Where Do Your Tree Fund Donations GO?

Alice Casselman

Benchmarking Biodiversity & Planning Future Forests in Urban Impacted Areas

The Carolinian forest zone in southern Ontario (the southernmost region of Canada) contains more rare and endangered species of plants and animals than any other part of Canada. Over 125 species have been declared at risk and over 400 others are considered rare. Forest cover has been reduced from 80% to 11% and in some places is less than 3%. Wetlands once covered 28% of the land but now are reduced to 5%. However, where remnant patches of existing Carolinian forest remain, this forest type contains some of the highest forest biodiversity in Canada.

The landscape of southern Ontario has been impacted greatly as a result of extensive land clearing since European settlement, intensive agricultural activity and growing urbanization pressures. Losses of native species have accompanied the changes in this highly impacted landscape. The threats to species are many and include habitat loss, largely from urban development, habitat fragmentation, multiple pollutants, exotic invasive species and climate change.

As the climate changes, the additional challenge for the future will be to revitalize this landscape for the conservation of biodiversity and for the enhanced ecological services that these areas will provide. Any attempts to reach this goal will require targeted tree planting programs for the recovery of populations of woodland dependent species by enlarging blocks of remnant habitats and establishing habitat linkages.

It is expected that climate change will have a greater than average impact on the biotas of the cold temperate and polar regions of the world where the greatest climate warming is expected. Southern Ontario, with its remnant Carolinian forest, lies within these regions and can expect significant climate warming. Globally, climate change models project a warming of 1.4 to 5.8˚C in mean annual temperatures by the end of the century, with warming of 2 to 5˚C for average daily temperatures with minimum temperatures

1 to 2˚C warmer than average daily temperatures projected for southern Ontario.

The Toronto urban location proved particularly beneficial for this study. The heart of Toronto is home to 2.5 million people with some one-third of Canada's population living within a 160 km radius of Toronto itself. The Toronto core has a well documented warming bias relative to surrounding rural sites. This "Toronto warming effect" of nearly 4.0˚C in minimum temperatures relative to rural sites includes thermal influences from the city's location on the shoreline of the Great Lakes as well as urban heat island effects.

The degree of warming in the Toronto core relative to nearby rural areas is consistent and within the range of anticipated future warming. It is hypothesized that this degree of temperature change in the city presents itself as a possible "learning laboratory." The current observed differences in minimum temperatures serve as an important indicator to better assess the responses of vegetation to the warming by a comparison to rural sites outside of the city.

Under global warming, changes in forest biodiversity in Ontario have the potential to shift northwards. This shift will not likely occur at a rate that will keep up with temperature changes, which will cause loss of native biodiversity. While a warmer landscape can support greater biodiversity, many of the future species will be the result of invasive exotic species – a further threat to native species.

Accordingly, the Association for Canadian Educational Resources (ACER) has developed a climate change experimental site at the Toronto Humber Arboretum in northwest Toronto to monitor the impacts of warmer temperatures on urban forest biodiversity.

Approximately 2,157 trees and shrubs were planted in this biodiversity plot. The Humber Arboretum plot is slightly larger but comparable to the standard 1 ha plot size with 25 quadrants, each 20 m by 20 m in size. Each quadrant has an average of 86 plants and the spacing is approximately 2.5 m between trees and less between shrubs. There are 76 different species of trees and shrubs planted in this 1 ha area plot. This is an unprecedented number of species for a community planting project. As well as planting for biodiversity and climatic warming, it was also designed to incorporate the four steps for disease resistance (i.e. not too many of one species; no more than 5-10% of any one species; no more than 20% of species in the same genus; and no more than 30% in the same family). To encourage good survival, we planted larger stock, plants that like direct sunlight and plants that grow well together according to plant utilization principles and moisture gradients. The soil is a rich loamy sand. It is the site of the former Etobicoke Tree Nursery and growing conditions are considered excellent provided that there is adequate weed protection and protection from browsing (brush blankets, mulch and tree guards were all used).

The landscape design consists of three different species arrangements: 1) Forestry Quadrants (2-3 families); Carolinian/Climate Change Quadrants (7-11 families, species that are expected to do well in warmer climates); and Biodiversity Quadrants (7-11 families, native species, same zone). There are several within-plot comparison's that can be made:

Carolinian Species/High Diversity Quadrants (2)

These quadrants contain species associated with warmer temperatures up to two zones to the south (e.g. Washington area) and also Carolinian species commonly found in Southern Ontario (e.g. Long Point). Tree species include Black Gum, Bladdernut, Ohio Buckeye, Spicebush, Sourwood, Tulip Tree, Chestnut Oak and Yellow Birch among others.

These quadrants are composed of a mixture of trees (hardwoods, no

Let's Plant, Measure & Mulch!

Project: Benchmarking Biodiversity and Planning Future Forests in Urban Impacted Areas

Location: Toronto, Ontario

Status: Ongoing.

Start/End Date: Project initiated in 2002. No end date.

Responsible Organization: Partnership between The Association for Canadian Educational Resources (ACER), the Humber Arboretum, Arborvitae (non-profit) and the Meteorological Service of Canada (government) involving community monitoring and the establishment of a new biodiversity plot in the Humber Watershed.

Level of Action: Local to regional

Biophysical Context: Urban forest (temperate zone)

Goals & Objectives: A goal of the project is to investigate the benefits of forest planting design and the selection of species to optimize the greater species biodiversity and to ensure increased climatic resilience of species under current and changed climate conditions, particularly for urban forests.

This project has multiple objectives, including:

- Teaching the community to benchmark existing biodiversity according to international, scientific protocols; training community members in the measuring, monitoring and proper planting of new urban forests.
- Demonstrations to communities on techniques to plant trees that will survive to age 40+ and development of tree planting protocols for forest biodiversity;
- To document the response of biodiversity plots containing various combinations of native and new forest and herbaceous species more suitable to the climate of the future. The observations from this site will help develop new adaptive management practices, including the selection of the best species for the future.

softwoods) and shrubs. There are 11 or more different families of trees and a total of 19 different varieties of tree and shrubs species per quadrant. The minimum number of any species of tree or shrub is 5 and the maximum is 24. The trees and shrubs are clustered in groups of the same or compatible species.

Moderate Mixed Wood Biodiversity Quadrants (7)

Both hardwoods and softwoods are planted in these quadrants. There are approximately a little over half the number of tree families found in the Carolinian quadrants. The trees and shrubs are planted in clusters with approximately 5 to 15 individual plants per species in any one quadrant. Species planted are known to do well in the zone that includes Humber Arboretum. Tree species would include Basswood, Beech, Green Ash, Red Oak, White Cedar, White Oak and Pin Cherry.

Moderate Hardwood Biodiversity Quadrants (10)

These quadrants contain both trees (hardwood, no softwoods) and shrubs. There are fewer families of trees (a little over half) than in the Carolinian Quadrants). Trees are planted in groupings of a minimum of 5 per quadrant to a maximum of 13.

Low Hardwood Biodiversity Quadrants (2)

These quadrants are planted with both trees (hardwoods only) and shrubs but have less than half the number of families of the Carolinian Quadrants. Species are planted in clusters and are typical of trees found growing around Humber Arboretum.

Forestry Quadrants (3)

These quadrants contain only three species of trees (no shrubs) – White Pine, Red Oak and Paper Birch. Each of these trees is traditionally used in forest products and the trees are planted in blocks and rows to simulate commercial planting designs.

City Street Planting Quadrants (4)

These four quadrants are planted with large numbers of Silver Maple, Pussy Willow, Red Osier Dogwood and Staghorn Sumac only. The shrubs are interspaced in the rows of Silver Maple. Half of each of these quadrants is allocated for the path to allow heavy equipment to effectively water the entire plot – thus these quadrants may simulate urban city street plantings.

Observations gathered on this one-hectare biodiversity plot by trained volunteers will document the response of native and new forest and herbaceous species to change and help in the development of new planting protocols and adaptive management practices under climate change. Choice of species planted at the experimental site have taken into account climate change projections as confirmed by scientifically reliable local field data on species vulnerability from impacts such as insect infestations, ice storm damage and invasive species.

areas in the Carolinian Zone of southern Canada. The globally agreed upon protocol requires that all trees above a certain diameter (10 cm dbh in the tropics and 4 cm dbh in southern Canada) are mapped, identified for species and measured for diameter at breast height (dbh) and total height (m). Parameters such as tree health and under story vegetation were monitored in the plots.

We adapted the standard protocols for new forest plantings. This includes monitoring the performance of the trees and shrubs over the next seven years. It generally takes up to 5-7 years to determine whether a planted tree will survive and have the freedom to grow that it needs to put on good volume growth. Good growth rates during this establishment period can result in increased volume growth rates by

> "This project demonstrated that community efforts are the main **driving force** behind requirements for monitoring, measuring and planting for the future, at least in urban environments."

30-50%. This has huge impacts on carbon sequestration, ecosystem health, biodiversity, ecological footprint assessment and accumulated carbon debt calculation. Our goal is to ensure survival to age 40 and beyond. Annual monitoring for this study included root collar diameter, total height, current leader length, crown dimensions (two measurements), bud size and dbh (if taller than 1.3 m). Survival, health and damage were also recorded.

The experimental plots will be monitored over their lifetime for changes using global biodiversity monitoring programs such as the Smithsonian Institution (SI/MAB) protocols. Trained community volunteers were chosen to undertake the monitoring and benchmarking of the site.

Tools and Monitoring Processes

Forest biodiversity benchmarking and monitoring activities followed the Smithsonian Institution and the UNESCO Man and the Biosphere Biological Diversity Program tested procedures (SI/MAB) for establishing forest inventory plots in world biosphere reserves. Plots monitored using SI/MAB protocols can be compared with measurements taken at other sites around the world and provide information on tree species abundance and diversity, long term trends in forest growth, mortality and regeneration and impacts of forest disturbance.

The use of a one hectare plot gives a relatively large sample and has been shown to be robust enough to capture the biodiversity of a site in the tropics and also in some of the most biologically diverse

Results Achieved & Lessons Learned

A valuable lesson drawn from this project, now in its third year, is the importance of community volunteers and their participation in benchmarking monitoring activities. The process of integrating a benchmarking activity (i.e. documentation of existing conditions) as an annual seasonal community event ensures that, with training by educators and scientists, communities can maintain a long-term interest in their urban forests and be better informed and proactive about potential changes in climate affecting local landscapes.

An objective of this case study was to demonstrate that communities can learn to plant trees that will survive to age 40+ and, with assistance, can pool their knowledge to choose the best species for the future. By transferring the required knowledge, communities can become proactive in ensuring the health of future urban forests by planting trees now, planning for the future and tracking these new trees over the next several years. Community involvement during this initial period is critical since trees that can survive the initial establishment period to start producing good growth have an increased likelihood to survive to maturity. At the same time, volunteers were taught how to choose tree species and design urban forested areas in order to maximize biodiversity and ensure tree survival under current and future climate conditions. The project demonstrated that community efforts are the main driving force behind requirements for monitoring, measuring and planting for the future, at least in urban environments.

By taking advantage of earlier studies documenting the Toronto warming influence and locating the experimental site within the urban core, the study has the added advantage of already providing an anecdotal indication of the impact of warmer temperatures, at least for minimum temperatures, on tree growth and response through comparison with conditions at cooler rural sites. By choosing consistent SI/MAB protocols to monitor the biodiversity condition of this experimental site, the site's measurements can readily be compared with other forest biodiversity monitoring sites in southern Ontario. Results from the Humber Arboretum benchmark site, along with its comparison to rural sites within a similar climatological region, will provide needed input for the development of guidelines for the selection of adaptive vegetative species for changing climate conditions. ♦

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November, 2006

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ACER Grant Update for 2006

Here is a student's recount of a recent field trip:
On November 2, 2006, [class] 7E went on a trip to the Humber Arboretum at Humber College in Etobicoke. We all measured trees. 7E measured the trees for ACER because they want to see how much the trees have grown over the year. Other students planted the trees four years ago and some of them have grown lots, but others not very much. When 7E measured the trees we would measure the root collar, the height and the width from the farthest twigs. After a little bit of mulching (which means adding wood chips to the base of a tree for insulation and protection), we got to have lunch and ACER was nice enough to bring everyone hot chocolate. Since we were all warmed up everyone went back to what they were doing. Overall I think 7E had a great day.
~ Jamie Wallace, Bliss Carman Senior Public School, Scarborough

Thank you for funding the ACER program *Let's Plant, Measure, Mulch!* Because of the generosity of donors and volunteers, more than 250 children have enjoyed similar experiences at the biodiversity field this year. Armed with calipers and measuring tape, the students set out in small groups on "search and rescue missions" for tree plantings hidden deep amongst the golden rod and grasses. At the same time that they measured, mulched and gathered important data on global warming, the children had an opportunity to explore the complex and intriguing world of nature in a unique setting within the GTA.

For some it was their first opportunity to feel the earth in their hands, to carefully examine delicate tree buds, feel the velvety texture of staghorn sumac, or squeal with wide-eyed delight over the discovery of a praying mantis cocoon. The children learned about the importance of trees to our health and to the future of the planet and – even more importantly – they left the field at the end of the day with an enthusiasm and connection to nature that, for many, will grow into a lifelong stewardship.

To date, the funding provided for the work in the Humber Arboretum Climate Change Laboratory Plot has allowed us to:
- Develop and distribute both spring and fall flyers for schools
- Prepare and tidy up the field (i.e. paint and number identifying posts permanently) and replace missing tags
- Install red-topped posts to signal danger areas (i.e. groundhog holes)
- Prepare field data sheets for student entry of spring and fall quadrats
- Teach proper tree measurement and tree care with trained volunteers.

We are about to finish our fall season and enter the data both on the 2006 sheets and in the cumulative data sheets which, with 2,100 tree plantings, is a considerable amount of information to formulate. We will now prepare the spring flyer and data sheets for 2007 measurement entries by students. We are discussing the template for five-year analysis as the first planting was done in the fall of 2002. We are also looking at beginning digital archives of tree diseases and tree measurement and care methods. Several schools have expressed interest in returning next year. We have some that have volunteered almost every season since the program began. *Let's Plant, Measure, Mulch!* continues to appeal to a wide variety of community volunteers and students from elementary to high school and from a variety of school boards in the GTA as well as private schools. Some schools have expressed interest in our new program *Our School Yard – Measuring Our Resources* which we are piloting in the Peel Halton area.

We thank you for your past and continued financial and motivational support for this important community-based project that twins students and volunteers with environmental research and learning. As Jamie Wallace's letter shows, the experience does have an impact and we hope to continue to provide this opportunity for many more students.

Sincerely,
Alice Casselman, President, ACER