

High-frequency observations reveal acute chloride pulses and chloride legacy effects in an urbanizing watershed impacted by road salting

EGU22-12985

HS2.3.2: Water quality and water age analysis to understand flow and transport processes in catchments

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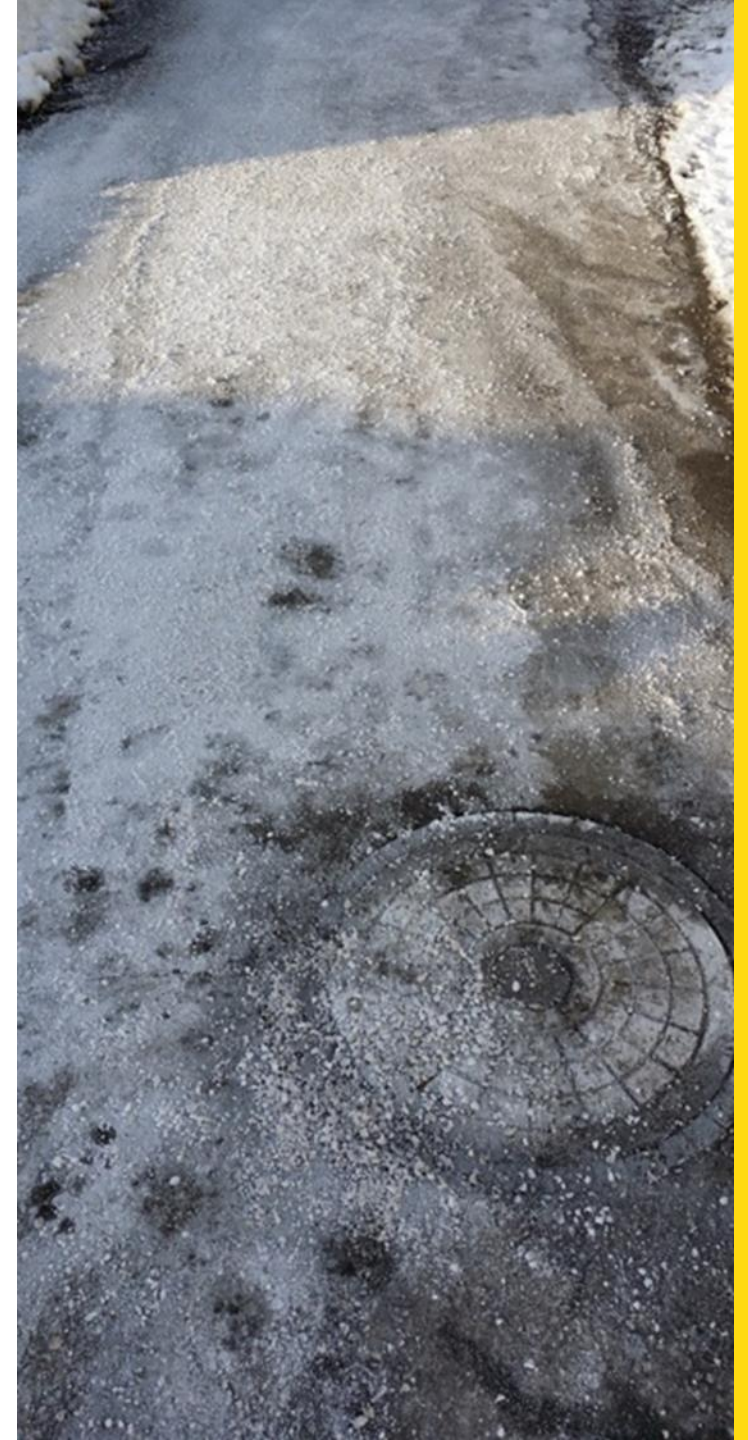


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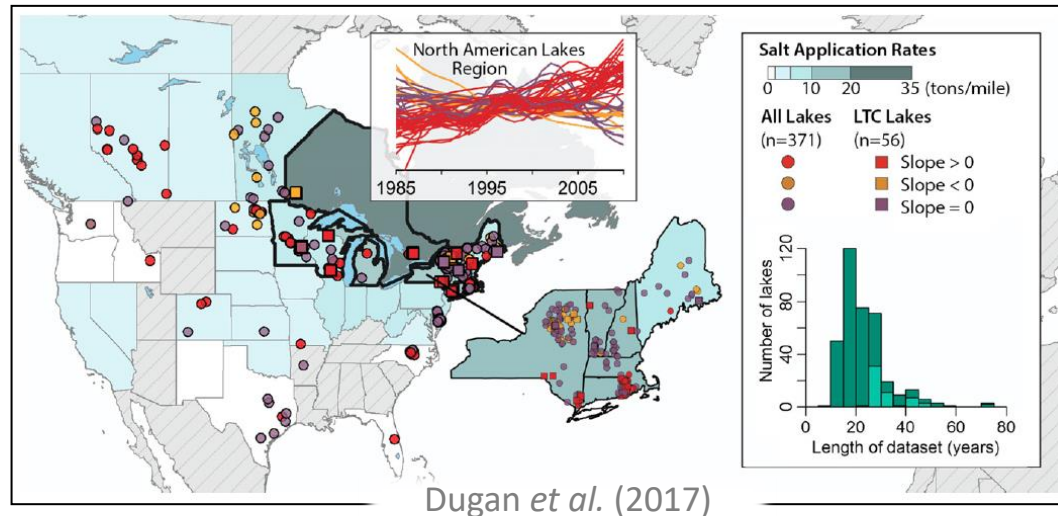
Why do we use winter salt?

- Lowers the freezing point of water
- Bare pavement = Safe travel
- De-icing
 - NaCl (97%; works to -7°C)
 - MgCl_2 (works to -15°C)
 - CaCl_2 (works to -31°C)
- Anti-icing
 - Brine
 - Alternatives
- Abrasives

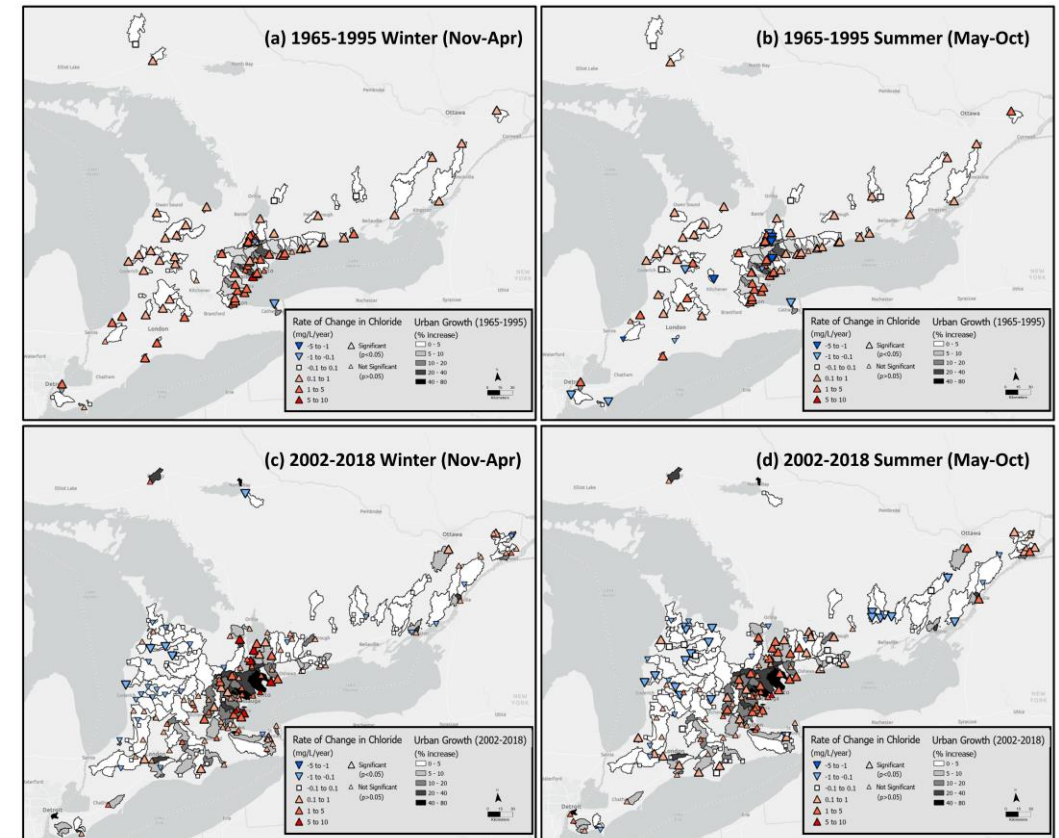


Impacts of Winter Salt on Surface Waters

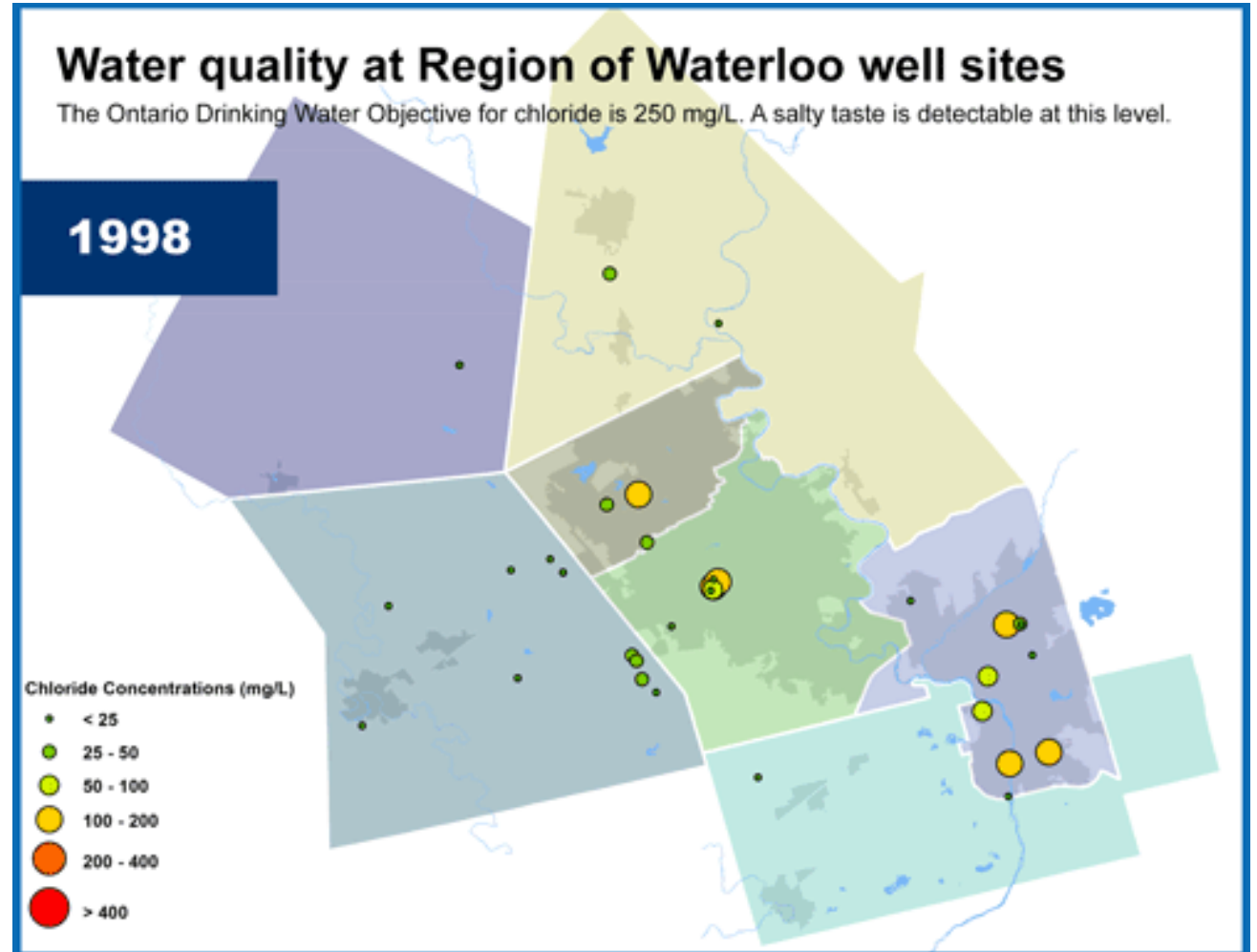
- Increasing chloride concentrations in lakes and streams



Mazumder, Wellen, Kaltenecker,
Sorichetti, Oswald. 2021.
Environmental Research Letters.



Impacts of Road Salt on Groundwater

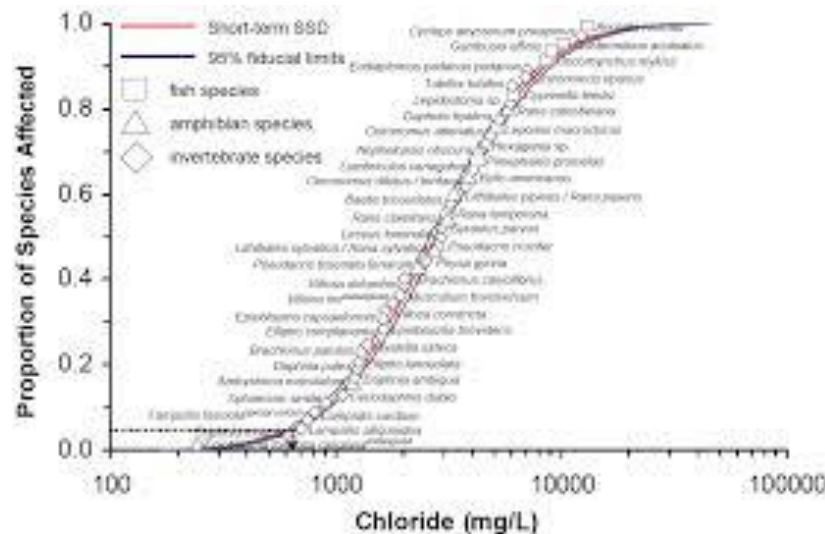


Source: Region of Waterloo

Available at <https://www.regionofwaterloo.ca/en/living-here/salt-management.aspx>

Canadian Water Quality Guidelines for the Chloride Ion for the Protection of Aquatic Life

- Long-term exposure (chronic) → 120 mg Cl/L
- Short-term exposure (acute) → 640 mg Cl/L
- Prolonged elevated Cl⁻ into the growing season may have **negative effects on the structure and function of aquatic ecosystems**

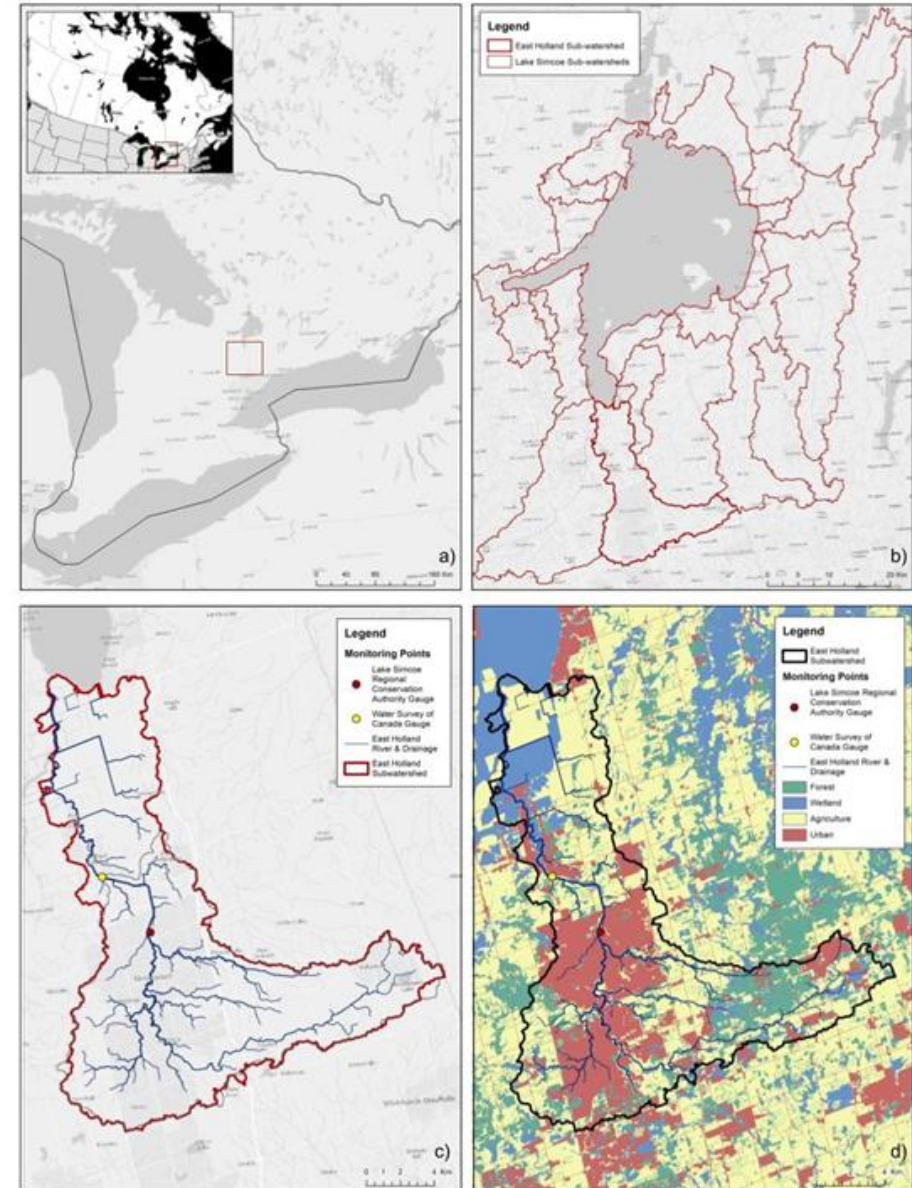


Research Questions

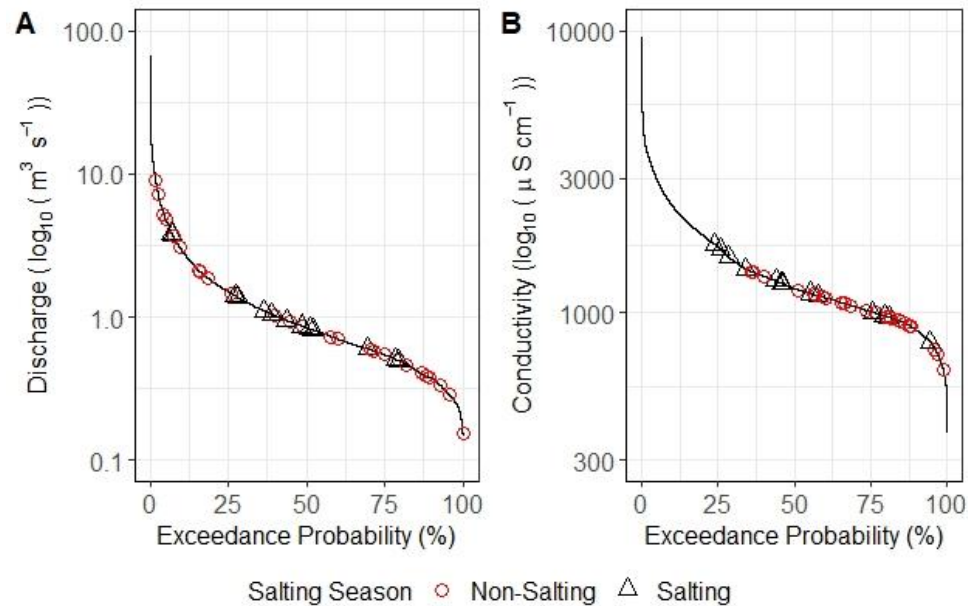
1. What is the frequency and duration of exceedances of the chronic and acute water quality guidelines for Cl in the salting and non-salting seasons across years?
2. How do Cl loads vary annually, between salting and non-salting seasons, and between event and inter-event periods?
3. Are there differences in the results of (1) and (2) between modelled Cl using surrogate water quality data vs. flow data.

Study Watershed

- Southern Ontario, Canada
 - Just north of Toronto and the Great Lakes
- East Holland River
 - 6th order river
 - Flows into Lake Simcoe
 - 50 species of cold-water fish
 - Drinking water source
- 243 km² watershed
 - 33 % forest/wetland
 - 31 % agriculture
 - 17 % urban

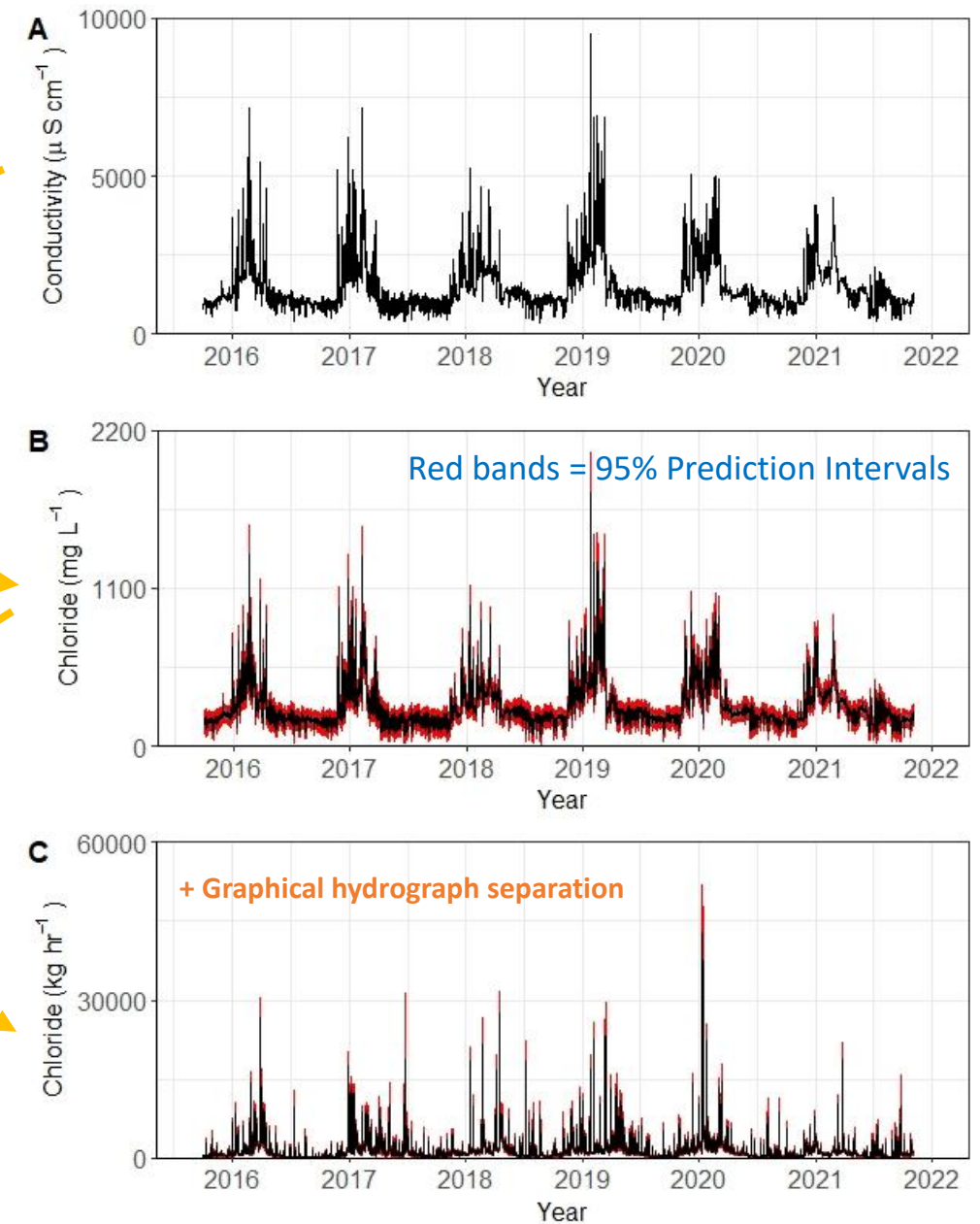
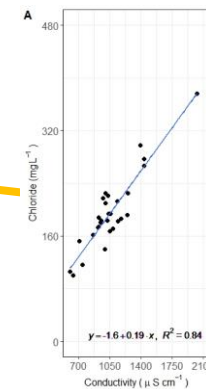


Methods



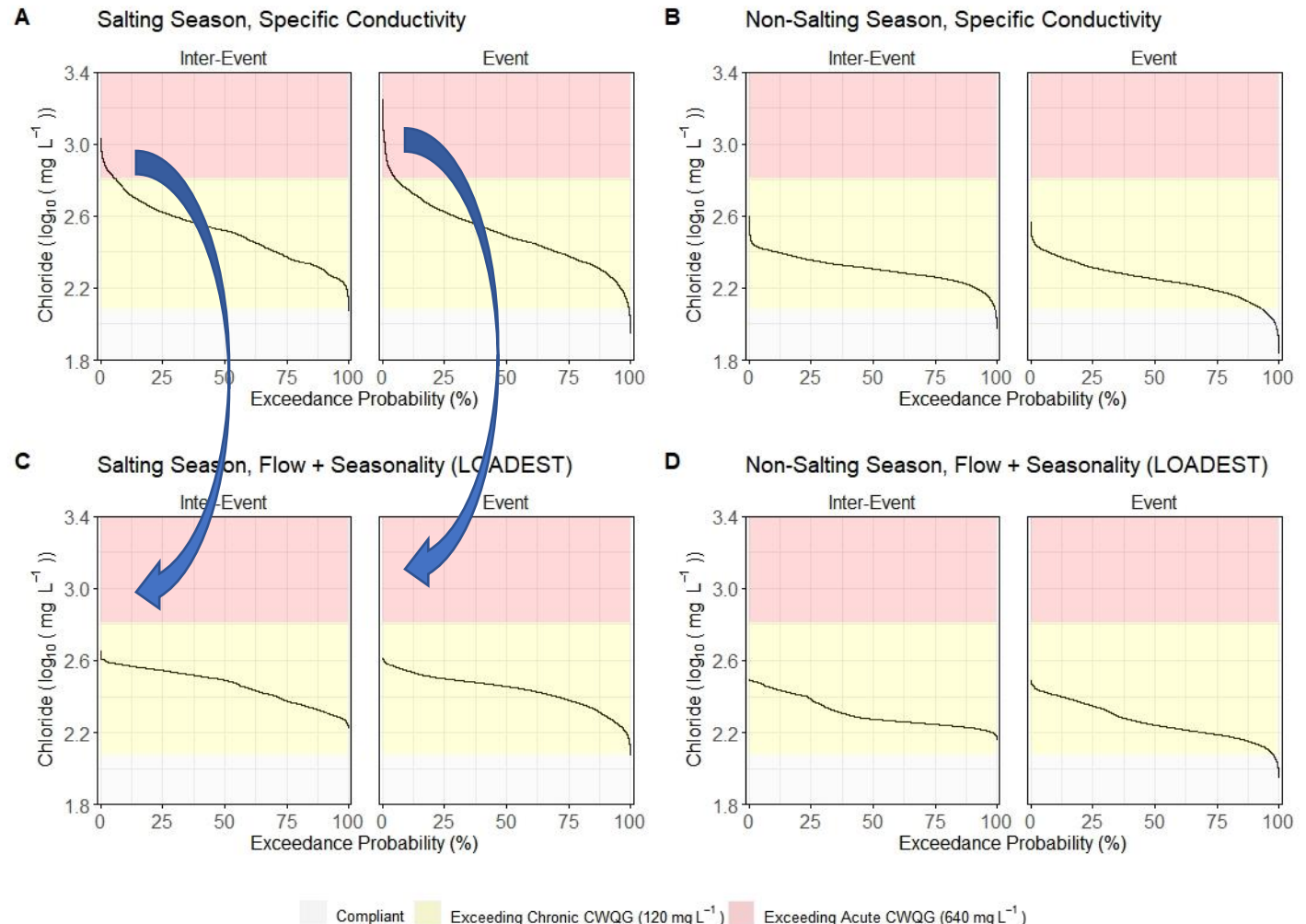
Flow (A) and conductivity (B) exceedance curves with salting and non-salting season discrete water samples with Cl measurements overlaid.

LOADEST:
 $[Cl] = f(Q, \text{seasonality})$



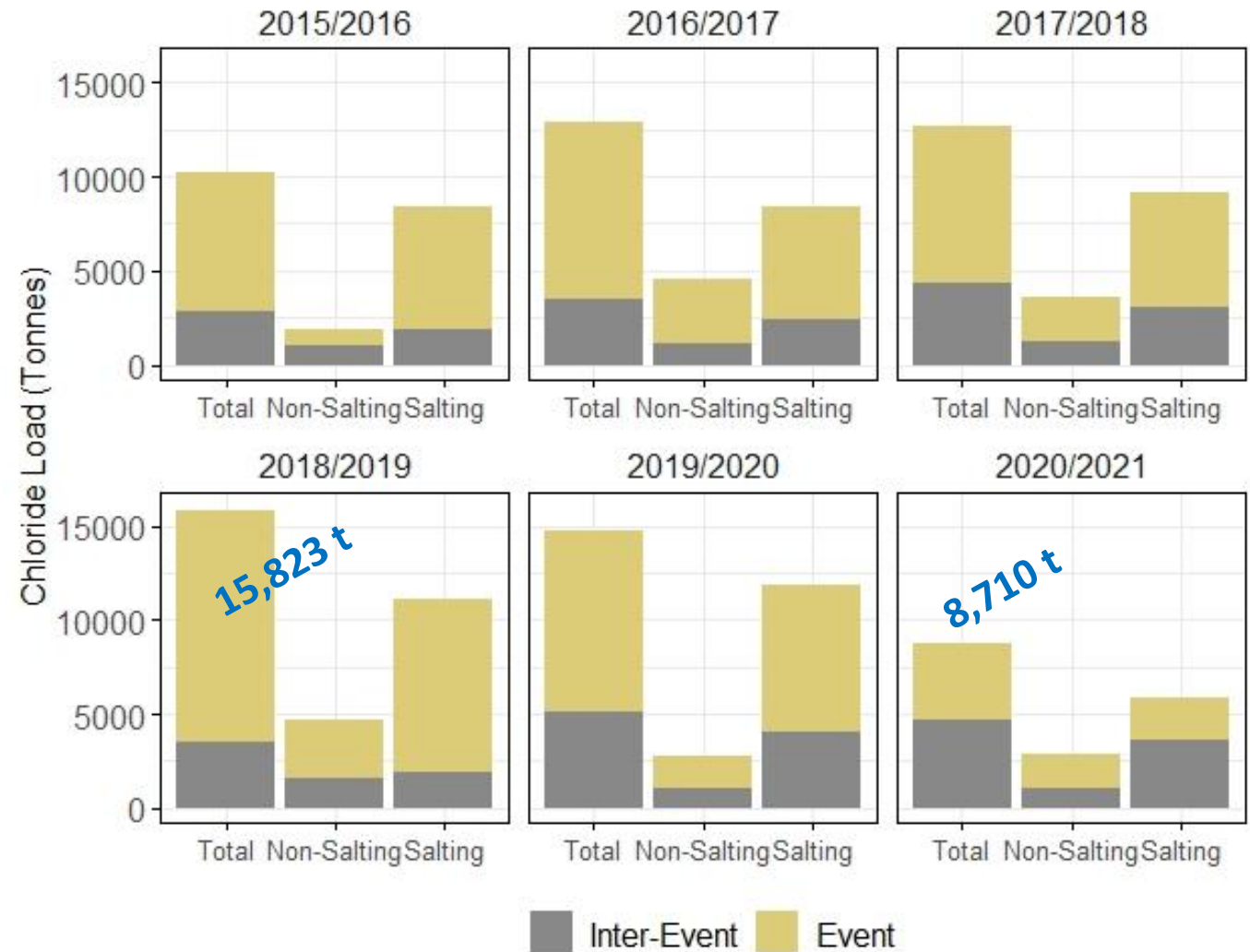
1. What is the frequency and duration of exceedances of the chronic and acute water quality guidelines for Cl in the salting and non-salting seasons across years?

- [Cl] exceeds the **acute** CWQG 3 % of the study period
 - 17 individual exceedances averaging 2 days in duration
 - Salting season only (event and inter-event periods) (**A**)
- [Cl] exceeds the **chronic** CWQG 95 % of the study period
 - 66 individual exceedances averaging 28 days in duration
 - Year-round (**A and B**)

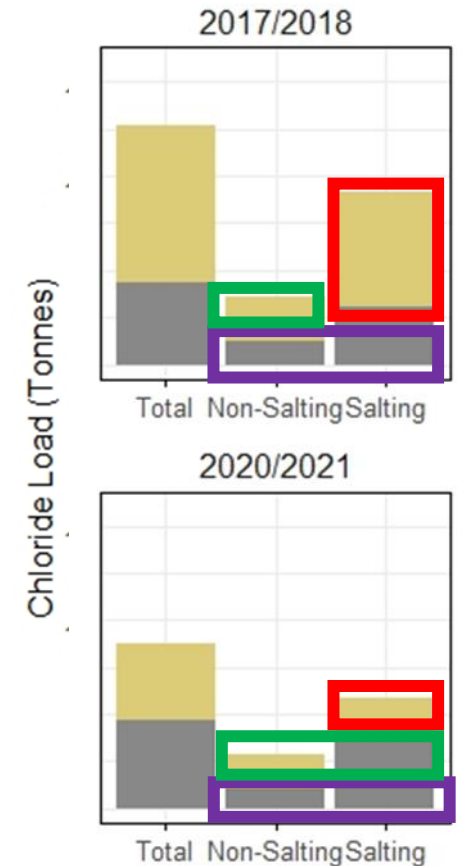
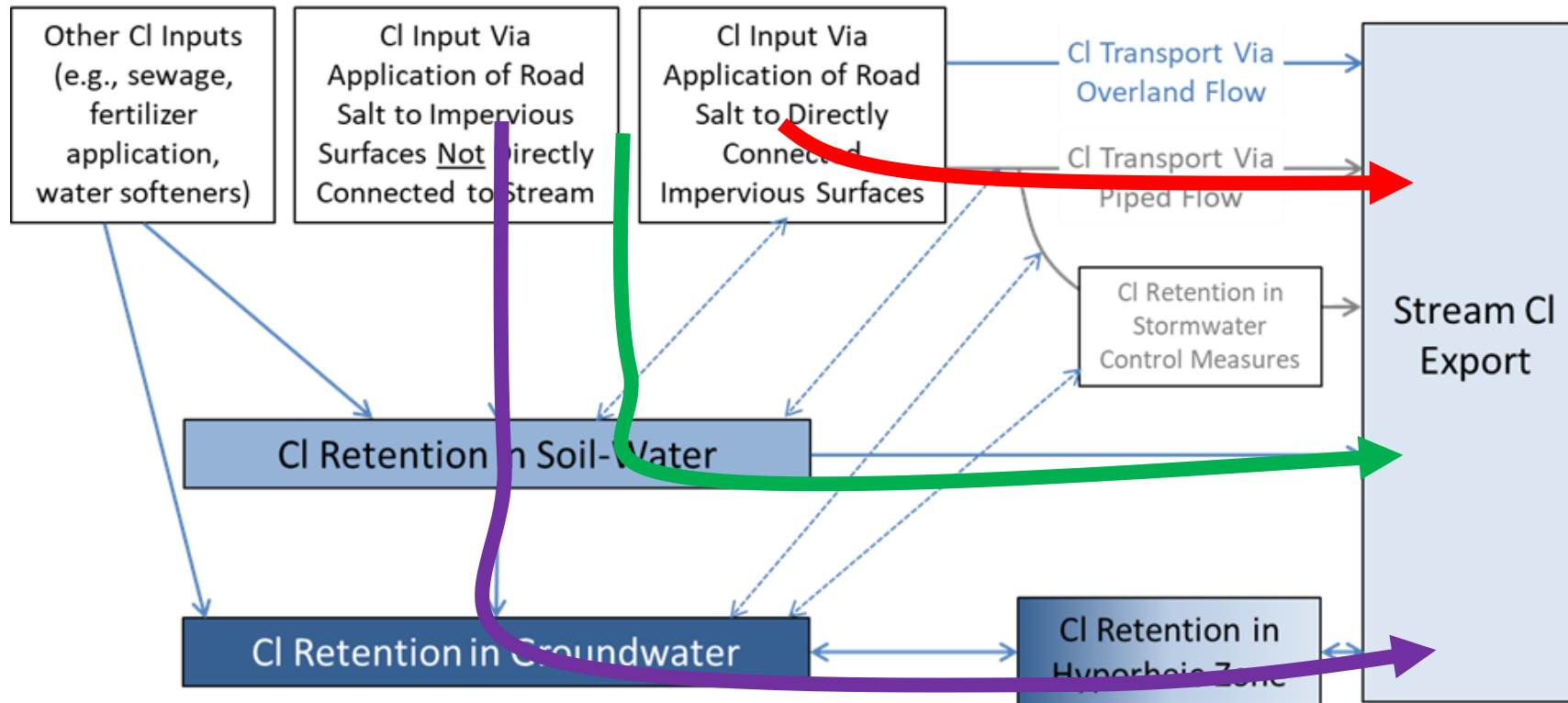


2. How do Cl loads vary annually, between salting and non-salting seasons, and between event and inter-event periods?

- Salting season Cl loads = (1.9 to 4.4) x Non-salting season Cl loads
- Inter-event periods contributed 22 – 53 % of the annual load
 - ‘Legacy’ Cl
- 0 – 24 % higher annual Cl loads using specific conductivity vs. flow + seasonality as predictors for [Cl]



Chloride Transport Pathways



Acknowledgements

- David Lembcke, Bill Thompson, Eavan O'Connor (Lake Simcoe Region Conservation Authority)
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References

- Canadian Council of Ministries of the Environment. (2011) Canadian Water Quality Guidelines for the Protection of Aquatic Life: Chloride. In: Canadian environmental quality guidelines, 1999, Winnipeg.
- Dugan, H. *et al.* (2017) Salting our freshwater lakes. *Proceedings of the National Academy of Sciences*, 114(17), 4453-4458.
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- Oswald, C.J., Giberson, G., Nicholls, E. Wellen, C., Oni, S. (2019) Spatial distribution and extent of urban land cover control watershed-scale chloride retention. *Science of the Total Environment*, 652, 278-288.

