DETERMINING CONDITIONS FOR STORAGE AND RELEASE OF ROAD SALT POLLUTION IN A CALCAREOUS FEN: A HYDROLOGICAL AND GEOCHEMICAL ANALYSIS OF KAMPOOSA BOG, STOCKBRIDGE AND LEE, MA

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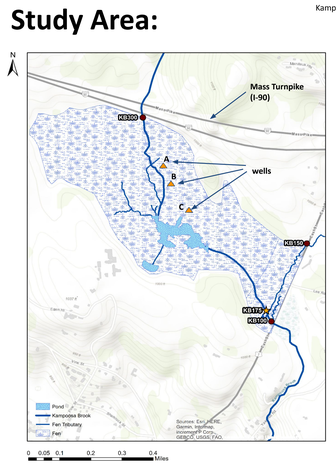
Project Objectives:

During winter, large volumes of road salts (NaCl) are applied on roads to lower the freezing point of water which prevents the formation of ice. These salts become a source of contamination of nearby soils and water bodies through groundwater and surface runoff. In wetlands adjacent to roads where salt accumulation is high, species diversity is altered and this leads to the abundance of salt tolerant plants and other invasives (A. Rhodes & Guswa, 2016; Richburg et al., 2001). Therefore, examining fluctuations in exportation and storage rates in wetlands can provide a better understanding of salt residence time in wetlands.

In this study we examine road salt contamination at Kampoosa Bog by quantifying the Cl fluctuations at different times of the year as a response to modifications to salt application rates and variations in precipitation and discharge patterns.

Study Area:



Map showing the Kampoosa Bog wetland. The red dots show location of gage stations. KB175 shown by the orange star is an additional site used in the model.

Kampoosa Bog is a 70 ha wetland complex located in a small watershed in Stockbridge and Lee, MA. Its primary inlet channel is the southern flowing Marsh Brook/Kampoosa Brook which flows under the turnpike before entering the bog. Another inlet stream (KB150) located south of the turnpike flows under Rt 7 before joining Kampoosa Brook at the outlet point (KB100).

Data Used:

- Streamflow and specific conductance (SC) data for tributaries flowing in and out of the wetland. SC is used to calculate chloride concentrations
- Monthly groundwater and surface water chemistry data for 3 wells in the fen
- Monthly precipitation and air temperature data
- Road salt application data for 1.2 mile stretch of Massachusetts Turnpike (I-90) (MassDOT, Personal Communication)

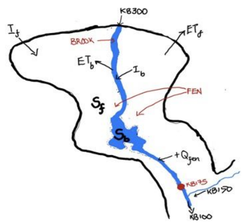
Mass Balance Equations:

Changes in water storage brook

$\delta S_b/\delta t = Q_{KB300} + (Q_{KB150} - Q_{KB100}) + Q_{fen} + (I_b - ET_b)A_b$

Changes in water storage fen

$\delta S_f/\delta t = (I_f - ET_f)A_f - Q_{fen}$



Changes in salt storage fen

$Salt_{fen}^{j+1} = Salt_{fen}^{j} + (Salt\ applied * 0.91)^{j} + M_{KB300}^{j} - M_{KB175}^{j}$

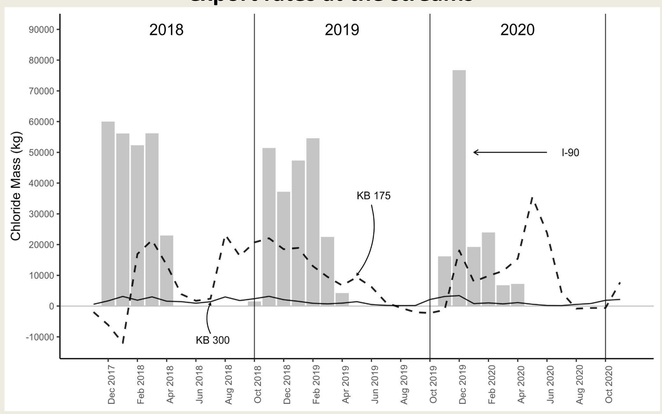
Results:

Annual Scale

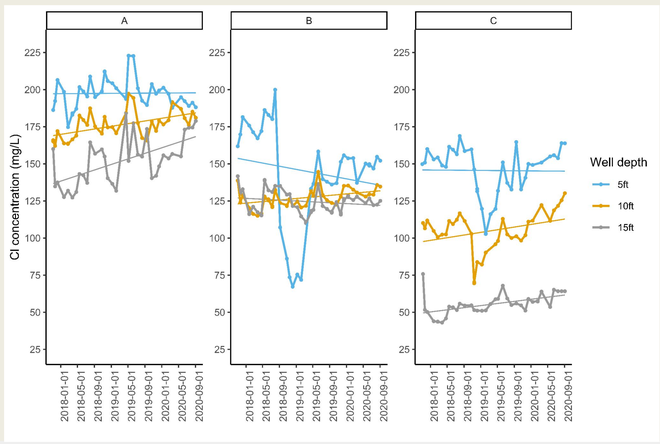
Table 1. Summary of hydrologic and chloride mass balances by water year for 2018 - 2020.

		Hydrology			Chloride inputs (thousand (kg)		Exported Chloride (thousand kg)		Stored Chloride (thousand kg)
Water Year	Total Precipitation (inch)	Average Discharge - KB300 (cfs)	Average Discharge - KB175 (cfs)	Applied to 1.2 miles stretch of I-90	KB300	Other channels	Mass	% Exported	Fen area
2018	47	1	2	214	20	194	47	22	167
2019	52	1	3	219	14	205	129	59	90
2020	46	1	2	150	15	135	120	80	30

Monthly chloride application and export rates at the streams



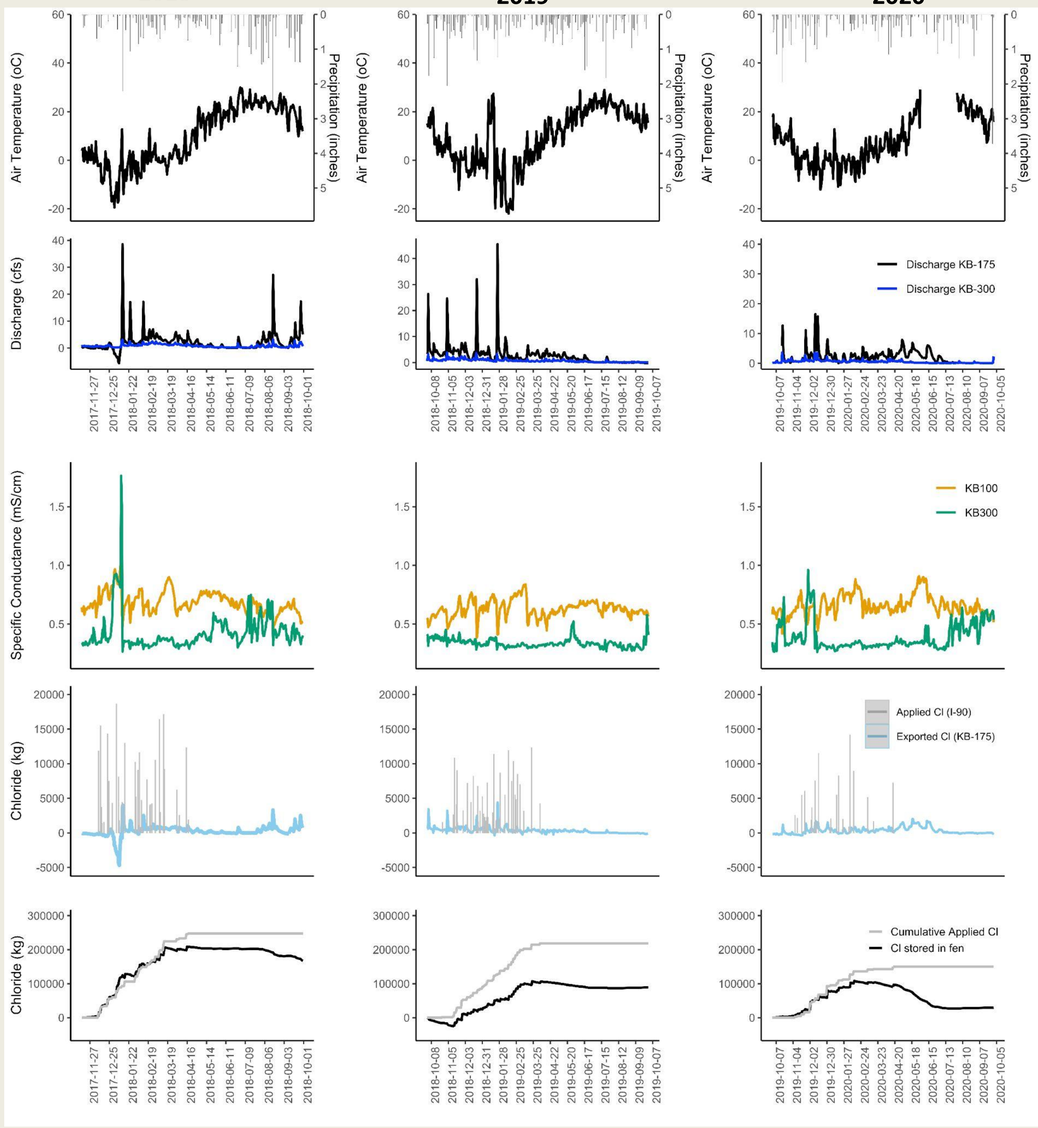
Are chloride concentrations in the fen changing?



Top: There is a seasonal trend in chloride export where higher rates occur during the non-salting summer and fall months in 2018 and 2020. Chloride application rates dropped in 2020.

Bottom: Chloride concentrations vary with depth and distance from the Turnpike, that is, they are higher towards the surface and closer to the Turnpike. Dilutions in the upper layers occur during high discharge periods. Over the study period, concentrations have increased at the 10ft and 15ft depths.

Daily Scale



High discharge at the outlet stream-KB175 (*2nd row*) due to snowmelt and precipitation events (*1st row*) leads to high chloride export rates at KB175 (*3rd and 4th row*). When discharge is high during the non-salting months, the net chloride accumulation in the fen drops (*5th row*).

References:

- Rhodes, AL, Guswa, AJ. 2016. Storage and release of road–salt contamination from a calcareous lake–basin fen, western Massachusetts, USA. Accessed Dec 2019
- Richburg, J. A. 1999. Water chemistry, Phragmites invasion, and changing plant communities at Kampoosa Bog, Stockbridge, Massachusetts. M.S. Thesis. University of Massachusetts, Amherst, MA, USA.

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