Accumulation of road salt in a calcareous fen: Kampoosa Bog, western Massachusetts

Wayne Ndlovu[1,2], Andrew Guswa[3], Amy Rhodes[1]

[1]Department of Geosciences, Smith College, Northampton, MA 01063
[2]Geology Department, University of Kansas, Lawrence, KS 66044
[3]Picker Engineering Program, Smith College, Northampton, MA 01063

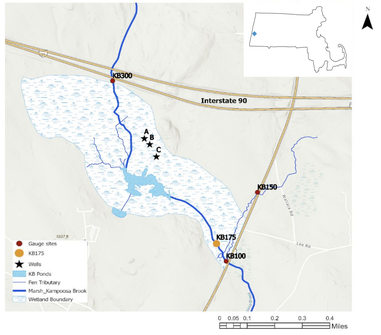
Road Salt Contamination at Kampoosa Bog

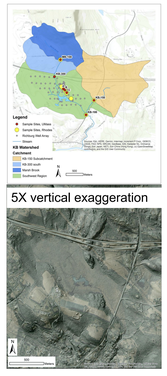
- Road salt applied in the winter months leads to increased salinity levels in soils and water bodies.
- High salinity at Kampoosa Bog has altered species diversity and lead to the abundance of salt tolerant plants and other invasives such as cattail and common reed.

Objectives:
- Estimate chloride budget over a 3-year period (2017-2020) at Kampoosa Bog.
- Determine conditions for storage and release of road salt in the fen.

Study Area:

- Kampoosa Bog is a 70 ha wetland complex located in a small watershed in Stockbridge and Lee, MA.
- Primary inlet channel is the southern flowing Marsh Brook/Kampoosa Brook which flows under the turnpike before entering the bog.





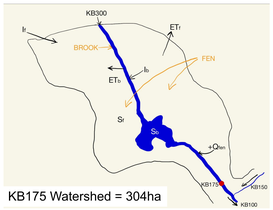
Methods:

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).

Monthly changes in salt storage fen

$$Salt_{fen}^{\,j+1} = Salt_{fen}^{\,j} + (Salt\ applied * 0.97)^{\,j} + M_{KB300}^{\,j} - M_{KB175}^{\,j}$$

(j = month)



KB175 Watershed = 304ha

Key Findings:

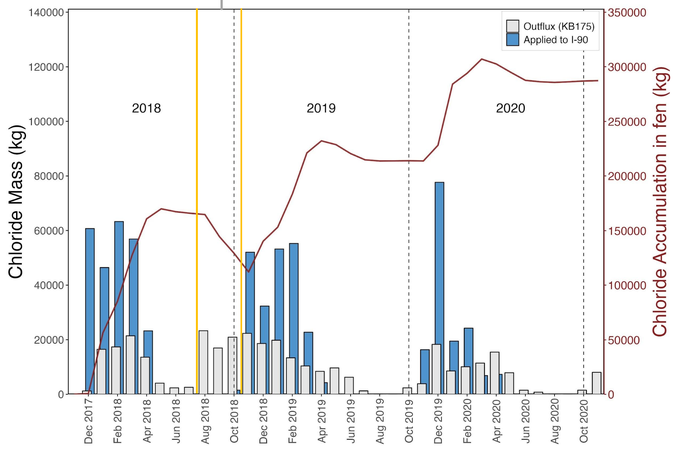
- There is a net accumulation of chloride in fen.
- Increases in chloride concentrations are more pronounced at the deeper (10ft and 15ft) wells.
- Chloride outflux is mainly driven by changes in discharge.
- **Next steps:** More detailed wetland characterization to understand the different groundwater concentration patterns at well B.

Annual Scale

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

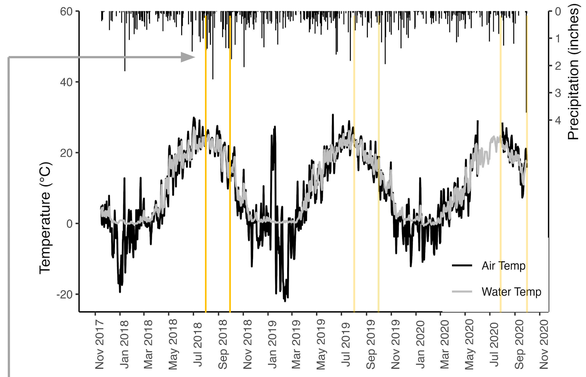
	Hydrology			Chloride Inputs		Chloride Exported		Chloride Accumulation
Water Year	Total Precipitation (inch)	Average Discharge *KB300 (cfs)*	Average Discharge *KB175 (cfs)*	Applied to 1.2 miles of I-90 (kg)	KB-300 Inlet (kg)	KB-175 Outlet (kg)	Average Flux Concentration *KB175 (mg/L)*	Fen Area (kg)
2018	46.9	0.8	2.1	251000	20500	119000	62.7	129000
2019	53.0	0.7	2.7	221000	14400	131000	54.9	85000
2020	46.8	0.5	1.4	152000	15100	80000	66.1	73000

Monthly chloride application, outflux and accumulation rates

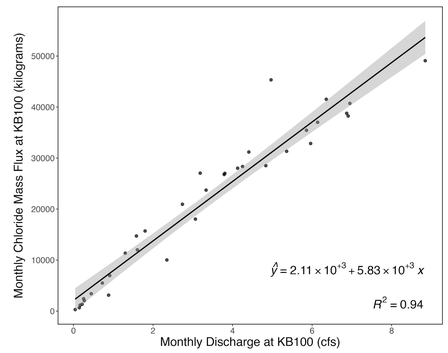


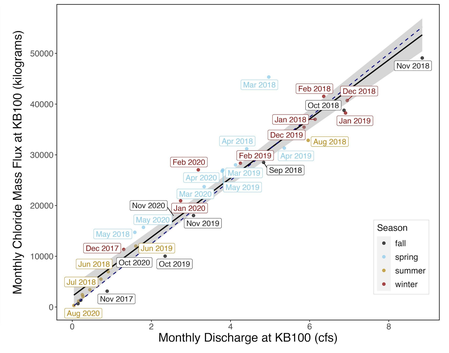
- Overall net chloride accumulation with greater accumulation rates during the winter.
- Chloride outflux mainly occurs in the winter and spring months.
- High chloride outflux in fall 2018.

Conditions for release of chloride from the fen

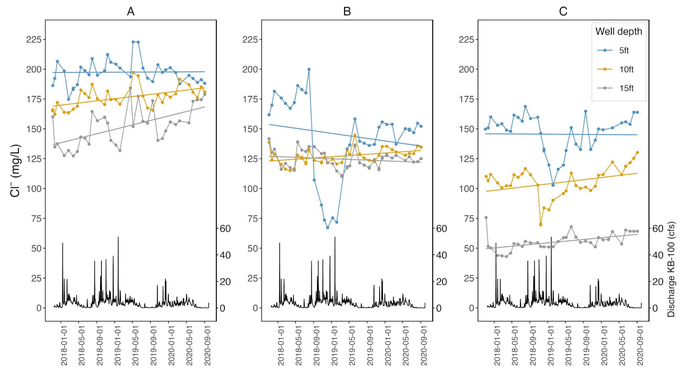


- High precipitation in fall 2018 coincide with high discharge chloride outflux at the outlets (KB-175 and KB-100).
- Strong positive correlation between discharge and chloride mass flux at the Kampoosa Brook outlet point (KB-100).
- Snow melt events lead to high discharge in the spring and summer months.





Groundwater Chloride Concentrations



- Concentrations vary with depth and distance from the Turnpike.
- Dilution in the upper layers occurs during high discharge periods.
- Concentrations increases at the 10ft and 15ft depths (A and C).
- Estimated concentration increases given a total accumulation of 294000kg range from (54.0 – 36.0) mg/L for water depths of (10-15) ft.

Acknowledgements

- Dr. Erich Hinlein and Dr. Camelia Rotoru (UMass Amherst)
- Massachusetts Department of Transport
- Tracy Tien (Smith College Spatial Analysis Lab); Will Hopper (Smith College – Statistical and Data Science)
- Smith College McKinley, Tomlinson and SURF Funds