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Wood Ash Amendments as a Potential Solution to Widespread Calcium Decline in Eastern Canada Forests

Adding wood ash could improve forest health

Calcium deficiency is an environmental issue in areas of the Canadian Shield with shallow soil and a history of acid rain, but the application of household wood ash is making a positive difference. Muskoka is one such area, and ash addition could improve the health of the trees and possibly other life in the forests.

Dr. Natalie Kim's scientific paper *Wood Ash amendments as a potential solution to widespread calcium decline in eastern Canada forests*, co-authored by Dr. Shaun Watmough from Trent University and Dr. Norman Yan from Friends of the Muskoka Watershed (FOTMW), reviews research on impacts of calcium deficiency on forests caused by decades of acid rain. Kim's review of the benefits of calcium and wood ash additions for forest health in eastern Canada was published in Environmental Reviews, a peer-reviewed scientific journal in September of 2022.

Working with FOTMW, Kim reviews the causes of calcium decline in forests soils, explores household ash as a treatment, analyzes its risks and benefits and draws quite positive conclusions. Given that this is among the most comprehensive recent reviews of the benefits of calcium and ash additions on the health of forests such as those in eastern Canada, her positive conclusions are quite significant.

Kim concludes that wood ash is most likely a suitable source of calcium and ash's other essential elements including potassium, magnesium and phosphorus are also good for forest soil.

Why is calcium important to our forests?

In plants, calcium has various roles in cell functioning, which can be broadly categorized as structural (helping to uphold the cell wall and plasma membrane) or labile (acting as a messenger in cell signaling and allowing cells to detect and react to external stimuli). Calcium is necessary for many plant processes including cell division, cell wall synthesis and functioning, cell membrane stability, protein synthesis, nuclear protein phosphorylation, freezing tolerance, and stomatal functioning. In trees suffering a shortage of calcium, it negatively affects wood formation and wound repair, cold tolerance, and the ability of trees to withstand insect defoliation and strong winds.

Kim concludes that the trace metal levels in ash derived from untreated wood likely pose minimal ecological risk, which are outweighed by the potential benefits of adding ash.

She concludes that the application of wood ash may help advance restoration efforts for forests suffering the after-effects of acidification, logging, and calcium loss, especially in eastern Canada. Still the knowledge is not yet complete, and she concludes

that more studies are needed to clarify both the short and long-term effects of wood ash addition on different tree species in both natural and managed forests.

Ash additions could help fight climate change

Of special interest is the need for more research into the potential benefit adding ash to forest soil could have on forest carbon capture and the climate change crisis. Healthier trees quite likely capture more carbon but the magnitude of the benefit needs more study. Adding ash to forests may also create a positive change for calcium deficient aquatic ecosystems. In other words, ash added to our forests could positively impact waters which are also short on calcium. Most water that enters lakes first passes through watershed soils. The impact of wood ash on our lakes and biota living in the lakes needs further study.

Calcium deficiencies impact everything from growth and wound healing in trees to wild bird egg strength and crayfish shell health. Ash can correct these deficiencies, but there are some challenges using wood ash locally. Ash is used as a forest fertilizer in many parts of the word but the addition of ash to forest soils is highly regulated in Canada, and the costs associated with obtaining approval and transporting and applying the ash often make landfilling a more economical option.

But wood ash also has positives. It has the right mix of nutrients as a fertilizer for our forests. It is available locally because of the number of homes with wood heat so has minimal transportation costs. She compared this to the expense and environmental impact of mining and transporting of lime for a similar soil remediation purposes.

Adding wood ash can improve soil conditions and result in healthier trees with more growth, says Kim, adding that future studies are needed to clarify both the short- and long-term effects of wood ash on different species and forest types. For example, research shows that species with high calcium requirements, such as sugar maple, may benefit the most from calcium additions via wood ash.

Some studies find the application of wood ash to acidic forest soils across eastern Canada to mitigate calcium decline and boost tree health may last for decades, especially in areas with little to no logging

In Canada, optimal wood ash dosage rates have not yet been established for forest soils but are likely in the range of just a few tonnes per hectare.

Kim found the calcium depleted forest soils of eastern Canada, including Muskoka, may be particularly suited to wood ash amendment. These soils are characterized by low calcium and pH and high nitrogen due to their history of acid rain, combined with shallow soils underlain by granitic bedrock. Lakes demonstrate the problem, for example, over 50 percent of lakes in the Muskoka River watershed have calcium concentrations less than 2 mg/L, critically low levels for aquatic life

Calcium limitation is not included in Canada's national agenda as a cause of forest decline (State of Canada's Forests 2020), but Kim's review of the literature suggests that it should be. The idea of amending forest soils with wood ash to replenish Ca and other minerals lost to soil leaching from acid rain, and biomass harvesting has only emerged fairly recently in Canada.

Kim recommends careful planning when adding ash to forests. Prior to land application, the anticipated benefits of wood ash amendment must be carefully weighed against the potential risks while considering factors such as the characteristics of the receiving soils, target tree species, existing flora and fauna, optimal doses, and whether trees will be harvested. Moreover, the lowest dose needed to achieve the desired outcome (i.e., replacing the soil calcium lost to leaching and harvesting) should be used. Roughly 2 tonnes of ash per ha may be appropriate.

Overall, the use of wood ash as a forest soil amendment holds promise for mitigating Ca declines across eastern Canada and for supporting forest

ecosystem health and sustainable forest management. Kim suggests areas of future research include verifying the efficacy of forest soil amendments with wood ash on carbon capture, and effects of wood ash additions on surface waters and aquatic biota.

Friends of the Muskoka Watershed thanks Natalie Kim for this work and appreciates her collaboration.