Bio-assay locations

Braving the snow, they put one set of eggs below the ring road at Nelson Way in Tributary 3A, which is contaminated with road salt.

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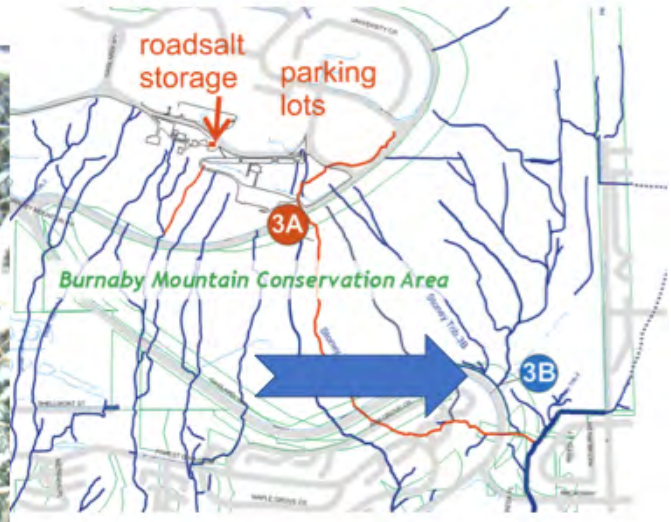

They put a second set of eggs in Tributary 3B, a clear part of the watershed.

Over the winter, Vladimir tended to the eggs. The eggs began to hatch on January 14 and all were hatched by February 3. Here are some alevins showing their size compared to a Loonie.

After all the eggs hatched, he moved the alevins into rearing trays. There they were able to swim around in the fast flowing water, but not out into the creek.

He released all the fry into the creek on April 25th.

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Chum in-stream bio-assay 2008-2009

Study Measure	Tributary 3A	Tributary 3B (control)
Egg survival	94.2 %	96.2 %
Alevin mortalities and deformities	4.8 %	1.0 %
Total egg and alevin losses	10.5 %	4.8 %

At the end of the study, he showed the **egg** survival in both locations was as high as hatchery raised eggs. But after hatching, the **alevins and fry** in Tributary 3A had more than **twice the mortalities and deformities** compared to those in the control set in Tributary 3B.

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For example, the top two alevins show hemorrhages in their yolk sacks …

the bottom one has a deformed yolk sac.

Vladimir also recorded conductivity and chloride in Tributary 3A with a sonde and data logger.

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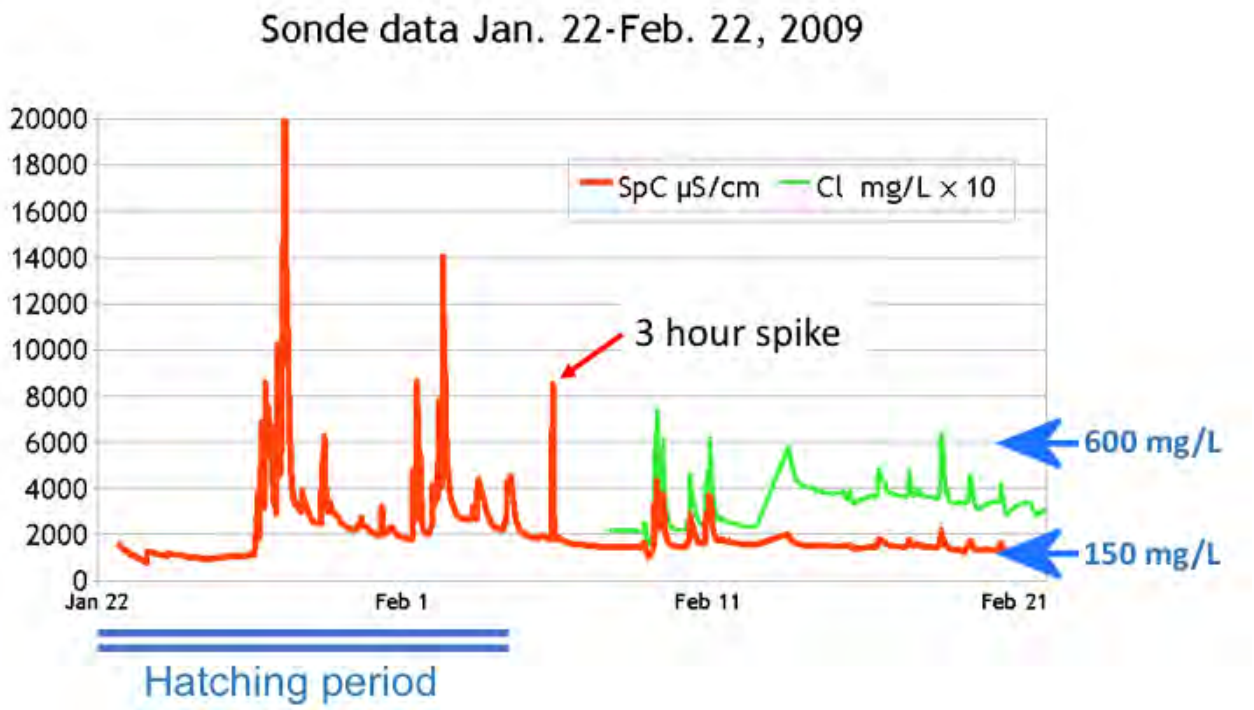
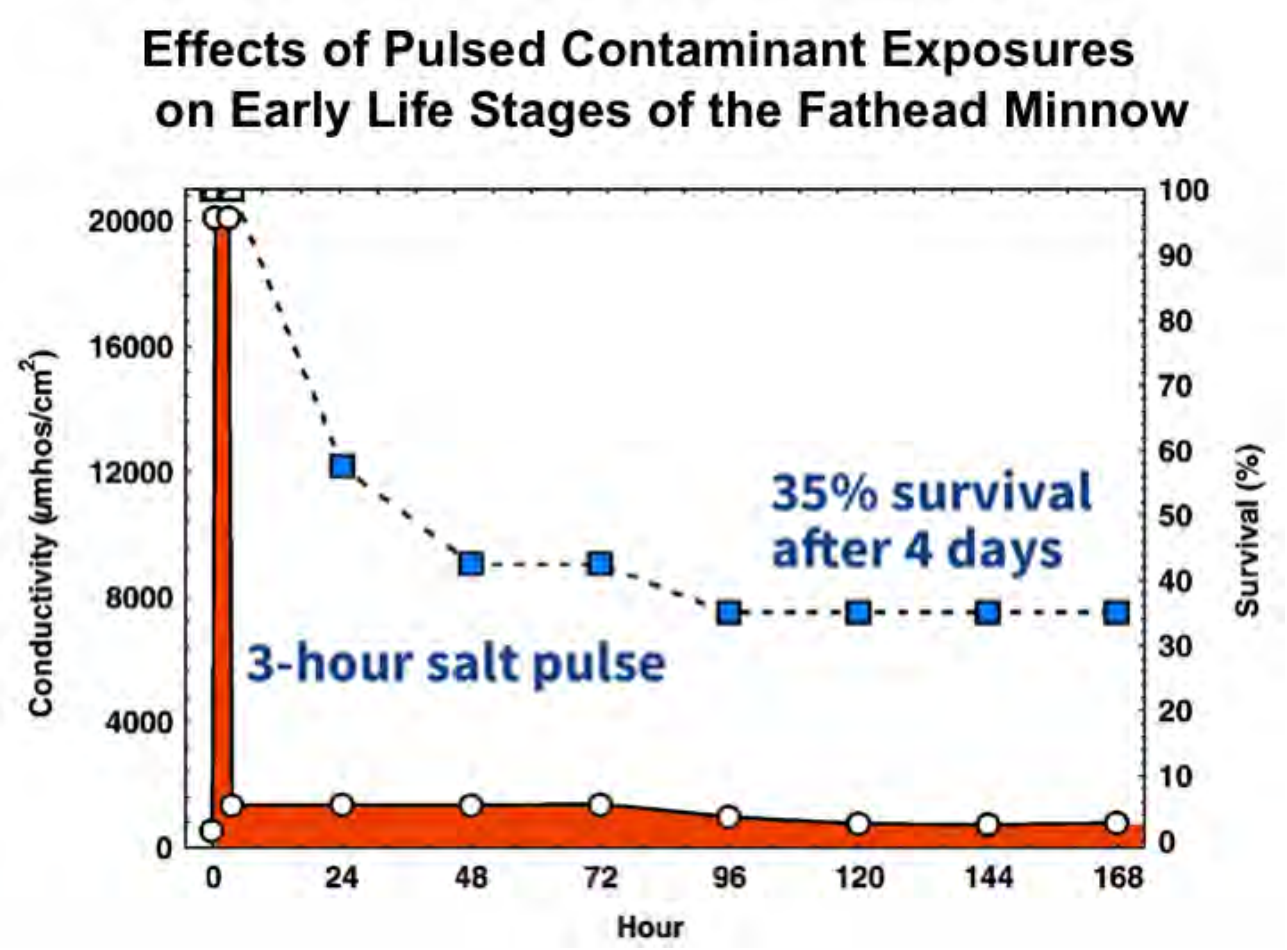


While the eggs were hatching, the snow began and SFU started spreading salt. The chloride concentration (in green) exceeded the BC Water Quality Guidelines for Sustaining Aquatic Life.

(both the instantaneous maximum of
600 mg/L – the upper blue arrow - and the 30-day average of 150 mg/L) – the lower blue arrow.

Note that some pulses of salt last only 3 hours. We believe that these wildly fluctuating salt concentrations are what most affect the young fish. Most studies of toxicity gradually raise the concentration of the substance being tested until 50% of the organisms die. That's the method used to inform Canada's Water Quality Guidelines .

[http://ceqg-rcqe.ccme.ca/download/en/337]



But, that's not the way it is with road salt. Studying a different fish, researchers discovered that a high, 3-hour salt pulse significantly reduced survival even though the average concentration was within nontoxic ranges for the organism. The red is the conductivity, the blue is the survival per cent.

Effects of Pulsed Contaminant Exposures on Early Life Stages of the Fathead Minnow [Arch. Environ. Contam. Toxicol. 49, 511–519 (2005)]

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Episodic exposure of Coho embryos to fifteen 48-hour pulses of road runoff

Results:

1. Low mortality before hatching
   - embryos protected by outer egg membrane
2. High mortality and abnormalities in alevin stage
3. Coho much more affected than Chum

There are very few studies looking at pulse contamination on **salmon**.

Researchers from Washington State University reported similar results to Vladimir's work, although the contamination is different and the pulses are longer.

[http://www.wastormwatercenter.org/jenmcintyre/]

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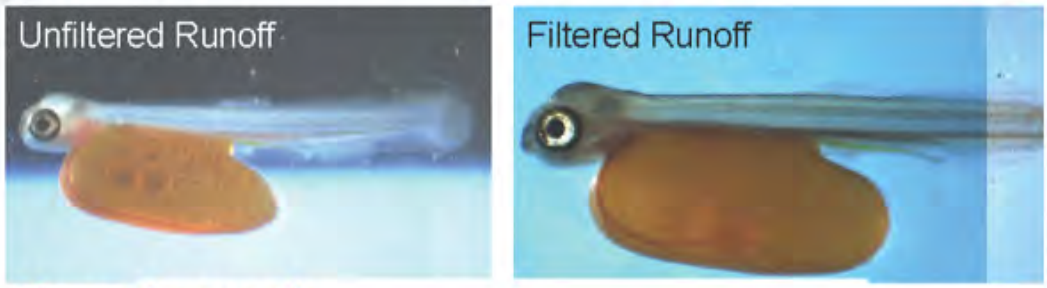
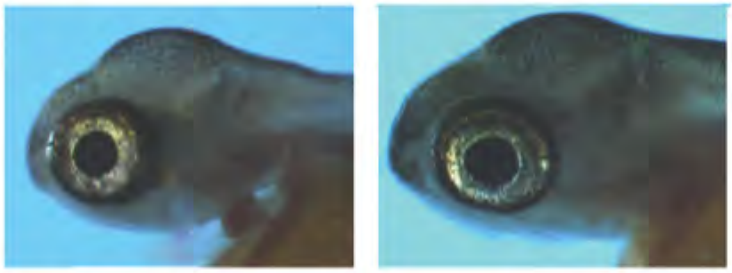
Coho Embryo Sublethal Effects of Runoff



Slowed growth



Deformities around eyes

Their research also demonstrated that rain gardens on the sides of the highway could bio-filter the runoff to make it less toxic.

The alevins on the left in the **unfiltered** runoff show slowed growth and deformities.

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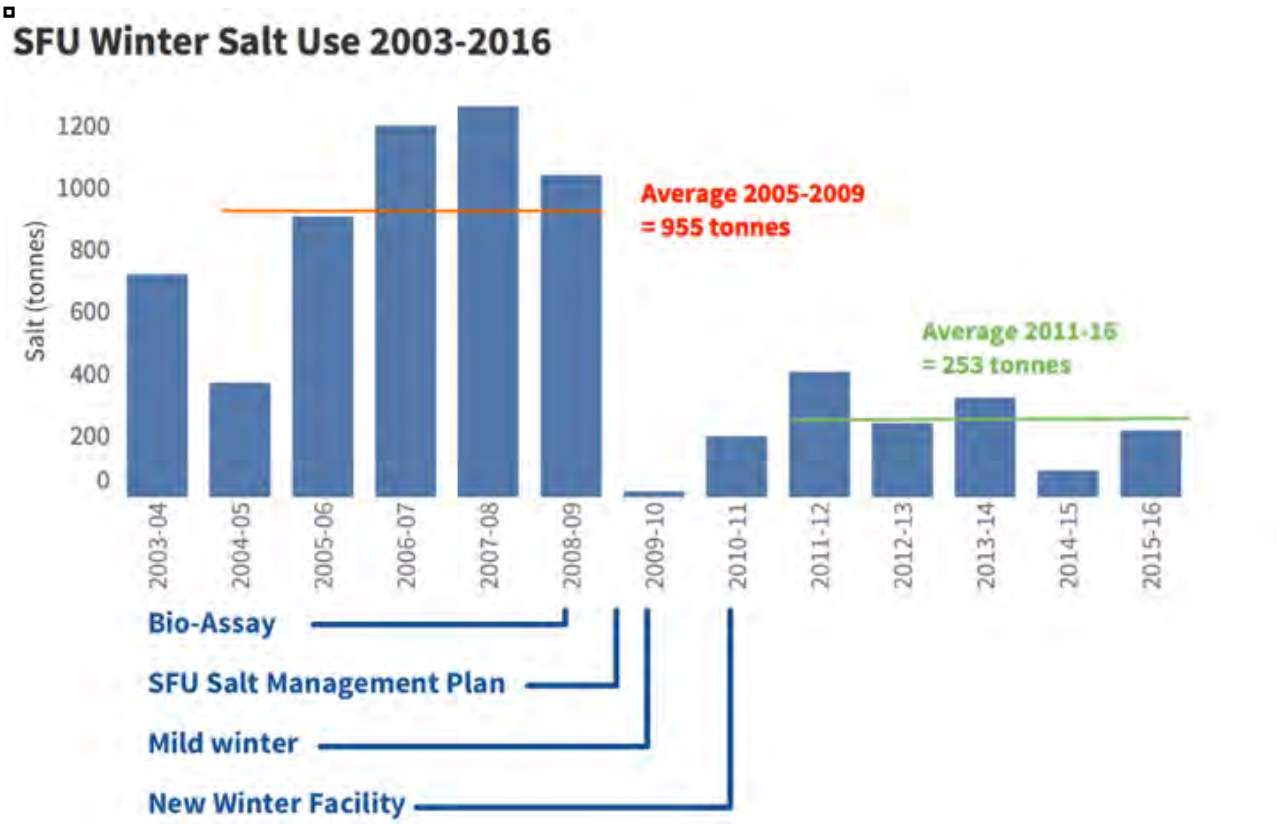
BRITISH COLUMBIA
Ministry of Environment and Climate Change Strategy

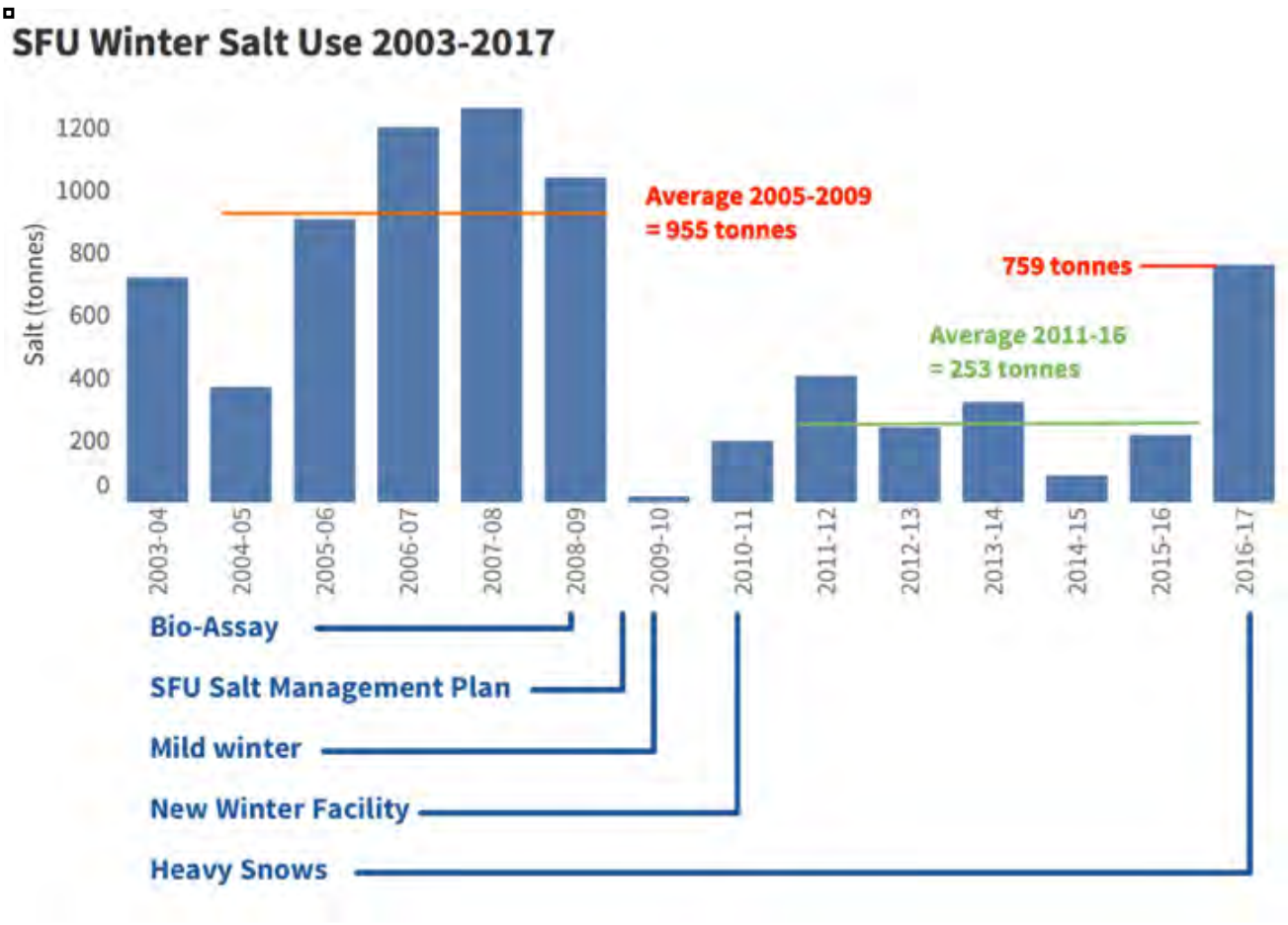
As a result of Vladimir's work, the BC Ministry of Environment ordered SFU to clean up the salt shed site. In May 2009, SFU issued a press release.

Quote: Simon Fraser University will spend more than $1 million to help protect Stoney Creek, one of the Lower Mainland's most productive salmon and trout streams.

SFU will relocate the road-salt storage facility on its Burnaby campus and is altering its snow and ice removal practices to reduce salty runoff that could affect the creek.
[http://www.sfu.ca/archive-university-communications/media_releases/media_releases_archives/media_05130901.html]



SFU **has significantly reduced** the amount of salt they use.



But, during the exceptionally snowy conditions in early 2017, they still spread **759 tonnes of salt** over campus roads and parking lots.

That is a lot of salt to dump into the surrounding Burnaby Mountain Conservation Area and into our creeks.

How many more fish would we have in our creek without this contamination?

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Winter facility completed in 2011

By 2011, SFU had moved the salt from the old open shed to a winter facility with state of the art impervious barriers.

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But the old shed is **still there** and the ground around it is **still contaminated**.

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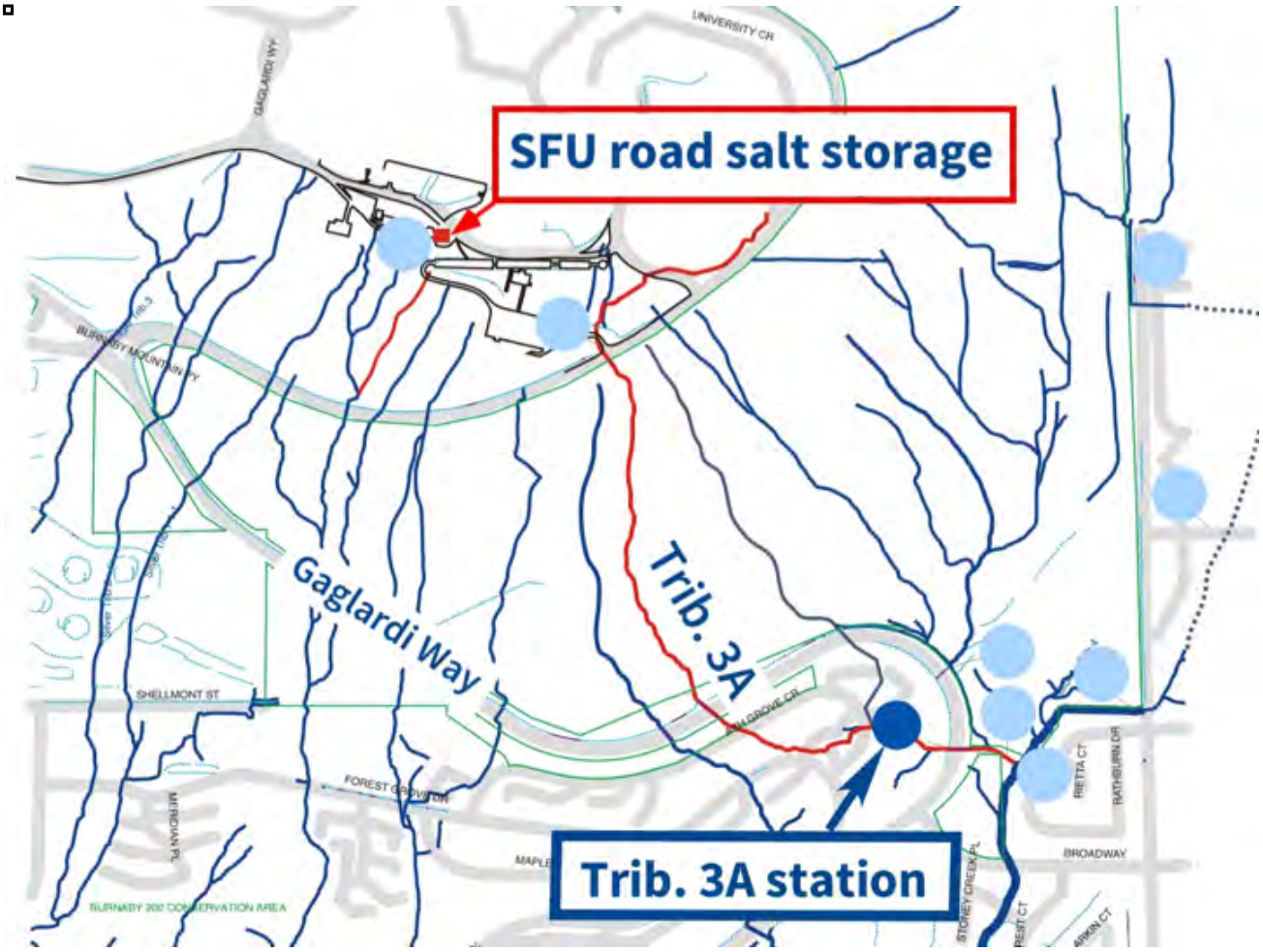
John Templeton

Another Stony Creek volunteer,

John Templeton,

has taken over water quality monitoring where Vladimir left off.



For the last five years, he has taken daily grab samples at Stony Creek tributary 3A.

That's over 1400 readings!

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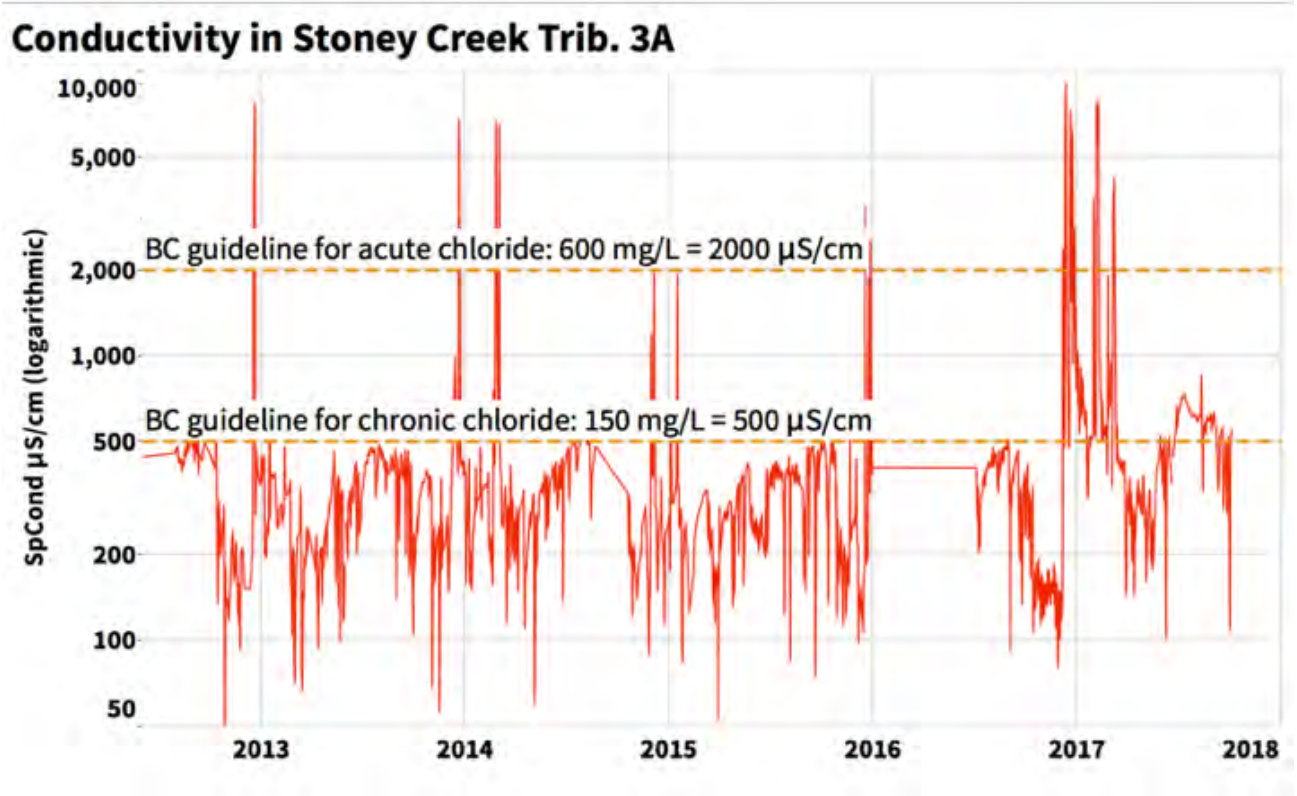

This graph of five years of monitoring shows that the **contamination is ongoing**.

We believe the salt comes from three sources, road salt spread during the winter, salt in the ground around the old salt shed, and salt in the ground around the parking lots.

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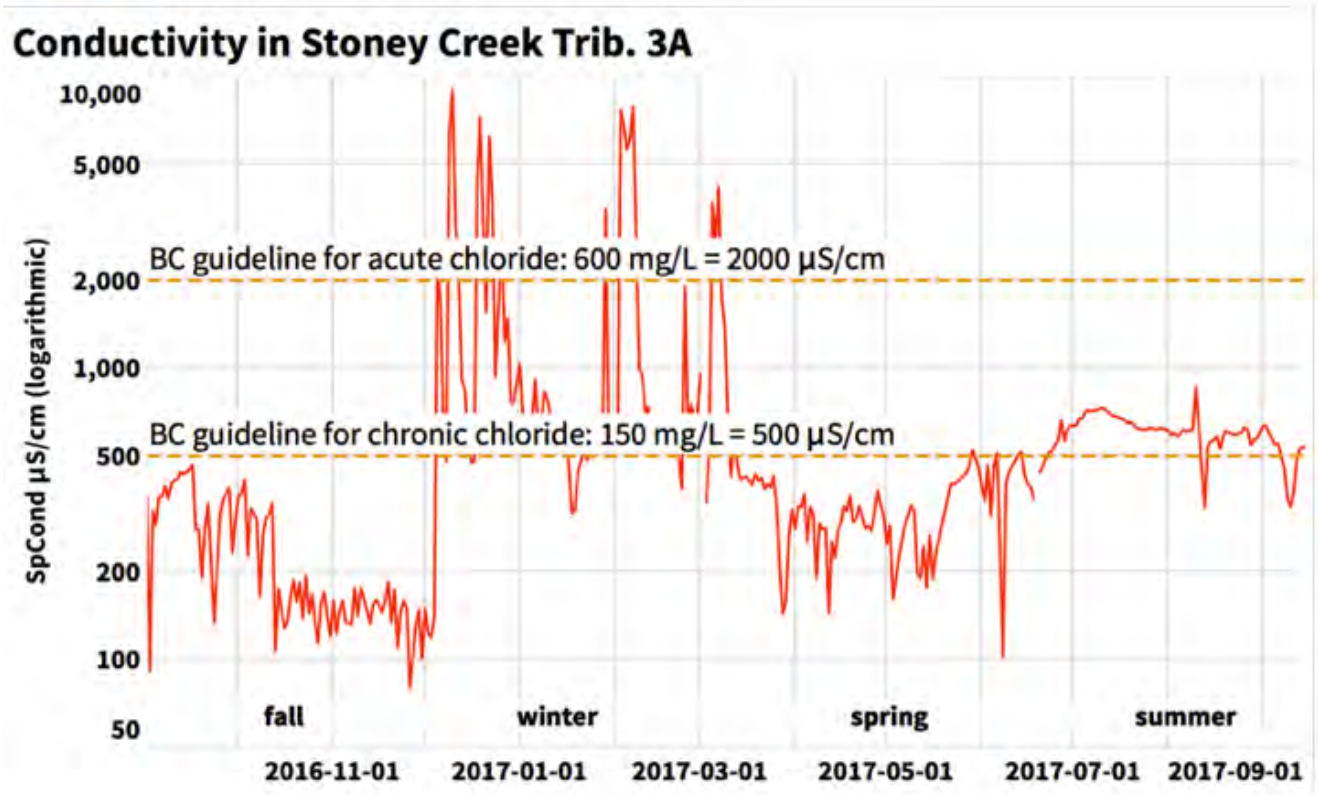


The most recent year's data shows a typical fall, winter, spring, and summer profile.
- Low conductivity during rainy fall and spring,
- high **spikes** from spreading road salt in winter.
and
- high, **steady** values from groundwater in summer.

Unfortunately, it seems that the groundwater contamination is **increasing**. Except for one rainy day last summer, conductivity was **over** the 30-day guideline from June 23 to September 6.

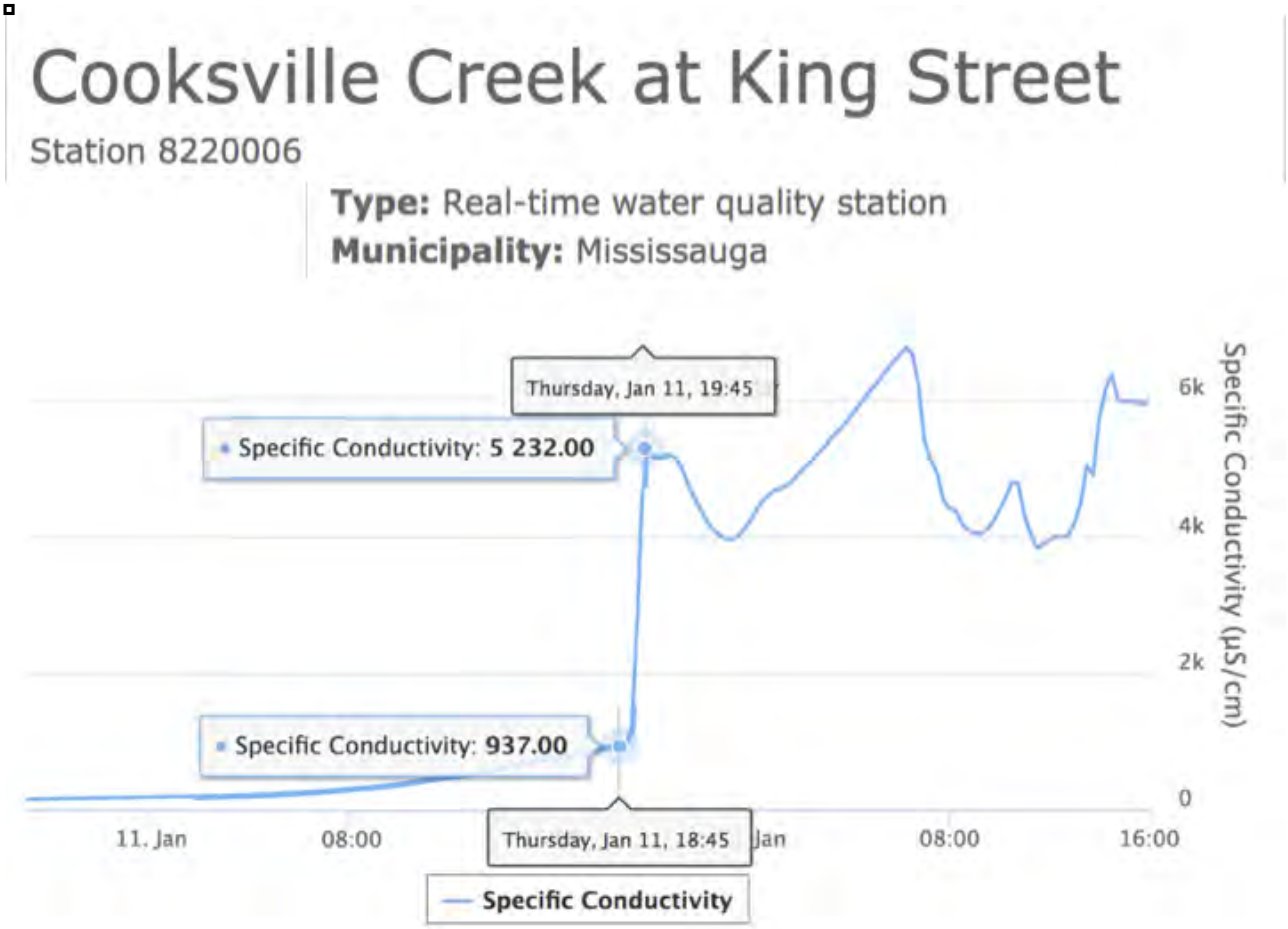
Road Salt Use in Connecticut: Understanding the Consequences of the Quest for Dry Pavement

Michael Dietz, Ph.D. and Lukas McNaboe

February 14, 2017

Other studies show similar data patterns.

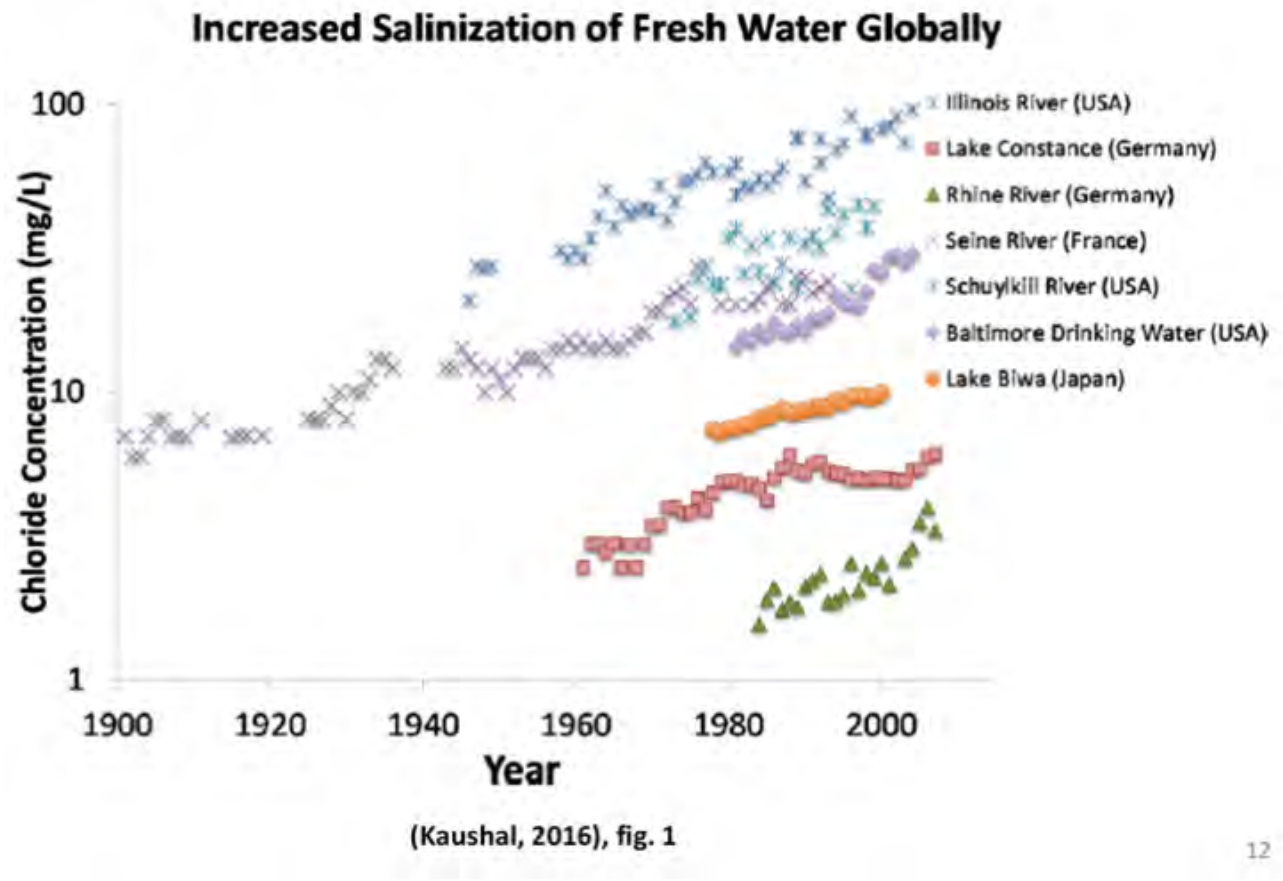
[http://clear.uconn.edu/webinars/CLEARseries17/roadsaltwebinar.pdf]



This graph shows continuous conductivity measurements in Cooksville Creek in Mississauga, Ont.,

After the first significant snowfall in January, the city applied road salt and the effects on the creek were evident within the hour.

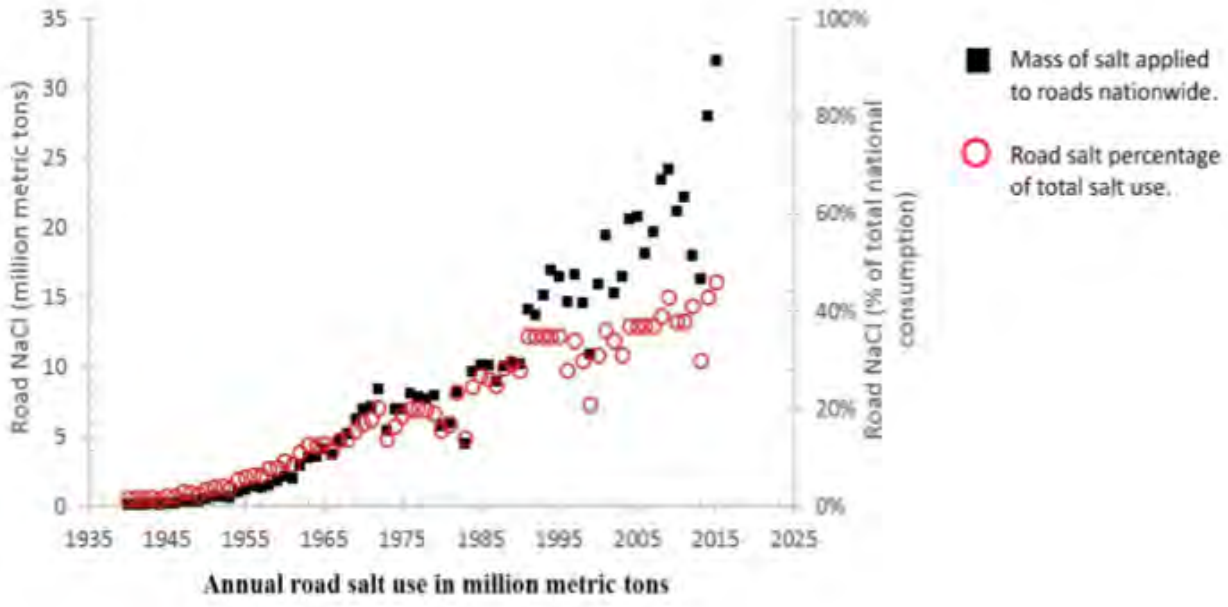
http://blog.wwf.ca/blog/2018/01/10/wildlife-dying-due-road-salt-must-stop/]



So, while salt is a local problem still to be solved, it is also a wider issue.

Here's some worldwide data showing increasing salinity in rivers and lakes.

Road salt use in US has increased



In 2015, the US applied more than 30 million metric tonnes of road salt. (the black squares)

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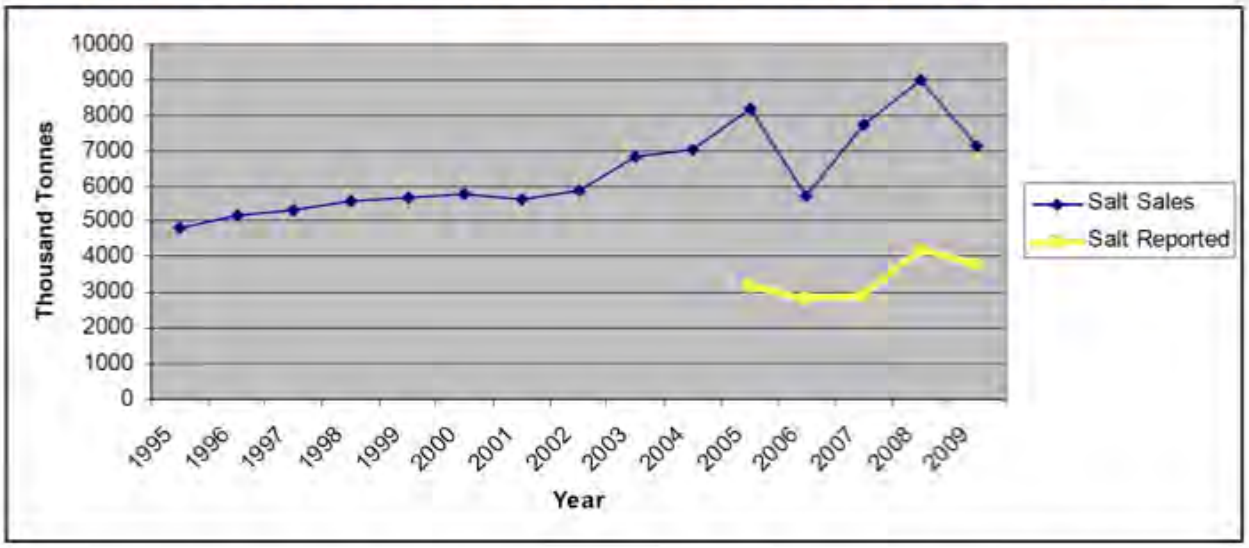
Road salt use in Canada has increased



Salt reported excludes data from Quebec. The source of salt sales data is the Salt Institute. Total salts include all types of chloride road salts.

Figure 2 Total Annual Salt Sales from 1995 to 2009, and Total Annual Salt Use Reported Under the Code from 2005 to 2009

Salt use in Canada is increasing, too. The top, blue line shows the annual salt sales; the yellow line is the road salt reported to Environment Canada by large organizations. Almost half, more than 3 million tonnes, are NOT reported. World Wildlife Fund says, "Seventy per cent of road salt contamination in the Great Lakes watershed comes from private property, often large parking lots…."

In 2001, Environment Canada issued a report that listed road salts as **TOXIC** under the Canadian Environmental Protection Act.

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Priority Substances List Assessment Report - Road Salts
Environment Canada, Health Canada 2001

Thus, road salts that contain inorganic chloride salts … should be considered "toxic" under CEPA 1999 because of tangible threats of serious or irreversible environmental damage.

The report also said that poorly designed or maintained salt storage depots **clearly present a threat** to the Canadian environment.

[http://hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/contaminants/psl2-lsp2/road_salt_sels_voirie/road_salt_sels_voirie-eng.pdf]

But, for reasons of public safety, they didn't ban the use of salt outright.

Instead, with the help of industry, they came up with a Voluntary Code of Practice.

The Code was reviewed in 2009, but Environment Canada didn't release the progress report until 3 years later.

The most recent review in 2014 was also late and minimal, in my view.

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Overview of 2013–2014 Reported Data in the Context of National Targets

196 road organizations including 8 provinces, 178 municipalities, 3 private roadways organizations and 7 national parks reported under the Code of Practice (target is 220).

Many large organizations voluntarily report to Environment Canada.

But **SFU** is not one of them although it often uses **more** than the 500 tonne limit set for reporting.

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Overview of 2013–2014 Reported Data in the Context of National Targets

Of the 196 organizations who reported:

- 98% keep their road salts are under a permanent roof and on impermeable pads
- 93% have equipped their vehicles with groundspeed electronic controllers (to ensure the even distribution of salt)

This all sounds **good**.

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Highway 3 near Princeton →

← Manning Park

City of Burnaby →

Until your realize what the phrase ‘permanent roofs and impermeable pads’ means.

Note how the salt spills out onto the open aprons.

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Overview of 2013–2014 Reported Data in the Context of National Targets

- 65% cover their treated abrasives [sand and salt mixtures]
- 64% are using pre-wetting or pre-treated salts

A couple of poorer results. Pre-wetting roads with brine before salting makes the salt stick better to the roads.

[http://www.trailtimes.ca/news/city-testing-out-brine-on-west-trail-roads/]

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Overview of 2013–2014 Reported Data in the Context of National Targets

But, only 20% of road organizations have identified their salt-vulnerable areas and have prepared an action plan.

Environment Canada wants organizations to identify areas vulnerable to salt. In my view, SFU should identify the **entire south side** of Burnaby Mountain as a salt-vulnerable area and **mitigate the roadside drainage** to smooth out the salt pulses. *Enhanced roadside drainage system for environmentally sensitive areas* William R. Trenouth, Bahram Gharabaghi, Hani Farghaly [Science of the Total Environment 610–611 (2018) 613–622]

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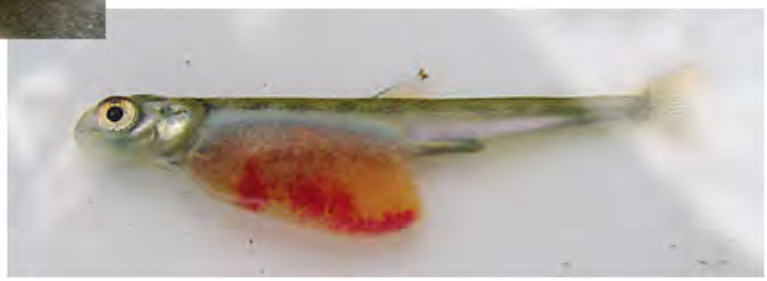
Conclusions

Road salt is TOXIC to salmon.



My main point is that Road Salt is **toxic** to salmon. But of course, it also inflicts **costly damages** to vehicles and infrastructure. In Canada, more than **$4 billion** annually.

[http://nationalpost.com/news/canada/the-awesome-price-we-pay-for-road-de-icing-melting-cars-collapsing-bridges-billions-in-damage]

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Conclusions

Unfortunately, we can't eliminate road salt until there is a cost-effective alternative.

Unfortunately, we can't eliminate road salt until there is a cost effective alternative.

We need some better or less costly alternative to salt soon.

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What are the current alternatives?

- Reduce salt use by plowing first.
- Sand instead of salt when appropriate.
- Eco-traction – a volcanic grit.
- Urea, which is not toxic, but it does have increased biochemical oxygen demand.
- Several pre-wetting options, like beet juice, decrease salt use by about 30%.

Much more research is needed.

Existing alternatives can cost between 6 to 18 times that of salt.

Here are some.

SFU has tested Eco-traction as well as beet juice which, like urea, has increased biochemical oxygen demand.

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Conclusions

- The Voluntary Guidelines are not enough to reduce salt use since only large organizations are involved.

- Government must enforce Best Practices and require **all** users to have training and certification similar to that required for pesticide application.

To sum up:

For best practices see: *Road salt application planning tool for winter de-icing operations*, William R. Trenouth, Bahram Gharabaghi , Nandana Perera [Journal of Hydrology, Volume 524, May 2015, Pages 401-410]

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What can we do?

1. Advocate for reducing road salt use in our local areas.

2. Encourage our organizations to develop methods for capturing or delaying road runoff before it hits our creeks.

Here's a test area along Toronto's Highway 401 that smooths out the pulses of salt entering the environment.

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What else?

1. We can advocate for federal mandatory requirements for Best Practices, user training, and certification.

2. You can join your local streamkeeping group and get out into nature.

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If you live nearby, the Stoney Creek Environment Committee would be happy to see you.

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Thanks

Thanks to all those who have contributed their photos and helpful critiques.

Thanks to you for listening.

Visit scec.ca

Thank you.