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Devin Page
University of Southern Maine

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Impact of road salts (NaCl) on winter water quality in Mill Brook, Westbrook, Maine

Devin A Page and Karen A Wilson
Department of Environmental Science and Policy, University of Southern Maine

ABSTRACT

Mill Brook is approximately 5 miles long and is an important migration route for Alewife during the spawning season. Mill Brook stretches from Highland Lake, Westbrook, Maine to the Presumpscot River in Portland, Maine and is surrounded by relatively well-protected forest land. However, chloride concentrations still rise from the upper end of the brook to the end: preliminary data, collected in the winter of 2017, showed an increase in mean chloride concentration from 37.28mg/L +/- 25.61mg/L at the start of Mill Brook to 51.25mg/L +/- 11.63 mg/L at the end of the brook. Chloride concentrations increase in the winter due to the use of road salts (NaCl) as a primary chemical for de-icing roads, parking lots, and sidewalks. The increase in salts in an aquatic system can negatively impact organisms that are adapted for freshwater habitats. The purpose of this study is to gather water quality indicators including specific conductance, salinity, dissolved oxygen, temperature, and chloride concentrations for each small tributary (e.g. streams, brooks, ditches, run off), as well as above and below each of those tributaries in Mill Brook. The goal is to help identify point sources of road salts which could be sources of other anthropogenic influences on the water quality for Mill Brook.

BACKGROUND

- In cold climates, road salts (NaCl) are the principal chemical used for deicing roadways and parking lots as a way to increase public safety during the winter months. Road salts depresses the freezing point of water and prevents formation of ice on those surfaces (Throwbridge *et.al.*, 2010).
- Many stream ecosystems have exceeded the United States Environmental Protection Agency (EPA) chronic (230 mg/l) and acute (860 mg/l) water quality criteria for chloride. The elevated salinity from an influx of deicing salts can act as a pulse or press disturbance to the ecosystem (Huntz & Relyea, 2017).
- Chloride concentrations can indicate a strong hydrological connection at the riparian-stream interface and is can be used to quantify groundwater inputs by comparing concentrations of solutes to the stream water (Bernal *et.al.*, 2015).
- Chloride is often assumed in many studies to be largely unreactive in ecosystems with little uptake and release by vegetation or soils. This allows chloride to be used as a conservative tracer to calculate fluxes of water and other ions (Svensson, Lovett, & Likens, 2012).
- Salts can have negative effects on aquatic organisms by altering the osmotic balance between the organism and its environment (Findlay & Kelly, 2011).

Research Question: How do chloride concentrations change from the headwaters to the mouth of a rural/suburban Maine stream?

STUDY DESIGN

Site Description:

- Mill Brook is designated as a Class B river in the State of Maine and must maintain a quality that is suitable for drinking water, fishing, agriculture, recreation, and hydroelectric power generation.
- Mill Brook extends 8 km from Highland Lake in Westbrook down to the Presumpscot river in Portland, Maine.
- Currently, the upper portion of the brook is monitored by the Presumpscot Regional Land Trust where approximately three miles of the brook has been designated as the Mill Brook Preserve

Methods:

- Main-stem sample locations were chosen at random along with small tributaries that lead into Mill Brook.
- Water quality variables tested included: specific conductance, conductivity, salinity, temperature, and dissolved oxygen. This data was acquired with a YSI Professional Plus meter at sampling sites
- Water samples were collected at sampling sites along Mill Brook in 250ml opaque jars. In the lab, chloride was measured using a YSI Professional Plus meter outfitted with a chloride sensor.

RESULTS

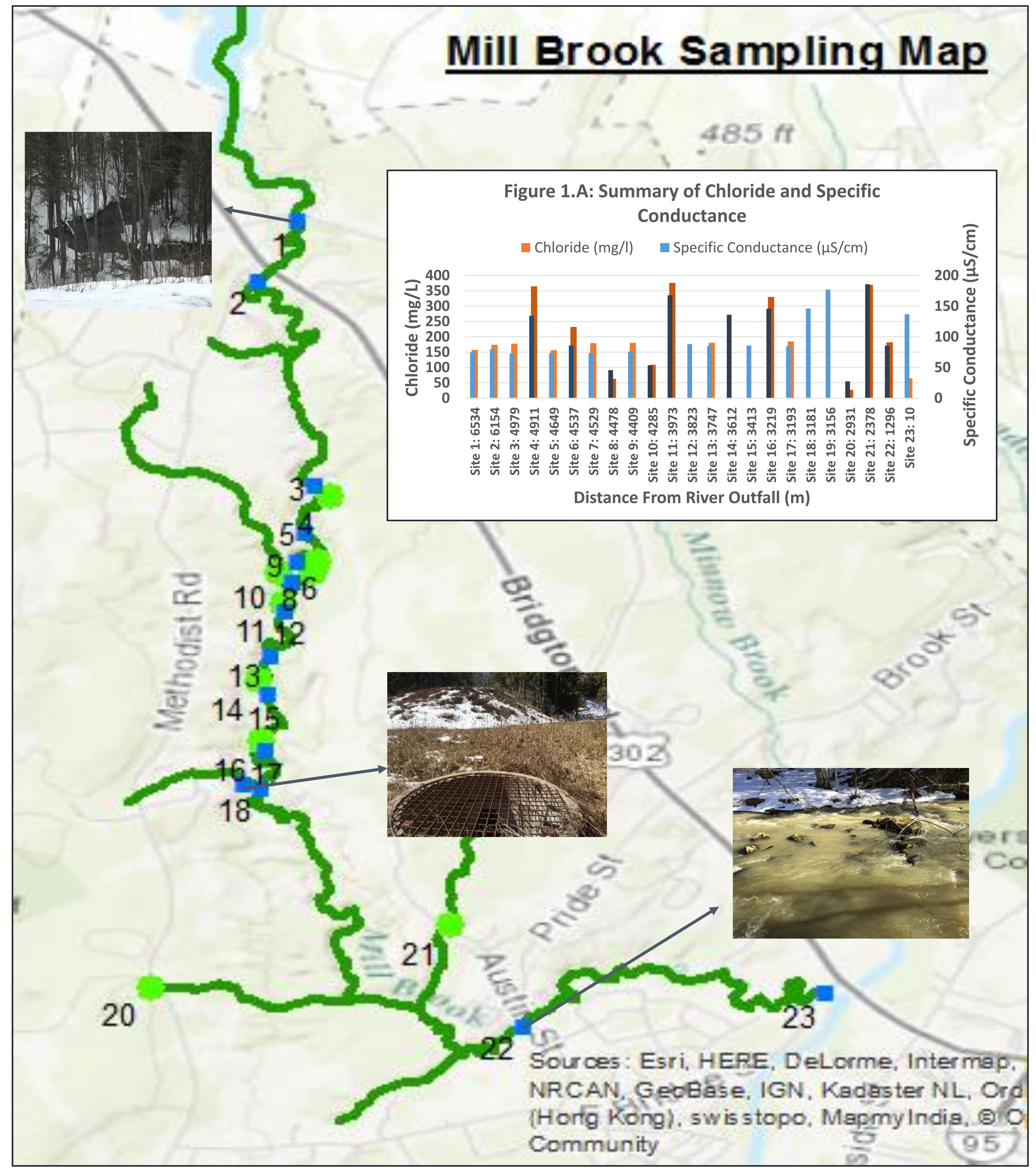


Figure 1: Mill Brook sampling sites based off GPS coordinates along Mill Brook. Figure 1.A (inset) provides a summary of chloride (mg/l) and specific conductance (µS/cm) for each individual sampling site located within the main part of Mill Brook (light shades of color) and the tributaries leading to the brook (darker shades of color). The x-axis is the distance from the confluence of Mill Brook and the Presumpscot River (m).

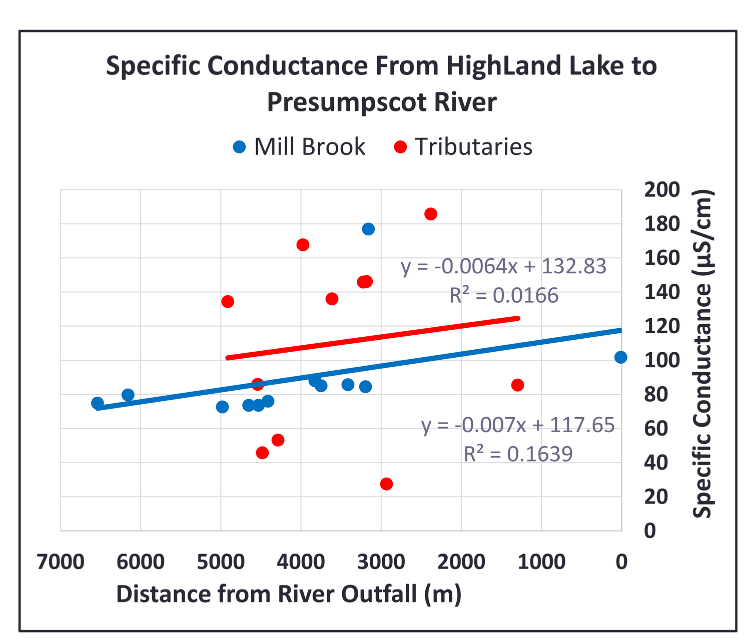


Figure 2: Specific conductance (µS/cm) measurements for Mill Brook and Tributaries leading to Mill Brook from Highland Lake to Presumpscot River. Specific conductance increased for both the main-stem sites (blue) and tributaries (red) the further downstream from Highland Lake the sites were located. Specific conductance was much more variable in the tributaries.

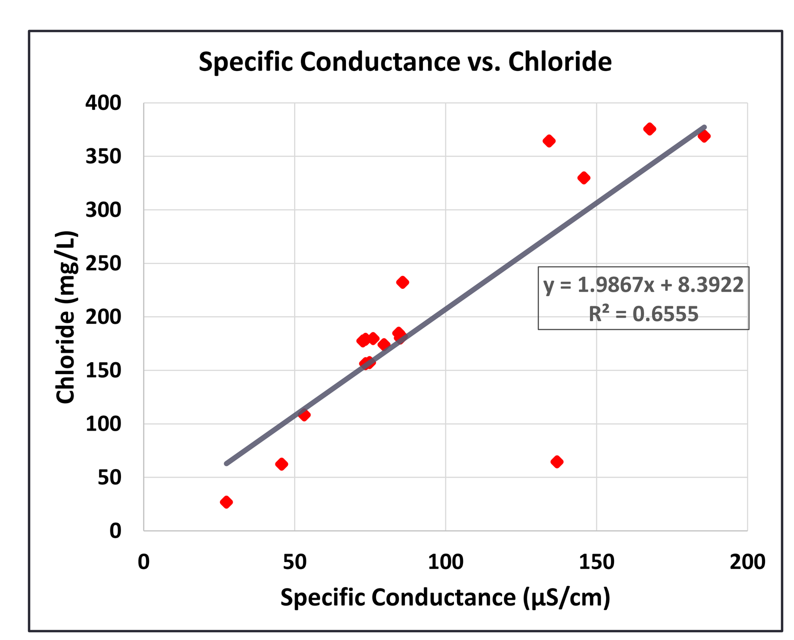


Figure 3: Specific conductance (µS/cm) vs chloride (mg/l) plotted for all sites. Chlorides were strongly correlated with specific conductance, a measure of total dissolved ions, suggesting that specific conductance is a good measure of chlorides in this stream in winter.

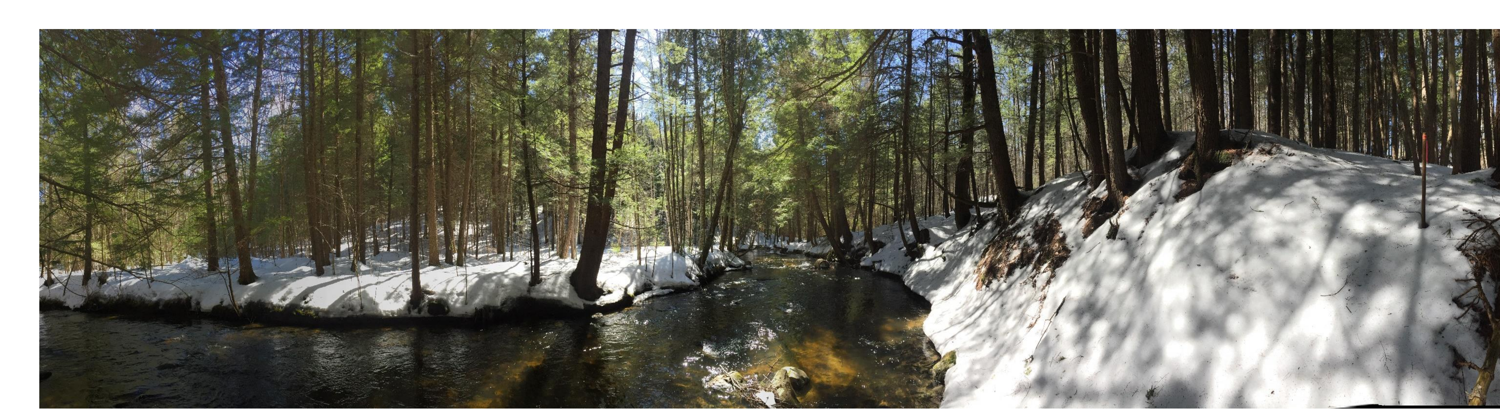
DISCUSSION AND FUTURE STUDIES

Discussion:

- Chloride and specific conductance increased closer to the confluence zone of Mill Brook and Presumpscot River (Figure 2).
- Chloride is correlated with specific conductance (R^2= 0.66, Figure 3).
- Chloride levels in the tributaries were much more variable as compared to the main-stem sites, with a mean of 161.4 +/- 37.9 mg/l of chloride in the main part of Mill Brook, and a mean of 227.78 +/- 139.17 mg/l of chloride in the tributaries.
- The mean tributary chloride level is just below the EPA's chronic threshold in a waterbody. It was observed that sites 4, 6, 11, 16, and 20 (tributaries) were above the EPA's chronic threshold (Figure 1.A).
- Despite the fact that the Mill Brook watershed is relatively under-developed, these results suggest that the influence of roads extends far into the preserve via tributaries leading from roads to Mill Brook. This suggest that the roads are draining into the brook which could cause the potential for other harmful pollutants (such as lead, mercury, and aluminum) to be included in the water runoff.

Future Studies:

- The evidence suggest there is an increase in chloride concentration coming from tributaries which could be caused by the use of salts for deicing road ways. What other pollutants are being drained into the brook along with Chloride?
- Further research should be performed to further quantify the impacts of road salts (and other runoff) on Mill Brook water quality and surrounding habitat.
- Seasonal monitoring of Mill Brook should be performed to create a baseline of chloride in the brook to quantify the impact from using road salts as deicing agents in the winter.



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