*Photo courtesy of Adam Pifko*

# Kawagama Lake Calcium Decline Mitigation Cost Benefit Analysis

## Overview

Calcium is an important nutrient, essential for plant growth and ecosystem health. Calcium decline is occurring in lakes across the boreal shield region, including Kawagama Lake. Previous work has focused on lake chemistry, but little information is available concerning the state of soils in this watershed.

This study builds on a report from Trent University students who worked with the Kawagama Lake Cottagers Association (KLCA); it explained the mechanisms, consequences, and mitigation methods for calcium decline. This study is an assessment of the soil characteristics of the Kawagama Lake watershed, with specific focus on the state of calcium decline. This information is intended to guide future decisions regarding mitigation and further research.

# Soil-to-Lake Linkages

- The biota, geology, and meteorological activities in a watershed transfer nutrients throughout, connecting the soils to the lakes and rivers[4]. Nutrient concentrations in soil are influenced by absorption, atmospheric deposition, erosion, fixation, leaching, transformation, and plant uptake[6].
- Interactions between vegetation, soils, and runoff waters influence the chemistry of the watershed. Shorelines are an important buffer zone where many of these interactions occur[6].
- Calcium (Ca), magnesium (Mg), and potassium (K) are essential nutrients (base cations) found in soils[2]. Base cations help to buffer soils against acidification and drop in pH[5].
- Sources of base cations include atmospheric deposition and soil mineral weathering[9]. Leaching and forest biomass harvesting can cause base cation availability to decrease, resulting in the soil acidification seen in across the boreal shield region[1, 2, 3, 6, 8, 9, 11].
- Possible mitigation methods include forest management planning, liming, and wood ash application[8, 10].

## Regional Calcium Levels

The Kawagama Lake watershed is located in Haliburton, Ontario.
To assess the state of Ca in this watershed, we compared our data to that of another study which sampled soil at sites throughout central and southern and Ontario[7].
**Figure 1** indicates that Kawagama is located in an area of low soil Ca concentrations.

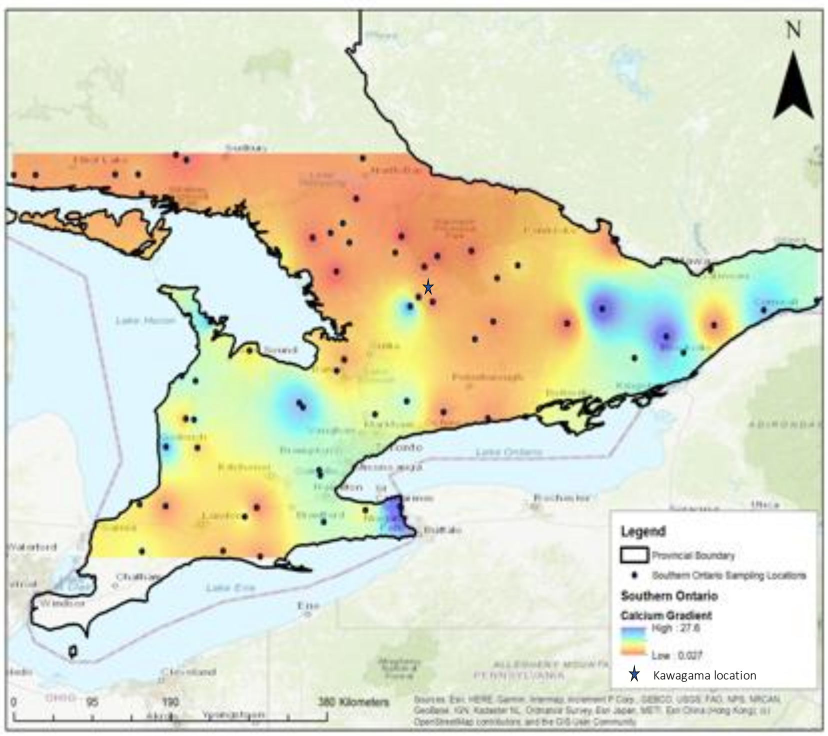


**Figure 1:** Calcium concentration gradient across southern and central Ontario, A horizon

# Sampling & Analysis

- Soil samples were collected from six sites along the north shore of the Kawagama Lake watershed (**Figure 2**).
- Each sample was comprised of four soil horizons: L (litter), FH (fibric and humus), A (upper mineral soil), and B (lower mineral soil) (**Figure 3**).
- The samples from each horizon at the six sites were analyzed for pH level, organic matter content, and exchangeable (plant available) base cations (including Ca, Mg, and K).

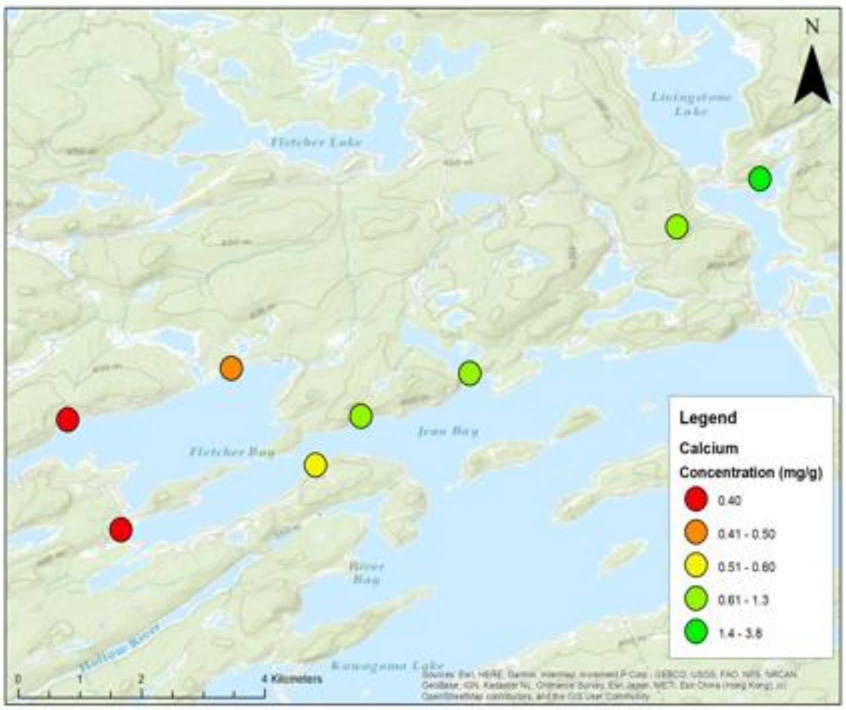


**Figure 2:** Calcium concentrations at sampling sites in the Kawagama Lake watershed

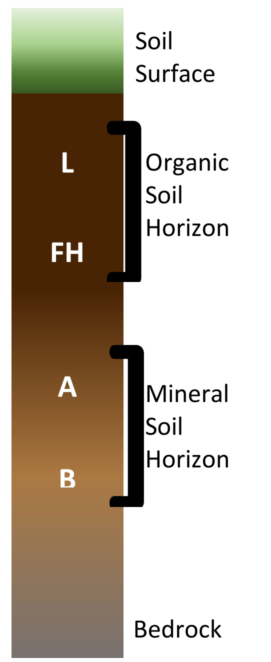


**Figure 3:** Soil profile diagram

- The concentrations of Ca, Mg, and K were compared across soil horizons and site locations, and soil base cation concentrations in the A horizon which was all compared to the regional values.
- Using GIS software, maps were created to display the regional calcium gradient and site-specific calcium concentrations in the A horizon (**Figure 1 & 2**).
- Graphs were created to show the differences between horizons (**Figure 4 & 5**).

# Results

- Kawagama is situated in an area of low Ca concentration (**Figure 2**). Calcium concentrations varied with soil depth and across site locations (**Figure 2 & 5**). The Ca concentration decreased with soil depth (**Figure 5**).
- The Ca measurements from the Kawagama were lower than the regional average (**Figure 1 & 4**). The watershed's Ca pool was approximately 0.45 kg/$m^2$, with a concentration of 3.74 meq/100g soil. Milliequivalents (meq) are a unit of measurement that describes concentrations to the thousandth chemical equivalent.
- When comparing the numbers from Kawagama to related literature, it is apparent that the watershed A horizon soils are Ca deficient. Although the average concentration is above the critical threshold of 2 meq/100g soil, two of the sites were approaching the threshold[8].

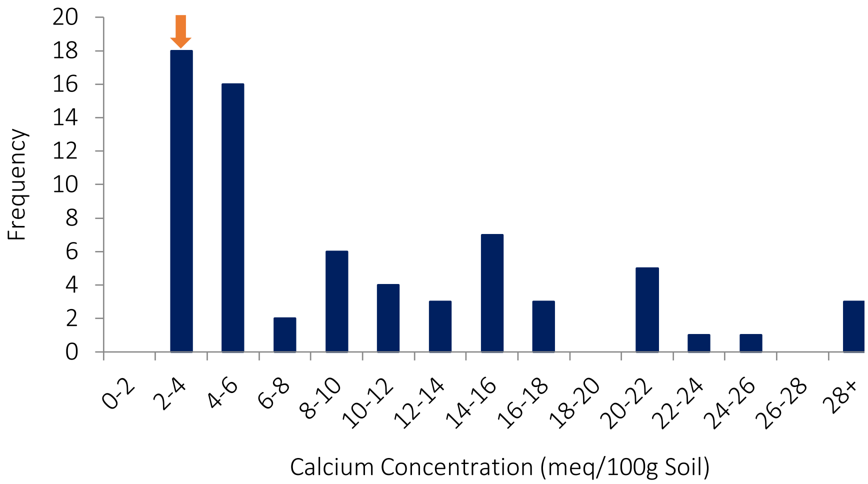


**Figure 4:** Histogram of sampling frequency for Ca concentrations in southern and central Ontario, with an arrow indicating where Kawagama is situated

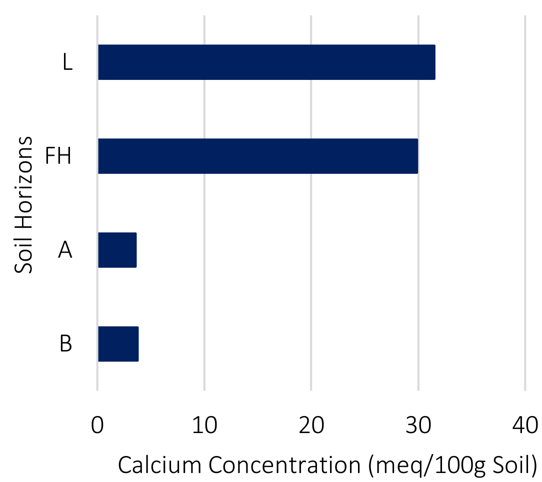


**Figure 5:** Average concentration of Ca across all soil horizons at the sampling sites around Kawagama

## Recommendations for Mitigation

The current state of calcium in the Kawagama watershed would benefit from mitigation efforts such as liming the soil or applying wood ash.
The areas of low calcium concentrations require about 400 kg/ha of calcium to be added.
To increase soil calcium levels by 2 meq/100g soil in areas where soil calcium is low would cost $200/ha – assuming liming costs of $0.5/kg.

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