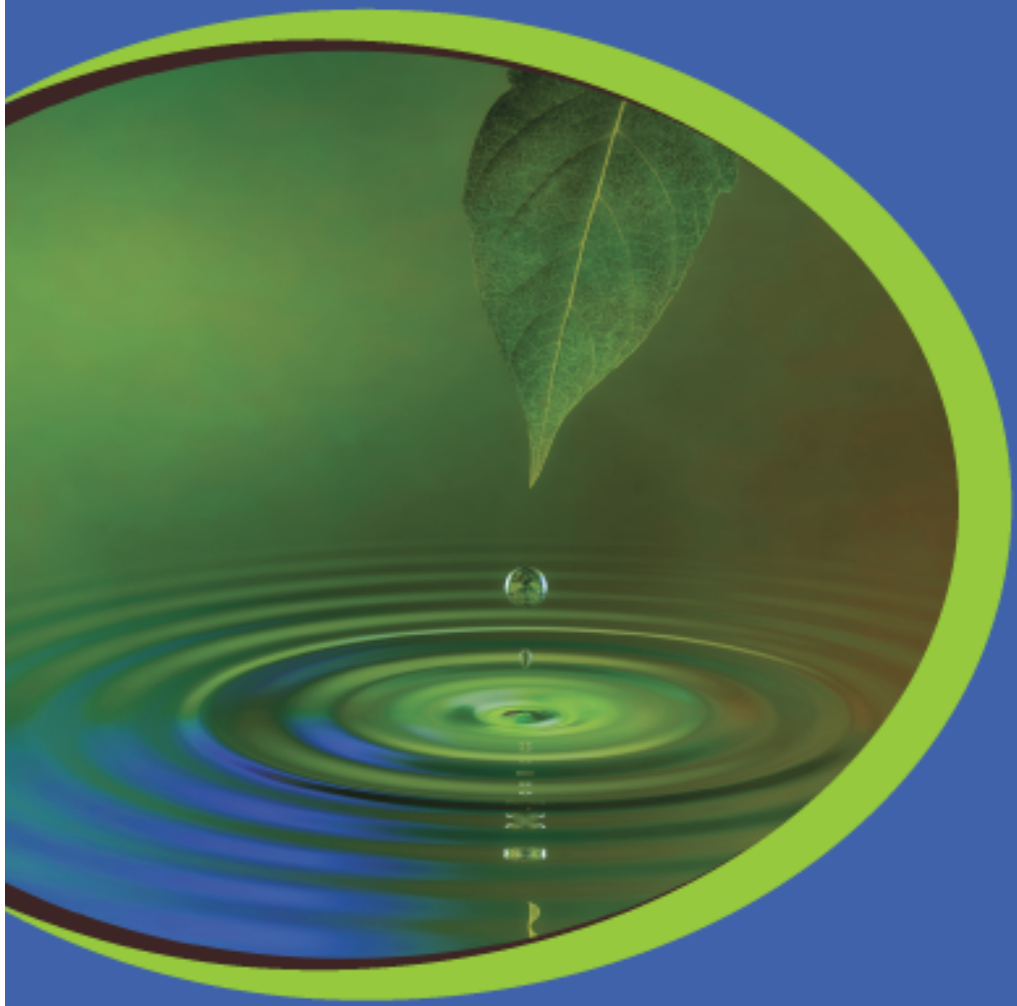
REPORT

COULD A RESIDENTIAL WOOD ASH RECYCLING PROGRAMME HELP SOLVE THE CALCIUM DECLINE PROBLEM:

INSIGHTS FROM A MUSKOKA WOOD BURNER'S QUESTIONNAIRE



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ACKNOWLEDGEMENTS

We thank the 53 Muskoka residents who completed the questionnaire on their wood ash generation and use, Joel Yan for pointing us to the biennial survey on primary heating systems in Canadian households conducted by Statistics Canada, and Norman Yan for comments on drafts of this report.

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1.0 INTRODUCTION

Over the past several decades, calcium (Ca) concentrations have been declining in Muskoka lakes and forests. In 2014, *The Muskoka Watershed Council's Report Card* highlighted Ca decline as a new environmental stressor affecting lake health in the area. The damage caused by declining Ca concentration is all around us. In forests, loss of Ca has resulted in slowed growth, seed production, seedling regeneration and dieback of sugar maple that can impact maple syrup production. In lakes, crayfish that have high Ca-demands are disappearing. Last, in offshore waters, a jelly-clad water flea, *Holopedium*, is replacing its more Ca-rich competitors, and creating the potential to clog water filters for residents drawing their water from lakes.

One possible solution to combatting Ca decline is active local engagement, if Muskokans become "gardeners of the forest". As gardeners, we can use wood ash - the residue remaining after the combustion of wood – to return Ca to forest soils where it originated. Wood ash contains many elements – both major and minor – that are required for tree growth (e.g., calcium, potassium, nitrogen, phosphorus). Of the elements present, Ca is the most abundant with calcium compounds forming between 15%[1] and 50%[2] of total ash weight, followed by potassium (K), magnesium (Mg), aluminium (Al), iron (Fe) and phosphorus (P).[3] Due to its high Ca content – mainly as calcium carbonate ($CaCO_3$) - wood ash is relatively alkaline and can be used as a garden fertilizer. In addition, wood ash can be used for pest control, to make soap, to melt ice and snow, absorb odours, remove oil stains on driveway or garage, and polish silver.

The use of wood ash as a forest or soil amendment is not unusual. In north-east United States of America, 80% of wood ash produced is used in land application[1]. In Europe (e.g., Sweden, Finland, and United Kingdom), wood ash is often added to forest soils to enhance biomass production. In Canada, wood ash is mainly used for liming and/or fertilizing in Alberta, British Columbia, New Brunswick, Nova Scotia, and Quebec. In Ontario, wood ash is not regularly used as a soil amendment on agricultural or forest soils, and there are currently no guidelines for such uses.[4]

2.0 SURVEY RATIONALE

As wood ash can be used as a restorative additive to garden and forest soils, and as ash recycling programmes have worked in other countries (e.g., Sweden and Finland), the Friends of the Muskoka Watershed (FMW) decided to gain an understanding of wood ash production and use in the Muskoka. Our primary objectives were to determine: 1) the main sources of wood used during the heating season; 2) if and how Muskokans were willing to participate in a residential wood ash recycling programme; and 3) how many buckets of ash are produced during the heating season. This survey falls under the umbrella of the "Hauling Ash to Solve Ecological Osteoporosis" or "HATSEO" project that is funded by an Ontario Trillium Foundation Seed Grant and aims to turn a waste product – wood ash – into a useful fertilizer that combats Ca decline.

3.0 METHODOLOGY

The *Survey of Wood Ash Users in Muskoka* was prepared and distributed to FMW members and posted on the FMW website[1] on March 7, 2017. Electronic copies of the survey were also sent to Lake of Bays Association, Kawagama Lake Cottagers Association, and the local branch of the Ontario Maple Syrup Association (Sweetwater Maple Syrup Supplies and Sugar bush). The survey was also promoted via individual Twitter and/or Facebook pages, and distribution lists. A copy of the questionnaire is attached as Appendix 1.

4.0 FINDINGS OF THE WOOD ASH SURVEY

4.1 Wood as a heating source

In total, 53 completed questionnaires were received and all respondents used wood or wood products as a heating source. There was no indication that residents used the wood for other purposes such as maple syrup production, bonfires, elimination of garden or yard waste, or wood fired cooking.

4.2 Main source of wood

The main source of wood ash produced in Muskoka was from hardwood, which was used by 57% of the respondents. Twenty-six percent of the respondents used 'mixed' wood, i.e., a mixture of hardwood tree pieces purchased from a supplier. Softwood and wood pellets were not as widely used as hardwood tree species, and accounted for 14% and 3% of the respondents, respectively (Figure 1). Biochar was not used by any of the respondents.

[1] http://friendsofthemuskokawatershed.org/hatseo-survey/

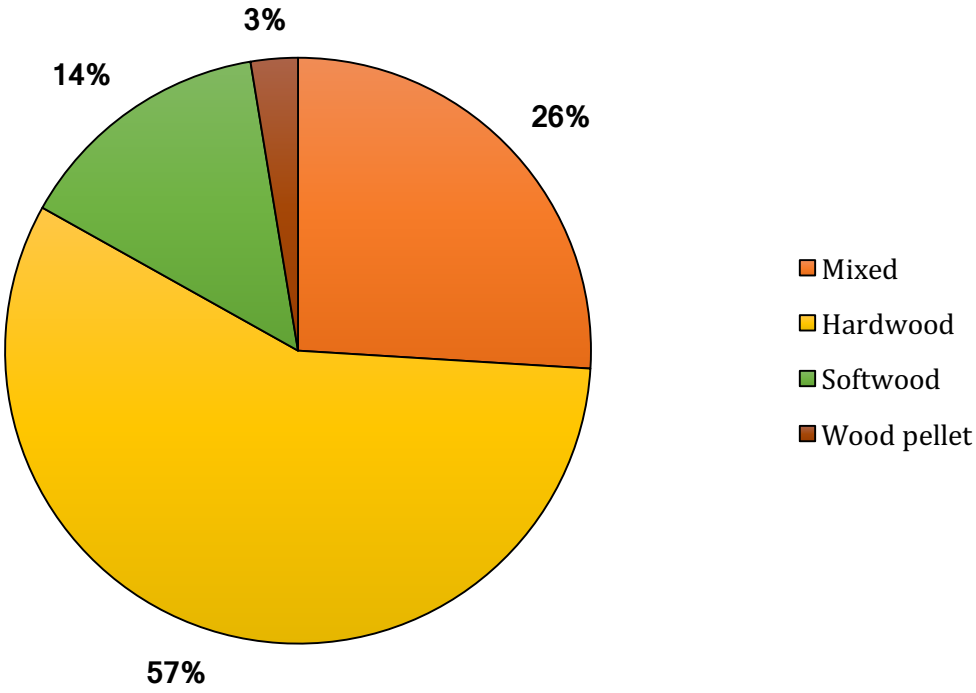

Figure 1: Pie chart showing percentage of wood or wood fuel types used by respondents

4.3 Parts of tree used to produce wood ash

The majority of the respondents used the stem or trunk of trees as a heating source (44%). Other respondents used the bark (30%) or branches (26%) (Figure 2). Tree roots or foliage were not used by any of the respondents to produce wood ash.

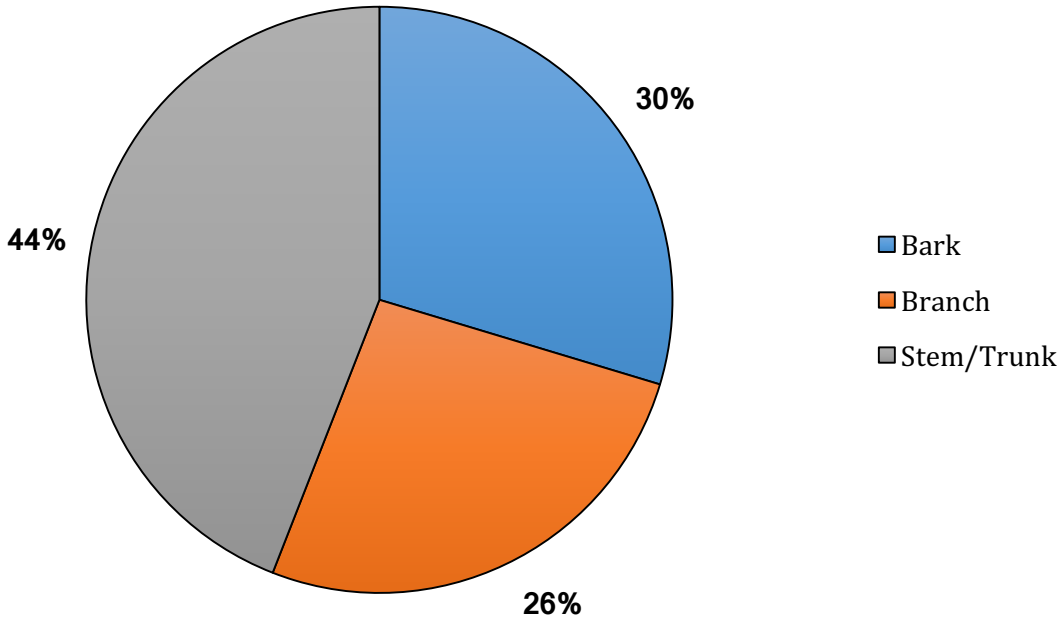

Figure 2: Pie chart showing percentage of main parts of trees used by respondents in wood ash production

4.4 Tree species used to produce wood ash

Many tree species were used as fuel, and thus to produce ash in Muskoka. The majority of the respondents used the hardwood tree species maple (29%) to produce wood ash. Other hardwood species used were beech (19%), oak (17%), birch (14%), ash (4%), and cherry (2%). Aspen, basswood, elm, moose-maple, and poplar, each accounted for 1% of the responses (Figure 3).

Softwood tree species were also used to produce wood ash, but in smaller amounts. The softwood species hemlock and pine, both accounted for 2% of the respondents. Spruce, cedar and balsam were also used, but each accounted for 1% of the responses. Four percent of the respondents had no knowledge of the tree species they used (Figure 3).

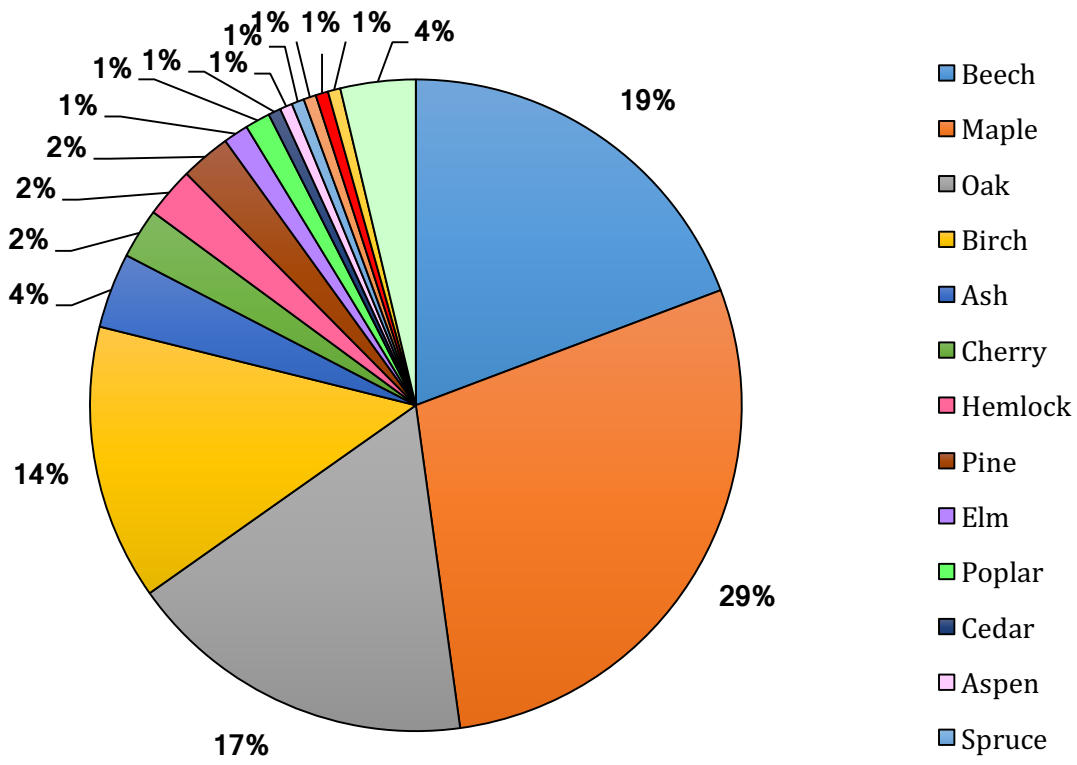

Figure 3: Pie chart showing percentage of tree species used by respondents in wood ash production

4.5 Current uses of wood ash

The majority of wood ash produced in Muskoka is used as fertilizer in gardens (39%) (Figure 4). Other primary uses included compost (24%), and melting ice and snow on driveways (19%). Few respondents used wood ash in their homes (3%) (e.g., cleaning glass on the wood stove) and for pest control (3%). In contrast, some respondents did not use wood ash produced, but disposed of it in the municipal landfill (4%), or in a forested area on their property (6%) (Figure 4).

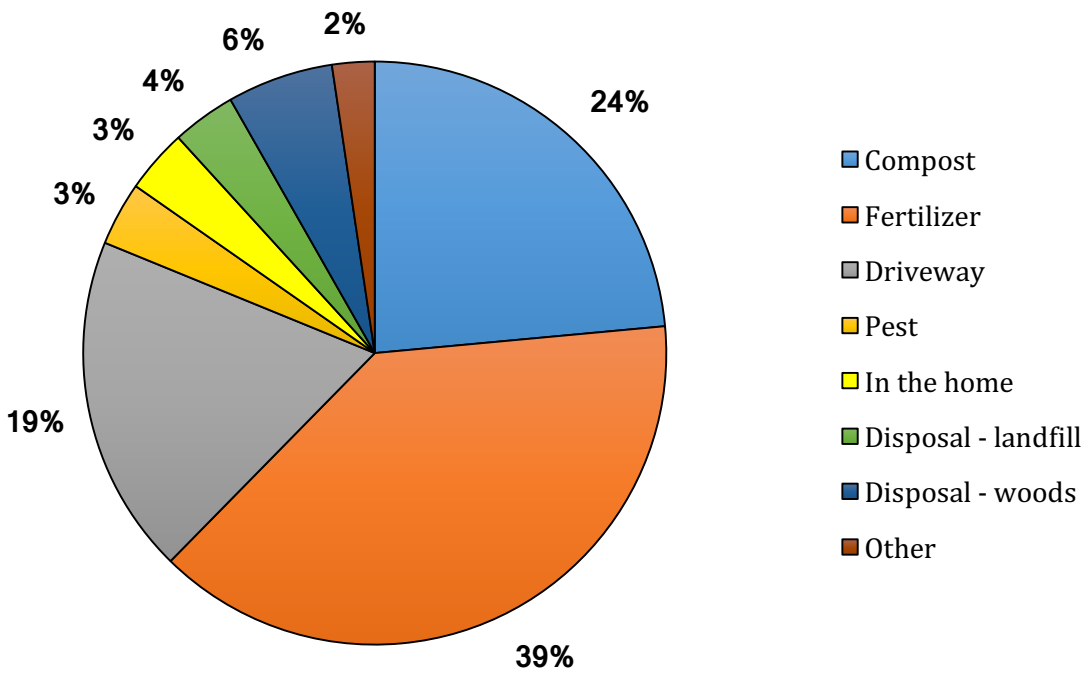

Figure 4: Pie chart showing percentage use of wood ash produced by respondents

4.6 Seasonal ash production

Of the 53 respondents that submitted a completed questionnaire, 35 (66%) used wood as a heating source only in the winter. The remaining 18 respondents used wood during the winter in conjunction with fall and spring (50%), fall, spring and summer (44%) or fall alone (6%).

4.7 Participation in residential wood ash programme

Of the 53 respondents that submitted a completed questionnaire, only 3 persons were not interested in participating in a wood ash recycling programme. Most of the willing participants preferred to transport their wood ash to the municipal landfill (29%) or to a centralized location closer to home (23%) (Figure 5). Eighteen percent of the respondents

were willing to separate wood ash from organic waste for curb side pickup. However, this activity is likely not feasible as the District of Muskoka Municipality has indicated that it would be an expensive undertaking.

Muskokans were also willing to participate in the distribution of wood ash to the forest (15%), to help promote and participate in an "ash drive" geared towards collecting wood ash in and around Muskoka (8%), or to serve on a wood ash recycling programme's advisory committee (4%). Three percent of the respondents preferred to continue disposing of wood ash in a forested area on their own properties (Figure 5).

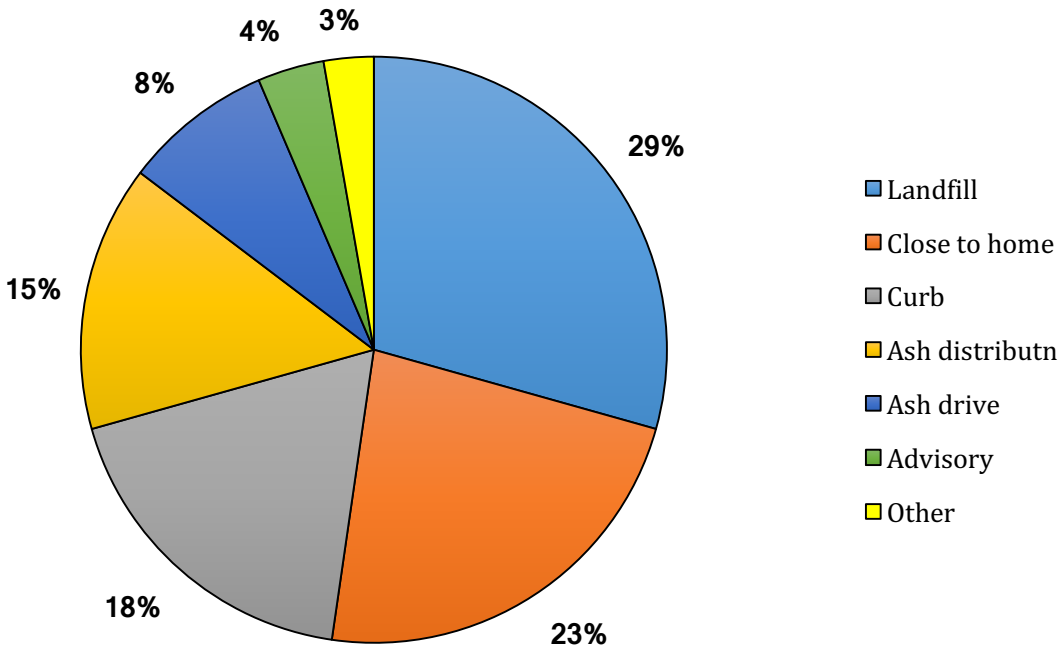

Figure 5: Pie chart showing willingness of respondents to participate in a residential wood ash recycling programme

4.8 Buckets of ash produced during heating season

During the heating season, 30% of the respondents produced either more than 20 buckets of wood ash or 5 to 10 buckets, whereas 28% produced either 10 to 20 buckets (Figure 6). In contrast, few respondents produced smaller numbers of buckets of ash. For example, 3 to 5 buckets (10%) and 1 to 2 buckets (2%) (Figure 6).

If we assume that a Muskokan uses an ash bucket that has a volume of 17.7 L (3.9 gal)[5], the most common size, then the 53 respondents would produce about 12151 L (~3210 gal) of wood ash. Given that the density of wood fly ash is 548 kg per cubic metre[6], then these 53 Muskokans would produce, on average, 125.6 kg of wood ash per individual during the heating season.

4.9 Number of face cords burnt during heating season

The amount of wood (in face cords) burnt during the heating season varies. The majority of the respondents burnt more than 5 face cords (38%) during the heating season (Figure 7). Other respondents burnt between 1 and 2 face cords (22%), 2 to 3 face cords (16%), 4 to 5 face cords (12%) or 3 to 4 face cords (10%) (Figure 7). Few respondents burnt less than 1 face cord (2%).

Overall, the 53 respondents burnt 176.5 face cords during the heating season. As a face cord is 1/4 a full cord (weighs approximately 2 tons)[7], then on average, about 1500 kg of wood is burnt per individual during the heating season.

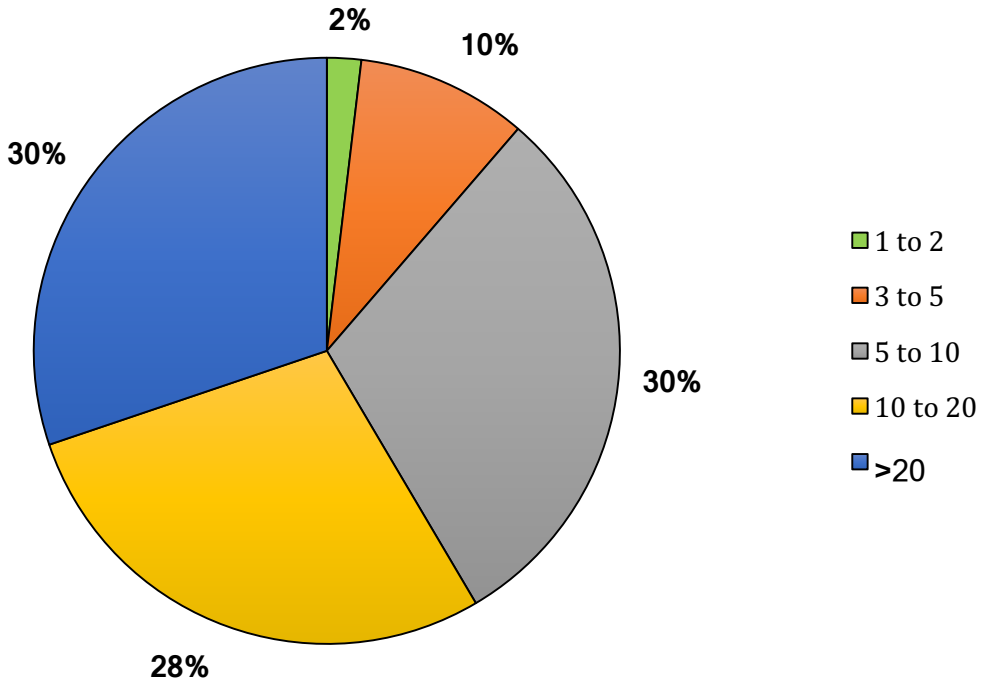

Figure 6: Pie chart showing how many buckets of ash are produced by respondents during the heating season

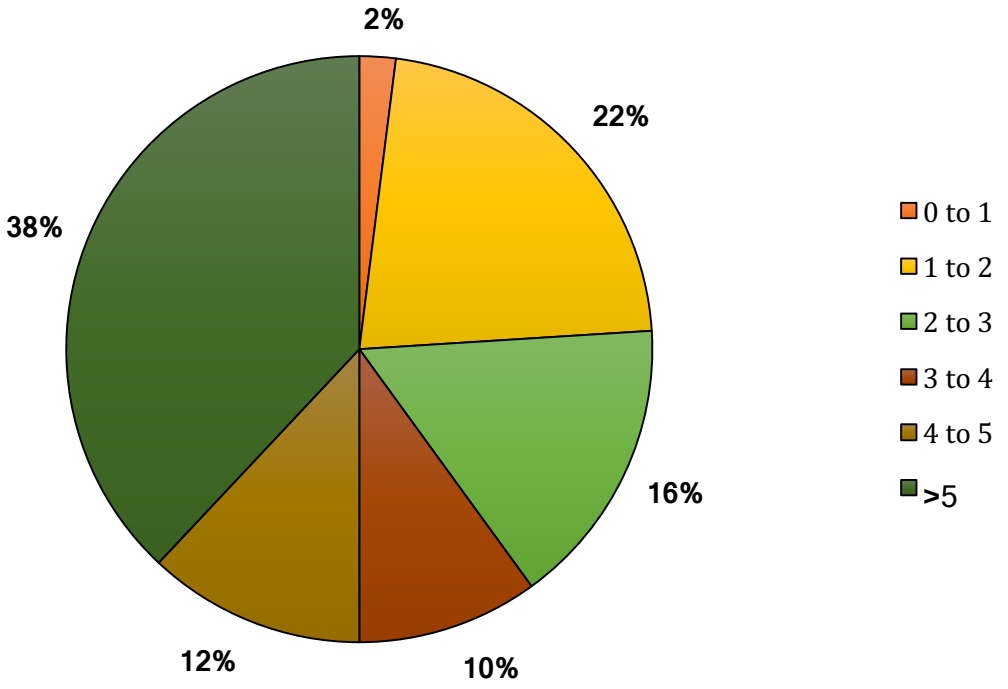

Figure 7: Pie chart showing the distribution of the amount of wood (in face cords) burnt per year

5.0 GAPS AND RECOMMENDATIONS

The purpose of the *Survey of Wood Ash Users* was to gather information on wood use and wood ash production in Muskoka. The survey was distributed to members of the FMW, cottage associations, and maple syrup producers who were thought to use wood as a heating source. Within Muskoka, there are 60,599 permanent and 85,163 seasonal residents[8]. If 3% of the population heats with wood[9], then the number of survey responses received (<1% of the number that heat with wood) may not be a representative sample. A larger sample should be sought, as it is likely more information will be needed to determine the feasibility of establishing a residential wood ash recycling programme in Muskoka that has the purpose of helping to solve the environmental Ca decline problem. In addition, more information on wood ash production would assist in determining if enough wood ash could be collected from residences and/or commercial businesses for distribution to the north-eastern portion of the 2EB Watershed, i.e., the Hollow River Quaternary Watershed, where > 50% of the lakes have Ca levels below 1.5 mg Ca/L, a level at which Ca-rich biota suffer population damage.

6.0 IS THERE ENOUGH WOOD ASH TO HELP SOLVE THE CA DECLINE PROBLEM?

<u>Scenario 1</u>

There are 60,599 permanent residents in Muskoka, of which 3% heat wood. Assuming our survey provided accurate estimates, the majority of Muskokans that heat with wood produce about 20 buckets of ash per heating season, which equates to approximately 36,359 buckets of wood ash in the watershed. Assuming an ash pail holds 17.7 L, permanent residents would

generate about 643,561 L (644 m^3) of wood ash. As the density of wood ash averages about 548 kg per cubic metre[6] (it varies with wood species), approximately 352,672 kg (~353 tonnes) of ash would be produced. As our survey indicated 2/3 of the respondents would be willing to transport wood ash to the dump or landfill, or a nearby transfer station, they could provide about 235,000 kg (235 tonnes) of ash per year to a wood ash recycling program. This amount of ash would be enough to treat the Ca decline problem in roughly 58 hectares of Muskoka forest at an application rate of 4 tonnes per hectare per year. Storage of this much wood ash for annual distribution requires a 500 m^3 building, and these are readily available for salt storage.

Scenario 2

There are an estimated 145,762 residents (permanent and seasonal combined) in Muskoka, especially during the summer. If 3% heat with wood and generate 20 buckets of ash, 87,457 buckets of wood ash would be produced. A 17.7 L pail would generate about 1,547,992 L (~1548 m^3) of ash. If 2/3 of the residents are willing to transport wood ash to the landfill, then FMW would have ~566,000 kg (566 tonnes) of ash available per year. With this amount of ash, approximately 140 hectares of Muskoka forest could be treated at an application rate of 4 tonnes per hectare per year.

Conclusion

With either scenario, the amount of wood ash generated for the application of 1 tonne per hectare, is certainly adequate for a large scale pilot project or feasibility study on wood ash

collection and application; however, not enough to solve the problem across Muskoka, given the widespread nature of Ca decline.

To solve the Ca problem, i.e., eliminate Ca limitation of tree growth, and provide excess Ca that could enter lake waters, a minimum of about 4000 kg (4 tonnes) per hectare of ash would likely need to be applied (Carolyn Reid, Trent University, pers. comm.). The Hollow River Watershed is approximately 40,000 hectares. If 53 residents produce about 12,151 L of ash that would weigh roughly 6659 kg (~7 tonnes), then FMW would require wood ash from about 41,000 people to treat the entire watershed. There are certainly enough people in the province that heat with wood to provide this much ash, but not in Muskoka alone.

As of 2016, Ontario's population was 13.9M. Of these, 1% use wood or wood pellets as their primary heating system. Assuming each of these persons generate 20 buckets of ash, then about 2.8M buckets of ash would be produced. Assuming 17.7 L pails, Ontario wood burners would generate about 49.5M L (~50,000 m^3) of ash. Assuming 2/3 of residents in Ontario are willing to transport wood ash to the landfill, then FMW would have ~18.1M kg (about 18000 tonnes) of ash available per year. Therefore, FMW could treat approximately 4,500 hectares per year with wood ash to help alleviate the Ca decline problem. As the Hollow River Watershed is 40,000 hectares, a province wide wood ash recycling programme may well solve the current Ca decline problem in 9 to 10 years with available ash supplies. A permanent wood ash recycling programme could then continue to support forest growth and lake health in the future. Based on these estimates, a larger scale wood ash recycling programme is justified, assuming there are no other problems that the use of wood ash might

cause. We will address these potential problems (metal levels and aquatic toxicity) in our next technical report

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APPENDIX

Appendix 1: Survey of wood ash users in Muskoka

SURVEY OF WOOD ASH USERS IN MUSKOKA

Name: _____

Address/Tele/Email: _____

_____

Please indicate with a tick or ticks (√) your answer(s).

1. Do you use wood or wood products as a heating source?
   - ☐ Yes
   - ☐ No

2. If you are not using wood/wood products for heat, how are you using it?
   - ☐ For bonfires
   - ☐ For elimination of yard or garden waste
   - ☐ For wood fired cooking (e.g., an outdoor pizza oven)
   - ☐ To prepare maple syrup
   - ☐ Other (*please specify*) _____

3. What is/are the main source(s) of wood you use?
   - ☐ Biochar
   - ☐ Mixed wood
   - ☐ Hardwood
   - ☐ Softwood
   - ☐ Wood pellets
   - ☐ Other *(please specify)*_____

4. What parts of the trees do you usually use (tick all that apply)?
   - ☐ Bark
   - ☐ Branches
   - ☐ Foliage
   - ☐ Roots
   - ☐ Stem/trunk
   - ☐ Other (*please specify*) _____

6. How do you use the ash you produce?
   - ☐ Compost
   - ☐ Fertilizer on your property
   - ☐ Pest control (e.g., deter slugs and snails)
   - ☐ Melt ice and snow on driveway
   - ☐ Making soap
   - ☐ Around the house (e.g., absorb odours, polish silver)
   - ☐ Other (*please specify*)_____

7. Do you produce wood ash only in the winter?
   - ☐ Yes
   - ☐ No

8. If you do not produce wood ash only in the winter, when else do you do so?
   - ☐ Autumn
   - ☐ Spring
   - ☐ Summer

9. Are you willing to participate in a wood ash recycling programme in the Muskoka?
   - ☐ Yes
   - ☐ No

10. If yes, how are you willing to participate?
   - ☐ Transport wood ash to landfill, i.e. the dump
   - ☐ Transport wood ash to a centralized location closer to home
   - ☐ Separate ash from organic waste for curb side pickup
   - ☐ Participate in a team that distributes ash in the forest
   - ☐ Help promote and participate in an "ash drive"
   - ☐ Serve on a wood ash recycling program's advisory committee
   - ☐ Other (*please specify*) _____

11. How many buckets of ash do you produce during the heating season?
   - ☐ 1-2
   - ☐ 3-5
   - ☐ 5-10
   - ☐ >10

- ☐ Other (*please specify*) _____

12. How many face cords (4'H x 8'L x 16"D) of wood do you burn during the heating?
    - ☐ 1-2
    - ☐ 2-3
    - ☐ 3-4
    - ☐ >5
    - ☐ Other (*please specify*) _____

THANK YOU FOR YOUR PARTICIPATION