The Association for Canadian Educational Resources (ACER)

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PLANTING FOR CHANGE FIVE-YEAR REPORT FOR CANADIAN TREE FUND

October 2013

Planting for Change Five-Year Report

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To date, there are 21 schools in the P4C network and 8 more schools will be planted in fall 2013. Teacher and student testimonials show how well received the P4C program has been to various schools across Southern Ontario.

Over the past 5 years, planting the trees in the schoolyards has been very successful. The majority of the trees planted between 2008 and 2012 are alive and healthy. The tree loss percentage was only 4%. Two schools in Oakville, Appleby College, and Oakville Trafalgar High School, are sequestering significantly more carbon (20.075 kg and 19.62 kg, respectively) with their trees than other schools (between 1-8 kg). Environmental stewardship may play significant factors in the success of these two plots. The trees sequester carbon and contribute to tree canopy cover targets in cities and towns in Southern Ontario.

The P4C program provides many uses and benefits. Schoolyards are being naturalized with native indicator species and contributing to native species habitat. The P4C plots have been applied to a variety of subjects in the classroom such as math, science, art, and geography, to help students enjoy the outdoors and allow teachers to enhance curriculum without having to undertake bus trips. This program helps to promote environmental awareness and stewardship and teaches students how to plant, measure annual growth and assess the health of trees. P4C continues to be embraced by new schools.

Alice Casselman
Founding President, ACER

1. Overview of ACER

The Association for Canadian Educational Resources (ACER) is a not-for-profit community educational organization and a registered charity. Alice Casselman founded ACER in 1987. Her vision was to create an organization that would enhance students' learning through the development of environmental education programs. These unique programs not only complement school curriculum, but also add value to the community and contribute to scientific research. Through the development of sites and resources, ACER has created and expanded an existing global network of long-term experimental plots in order to monitor forest ecosystems. The network uses scientifically sound, internationally recognized protocols developed by the Smithsonian Institution to track changes in biodiversity. After 25 years, ACER continues to teach not only schools, but also organizations, communities, and individuals how to plant trees and monitor their growth in order to study and better understand the impact of climate change on forest ecosystems.

ACER's community-based research projects and programs help citizens take ecological action in response to climate change. Our organization trains citizen scientists to accurately monitor and report ecological changes to contribute to their understanding of climate change and increases environmental awareness. The training methods, materials, and equipment that are developed and provided by ACER are distributed to individuals and groups to help them track changes in their local forest ecosystems.

ACER has come a long way since establishing three original experimental plots in 1997. Our organization now collaborates and works with school boards, private landowners, conservation authorities, colleges, agency educational programs and scientists to measure tree growth and track tree species success. Trained volunteers, interns, and students help to keep our programs running. The data collected from the forest plots/sites is entered into our database and accessible to the public from our website. Our online database allows people to share and compare data collected from their location to data from other forest plots/sites. Scientists analyze the data and the results contribute to decision making for future communities. Currently ACER has 5 programs: Planting for Change, Measuring Our Resources, Tracking for Success, Go Global, and Youth Stewardship Project.

ACER is proud of the accomplishments made over the past 25 years. The programs that we have developed, tested, and established continue to accumulate data for sharing. Our experimental forest plots at Humber College (home to four of our programs) and other sites continue to educate volunteers and schools. We are privileged to receive and provide the mentoring by the best Canadian scientists in the fields of forestry, meteorology, risk assessment and climate change impacts. In addition, we participated at the Biodiversity of the Americas in Panama and have prepared an educational resource called Climate Change in Context.

Our educational and research projects could not have been made possible without the support of our funders, the help from our partners, and the time and effort of our volunteers. We truly appreciate all of your efforts, interest, and commitment.

Ridgewood P.S. (Mississauga, ON) tree re-measuring group, 2013

2. Planting for Change (P4C) Program

The Planting for Change (P4C) program allows classrooms to create their own living laboratory in their schoolyard in order to study the effect of climate change on the growth of different tree species. ACER's growing network of P4C tree research stations in schoolyards allows students to collect and share scientific data. This unique program broadens participants' understanding about the impacts of climate change and can be used to complement school curriculum in subjects such as math, geography, science, world studies, and art. To the best of our knowledge, no other organization uses this type of community-based research model to study climate change/environmental issues while simultaneously providing valuable environmental education.

The cumulative data from the P4C long-term monitoring plots collected by students, or citizen scientists, is relevant and important to climate change research. Climate change scientists can use this data to determine which species of trees will survive and thrive in the warming climate. Their results may then aid urban planners in choosing tree species that can adapt to the changing climate which can result in numerous benefits for cities including money savings, aesthetic beauty, and shade.

There are two main goals of ACER's P4C program. One is to provide meaningful environmental education to youth by reinforcing the importance of climate change initiatives and environmental stewardship. The second goal is to study the effect of climate change on the growth of five native species of trees planted in different geographic regions in Southern Ontario.

The P4C network of schools is located mainly in the Golden Horseshoe of Lake Ontario with the most southern schools being located in the Niagara region. The geographical factors that affect the growth of the trees may include soil type, distance from the lake, elevation, and temperature. In addition, many of the P4C schools are located within the Greater Toronto Area (GTA)'s urban heat island. The urban heat island of Toronto is nearly 4.0 Celsius degrees warmer than rural Ontario (Karsh 2012). How does the climate change affect the growth of each school's P4C suite of trees in these different geographic locations?

These two goals are achieved by educating young citizen scientists to accurately obtain results/collect scientific data for climate change researchers to analyze, while spreading environmental awareness to different communities in Ontario.

From left to right: Planting Day at Dr. G.J. MacGillivray P.S., Courtice, ON, Smithville Christian H.S., Smithville, ON and Dr. G.J. MacGillivray P.S., Courtice, ON

How?

The P4C program engages students outside through hands-on fieldwork. Through this outdoor education experience, students learn the basic anatomy of trees, how to properly plant trees, how to measure their growth and map their location, and about issues surrounding climate change on a local and global level. The methodology used to measure the growth of the trees is in accordance with Smithsonian monitoring protocols.

For this study, each P4C school site planted 15 trees. At each school's experimental plot, there are three of 5 native tree species planted: Bur Oak, Sugar Maple, Basswood, Hop Tree, and White Spruce. Data is collected on planting day and on an annual basis after planting day. The data collected is then posted on ACER's website and is available to the public. Students can view their data and compare it to other schools' data. The cumulative data is then analyzed and students can take pride in contributing to meaningful scientific research.

ACER
ASSOCIATION FOR CANADIAN EDUCATIONAL RESOURCES

3. Project Achievements

The P4C program commenced in 2008 and the P4C network currently consists of 21 schools. Six schools planted in 2008; three in 2010; six in 2011; five in 2012; and one in 2013. In fall 2013, seven more schools will be added to the P4C network. The municipalities that currently host the P4C program include Mississauga, Toronto, Brampton, Oakville, Burlington, Hamilton, Smithville, Welland, St. Catharines, Courtice, and Markham. Over 3400 students have participated in the P4C program between 2008-2012.

Map of P4C Schools in Southern Ontario

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LEGEND
Schools that are currently in the P4C program:

1. Herb Campbell P.S.
2. Appleby College
3. Applewood Heights S.S.
4. Oakville Trafalgar H.S.
5. Robert Bateman H.S.
6. Christ the King S.S.
7. Ridgewood P.S.
8. John Fisher P.S.
9. Guido de Bres H.S.
10. Richmond Street P.S.
11. Quaker Road P.S.
12. Princess Elizabeth P.S.
13. T.L. Kennedy S.S.
14. West Credit S.S.
15. Humber Arboretum
16. David Suzuki S.S.
17. Dr. G.J. MacGillivray P.S.
18. Assumption Catholic E.S.
19. Smithville Christian H.S.
20. Montclair P.S.
21. Armadale P.S.

4. P4C Five-Year Data Analysis

I. Methodology

The site for the long-term monitoring program is carefully selected based on proximity to school, obstacles (i.e. underground lines), mature trees, shade, and wind exposure. Each site is approximately 400m^2. The five tree species that were chosen by ACER's technical advisory team for this experiment are native to Ontario, able to grow in clay soils, in exposed, often dry areas, hardy to urban conditions, and are representatives of a range of species for teaching tree identification and taxonomy (i.e. creating a dichotomous key) (P4C Manual, ACER 2012). These five indicator species were also chosen because they grow optimally at different latitudes or hardiness zones.

The indicator species include Basswood (*Tilia americana*), Bur Oak (*Quercus macrocarpa*), Hop Tree (*Ptelea trifoliate*), Sugar Maple (*Acer saccharum*), and White Spruce (*Picea glauca*). The White Spruce, a representative of coniferous trees, generally grow best in northern climates. Hop Trees are native to the southern range of Ontario. Bur Oak, Sugar Maple, and Basswood grow in more temperate regions and were chosen to represent southern Ontario's deciduous trees. The trees are planted as a mixed community and distances between trees are measured and mapped.

ACER helps each school prepare to plant the trees on planting day. The site preparation has varied between schools as in the past, some schools rototilled their sites and used triple mix soil, while others dug soil out only where trees were to be planted and used compost or topsoil to mix the dug out soil with and newspapers (See Appendix A). Please refer to Planting for Change Fall 2013 Manual for Teachers for detailed planning methods.

Students are told to dig a "bowl" and not a hole for the plants. The soil that is dug out is mixed with topsoil and the mixture is put back in the bowl after each tree has been placed in the bowl. A sod berm around each tree is created and layers of newspapers are placed around each tree and mulch is added for water retention. Two wooden stakes are oriented in the northwest direction on either side of each tree in order to provide protection from westerly prevailing winds and pounded into the ground just outside of the root zone of each tree and tied to the tree with burlap. Tree guards are installed on the trees to help prevent small animals from eating the bark. A unique tag is added to each tree for identification purposes.

Three native shrubs are planted in a triangular orientation around each tree to help protect the rooting area of the tree and reduce soil compaction caused by student traffic. These shrubs are planted about 1-2 feet away from the tree's base. After the 15 trees and 45 shrubs have been planted, students put down layers of newspaper around the plants and then mulch on top of it to create mulch islands which include the three shrubs and tree.

Educational tools also given out are P4C manuals for students and teachers. Teachers are asked, if time permits, to teach students about anatomy of a plant and planting procedure before actual planting and measuring day.

P4C site photo of planting day at Montclair P.S.
Trees are staked and mulch islands are formed.

Materials

All schools are provided with an ACER Bag, which includes equipment to measure mature and small trees and educational CDs including "Climate Change in Context". Equipment used to measure the small trees between 2008-2012 include calipers, 1.5 m measuring tapes, trundle wheel, and 30 m measuring tapes.

Measurements

The methodology of measuring the growth of each tree is in accordance with Smithsonian monitoring protocols.

- Root Collar

Students measured the root collar diameter (in mm) of each tree using a caliper.

- Total Height

The total height is measured in centimetres using a 1.5m measuring tape. The total height is determined by measuring from the root collar of the tree to the base of the terminal bud. If the total height was greater than 1.3m, the total height was not measured and instead the diameter at breast height (DBH) is measured using the caliper.

- Diameter at Breast Height or DBH
The DBH is a measurement of the tree's diameter at 1.3m in millimetres. For trees under 4 cm DBH, calipers are used to measure the DBH in millimetres.

- Crown Width
The crown width of the tree is measured in centimetres and two widths, W1 and W2, taken at right angles to each other, are recorded. W1 is the greatest width of the crown and is measured by placing the measuring tape against the bark of the main stem. Leaves of deciduous trees are not included in crown width measurements.

W2 is the width perpendicular to W1. These two widths provide a cross-section of the crown width from a birds' eye view and are used to determine how much space the crown occupies.

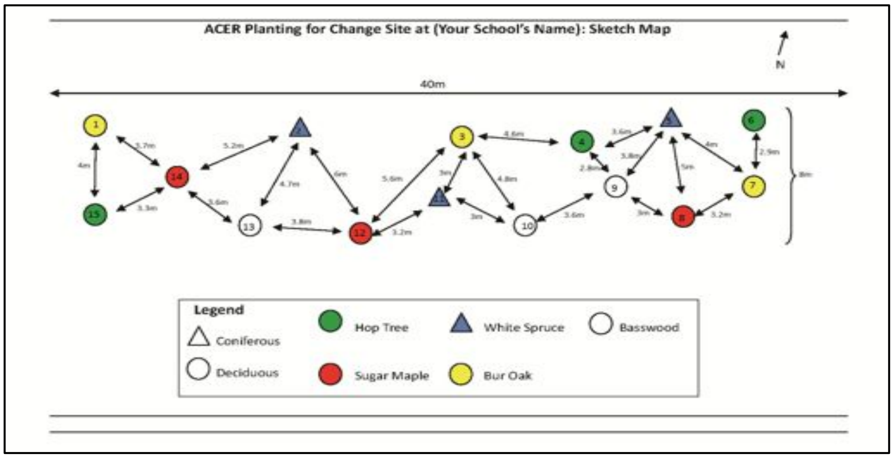
- Health
The health of each tree is assessed based on a status code below.

HEALTH CHECK

A: Alive/Healthy	LB: Lightly browsed
D: Dead/Dying	N: Not browsed
HB: Heavily browsed	S: Basal sprouting
I: Sick/Infested	Tag M: Tag missing
	Tree M: Tree missing

- Triangulation

A trundle wheel or measuring tape is used to measure the distance in metres between the trees. A sketch map is then drawn showing the trees distances from one another.



II. **Results and Interpretation**

P4C is a unique and important educational program that allows individuals to plant and monitor tree growth in urban and rural environments. Students collect the tree data and by doing so, learn about the effect of climate change on forest biodiversity while broadening their awareness of climate change impacts.

ACER identified a need to collect tree species data to track changes in biodiversity and monitor climate change impacts on ecosystems in collaboration with the community. According to Dr. Sean Thomas, a professor at the Faculty of Forestry at the University of Toronto, it is fair to say that there is a lack of baseline data collected in the Greater Toronto Area (GTA) region for the tree species, at least that is readily available. The benchmark data collected for the five indicator species through the P4C program is accessible to the public through ACER's website.

By teaching students to take action against the causes of climate change they may become environmental stewards who will positively affect future forest ecosystems. Educating individuals about their biophysical environment helps to enrich their understanding of such ecosystems as well as their awareness, which seems to be a prerequisite for environmental stewardship according to Lianne Fisman (2005). Environmental stewardship then plays an important role in sequestering more carbon to help reduce greenhouse gas emissions.

The P4C program benefit and complement the school curriculum in a variety of ways. By planting a suite of trees in the schoolyard, teachers can have their classes learn outdoors without taking a field trip, thus eliminating transportation costs and decreasing carbon emissions. Teachers have used their P4C sites for a range of curricular activities including outdoor art lessons, photography, English, math, geography, science, physical education and recreation such as nutritional breaks under the trees or a quiet spot to write and read. The trees have increased the opportunities for classes to go outside, thus helping the students reconnect with nature.

One method of combatting climate change is to plant trees, which store carbon. Planting trees to reduce greenhouse gas emissions will require the help of citizens and communities to make a significant impact on the amount of carbon sequestered. Ontario intends to plant 50 million trees by the year 2025, which is part of the United

Nations Billion Tree Campaign (Ontario Ministry of Natural Resources, 2013). Environmental stewardship and awareness are the keys to successfully growing trees that will sequester more carbon per year, as care is needed in the early years of a tree's life. The P4C program teaches students and communities how to care for trees in the early years, but also aims to encourage students to think beyond the planting of trees solely to store carbon. The P4C program encourages students to consider how their actions affect the natural environment and to reflect on what steps they can take to ameliorate the effects of climate change.

Figure 1: 2012 Percentage of carbon sequestered by tree species at each P4C site planted 2008-2012

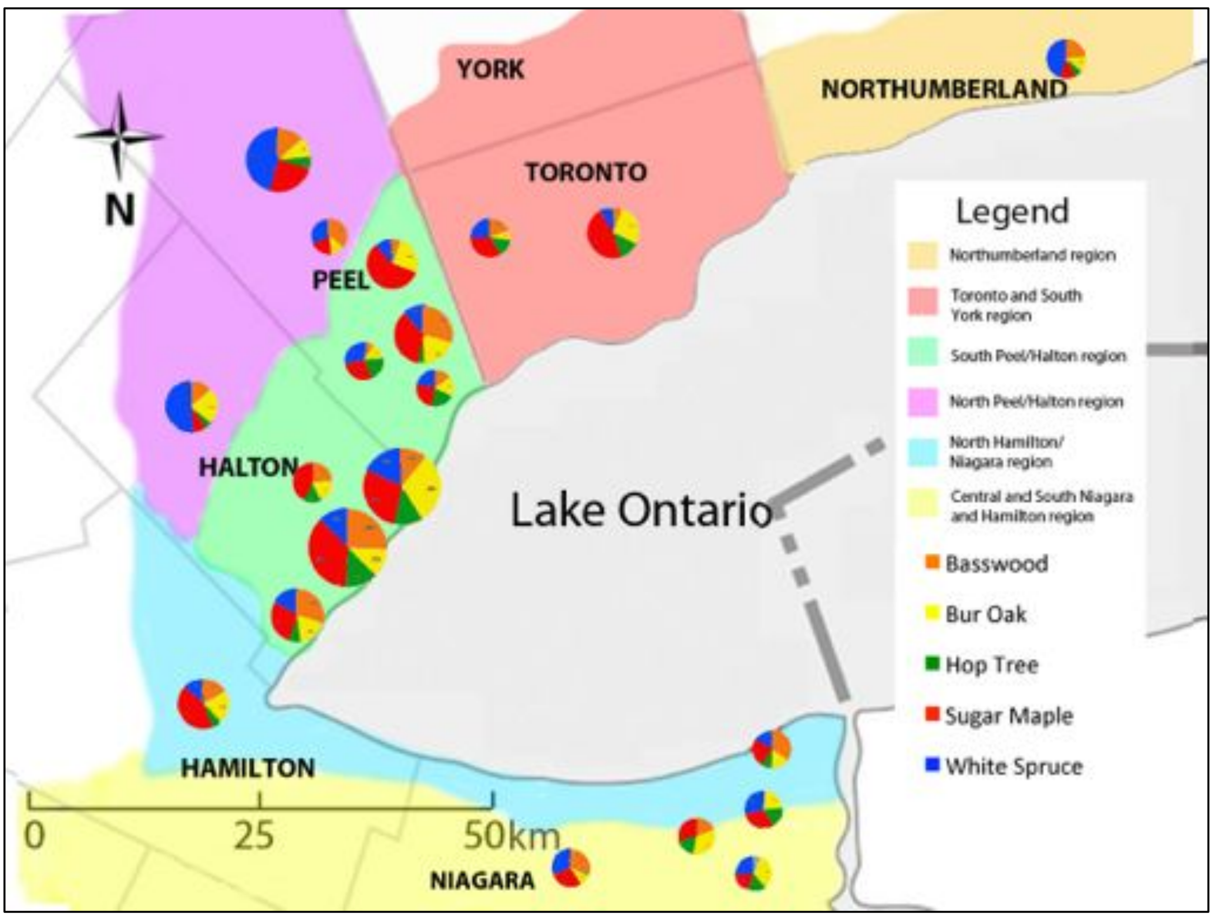


Table 1: Ontario regions where P4C species grow best according to Ontario Ministry of Natural Resource's (OMNR) Tree Atlas

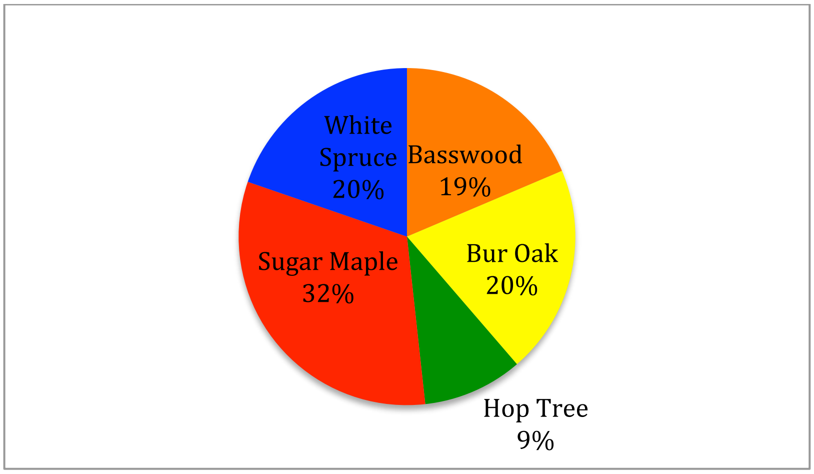
Ontario region	Area in region	Tree species that grow best in area	Year P4C species planted	P4C School
South Central Ontario	Toronto region and South York region	Basswood Bur Oak Sugar Maple	2010	John Fisher P.S.
			2011	Humber Arboretum
	South Northumberland region	Basswood Bur Oak Sugar Maple White Spruce	2012	Dr. G.J. MacGillivray P.S.
South West Ontario	South Peel/ Halton region	Basswood Bur Oak Sugar Maple	2008	Oakville Trafalgar H.S. Appleby College Robert Bateman H.S. Applewood Heights S.S.
			2010	Ridgewood P.S.
			2011	T.L. Kennedy S.S. West Credit S.S.
			2012	David Suzuki S.S. Montclair P.S.
	North Peel/ Halton region	Basswood Bur Oak Sugar Maple White Spruce	2008	Herb Campbell P.S. Christ the King S.S.

	North Hamilton/ Niagara region	Basswood Bur Oak Sugar Maple	2010	Guido de Bres H.S. Richmond Street P.S.
			2012	Assumption Catholic E.S.
	Central and South Niagara and Hamilton region	Basswood Bur Oak Common Hop Tree Sugar Maple White Spruce	2011	Quaker Road P.S. Princess Elizabeth P.S.
			2012	Smithville Christian H.S.

A distribution of the carbon sequestration by species, site and region is found in Figure 1. The regions in Figure 1 and Table 1 were areas defined in OMNR's Tree Atlas (OMNR, 2013). Certain tree species grow best in each defined area (see Table 1), which allows for comparison of the planted tree species within each region and between different regions. For example, White Spruces typically grow well in northern climates, and the P4C sites in the north show that White Spruce has sequestered more carbon than the other species at higher latitude sites. Hop Trees typically grow well in more southern climates and according to the Tree Atlas, the Hop Trees should grow best at P4C sites (Quaker Road P.S. and Princess Elizabeth P.S.) located in Central and South Niagara and Hamilton region. However, the Hop Trees planted in 2011 have sequestered slightly more carbon in the P4C sites located in Toronto, Peel, and North Niagara regions (Humber Arboretum, T.L. Kennedy S.S., and West Credit S.S.). Therefore, the increased temperatures may play a role in the increased growth of the Hop Tree in the more Northern Ontario regions. More cumulative data needs to be collected since these trees have been recently planted.

The species that has sequestered the most carbon is Sugar Maple (Figure 2). The White Spruce, Bur Oak, and Basswood trees have sequestered similar amounts of carbon (19-20%, Figure 9) and the Hop Tree has sequestered the least amount of carbon (9%). This is expected as the Hop Tree has smaller branches and generally has a smaller biomass than the other tree species.

Figure 2: Percentage of total carbon sequestered (kg) in 2012 by each tree species for all P4C sites



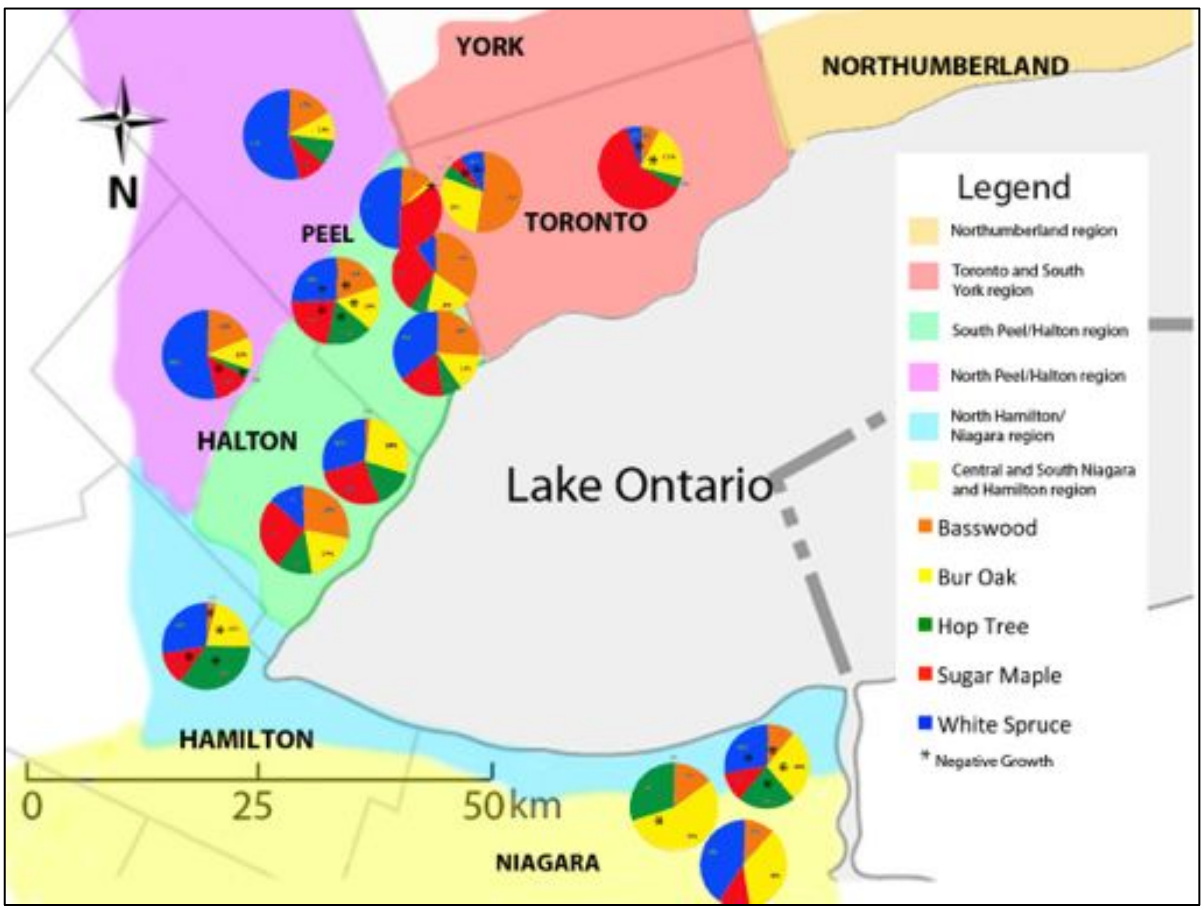
The environmental stewardship given to the trees on each P4C site appears to play a role in increasing the carbon sequestration for the schoolyard. The two highest carbon-sequestering schools, Appleby College and Oakville Trafalgar High School, stored 20.075 kg and 19.62 kg of carbon over a span of 5 years, respectively. The other schools which also planted their trees 5 years ago, sequestered between 1-8 kg of carbon. Some notable differences between these two schools and the other schools are the amount of mulching per year, maintenance of plot and other plants planted (i.e. wildflowers) which helped to enrich the ecosystem. The P4C teacher at Oakville Trafalgar H.S. also has her geography classes do stewardship activities such as mulching, edging, and weeding on the plots.

Table 2: 2012 Carbon sequestration (kg) for P4C sites planted in 2008

School	Carbon Sequestered (kg)
Appleby College	20.075
Oakville Trafalgar H.S.	19.62
Herb Campbell P.S.	7.545
Christ the King S.S.	2.935
Applewood Heights S.S.	7.215
Robert Bateman H.S.	3.5
Total	60.89

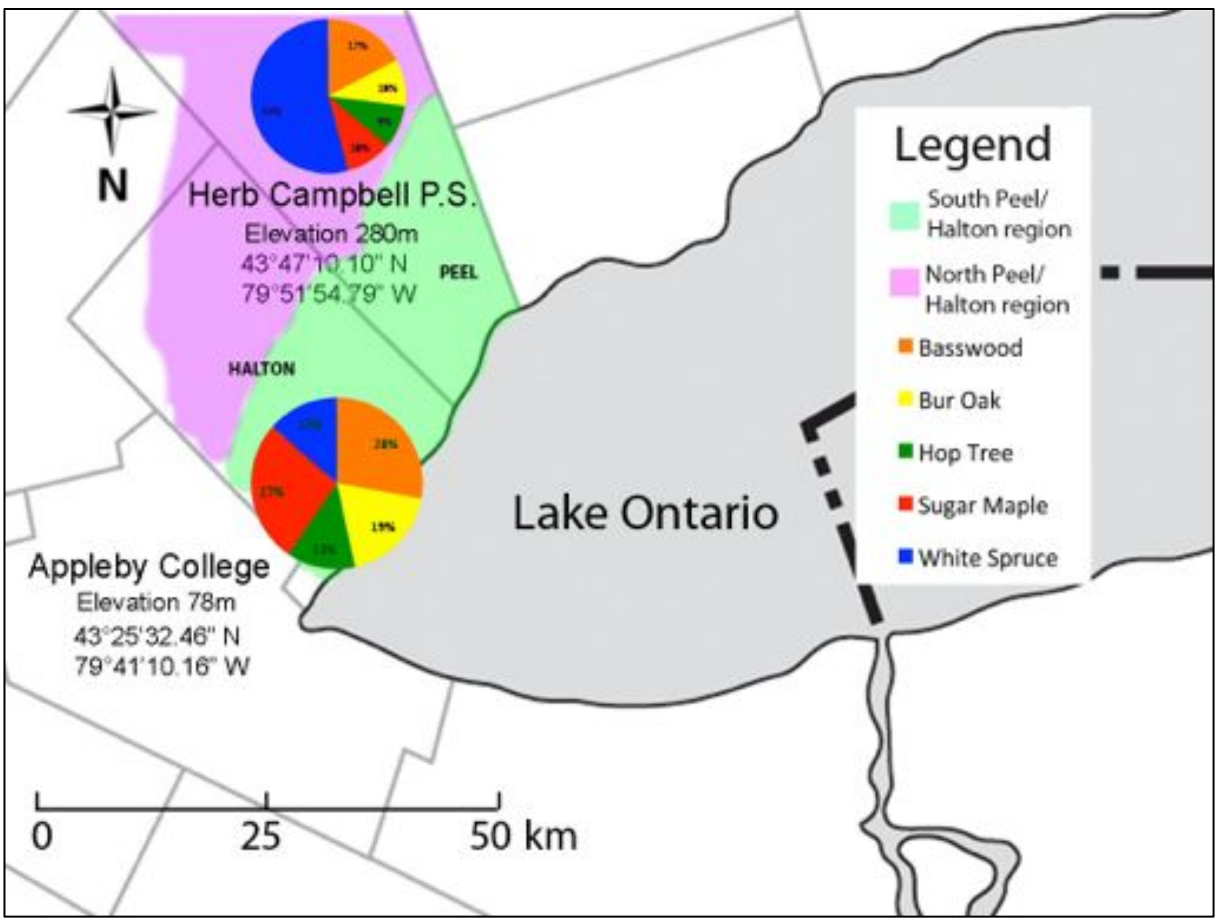
After planting 300 trees between 2008 and 2012, the P4C program has sequestered 80.5 kg of carbon, which is equivalent to driving a small car about 28 minutes from east Mississauga to downtown Toronto (city hall) about 8 times one-way or 4 return trips (using a 1996 Mazda 626 driving in the city and on the highway 26km emits 0.01 tonnes or 10 kg of carbon dioxide gas. Carbon Emissions Calculator used was: http://www.carbonzero.ca/calculate). In 2010, Canadians who drove to work had an average commute time of 24 minutes and about 82% of Canadians drove a car to get to work in 2010 (Turcotte, 2010). According to Statistics Canada, Toronto had the highest average daily commuting time in the country, which was 33 minutes. Cars are a major source of greenhouse gas emissions, and therefore the importance of climate change education could not be more crucial.

Figure 3: Average change in DBH (% of total change for each site) by tree species planted on P4C sites from 2008-2012



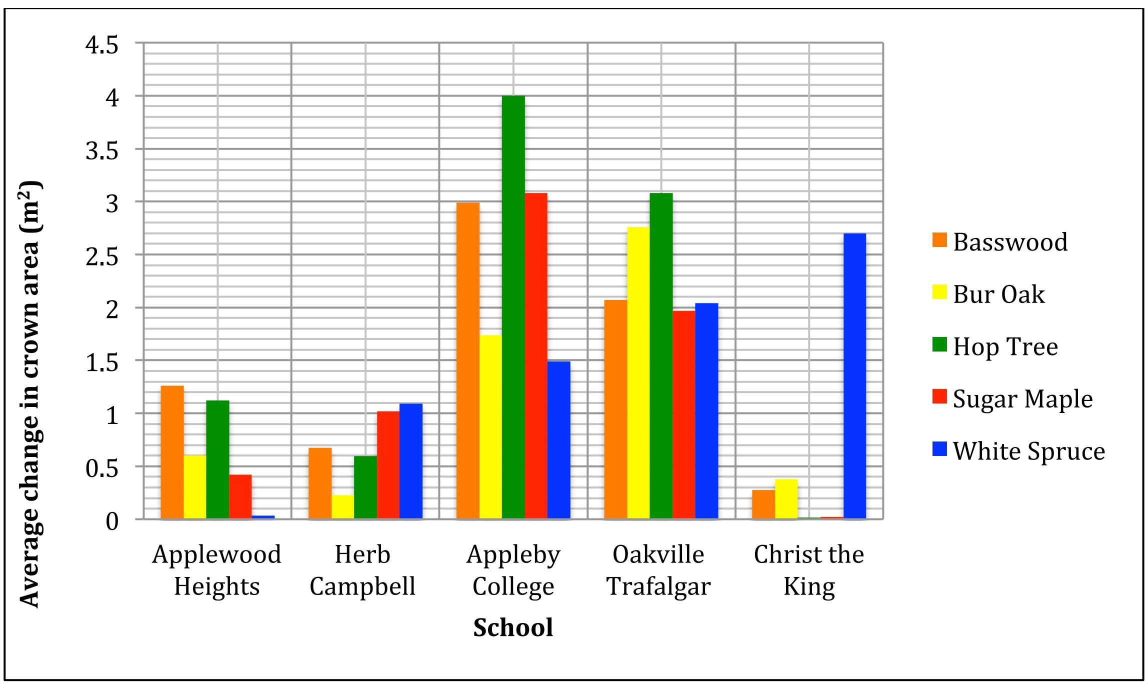
There was an increase in average growth in DBH from southern latitudes towards more northern latitudes observed in the White Spruce (Figure 3). The Hop Trees are growing much slower than the other tree species which is expected since they may only grow best in the South Niagara region (OMNR 2013). Statistical analyses will need to be completed to confirm these results. Some of the data indicated negative growth for the tree species. Negative growth may have been due to: browsing, deer rubbing (particularly at Humber Arboretum), experimental error/inaccurate measurement. More monitoring plots should be established to determine if trends in growth are replicated and so that more comparisons of tree species within regions and in different regions can be made. In addition, plots should continue to be audited.

Figure 4: Comparison of average change in DBH (% of total change for each site) at Appleby College and Herb Campbell P.S. by tree species between 2008-2012



A comparison of two P4C sites (measured from 2008-2012) planted in 2008, Appleby College (south Oakville) and Herb Campbell P.S. (Caledon) shows that tree species at each site are growing at different rates (Figure 4). The elevation at Herb Campbell P.S. (280m) is 3.6 times greater than that of Appleby College (78m). The average crown areas of the tree species at Appleby College are 1.36-7.56 times greater than the average crown areas of the Herb Campbell tree species (Figure 5). The average change in DBH is 0.6-6.4 times greater at Appleby College, and as a result the carbon sequestration is 2.7 times greater at Appleby College (20.075kg) then at Herb Campbell P.S. (7.545 kg). Some reasons for this may be that Appleby College's site receives regular maintenance by school caretakers, fertilizer, and local site conditions (sunlight, soil and close to lake) are more optimal for tree growth. The White Spruce trees at Herb Campbell have a greater average change in DBH than those at Appleby College. The White Spruce favours more northern climate conditions and is expected to grow best in North Halton/Peel region in comparison to South Halton/Peel region (OMNR, 2013). The other four species have a greater average change in DBH at Appleby College.

Figure 5: Average change in crown area (m^2) from 2008-2012 for P4C tree species planted 2008



Students plant the trees and shrubs themselves and this has an effect on how they treat the trees and gives them a sense of ownership. There have been few reports of vandalism regarding the trees. John Fisher P.S. reported that a few students burnt the wooden stakes next to the trees, which left burnt marks on the trees. In spite of this, the trees are still healthy this year. One Halloween at Robert Bateman High School, the trees were pulled out and removed by a few students. Soon afterwards, the students were turned in by other students and had to complete 40 hours of community service. The school then replanted the trees and shrubs. The actions of these students helped the trees and shrubs to survive and could be a reflection of the ownership they feel towards them.

One goal of the P4C program is to spread environmental awareness. This is accomplished by involving members of the community at each P4C site. The tree and shrub plantings, maintenance, and measuring become a community undertaking as teachers, students, and volunteers including parents, Master Gardeners and others from our partner organization Climate Action Niagara (CAN) all help to ensure the success of the program. Every year a new class of students, and occasionally new teachers, re-measure the trees, which allows the program to reach more and more people in each community every year. Schools are encouraged to reach out to the community for their supply of mulch and soil. Once the students have been trained to plant and measure trees, they may then go on to use these skills to help in other community plantings or other related job.

The P4C program will help increase total tree canopy cover in cities and towns. Many of these cities and towns (i.e. Burlington, Oakville, Toronto, Mississauga, St. Catharines) that currently host the P4C program have targets for increasing their total tree canopy cover. For example, Toronto has an estimated tree canopy cover of over 180km^2 (City of Toronto, 2008) or about 20%. The city of Toronto's goal is to increase its tree canopy cover to 30-40% within the next 50 years. Planting trees in cities can be difficult as space is limited and city guidelines and regulations must be met. P4C makes use of open space in schoolyards and when the tree species are fully mature, each P4C site can potentially contribute up to approximately 3.2-3.3 km^2 of tree canopy.

According to the City of Toronto's report, the most effective way to increase average tree canopy is to maintain existing trees. However, more trees must be planted in order to maintain tree canopy to replenish those trees that have died. In addition, the size of the tree and amount of healthy leaf area is proportional to the benefits it provides to the community (City of Toronto, 2008). For example, a 75 cm tree in Toronto intercepts ten times more air pollution, can store up to 90 times more carbon and contributes up to 100 times more leaf area to the tree canopy than a 15 cm tree (City of Toronto, 2008). ACER's Measuring Our Resources (MOR) program enables schools to inventory and monitor the small and mature trees that are located in their schoolyards. Therefore, students can determine the tree canopy percentage that covers their school, carbon sequestration, and map the trees using GIS. The field activities used in the P4C and MOR program can also provide valuable environmental education.

Since much time and effort is often invested in community-based tree plantings/massive tree plantings, it is important to monitor the tree loss percentages/mortality rates to determine which tree species are surviving, dying, or thriving in the changing climate. The percentage of tree loss due to mortality or tree removal from site for P4C was 4% (based on trees planted 2008-2011, see Table 3). Tree loss percentages are rarely measured after community-based plantings. Data collected from community-based planting programs would allow tree loss percentages/mortality rates to be compared and analyzed, which could aid city and community planners in deciding which tree species to plant in the future. If more programs or communities across Canada measured tree loss percentages/mortality rates, there would be a greater amount of data that would increase the reliability of results and therefore better aid city/community planner decisions.

Table 3: Tree Loss at P4C School Sites due to mortality or removal

School						
	Basswood	Bur Oak	Hop Tree	Sugar Maple	White Spruce	Total
Applewood Heights S.S.	0	0	0	0	1	1
Herb Campbell P.S.	0	0	0	0	0	0
Appleby College	0	0	0	0	0	0
Oakville Trafalgar H.S.	0	0	0	0	0	0
Christ the King S.S.	0	0	2	1	1	4*
Robert Bateman H.S.	0	0	0	0	1	1
Guido de Bres H.S.	0	0	0	0	0	0
Ridgewood P.S.	0	0	0	0	0	0
John Fisher P.S.	0	0	0	0	0	0
T.L. Kennedy P.S.	0	0	0	0	0	0
Richmond Street P.S.	0	0	0	0	0	0
West Credit P.S.	0	0	0	0	0	0
Quaker Road P.S.	0	0	0	0	1	1
Princess Elizabeth P.S.	0	0	0	0	0	0
Humber Arboretum	1	0	0	1	0	2
Total	1	0	2	2	4	9

Total Tree Loss = 9/225 or 4%* trees were removed at Christ the King S.S.

Overall, the P4C tree species are mostly healthy/alive. Most trees planted in 2008 were healthy/alive. Of the trees planted in 2008, Basswoods had the highest % Sick/Infested (%I) at 16.67%, Bur Oaks, Hop Trees, and Sugar Maples have a %I of 5.56%, and White Spruce was 0% (Figure 6). There were low browsing percentages recorded (0-5.56%) for all tree species planted in 2008. Hop Trees and White Spruces had no browsing while Bur Oaks, Basswood, and Sugar Maples had 1-2 trees that were browsed. White Spruces had a slightly higher mortality rate of 11.11% in comparison to other tree species (5.56%). Four of the missing trees (two Hop Trees, one Sugar Maple and one White Spruce) can be accounted for as they were removed from Christ the King S.S.'s site by the school to make room for a football field. All tree species planted in 2010 were recorded as healthy/alive (Figure 7). Trees planted in 2011 (Figure 8) were mostly healthy/alive and only have two trees recorded as sick/infested, a Basswood and a Bur Oak tree. Low browsing percentages were recorded (0-5.56%) for all tree species planted in 2011 and there was no browsing for Bur Oaks and Sugar Maples. Out of all the trees planted from 2008-2011, only one White Spruce had basal sprouting. The Hop Tree had the highest mortality rate (11.11%) and Basswood, White Spruce, and Sugar Maple trees had mortality rates of 5.56% and Bur Oaks had a mortality rate of 0%.

Figure 6: 2012 Health status of P4C tree species planted in 2008

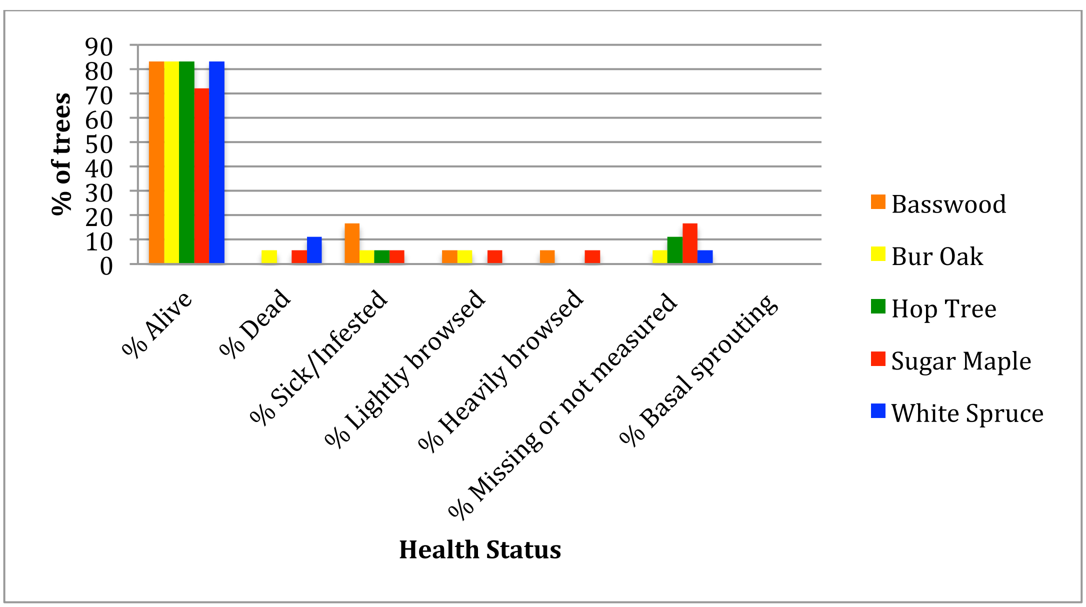


Figure 7: 2012 Health status of P4C tree species planted in 2010

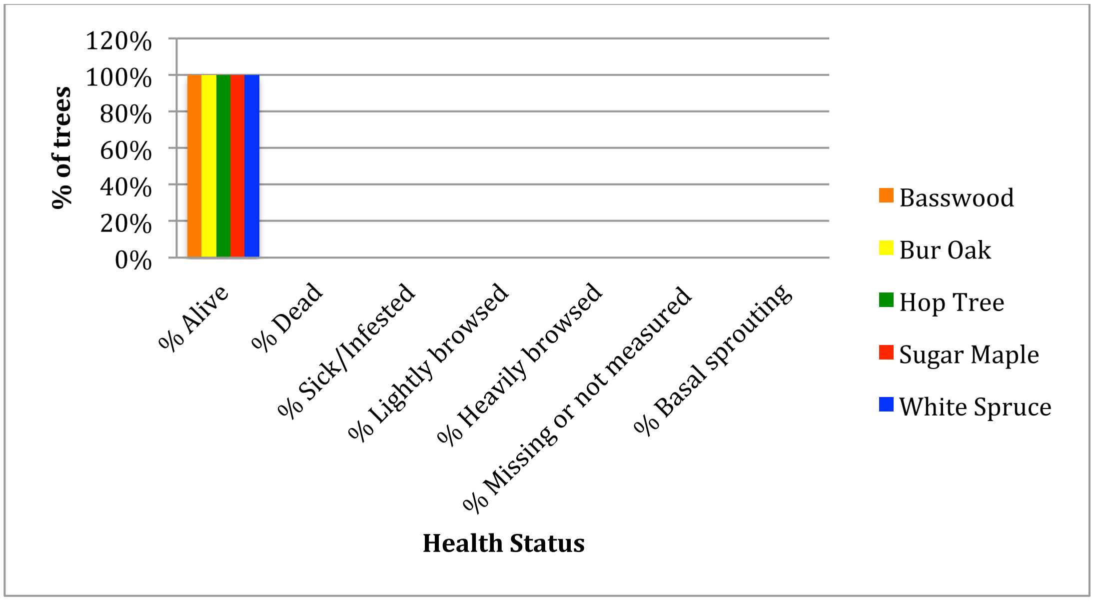
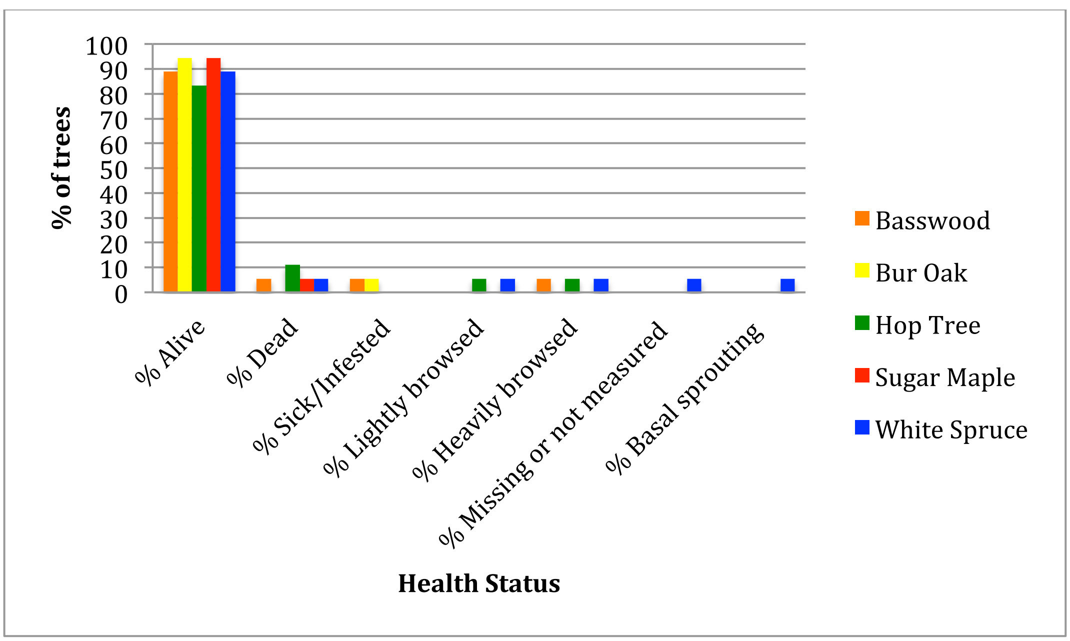


Figure 8: 2012 Health status of P4C tree species planted in 2011



Conclusions

- Over the past 5 years, planting the trees in the schoolyards has been very successful and more schools are embracing this program. The majority of the trees planted between 2008-2012 are alive and healthy. The tree loss percentage was 4%.
- There was an increase in average growth in DBH with respect to latitude seen in the White Spruce. The Hop Tree appears to be growing more slowly than the other tree species. This is expected since there are many P4C plots north of the Niagara region, and the Hop Tree is expected to grow best only at the plots in southern Niagara region.
- Two schools in Oakville, Appleby College, and Oakville Trafalgar H.S., are sequestering significantly more carbon with their trees than other schools and environmental stewardship/maintenance methods may play significant factors in the success of these plots.
- The P4C program provides many uses and benefits to schools and communities. Schoolyards are being naturalized with native indicator species for which data is collected with the help of students and analyzed for climate change research purposes. The P4C plots are applied to a variety of subjects in the classroom, helping teachers to enhance school curriculum while reconnecting students to nature. This program also helps to promote environmental awareness and stewardship and teaches students how to plant, measure annual growth and assess health of the trees. The trees sequester carbon and contribute to native species habitat and tree canopy cover in cities and towns.
- The P4C program has added great value to schools and communities and allows students to participate in meaningful hands-on science.

Recommendations

- More P4C long-term monitoring sites should be established in different regions/latitudes to determine if trends in data are replicated and to allow for comparison of tree species in different regions.
- Sites should be audited and school participants should be provided with refresher training due to turnover of teachers and students.
- Environmental stewardship can significantly increase growth of trees, which may significantly increase carbon storage; therefore maintenance of plots after planting day is important.
- Most successful sites appear to mulch more often and have well maintained plots; schools should set up tree maintenance program and mulch twice a year.

- Further analyses of the data should include standard deviation calculations and analyses of local site conditions such as soil sampling. Factors that should be considered are included in Table 4.

Table 4: Factors to be considered for future P4C data analyses

Local Site Conditions	• Soil • Elevation • Temperature • Distance from lake • Latitude • Species density • Region in Southern Ontario
Year P4C Trees Planted	• 2008 • 2010 • 2011 • 2012 • 2013 • Future years
Human Impacts	• Population density • Attitude toward environment • Invasive species

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Appendix 1

Site Preparation for each School

School	Year Planted	Site Preparation
Herb Campbell P.S.	Fall 2008	Rototilled, triple mix, mulch
Appleby College	Fall 2008	Not rototilled, soil, mulch
Applewood Heights S.S.	Fall 2008	Not rototilled, triple mix, mulch
Oakville Trafalgar S.S.	Fall 2008	Rototilled, triple mix, compost, mulch
Robert Bateman H.S.	Fall 2008	Not rototilled, triple mix, mulch
Christ the King S.S.	Fall 2008	Not rototilled, top soil, mulch
John Fisher Junior P.S.	Spring 2010	Not rototilled, top soil, mulch
Ridgewood P.S.	Spring 2010	Not rototilled, triple mix and sod, compost, mulch
Guido de Bres H.S.	Spring 2010	Top soil and sod, mulch
Humber Arboretum	Fall 2011	Not rototilled, dug bowls, top soil and sod, mulch
T.L. Kennedy S.S.	Spring 2011	Not rototilled, sod, started mulch islands
West Credit S.S.	Fall 2011	Not rototilled, triple mix and sod hardware cloth, mulch
Richmond Street P.S.	Spring2011	Not rototilled, dug bowls, compost, sod, newspapers, mulch islands
Quaker Road P.S.	Fall 2011	Not rototilled, dug bowls, compost, sod, newspapers, mulch islands
Princess Elizabeth P.S.	Fall 2011	Not rototilled, dug bowls, triple mix and sod, newspapers, mulch islands
David Suzuki S.S.	Fall 2012	Not rototilled, dug bowls, top soil and sod, newspapers, mulch islands
Dr. G.J. MacGillivray P.S.	Fall 2012	Not rototilled, dug bowls, top soil and sod, newspapers, mulch islands
Assumption Catholic Elementary School	Fall 2012	Not rototilled, dug bowls, top soil and sod, newspapers, mulch islands
Smithville Christian H.S.	Fall 2012	Not rototilled, dug bowls, top soil and sod, newspapers, mulch islands
Montclair Public School	Fall 2012	Not rototilled, dug bowls, top soil and sod, newspapers, mulch islands

Appendix 2

Teacher/Parent Testimonials

"I would just like to recommend the P4C. It was a fantastic experience for my class and for the school. We learned a great deal about trees and about our environment while working together to beautify our schoolyard. The kids wrote about this experience and also learned how to plant and measure the plant's growth. The individuals that we worked with from ACER were professional and organized and were able to share much of their knowledge and their passion for the environment with the students. All the classes in the school wanted to help with some part of the project. We were happy to be the first school with our board involved with the project, however there are many others now that want to get on board and start planting in their own school yards. P4C is a great idea and a great program for schools." **Laura Martineau, Teacher, Assumption Catholic Elementary School, St. Catharines, ON**

Students on planting day at Dr. G. J. MacGillivary P.S. in Courtice, ON

Planting day celebration at Montclair P.S. in Oakville, ON

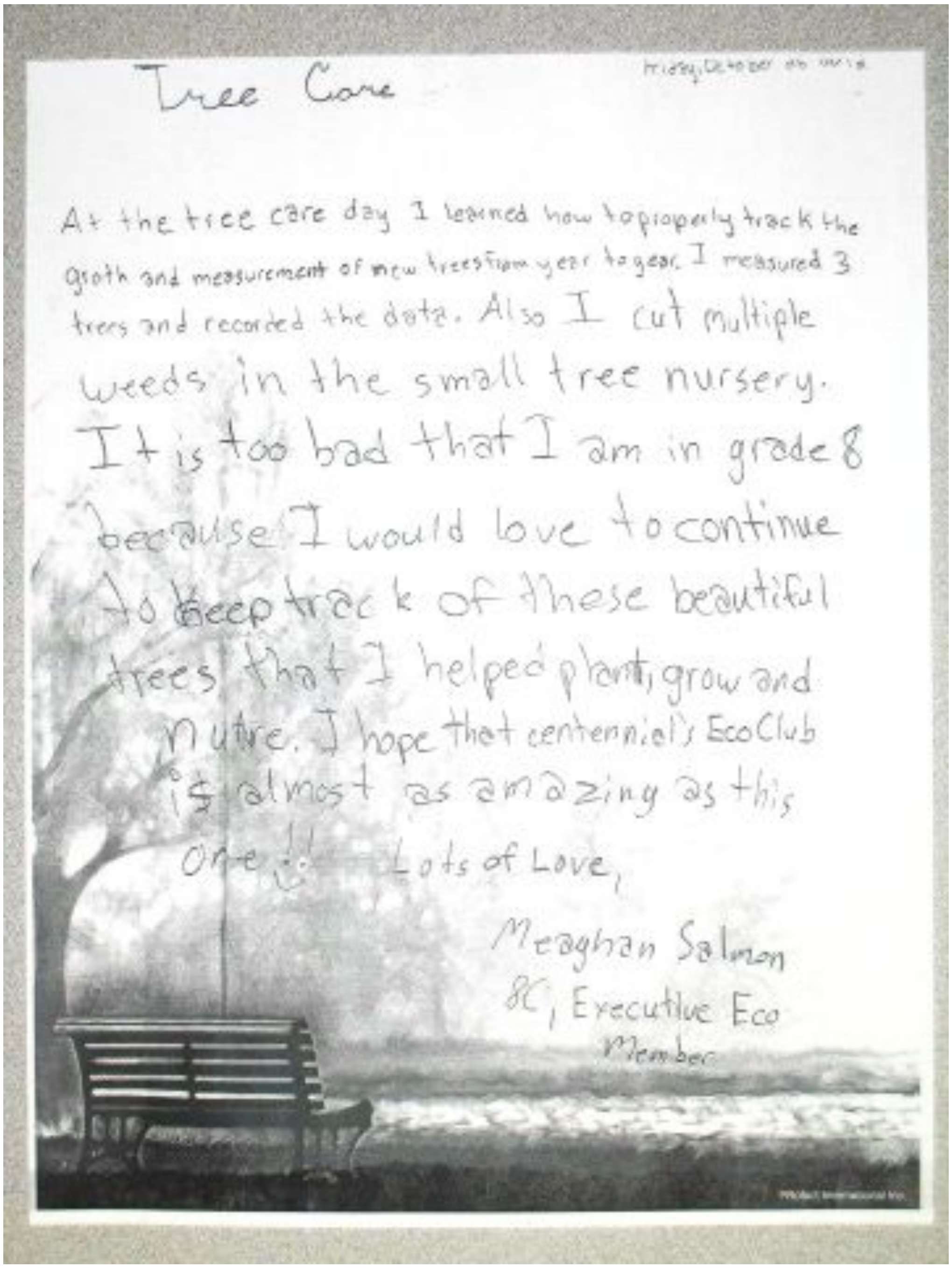
"[The P4C program] provides Geography classes with hands on activities re: measuring, tree and plant identification, stewardship (mulching, edging and weeding); greening of the schoolyard." **Marlene Hume, Teacher, Oakville Trafalgar H.S., Oakville, ON**

“Our schoolyard didn’t have shade or a defined area for a class to gather for nature study. ACER’s well-organized P4C project offered us both. Their dedicated team provided us with checklists and educational materials so that we were properly prepared for planting day; onsite they worked with students teaching planting techniques and about the specific trees. Two seasons later we have a beautiful green growing young forest in our schoolyard inviting teachers to bring their students outdoors to extend the work they are doing in the classroom. Personally, I have noticed a significant increase in bird activity on the school grounds and it is mainly clustered in the planted area.” **Ina Legzdins, Montclair Public School, Gardening Committee, Oakville, ON**

Herb Campbell P.S. (Caledon, ON) tree re-measuring group 2012

Students at West Credit S.S. in Mississauga measuring crown width

Student Testimonials



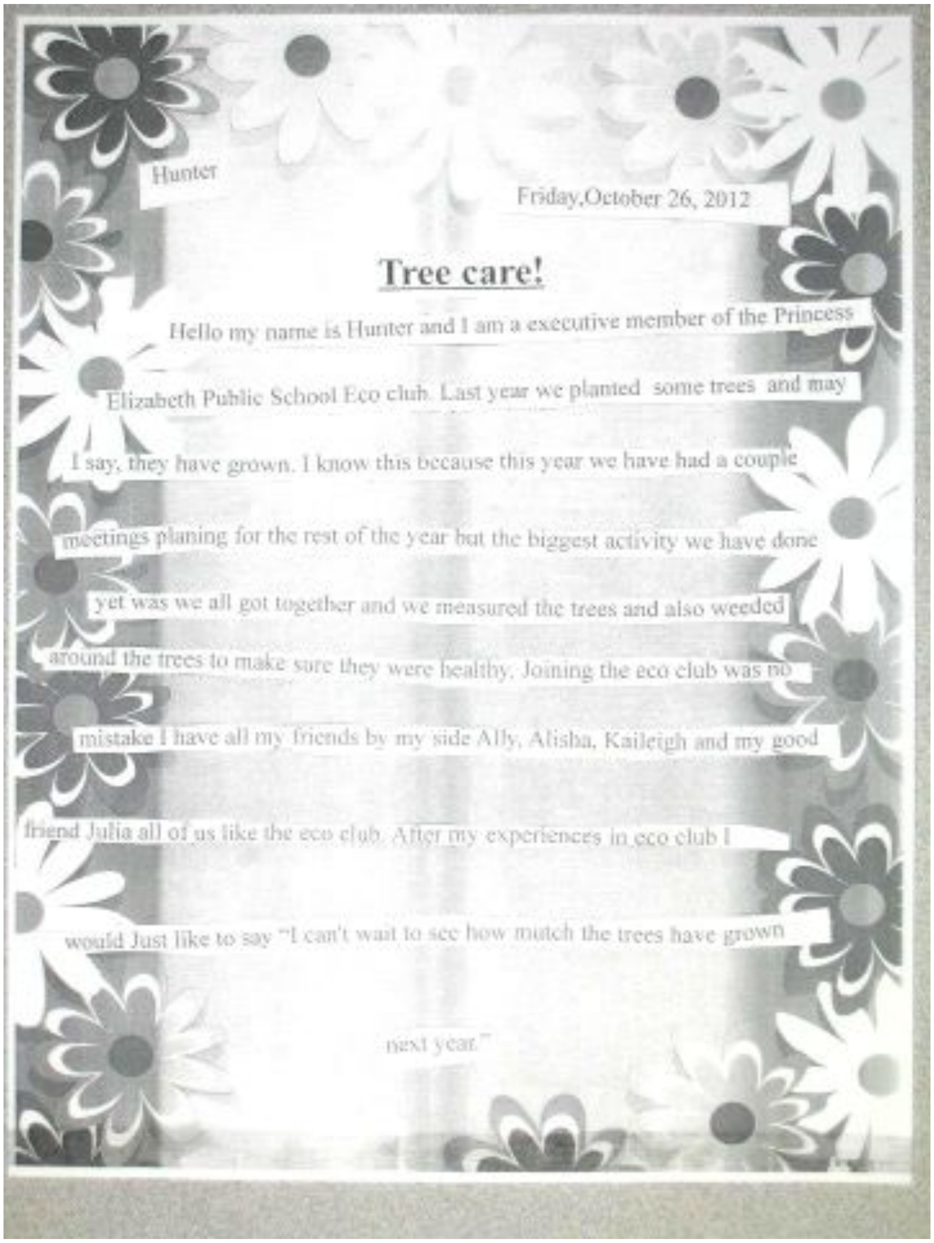
Friday, October [illegible]

Tree Care

At the tree care day I learned how to properly track the groth and measurement of new trees from year to year. I measured 3 trees and recorded the data. Also I cut multiple weeds in the small tree nursery. It is too bad that I am in grade 8 because I would love to continue to keep track of these beautiful trees that I helped plant, grow and nutre. I hope that centennial's EcoClub is almost as amazing as this one!! Lots of Love,

Meaghan Salmon
8C, Executive Eco Member

Meaghan S., Executive Eco Member, Princess Elizabeth P.S., Welland, ON



Hunter

Friday,October 26, 2012

Tree care!

Hello my name is Hunter and I am a executive member of the Princess Elizabeth Public School Eco club. Last year we planted some trees and may I say, they have grown. I know this because this year we have had a couple meetings planing for the rest of the year but the biggest activity we have done yet was we all got together and we measured the trees and also weeded around the trees to make sure they were healthy. Joining the eco club was no mistake I have all my friends by my side Ally, Alisha, Kaileigh and my good friend Julia all of us like the eco club. After my experiences in eco club I would Just like to say "I can't wait to see how mutch the trees have grown next year."

Hunter N., Princess Elizabeth P.S., Welland, ON

"I think this project is an easy way to leave a lasting impression on the community. In the future, it will help with climate change research and will add a new look and some shade to our schoolyard. It was a good thing to get involved with because it reflects our classes theme to be stewards of God's creation"

Kirsten W., Smithville Christian High School, Smithville, ON