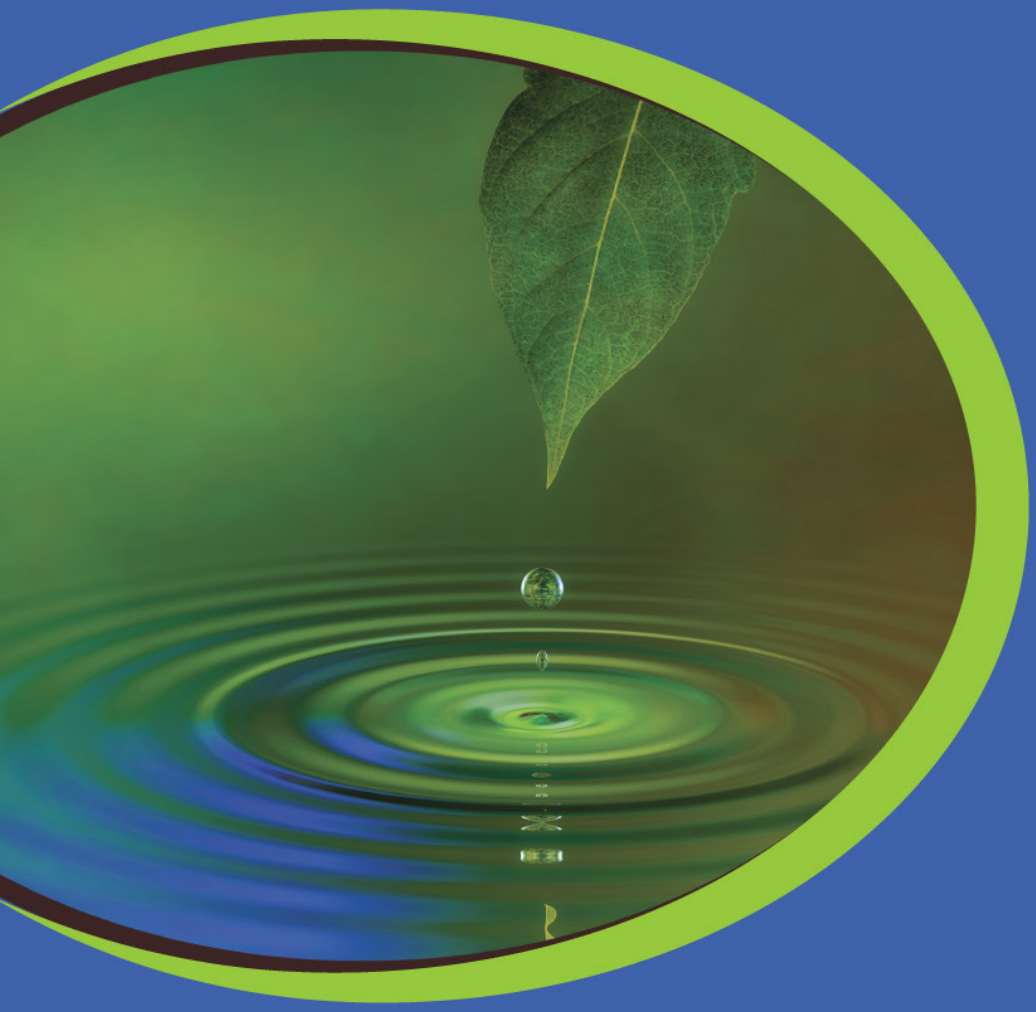
GUIDE

Your Guide to HATSEO* Wood Ash Recyling in Muskoka



Shakira Azan, PhD

Friends of the Muskoka Watershed

We gratefully acknowledge the financial support for this project provided by

Ontario Trillium Foundation

Fondation Trillium de l'Ontario

An agency of the Government of Ontario
Un organisme du gouvernement de l'Ontario

*HATSEO is a research program of Friends of the Muskoka Watershed and is a registered trademark.

Please direct all questions and comments to:
friends@fotmw.org

Contents

Introduction

How would you like to help fix a serious problem in Muskoka's forests and lakes at no cost to you, while helping to recycle and re-purpose a waste you now generate in your home?

Sound too good to be true? It is not.

We are talking about using ash from your wood stove or fireplace to help solve the calcium decline problem in Muskoka. Scientists call this problem "ecological osteoporosis", and by analogy to osteoporosis in people, the issue is critical losses in calcium from forest soils and lakes, enough losses that calcium-rich plants and animals are suffering and, in some cases, have disappeared.

The discovery of how to make fire to burn wood is one of mankind's greatest inventions, and the use of wood fires for cooking and heating likely pre-dates human civilization, going back to Neanderthal times. First Nations around the world have used fire to manage their landscapes for untold millennia, and in Muskoka, we still burn wood for heating, cooking, land clearing, and entertainment.

In this guide you will learn how we can use the leftover waste from your wood burning to help solve ecological osteoporosis in Muskoka. Join your neighbours and become a local environmental hero, helping the Friends of the Muskoka Watershed solve the environmental osteoporosis problem in Muskoka.

Read on please, to learn how your help will protect and restore the Muskoka we all love from the scourge of calcium decline.

Reasons for wood ash recycling

Alleviating calcium decline

There is growing recognition among environmental scientists that declines in calcium concentrations in eastern Canada and western Europe are both slowing ecological recovery from acid rain and directly damaging many native plants and animals. For example, on land, the loss of calcium from forest soils slows growth, and reduces health, seedling survival and regeneration of sugar maple - a concern to both maple syrup producers and those that love fall colours.

Figure 1: Image of water flea, **Daphnia**, with two eggs in her brood pouch.

The nearshore waters of lakes support many species with high calcium demands including amphipods (commonly called scuds) and crayfish, and their populations are in decline or disappearing in several lakes. The fate of other nearshore crustaceans and molluscs, all calcium-rich groups of species, is unknown, but impacts of calcium decline are likely. Finally, in offshore waters, the calcium-rich water flea Daphnia (Figure 1) is being outcompeted by a jelly-clad water flea, Holopedium (Figure 2) that has low calcium demands. Loss of Daphnia increases the risk of algal blooms that can impair or reduce water quality.

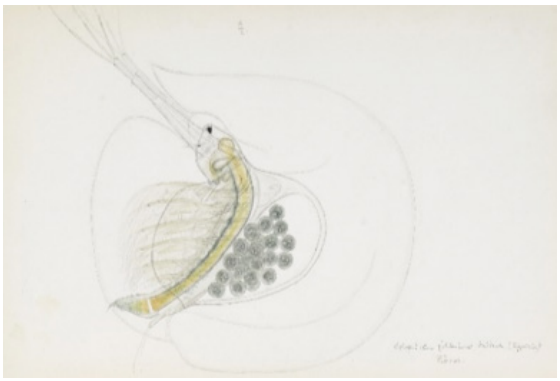


Figure 2: Drawing of jelly-clad water flea, **Holopedium**, that is replacing **Daphnia** in offshore waters of lakes suffering from calcium decline.

Calcium levels in forest soils and, indirectly, in downstream lakes will recover very slowly if at all without our help. Levels can be restored by liming, i.e. spreading crushed limestone or calcite (calcium carbonate) in the forest. However, limestone is costly to mine and transport, and it contains minimal quantities of nutrients that are required for plant growth other than calcium. Unlike limestone, wood ash is readily and freely available. During the combustion of wood, many nutrients which are essential for plant growth are concentrated in the ash. This makes wood ash ideal as a forest soil additive that can replace the calcium lost due to decades of acid deposition and repeated cycles of logging and/or land clearing and regrowth of forests. For this reason wood ash is used extensively in Europe, but it is not yet used in Canada.

Reducing waste to landfill

Currently, wood ash is treated as a waste product in Canada[1], and it is landfilled at a cost to society and potentially to the environment. As the bioenergy sector expands in Canada and home owners continue to burn wood for heat, continuous disposal of wood ash in municipal landfills reduces their longevity (Figure 3). A cost analysis conducted on wood ash disposal in Canada demonstrated that using the ash as a forest soil additive saved money compared to disposal in municipal landfills[2] . In Sweden, wood ash recycling (i.e., returning the ash to the forest) reduced the amount of wood ash dumped in landfills from 22,000 tonnes to 13,000 tonnes over three years (2013-2016)[3].

Figure 3: Dumping of waste (including wood ash) in landfills.

The ecological benefits of wood ash recycling (Figure 4) to gardens, tree growth (e.g., sugar maple), and on soil and water chemistry have been thoroughly studied in recent decades. By recycling wood ash, we all have the opportunity to return nutrients to the forest soils from which they originated and reduce the supply of waste to landfills. Applying wood ash to forest soils is one way to close the nutrient cycle, and neutralise soil acidity due to its liming effect, thus both speeding recovery from historical acid rain damage and more recent damage caused by ecological osteoporosis.

Mitigating climate change

Figure 4: Manual recycling of wood ash to assess its effect on seedling growth at Island Lake.

The effects of climate change are now undeniable, and all around us. Sea levels and global temperatures are rising, ocean waters are warming and acidifying, ice sheets are shrinking, and extreme weather events, droughts and heat waves are increasing in frequency and intensity. There is a widespread consensus among scientists and most politicians that global emissions of greenhouse gases must be reduced in order to avoid the worst international consequences of climate change. Wood burning does release greenhouse gases, but reduces the use of fossil carbon (Figure 5), much of which must stay in the ground if we are to avoid the worst effects of climate change. More importantly we now know that applying wood ash to some forest soils, i.e. those on the Canadian Shield in eastern Canada, can dramatically improve forest growth, because it is calcium levels in the soil that are currently limiting forest productivity. Thus adding enough wood ash to eliminate calcium limitation of forest growth can dramatically increase carbon capture and retention in forest biomass. Both approaches can help mitigate climate change.

Increasing forest production

There is growing recognition that wood ash can help alleviate the loss of calcium in forests impacted by acid deposition and/or whole tree harvesting. The fertiliser effect of wood ash on plants in gardens is well-known as it contains many essential minerals required for growth (e.g., calcium, potassium, magnesium, phosphorus). There is, however, little to no nitrogen in wood ash, as it is lost during combustion. Several studies have demonstrated that following wood ash application (Figure 6), tree growth increases, promoting an overall increase in forest productivity over time.

Figure 5: Combustion of wood would reduce the need for fossil fuels and help in mitigating climate change.

Figure 6: Ash recycling in a forest can improve tree growth, especially of sugar maple, which are calcium-rich trees.

Wood ash

Chemical & physical properties of wood ash

Wood ash is the residue from the combustion of wood or wood products including fuel wood, sawdust, wood waste from industry or construction, and wood pellets. Dependent on the operation and type of furnace, boiler, stove, fireplace or fire pit used, wood ash is composed of various amounts of fly (Figure 7) and 'bottom' ash. Fly ash is the lightest component[4] comprised of fine, mainly mineral particles that are easily airborne. In contrast, 'bottom' ash is much coarser and generally darker than fly ash, and contains the organic residues that are the result of incomplete combustion. 'Bottom' ash is often produced as a by-product of coal combustion.

Wood ash contains several plant and animal macronutrients of which calcium is the most dominant (29% to 37% by weight)[5], followed by potassium, magnesium, aluminum, iron, sodium, sulphur, manganese, and phosphorus. Wood ash generally has little nitrogen as it is vaporised during combustion. Trace metals found in wood ash may include antimony, arsenic, barium, beryllium, cadmium, copper, cobalt, lead, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, vanadium, and zinc. If concentrations are high enough, these metals may pose a risk to the environment. However, our tests of residential wood ash in Muskoka indicate our wood ash should be safe to add to most forest soils. After all, we are simply returning material to the forest from which it originated.

Figure 7: Fly ash.

Wood ash raises the pH of water to 10 to 12 which makes it alkaline in nature. It reacts easily with water producing carbonates, hydroxides, and oxides[6], which makes it a good liming agent that can be used to neutralise acidity . However the properties of wood ash vary widely and depend on the type of wood burnt, the part of the tree burnt (e.g., bark, branch), the chemistry of the soil supporting the wood, the temperature at which the wood is burnt, the type and nature of the furnace or stove used, and storage conditions. Because of this uncertainty, we recently assessed the wood types burnt and the chemistry, solubility and potential for toxicity of wood ash generated by residents of Muskoka.

Wood types that generate ash in Muskoka

As expected, residents of Muskoka burn mainly hardwood tree species. In a **Survey of Wood Ash Users**[7] in Muskoka, 83% of the respondents used hardwood or a mixture of hardwood species during the heating season. Species often burnt included maple, beech, oak, and birch. Some residents also used softwood tree species (14%) but in smaller amounts. Softwood species such as cedar, hemlock, spruce and pine were mainly used outside (e.g., bonfires, production of maple syrup) to avoid creosote build-up in home furnaces. Some residents also burn wood pellet, but accounted for only 3% of the respondents (Figure 8).

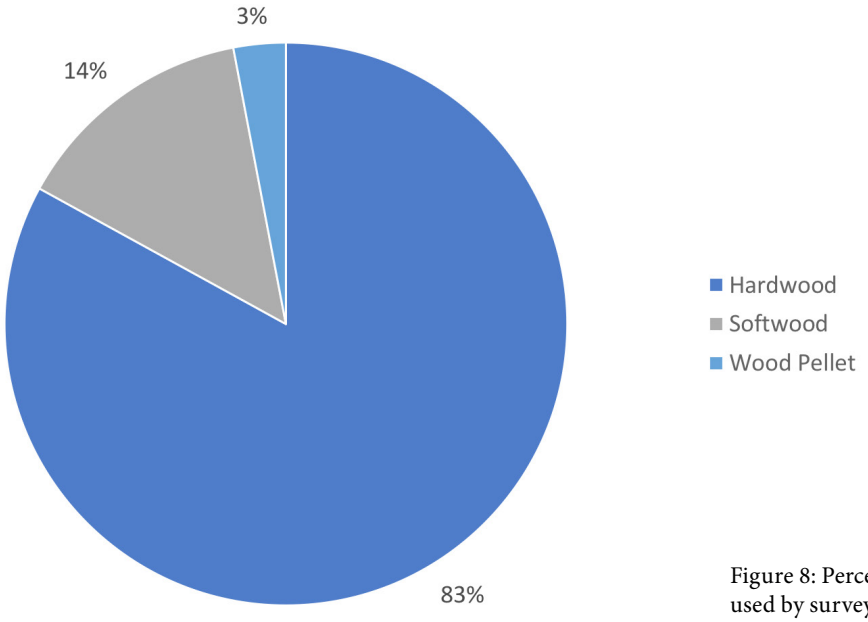


Figure 8: Percentage of wood types used by survey respondents to produce wood ash..

Amount of available residential wood ash

As of the 2016 census, there are 60,599 permanent residents in Muskoka, of which 3% heat with wood. Data obtained from the **Survey of Wood Ash Users**, indicated that the majority of residents generate about 20 buckets of wood ash per heating season. Assuming our survey provided accurate estimates, residents of Muskoka thus generate ~36,500 buckets of wood ash during the heating season. If all residents use an ash pail that holds 17.7 L, about 643,561 L (644 m^3) of wood ash would be generated. As the density of wood ash (it varies with wood species) averages about 548 kg per m^3, ~352,672 kg (~353 tonnes) of wood ash would be produced. From our survey, 2/3 of respondents indicated their willingness to transport wood ash to the landfill or the nearest transfer station. If 2/3 of the respondents transport wood ash, they could provide ~235,000 kg (235 tonnes) of ash per year to a wood ash recycling programme.

We believe that the number of responses received during the **Survey of Wood Ash Users** provides a conservative estimate of how much residential wood ash is

actually generated in Muskoka, i.e., not all those that generate wood ash report it. We also had a relative small sample size of respondents to our survey. As such, we would need a larger sample size to determine how much wood ash could be collected from residences in Muskoka, and thus how large an area suffering from calcium decline could be helped by a wood ash recycling programme.

Risks associated with wood ash recycling

There are some risks associated with wood ash recycling:

- The wood ash must cool completely before it can be recycled, or there is a fire risk.
- The fly ash component of the wood ash is a fine particulate. If it is not handled carefully, or if suitable eye and breathing protection is not used, it could become airborne and pose a health risk.
- Wood ash can contain heavy metals such as arsenic, mercury, and cadmium that could pollute freshwater environments. While recent studies have demonstrated that the levels of heavy metals in residential wood ash is relatively low, and likely do not pose an ecotoxicological risk, metal levels in wood ash should be quantified on an ongoing basis, and toxicity to model taxa should be conducted on a repeating schedule.
- Some studies have suggested the presence of polyaromatic hydrocarbons (PAHs), environmental pollutants generated mainly from the incomplete combustion of organic materials (e.g., coal, oil, petrol, and wood) in wood ash. However, the concentrations of PAHs appear low in pure wood ash. High PAHs have been detected in wood treated with wood preservative. We recommend that ash from the combustion of treated-wood should not be included in the recycling programme.

Recycling and reusing wood ash

Wood ash can be used in many ways. Here are some ways you can reuse/recycle your wood ash:

- Use cold wood ash in your gardens, on driveways, and on forest soils.
- Use ash from wood that is not pressure-treated, contains preservatives, insecticides, metals, or plastic products, or any foreign matter (e.g., nails, staples).
- Spread wood ash widely on your wood lot, focusing on sugar maple trees that may well receive the most benefit from it. Do not concentrate in any one area.

- Do not sprinkle wood ash in any waterbody on or near your property.
- If you live in NE Muskoka, you will see the most benefit at application rates of several tonnes per hectare as your soils are thin and will easily gobble up the nutrients present in wood ash.

If you have thick soils on your wood lot, wood ash may not be of particular value to you. So, why not share your wood ash with the FMW to help solve the ecological osteoporosis problem in Muskoka. To do this, please:

- Keep your woodstove or fireplace and chimney (if appropriate) clean and operate them following manufacturers' specification.
- Avoid burning metallic foils or pressure treated wood.
- If you are burning wood materials with nails or screws, try to coarsely screen the metal out of the ash before adding it to you collection pail.
- Ensure your ash is completely cooled before you add it to the transfer container.
- Add the ash to a container with a tight-filling lid for transport.
- Consult the FMW website and/or watch your local newspaper for information on dates and locations of wood ash drives or transfer stations that will accept residential wood ash.

Our knowledge of wood ash is improving all the time as our ability to design an optimal wood ash addition programme. Please keep watch at the FMW website for updates as our knowledge and plans mature.

References

1 Hannam, K. D., C. Deschamps, M. Kwiaton, L. Venier, & P. W. Hazlett. (2016). Regulations and guidelines for the use of wood ash as a soil amendment in Canadian forests. Natural Resources Canada, Canadian Forestry Service, Ontario, Canada.

2 Hope, E. S., D. W. McKenney, D. J. Allen, & J. H. Pedlar. (2017). A cost analysis of bioenergy generated ash disposal options in Canada. Canadian Journal of Forest Research 47: 1222-1231.

3 RecAsh (n.d.). Regular recycling of wood ash to prevent waste production. Layman's Report. Available at http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFierep=file&fil=LIFE03_ENV_S_000598_LAYMAN.pdf (Last accessed March 30, 2018)

4 Pitman, R. M. (2006). Wood ash use in forestry – a review of the environmental impacts. Forestry 79: 563-588.

5 Azan, S. (2018). Is residential wood ash safe for use to help solve the calcium decline problem in Muskoka? HATSEO Technical Report #2. Available at http://friendsofthemuskokawatershed.org/hatseo-residential-wood-ash-recycling-reports/

6 Karltun, E., A. Saarsalmi, M. Ingerslev, M. Mandre, S. Andersson, T. Gaitnieks, R. Ozolinčius, & I. Varnagiryte-Kabasinskiene. (2008). Wood ash recycling – possibilities and risks. In: Sustainable use of forest biomass for energy: A synthesis with focus on the Baltic and Nordic Region (D. Röser et al. eds), pp.79 108. Springer Science+Business Media B. V.

7 Azan, S. (2017). Could a residential wood ash recycling programme help solve the calcium decline problem: Insights from a Muskoka wood burner's questionnaire. HATSEO Technical Report #1. Available at http://friendsofthemuskokawatershed.org/hatseo-residential-wood-ash-recycling-reports/

Attribution

Figure 1: Derek Taylor, University of Buffalo

Figure 2: Georg Ossian Sars, National Library of Norway, Manuscript Collection

Figure 4: Paul Hazlett, Natural Resources Canada

Figure 6: Suzanne Brais, UQAT