


# SUSTAINING AND EXPANDING THE URBAN FOREST:
## TORONTO'S STRATEGIC FOREST MANAGEMENT PLAN
## 2012-2022

TORONTO

Parks, Forestry and Recreation

## Acknowledgements

The Parks, Forestry and Recreation Division would like to extend our sincere thanks to the representatives from City divisions, agencies and organizations who provided technical and strategic input into the development of Toronto's Strategic Forest Management Plan. We also thank all of our community partners who helped make this project possible. Their support and insight have added tremendous value to this plan.

Toronto City Council adopted this Plan at its meeting of February 20 and 21, 2013.

For reference purposes, this document should be cited as follows; Sustaining & Expanding the Urban Forest: Toronto's Strategic Forest Management Plan. Toronto, Ontario. City of Toronto, Parks, Forestry and Recreation, Urban Forestry, 2013.

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View of downtown Toronto from Crothers Woods

# EXECUTIVE SUMMARY

The urban forest includes all the trees within the city's boundaries. The trees in this forest provide a wide range of environmental, ecological, social, cultural and economic benefits. The benefits from air pollution filtration and energy savings (i.e., related to temperature moderation by trees near homes and buildings) alone have been valued at more than $28 million per year. This value does not include the physical health benefits related to natural cooling and air quality improvement, or the documented mental health benefits of simply having trees in our neighbourhoods. This forest is a shared resource that benefits the entire community.

Currently, Toronto has approximately 17,000 to 18,000 hectares of urban forest canopy cover provided by approximately 10.2 million trees. This equates to a range of 26.6% to 28% tree canopy cover. Of the 10.2 million trees, about 6% (600,000 trees) are City-owned street trees, 34% (3.5 million trees) are in City parks and natural areas, and 60% (6.1 million trees) are on private lands. The city's urban forest contains at least 116 different tree species, with a high proportion (68%) being less than 15.2 cm in diameter. Despite the many challenges of growing in an urban environment, 81% of Toronto's tree population is estimated to be in good condition.

Toronto has long recognized the importance of the urban forest and the benefits it provides and over the past decade has improved tree-related policies, by-laws and guidelines to better support the protection and enhancement of its urban forest. With City Council adopting the goal of increasing tree canopy cover across the city to between 30% and 40% in July 2004, there was a firm commitment to growing the city's urban forest to maximize the potential ecological, social and economic benefits derived from urban trees.

**Table 1 - A summary of information about Toronto's urban forest**

| MEASURE | RESULTS |
|---|---|
| Number of trees in Toronto | approximately 10.2 million |
| Canopy cover | 26.6% to 28%* |
| Canopy cover target | 40% |
| Number of trees on public lands | approximately 4.1 million (40%) |
| Number of trees on private lands | approximately 6.1 million (60%) |
| Characteristics of the trees that make up the urban forest | • 68% are less than 15.2 cm diameter<br>• 18% are between 15.2 cm diameter and 30.6 cm diameter<br>• 14% are greater than 30.6 cm diameter<br>• predominance of native species (64%) |
| Structural value of the urban forest | Approximately $7 billion |
| Ecological services** provided by the urban forest | valued at $28.2 million annually |
| Carbon storage | valued at $25 million |

**Canopy cover estimates for the city have been generated using different methods and results have varied from 19.9% to 28%, but the most current assessment indicates the range is between 26.6% and 28%.*
***This valuation only includes an estimate for: air pollution removal, energy savings, avoided carbon related to energy conserved and carbon sequestration.*

The City of Toronto has been called "a city within a park" in recognition of its extensive parks, treed and natural areas. However, there are threats to the urban forest that must be addressed and managed if it is to continue to provide benefits to the community. Sustaining & Expanding the Urban Forest: Toronto's Strategic Forest Management Plan (referred to as "the Plan" in this document) was developed as a means to identify the efforts required to achieve a healthy, sustainable urban forest with a goal of providing 40% canopy cover. Although most of the recommended actions are to be implemented by the Urban Forestry branch, the Plan identifies issues that are city-wide in scope and are of interest to other City divisions, external agencies, residents, businesses, other stakeholders and the community-at-large. Successful implementation of the actions identified in the Plan can only be achieved in partnership and cooperation with all of these parties.

The City of Toronto continues to invest in many activities and initiatives that support both the sustainability

and the expansion of its urban forest in support of this “big picture” goal. The Plan is meant to provide the context and direction for these activities and initiatives over the next 10 years. Direction is provided, at the highest level, through the vision and strategic goals for the Plan. More specific direction for implementation is provided through a series of actions as well as a monitoring plan with specific indicators of success against which progress in meeting the goals and objectives of the Plan will be measured.

## Vision

The long term vision for the urban forest and strategic goals for this Plan were developed in consultation with City staff from various divisions, external stakeholders and the community.

### Long Term Vision

> *Toronto’s diverse urban forest is the vital green infrastructure that creates healthy neighbourhoods, supports habitat and biodiversity, promotes clean air and water, offers opportunities for recreation and education, fosters economic prosperity and enhances quality of life for everyone in the city.*

### Vision for the 10 Year Life of this Plan

The 10 year vision was also developed in consultation with others and provides a vision that has been tailored to the time frame of this Plan.

> *A healthy and expanding urban forest, incorporating sound urban forestry practices and community partnership.*

## Strategic Goals

1. **INCREASE CANOPY COVER**
   Protect, maintain and expand the urban forest to achieve a healthy, sustainable forest with a canopy cover of 40%.
2. **ACHIEVE EQUITABLE DISTRIBUTION**
   Achieve an equitable distribution of the urban forest, increasing canopy where it is most needed.
3. **INCREASE BIODIVERSITY**
   Increase biodiversity to improve urban forest resiliency and respond to climate change.
4. **INCREASE AWARENESS**
   Increase awareness of the value of trees, the natural environment and the sensitivity of these resources.
5. **PROMOTE STEWARDSHIP**
   Promote stewardship and education of the multiple benefits of the urban forest and build collaborative partnerships for expanding the forest.
6. **IMPROVE MONITORING**
   Improve information management systems and enhance the ability to inventory, monitor and analyze the urban forest.

The Urban Forestry branch of the City's Parks, Forestry and Recreation division plays an integral role in managing Toronto's urban forest. This branch has led development of this Plan and will be responsible for ensuring much of its implementation. It is through the performance of Urban Forestry's core programs and functions organized under four service pillars that the goals of the Plan will be brought to fruition.

### Four Service Pillars

1. Maintenance of the Urban Forest
2. Protection of the Urban Forest and Natural Heritage
3. Planting to Expand the Urban Forest
4. Planning to Ensure Strategic Advancement of Forest Management Objectives

## Challenges to Sustaining and Expanding Toronto's Urban Forest

The Plan identifies six key challenges currently being faced by the City in sustaining and expanding its urban forest. A description of each of these challenges, including current practices and actions is included in the Plan and has been summarized below.

### Forest Health Threats

Through integrated pest management, Urban Forestry monitors and treats pests using the most appropriate method of control. Urgent forest health issues are addressed in partnership with other agencies. Currently, the most significant threat to the urban forest is Emerald Ash Borer (EAB) (*Agrilus planipennis*). As previously reported, Toronto could lose approximately 8.4% of the tree population, or 860,000 ash trees (*Fraxinus spp.)* (2.2% to 2.3% canopy coverage) worth an estimated $570 million in structural value. It is necessary to focus on implementation of the EAB management strategy in order to mitigate the impacts extensive tree mortality will have on the tree canopy.

**Injection of an ash tree with TreeAzin™**

While there is no way to eradicate this pest, individual trees may be protected through tree injection with products registered in Canada for use against EAB. The tree injection program using the pesticide TreeAzin™ against EAB has been expanded in Toronto. In 2012, over 4,000 ash trees (in select parks and street trees) have been injected. Thousands of additional candidate trees have been identified for potential injection in subsequent years. However, the City of Toronto will be required to remove thousands of dead and dying ash trees on streets, in parks and in natural areas. All street trees and a significant number of park trees lost to EAB will be replaced.

The European Gypsy Moth (*Lymantria dispar*) is an introduced defoliating insect that is considered a widespread pest in North America. The caterpillar (larval stage of the insect), eats the leaves of trees making them more susceptible to disease and damage from other insects.

Removing European Gypsy Moth egg masses with portable vacuum cleaners

In 2007 and 2008, the City of Toronto undertook an integrated pest management program to control the European Gypsy Moth outbreak. This included aerial and ground spray programs to control the outbreak levels in selected areas of the city. Other control measures such as tree banding and vacuuming of egg masses with portable vacuum cleaners were also used.

European Gypsy Moth will always be present in the landscape at varying levels, with populations rising and falling in cycles dependent on natural controls and the weather. In 2012, levels of European Gypsy Moth were seen to rise in some areas of the city. Control measures, including ground based and aerial spraying of the biological control agent *Bacillus thuringiensis* subspecies *kurstaki* (Btk) have been implemented successfully in the past and will be utilized in the future to control high population levels of this insect.

Actions to address forest health threats include among other things, continued communications and outreach programs; maintenance of consistent funding to a city-wide forest health care program; monitoring the effectiveness of pest management programs; and refining strategies going forward.

## Tree Maintenance Requirements and Expectations

Urban Forestry is responsible for maintaining approximately four million trees in a healthy and safe condition. Maintenance of this important resource has largely been done on a reactive basis where members of the public request maintenance services when trees are suspected to be in need of attention. This type of complaint-based, reactive service is not efficient and does not adequately meet public expectations. Reactive maintenance reduces the opportunity to perform corrective pruning or other preventative maintenance activities thus resulting in more frequent storm breaks and shortened tree life spans. A proactive systematic maintenance regime for trees based on geographic area is a best practice that enables operational efficiencies to be realized and provides tree maintenance that will mitigate risk and improve the long term health of trees. Urban Forestry's practice is currently in transition from reactive based maintenance to proactive area tree maintenance.

Tree maintenance requirements and expectations will be addressed in part through progressive implementation of a city-wide proactive area tree maintenance program to bring the average pruning cycle to approximately 7 years; reducing tree service delay from the current 6 to 9 months, to 3 to 6 months; reducing tree mortality in new street tree plantings; and improving public awareness of proper tree care and maintenance techniques.

## Balancing Urbanization Impacts and Sustaining the Urban Forest

Urbanization continues to have impacts on trees and the natural environment. Briefly summarized, some of the impacts are as follows:

- increased development pressure results in fragmentation of available habitat for the growth of trees and other vegetation,
- increased density of development results in less soil volume for root growth and less aerial space for tree crown spread and development,
- salt levels in soils are increased as a result of de-icing salt use in winter months, causing dehydration in trees,
- conflicts with utilities and other service infrastructure result in less area for tree growth,
- increased urbanization also contributes to stream bed erosion and erosion of forest soils caused by increased volume and intensity of run-off, and
- expanding areas of development also limit permeability and soil moisture available to support the growth of trees

Efforts to grow trees along city streets as well as in new subdivisions can be hampered by the severely altered soils following site development. The typical result is site conditions that may limit the growth of large-stature shade trees and many sensitive native species that support biodiversity in the city.

As stated in the City's Official Plan, protecting the natural environment and urban forest should not be compromised by growth, insensitivity to the needs of the environment or neglect.

One of the fundamental aspects of increasing tree canopy coverage across the city is protection of the existing resource. Tree protection is currently accomplished through implementation of various tree and natural feature protection by-laws which provide opportunities to educate the public on the benefits of trees. Efforts to protect trees need to be improved.

Some of the actions identified for addressing this challenge include: developing mapping systems that support planting activities; monitoring change in canopy coverage; identifying strategic planting areas; increasing compliance with tree protection requirements through enhanced monitoring; and working with green community organizations to realize canopy targets in communities and neighbourhoods.

## Climate Change Impacts

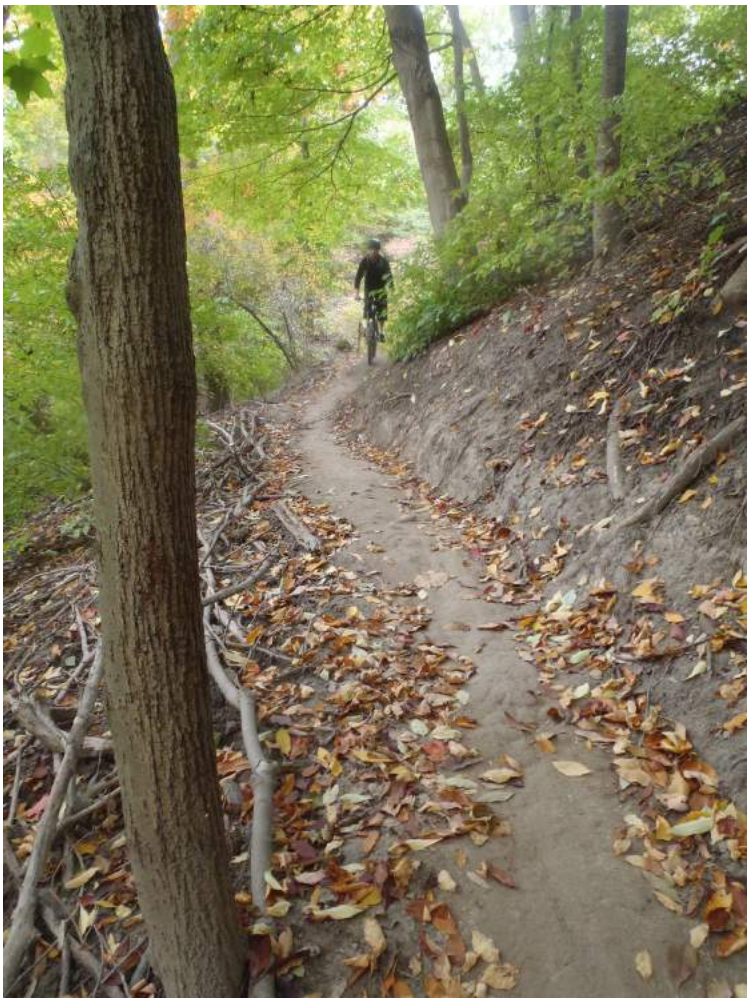
According to Natural Resources Canada, some of the predicted impacts of climate change in the coming decades include warmer winters and longer growing seasons, changes in the seasonality of precipitation and extreme events such as droughts and heavy rainfall, expanded ranges of insects and increased over-winter survival rates, and increased frequency and severity of storm events including increased wind velocity.

Though the exact nature of the impacts of climate change on the city's urban forest are not clear, certain management implications and related effects on required resources can be anticipated and strategies to adapt to climate change must be implemented.

Actions to be taken for climate change adaptation include: increasing and adapting tree species planting lists to include more species; developing a database with mapping of robust populations of native species for seed collection; promoting new standards for tree planting in hard landscapes that accommodate adequate soil volume; and collaborating with Toronto Public Health on achieving common objectives such as reducing heat vulnerability in low canopy areas.

## Recreational Pressures on the Urban Forest

Toronto's ravines and the city's natural heritage system are exceptional assets that support a diversity of wildlife and native plant species. However, increasing recreational pressures on the natural areas have degraded the natural environment and are impacting sensitive native species. Some of the challenges inherent to the effort to minimize or prevent degradation of parks and natural areas include:



- lack of public awareness of the sensitivity of these areas,
- limited opportunities for public recreation in some areas of the city, leading to misuse and overuse of certain parklands, and
- insufficient recreation/trail infrastructure to direct activity appropriately outside of sensitive sites to minimize disturbance impacts

The effects of high recreational use in natural areas can include soil compaction from repeated human, bike and pet traffic. Tree saplings and groundcover vegetation are trampled, resulting in a loss of forest regeneration, disturbance to wildlife (especially during breeding season) and increased dispersal of invasive

species. Habitat loss and the introduction of invasive species threaten native biodiversity in Toronto.

Urban Forestry staff, together with other City divisions and stewardship groups, are currently involved in the stewardship of many ecologically sensitive sites with a view to supporting and encouraging native biodiversity, restoring the natural integrity of sites and maximizing habitat connectivity. Volunteer involvement is critical to increasing public awareness of natural environment sensitivity.

Examples of actions for managing recreational pressures on the urban forest include: working with a range of partners to expand vegetation management in natural areas; maintaining existing stewardship programs and working with others to expand stewardship to enable more volunteer stewardship in public natural areas; developing policies to restrict inappropriate uses and prevent further habitat fragmentation in significant natural areas; and engaging the public through programs supporting private land and garden naturalization and education.

### Increasing Public Awareness of the Value and Sensitivity of the Urban Forest

Historically, there has been a lack of tools to evaluate and assign value to trees in the urban environment. This resulted in a lack of awareness of the value that the urban forest provides to the well-being of a city and its residents. This resource is not limitless. Everything humans do can have an impact on trees and natural features resulting in a reduction of the ecological services they provide.

Through existing initiatives such as volunteer planting, trail building and other stewardship events, volunteers and the diverse communities at large are educated about the natural environment and gain an understanding of the importance of restoration and how such activities contribute to enhancing the ecological value of the city's natural environment.

Actions presented in the Plan to improve awareness of the value and sensitivity of the urban forest resource include: increasing public education regarding natural area management activities, trail systems and appropriate user conduct through a co-ordinated communication strategy; proceeding with a natural surface trail study; encouraging the stewardship of privately owned sites adjacent to public sites by private partners; and continuing to make data available to the public to facilitate studies of local forest conditions.

## Measuring Performance and Progress

This Plan covers a period of 10 years, following which time a review will be conducted to determine if the City is meeting its goals, ensure that any new issues affecting the urban forest are sufficiently addressed and revise the Plan as necessary to continue work towards achievement of the long term vision.

Progress towards forest sustainability and success of the Plan will be evaluated and measured through a monitoring plan (included in Section 7) that includes a series of criteria and indicators that are aligned with the three components understood to be the foundation for achieving urban forest sustainability (i.e., the vegetative resource, appropriate management of the resource, and a strong community framework). The objectives and indicators with targets have all been tailored to the City's current challenges and goals. Factors such as simplicity, cost effectiveness, reliability and objectivity were also considered in selecting the criteria and indicators of success.

## Conclusion

Toronto has large connected natural areas that provide the core of the forest system, as well as small groupings of trees and individual trees along its streets, in its parks, as well as among a variety of private land use types including residential, commercial and industrial areas. This urban forest represents a tremendously valuable resource to the city and the people who live, work and play here.

In an urban setting a range of management strategies are required to deal with the various challenges faced by trees and the urban forest as a whole. As a result of these challenges, this extensive natural resource requires management in order for it to be sustained and enhanced, in accordance with City Council's direction. Some of the approaches and tools used by the Urban Forestry branch are innovative and precedent setting. It is important to the people who live and work in Toronto that this resource be protected, maintained and expanded to enable continued enjoyment of shady streets, parks and natural areas. Trees are a big part of what makes Toronto a very livable city; a "city within a park".

Although this Plan will be led by the Urban Forestry branch, its full and effective implementation depends on the support and cooperation of other City divisions and partners in the public and private sectors, including local businesses and members of the community. With approximately 40% of the resource in public ownership and the remaining 60% of the resource in private ownership, partnerships, internally and externally, are fundamental to making progress towards the goal of expanding the quality and quantity of the urban forest across the city.

# 1. INTRODUCTION

## What is the Urban Forest?

The urban forest includes all trees, other vegetation and their habitat within a city's boundaries. This includes: trees along city streets; trees in parks, ravines and natural areas; trees in front and back yards; and trees in landscaped open spaces associated with health care facilities, academic institutions, golf courses, cemeteries and local businesses. It is a shared resource that benefits the entire community.

## Why is the Urban Forest Important?

Toronto is the fifth largest municipality in North America with a population of 2.6 million people. The extensive ravine and green space system within Toronto sets it apart from other North American cities of similar size. This includes approximately 17,000 to 18,000 hectares of urban forest and approximately 10.2 million trees. Toronto's forest resource is estimated to have a structural value of approximately $7 billion and provides ecological services worth more than $28.2 million to the community every year in pollution removal, carbon sequestration and energy conservation alone. The urban tree canopy and associated green spaces contribute significantly to the city's consistent ranking as one of the most livable large urban areas in the world[1].

It is well documented that urban forests provide significant environmental and community benefits and thanks to evolving research tools, trees are being increasingly recognized as valuable municipal assets. If properly managed, the urban forest can support a variety of environmental functions, provide a range of economic benefits and make significant contributions to human health and community well-being. As articulated in Toronto Public Health's report, *Healthy Toronto by Design*[2], trees, forests and natural areas are an essential element of a healthy city that supports and promotes the health and well-being of its citizens. Some of the documented benefits are summarized below.

**Environmental and ecological benefits:**

- trees improve local air and surface water quality, make urban environments more hospitable and contribute to improved public health and well-being in very tangible ways,
- the city's urban forest helps mitigate the impacts of climate change by sequestering and storing carbon. It is estimated that the value of this carbon storage is about $25 million in Toronto,
- trees help with storm water management by stabilizing steep slopes and taking up water through their roots helping to control erosion and improve surface water quality. These benefits are particularly relevant in the city's ravine areas, and
- trees and natural areas provide habitats for a wide range of resident and migratory species of wildlife, as well as hundreds of native plant species

**Human health and community benefits:**

- open space and forests provide opportunities for exercise, physical activity and relaxation. Contact with nature is associated with health benefits such as lower blood pressure and cholesterol levels, enhanced survival after a heart attack, more rapid recovery from surgery, fewer

[1] http://www.citymayors.com/features/quality_survey.html, http://www.citymayors.com/environment/eiu_bestcities.html

[2] http://www.toronto.ca/health/hphe/pdf/healthytoronto_oct04_11.pdf

minor medical complaints and lower self-reported stress[3]. Contact with, or playing in nature can improve concentration and enhance mental development and creativity[4]. There is also evidence to suggest that well treed areas reduce crime, encourage better neighbour relationships and reduce aggressive behaviour[5],

- trees can also provide indirect health benefits by promoting physical activity by making walking and cycling routes aesthetically pleasing. Physical inactivity has been clearly linked to increased risk of chronic diseases such as colon cancer, type 2 diabetes, osteoporosis and heart disease. Studies have demonstrated that people walk and cycle more if routes have less air pollution (more trees) and are convenient and safe[6],
- large urban centres, such as Toronto, are subject to high levels of pollution which can create and aggravate health issues in the population such as respiratory illnesses and severe allergies. Toronto's trees filter the air, removing small particulate matter from the air and releasing oxygen in return,
- the presence of trees and green spaces have been specifically linked to better health in urban residents. Studies in various locations in the United States and Britain found that children from "green" neighbourhoods were less likely to gain weight and had lower asthma rates than their counterparts in less green neighbourhoods[7]. In Britain, health disparities between high and low income populations were also less among families who lived in neighbourhoods with green surroundings,
- trees provide protective shade. Over-exposure to the ultraviolet radiation (UVR) in sunlight increases the risk of skin cancer, cataracts, premature skin aging and wrinkling. Skin cancer is the most common cancer diagnosed in Canadians yet it is largely preventable. Children are at greater risk of UVR over-exposure because they generally spend more time outdoors and have more sensitive skin than adults[8], and
- trees can literally save lives by reducing outdoor air temperatures, providing shade and cooling buildings. Large urban centres get hotter and retain heat longer during heat waves because the heat is absorbed and stored in concrete and pavement. Toronto Public Health and Environment Canada have estimated that heat contributes to about 120 deaths per year in Toronto and these numbers are expected to increase with climate change[9]. In 2011, Toronto Public Health released a report, *Protecting Vulnerable People from Health Impacts of Extreme Heat*, which identified both the areas of the city where temperatures are the highest and the areas of the city where residents are most vulnerable to high heat[10].This information will be used for developing future strategies for mitigating this risk

**Economic benefits:**

- it is no coincidence that some of the areas of highest property value in the city are associated with ravines and other treed green spaces. Research has shown that appraised property

[3] http://www.toronto.ca/health/hphe/pdf/healthytoronto_oct04_11.pdf

[4] Dannenberg, Andrew, Howard Frumkin, and Richard Jackson. *Making Healthy Places: Designing and Building for Health, Well-being, and Sustainability.* Washington, DC: Island Press, 2011.

[5] Kuo, F.E., and Sullivan, W,C., "Environment and Crime in the Inner City: Does Vegetation Reduce Crime?." *Environment and Behavior* 33.3, (2001): 343-367. Print.

[6] Marshall, J.D., Brauer, M., and Frank, Lawrence D. "Healthy Neighbourhoods: Walkability and Air Pollution." *Environmental Health Perspectives* 117.11, (2009):1752-1759. NCBI. Web. 20 July. 2009.

[7] Liu, G.C., Wilson, J.S., Qi, R., and Ying, J. "Green Neighborhoods, Food Retail and Childhood Overweight: Differences by Population Density." *American Journal of Health Promotion* 21(4 Suppl), (2007):317-325. Print.

[8] http://www.toronto.ca/health/resources/tcpc/pdf/shade_guidelines.pdf

[9] http://www.toronto.ca/health/hphe/air_quality/pdf/protecting_ppl_in_extreme_heat.pdf

[10] http://www.toronto.ca/health/hphe/pdf/healthytoronto_oct04_11.pdf

values of homes that are adjacent to parks and open spaces are typically higher than those of comparable properties elsewhere[11],

- the benefits of trees in commercial areas are also well-documented. For example, in one study rental rates of commercial office properties were about 7% higher on sites having a quality landscape, which included trees[12]. Other studies show that consumers claim they are willing to pay more for products in downtown shopping areas with trees versus in comparable districts without[13],
- trees that are at least 6 m tall and within 18 m of a residential or small building provide direct energy savings by reducing cooling costs in the summer as well as reducing heating costs in the winter (particularly coniferous trees). These savings are linked to shading, windbreak effects, and local microclimate moderation[14], and
- trees, if properly maintained, can help support the function and extend the life of "grey infrastructure" (such as sidewalks and roads) in urban areas

Currently, over 80% of the Canadian population lives in urban areas[15]. This trend is expected to continue and as a result it is anticipated that Toronto's population will continue to rise over the next several decades. To ensure that Toronto remains one of the most livable cities in the world, the size and health of the urban forest must be increased to an extent that is both sustainable and practical within a major international urban centre. This Plan sets out a vision, goals and a series of actions for progressively improving the quality and quantity of the urban forest so that all those who live, work and play in the city can continue to derive the full range of benefits that the urban forest provides. The future sustainability and expansion of the urban forest will require the support of the entire community.

[11] Anderson, L.M., and Cordell, H.K. "Influence of Trees on Residential Property Values in Athens, Georgia (U.S.A.): A survey based on actual sales prices." *Landscape and Urban Planning* 15.1-2 (1988): 153-164. Print.

[12] Crompton, John L. *The Proximate Principle: The Impact of Parks, Open Space and Water Features on Residential Property Values and Property Tax Base*, Ashburn, VA: National Recreation and Parks Association, 2004.

[13] Wolf, Kathleen. "Trees Mean Business: City Trees in the Retail Streetscape." *Main Street News* 263 (2009): 1-9. naturewithin. Web. August. 2009.

[14] TRCA. *Town of Ajax Urban Forest Study, Part A.* 2009.

[15] Statistics Canada. http://www40.statcan.gc.ca/l01/cst01/demo62a-eng.htm

Table 2 - Benefits of the urban forest

## ENVIRONMENTAL

*Helps mitigate the effects of climate change*
*Improves local and regional air quality*
*Reduces summer air and stream water temperatures*
*Reduces urban heat island effects*
*Improves local soil and surface water quality*
*Reduces storm water runoff*
*Reduces stream channel erosion*
*Provides habitat for terrestrial and aquatic wildlife*

## COMMUNITY

*Improves quality of life*
*Improves health and well-being*
*Provides cooling, shade and blocks UV radiation*
*Buffers wind and noise*
*Promotes outdoor activities*
*Provides aesthetic value*
*Supports educational and recreational opportunities*

## ECONOMIC

*Decreases heating and cooling costs*
*Enhances tourism and viability of business areas*
*Reduces demand on storm water treatment operations and valley infrastructure repair*
*Increases property values*
*Positively influences consumer behaviour*

# 2. OVERVIEW OF THE STRATEGIC FOREST MANAGEMENT PLAN

This Strategic Forest Management Plan for the City of Toronto is a functional document that provides regional context, outlines current practices and defines future direction for local urban forest management. The Plan builds on the technical information about the urban forest gathered through the following two studies:

- *Every Tree Counts: A Portrait of Toronto's Urban Forest*[16], *and*
- *Assessing Urban Forest Effects and Values, Toronto's Urban Forest*[17]

The key findings from these studies are presented in Section 5 of this Plan and are summarized in Table 3.

**Table 3 - Toronto's urban forest**

| MEASURE | RESULTS |
|---|---|
| Number of trees in Toronto | approximately 10.2 million |
| Canopy cover | 26.6% to 28%* |
| Canopy cover target | 40% |
| Number of trees on public lands | approximately 4.1 million (40%) |
| Number of trees on private lands | approximately 6.1 million (60%) |
| Characteristics of the trees that make up the urban forest | • 68% are less than 15.2 cm diameter<br>• 18% are between 15.2 cm diameter and 30.6 cm diameter<br>• 14% are greater than 30.6 cm diameter<br>• predominance of native species (64%) |
| Structural value of the urbanforest | Approximately $7 billion |
| Ecological services** provided by the urban forest | valued at $28.2 million annually |
| Carbon storage | valued at $25 million |

**Canopy cover estimates for the city have been generated using different methods and results have varied from 19.9% to 28%, but the most current assessment indicates the range is between 26.6% and 28%.*
***This valuation only includes an estimate for: air pollution removal, energy savings, avoided carbon related to energy conserved and carbon sequestration.*

A successful plan must identify a thoughtful, disciplined approach to achieving goals and objectives while being sufficiently flexible to enable adaptation. The key question over the next several years will be how best to allocate available resources to sustain and expand an urban forest that is healthy and supports all life in the city. This Plan provides such direction and defines the path for the City and particularly for the Urban Forestry branch. It also considers the important role of private landowners, businesses and all residents of Toronto in this effort, the importance of effective outreach to promote the significance of the urban forest and the use of new tools for further refining the success of programs.

This Plan provides direction for forest management over the next 10 years through the vision, (both long-term and for the 10 year time frame of this Plan), strategic goals and a series of actions that address the key management challenges identified for Toronto's urban forest.

A key aspect of the Plan is that it is intended to be adaptive to enable timely response to new research, technological advancements and changes in current and future urban forest threats. It also includes a detailed monitoring plan (see Section 7) with specific success criteria to allow for the ongoing assessment of the state of Toronto's urban forest. While this Plan is for a ten year period, it is understood that the urban forest is a long-lived resource that will require additional plans to direct ongoing future management and monitoring.

[16] Parks, Forestry & Recreation, Urban Forestry. *Every Tree Counts: A Portrait of Toronto's Urban Forest*, Toronto: City of Toronto, 2010.

[17] Nowak, David. J., et al. *Assessing Urban Forest Effects and Values: Toronto's Urban Forest*, Newtown Square, PA: US Department of Agriculture, Forest Service, 2012 in press.

This Plan identifies both long term and short term actions for achieving goals. Short term actions include:

- actions for outreach, expanding awareness of the urban forest,
- establishment of best standards for tree maintenance, tree planting and establishment,
- enhanced coordination between programs for sharing best practices,
- refinement of planning tools/methods that further enable:
  - detailed urban forest analysis for proactive maintenance planning,
  - identification of environmental priorities for management, canopy gaps and planting opportunities, and
- use of defined performance measures

Longer term actions are based on a systematic planning framework centered on urban forest health and sustainability and include such deliverables as:

- increased canopy cover and the equitable distribution of tree canopy,
- increased biodiversity of trees and other vegetation, and a reduction in non-native invasive species, and
- uneven tree size class distribution with a shift in the tree size class distribution towards an increase in the number of mid to large sized trees

The longer term actions will need to be addressed as part of this, as well as future Plans.

Implementation of this Plan will be achieved through the core programs and functions of the Parks, Forestry and Recreation division (through annual operating plans as well as the multi-year Service Plan), as well as in cooperation with other City divisions and agencies, external stakeholders, the community and through special projects resulting from the strategic planning process.

## 2.1 Guiding Plans and Strategies

The Plan is informed by the vision and policies for green spaces, clean air and water, tree lined streets and protecting the natural environment expressed in Toronto's Official Plan[18]. The Plan includes strategies that help address a number of City Council adopted environmental initiatives. Key plans, strategies and guidelines that have been considered in the development of this Plan are:

- *Toronto's Wet Weather Flow Master Plan*[19]
- *Climate Change, Clean Air and Sustainable Energy Plan*[20]
- *The Climate Change Adaptation Strategy*[21]
- *Identification of Potential Environmentally Significant Areas (ESAs) in the City of Toronto*[22]
- *Toronto & Region Conservation Authority (TRCA) - Terrestrial Natural Heritage System Strategy*[23]
- *Toronto Public Health - Protecting Vulnerable People from Health Impacts of Extreme Heat*[24]
- *Shade Guidelines*[25]

[18] http://www.toronto.ca/planning/official_plan/introduction.htm

[19] http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=972bab501d8ce310VgnVCM10000071d60f89RCRD

[20] http://www.toronto.ca/changeisintheair/pdf/clean_air_action_plan.pdf

[21] http://www.toronto.ca/legdocs/mmis/2008/pe/bgrd/backgroundfile-12950.pdf

[22] http://www.toronto.ca/planning/pdf/Toronto-Potential-ESA-Report-2008.pdf

[23] http://www.trca.on.ca/dotAsset/26746.pdf

[24] http://www.toronto.ca/legdocs/mmis/2011/hl/bgrd/backgroundfile-39469.pdf

[25] http://www.toronto.ca/health/resources/tcpc/pdf/shade_guidelines.pdf

- *Toronto Streetscape Manual*[26]
- *The Walkable City: Neighbourhood Design and Preferences, Travel Choices and Health*[27]

## 2.2 Role of the Urban Forestry Branch

The Urban Forestry branch of the City's Parks, Forestry and Recreation division plays a critical role in the maintenance and management of Toronto's urban forest. This branch has led development of this Plan and will be responsible for ensuring much of its implementation. Therefore, an overview of Urban Forestry's key responsibilities is provided below.

Urban Forestry's mandate is based on the following four service pillars:

1. **Maintenance of the Urban Forest**
   Maintaining trees and managing forests is critical for establishing a mature, sustainable urban forest where public safety is assured. Tree maintenance includes among other things, pruning, tree risk management, tree removal, and treatment to manage pests. Management of forested and natural areas also includes silvicultural activities such as prescribed burns and invasive species control.

2. **Protection of the Urban Forest and Natural Heritage**
   In order to improve and expand the urban forest it is imperative that the existing resources and the opportunities for expanding it in the future are protected. Toronto's various tree protection by-laws (Street Tree, Private Tree, Ravine & Natural Feature Protection, and Parks By-laws) have proven to be effective tools in achieving this goal. By-law enforcement provides opportunities for education and increasing awareness about the importance of trees. Continued implementation of these by-laws must remain a priority. Protecting the conditions and habitats that support tree growth is a priority.

   Natural areas define Toronto as a unique city on an international scale. These areas span the boundaries of both private and City-owned property. Restoration and stewardship of the publicly owned portions of these areas is a fundamental service provided by Urban Forestry. Management of privately owned natural areas is achieved by educating property owners and through implementation of the Ravine and Natural Feature Protection By-law. This work serves to restore, maintain and enhance these important natural heritage assets for both the short term benefits of current residents as well as long term benefits for future generations of Toronto residents.

3. **Planting to Expand the Urban Forest**
   Toronto has adopted the goal of increasing tree canopy coverage across the city. One of the primary ways of achieving this goal is through the planting of new trees, with a focus on planting large canopy species for maximizing shade wherever space permits. Urban Forestry works with a wide range of partners internal and external to the City to ensure that all tree planting opportunities are utilized. Extensive efforts are made to improve planting conditions in order to provide newly planted trees with the elements required to support mature growth i.e., quality soil, water, oxygen and room to grow both above grade and below.

   Urban forests need to be diverse in species composition to ensure they have the required resiliency to meet the challenges of the urban environment, ie., insect pests, exotic invasive plants, development pressures, poor growing conditions and pollution. The Urban Forestry branch advocates maximizing species diversity through its planting programs.

[26] http://www.toronto.ca/planning/urbdesign/streetscapemanual.htm

[27] http://www.toronto.ca/health/hphe/pdf/walkable_city.pdf

4. **Planning to Ensure Strategic Advancement of Forest Management Objectives**
   Good planning, including co-ordination with other City divisions and external partners, is a cornerstone of providing Urban Forestry services effectively and efficiently. This includes incorporation of new technologies and innovations to increase efficiencies and facilitate education and knowledge transfer. It also includes the ongoing development and implementation of standards and policies, as well as coordination of studies, planning and analyses aimed at supporting a consistent approach to urban forest management issues.

These four service pillars – maintain, protect, plant and plan – as they relate to Toronto's urban forest represent the four overarching actions for sustaining and enhancing the urban forest. These are provided by working regularly with various divisions in the City as well as TRCA, particularly with respect to protecting and managing the city's natural heritage system (which includes woodlots, forested ravines and other treed areas).

## 2.3 Stakeholder Engagement in Plan Development

Throughout the planning process, in addition to extensive consultations with representatives from various City divisions, efforts were made to engage stakeholders and the community in the development of this Plan.  Consultation included:

- three facilitated stakeholder workshops in November 2009 and May 2012,
- four public and five stakeholder workshops conducted as part of the Parks Plan Consultation Process during November and December of 2011, and
- coordinating with stakeholder groups such as Local Enhancement and Appreciation of Forests (LEAF), Trees For Life: The Urban Tree Coalition (for Toronto and surrounding areas), Toronto District School Board and TRCA to share information and discuss common initiatives

# 3. VISION & GOALS

## Vision

The long term vision for this Plan was developed in consultation with City staff in City Planning, Toronto Public Health, Transportation Services and Toronto Water. Input was also received from the Clean Air Partnership, LEAF, and TRCA. The input received from other stakeholders and the community during the Parks Plan consultations was also carefully considered.

The 10 year vision was also developed and has been tailored to the time frame for this Plan.

### Long Term Vision for Toronto`s Urban Forest

> *Toronto's diverse urban forest is the vital green infrastructure that creates healthy neighbourhoods, supports habitat and biodiversity, promotes clean air and water, offers opportunities for recreation and education, fosters economic prosperity and enhances quality of life for everyone in the city.*

### Vision for the 10 Year Life of this Plan

> *A healthy and expanding urban forest, incorporating sound urban forestry practices and community partnership.*

As the primary City branch responsible for the implementation of this Plan, Urban Forestry's vision has direct relevance for and aligns closely with both the 10 year and the long-term vision for this Plan. Urban Forestry's mission statement is as follows: *Through shared commitment and stewardship Urban Forestry plans, protects, plants and proactively maintains the urban forest. Urban Forestry works with partners to expand the urban forest and in so doing, progressively improves the quality of life within Canada's largest city.* This statement embodies the City's commitment to support a wide range of management and stewardship activities intended to achieve the vision statements provided above.

## Strategic Goals

The strategic goals of this Plan are as follows:

1. **INCREASE CANOPY COVER**
   The City is committed to increasing the tree canopy cover as much as is practical and feasible, while still recognizing the importance of growth and development. A target of 40% has been set to ensure that the City of Toronto remains one of the most livable cities in the world and that people throughout the city benefit from the full range of environmental, economic and community services that trees can provide.

2. **ACHIEVE EQUITABLE DISTRIBUTION**
   Healthy communities are associated with healthy tree populations for all the social, economic and

ecological benefits they provide. For these reasons, the City and its partners will strive to ensure that areas with less tree canopy are prioritized for tree planting. This will increase equitable distribution of the forest and benefits for all communities.

3. **INCREASE BIODIVERSITY**
   Healthy forests are diverse forests. Toronto aims to maximize species diversity as much as possible, as this provides increased resiliency when certain species are threatened. Supporting, sustaining and encouraging native biodiversity through management of natural areas helps maintain the integrity of Toronto's natural systems for all life forms that depend on these areas. Ensuring diversity of street and park trees helps build up resilience to climate change and pests that target certain tree species over others.

4. **INCREASE AWARENESS**
   Educating the community about the tremendous environmental, economic and social and community value of the urban forest is also essential.

5. **PROMOTE STEWARDSHIP**
   Sixty percent of the city's urban forest resource is located on private property. Therefore, the engagement of residents, neighbourhoods, community groups and landowners in tree and forest stewardship is key.

   Issues that have an impact on urban forest expansion are city-wide in scope. Collaboration within Parks, Forestry and Recreation as well as with other City divisions, agencies and partners to share information, exchange ideas and leverage resources will be critical to successfully achieving the goals of this Plan.

6. **IMPROVE MONITORING**
   In order to effectively manage the city's forest resource; a comprehensive and ongoing understanding of the current state of the forest is required. The urban forest is dynamic and subject to change, therefore measurement of its composition, structure, size and health must be routinely undertaken. Enhancing inventory practices and improving data management systems used to store information about the urban forest, will enable forest managers to analyze and monitor change over time.

# 4. CONTEXT FOR THIS PLAN

The direction provided in this Plan has been shaped by the applicable policies and legislation, the history of the city's forests and trees and the current biophysical conditions that occur in the city. These are described briefly below.

## 4.1 Policy Context

Unlike the United States, where the United States Department of Agriculture (USDA) Forest Service is extensively involved in urban forest research and partnerships across the country, urban forestry in Canada remains primarily the responsibility of the municipality (with the exception of the Canadian Food Inspection Agency (CFIA), as described further on). It is up to each municipality to decide how best to address the wide range of issues related to its urban forest.

### Municipal Policies and Legislation

In Toronto, high level policy direction for urban forestry is provided by the City's Official Plan. The Official Plan, which is in the process of being updated, lays out the framework for orderly development in the City, with consideration for the natural environment as represented by the city's ravines, parks, natural areas, lake front, watersheds, street trees and other components. The City's current Official Plan includes policies to protect Toronto's natural heritage system for the long term and includes protection for remnant forests and trees (i.e., sections 2.3, 3.2, 3.4 and 4.3).

***Toronto's Official Plan Supports the Urban Forest***

Official Plan policy 3.4.1(d) identifies the need for preserving and enhancing the urban forest by:

i. *providing suitable growing environments for trees,*
ii. *increasing tree canopy coverage and diversity, especially of long-lived native and large shade trees; and*
iii. *regulating the injury and destruction of trees.*

Official Plan policy 3.4.1(b) also identifies the importance of protecting and restoring the health and integrity of the natural ecosystem, supporting bio-diversity in the city, and targeting ecological improvements, paying particular attention to:

i. *habitat for native flora and fauna and aquatic species;*
ii. *water and sediment quality;*
iii. *landforms, ravines, watercourses, wetlands and shoreline and associated biophysical processes; and*
iv. *natural linkages between the natural heritage system and other green spaces.*

Toronto has also developed a comprehensive set of by-laws and specifications that protect trees in the city[28]. These include: the *Street Tree, Private Tree and Ravine and Natural Feature Protection By-laws*. The *Parks By-law* also includes provisions for the protection of trees in parks. All infrastructure works and development, whether private or public sector, are subject to the provisions of these by-laws.

[28] http://www.toronto.ca/trees/bylaws_policies.htm

There are trees within Toronto that are also protected under the *Ontario Heritage Act* or are acknowledged as heritage trees by *Trees Ontario*.

The City has acknowledged that climate change is a challenge that needs to be addressed. The *Climate Change, Clean Air and Sustainable Energy Action Plan* identified 64 recommendations aimed at helping to achieve targets for the reduction of greenhouse gas and smog causing pollutants. The recommendations, which were unanimously adopted by City Council in July 2007, included an affirmation of Council's commitment to increasing the tree canopy. In July 2008, City Council also unanimously adopted the *Climate Change Adaptation Strategy*[29] which identified both short and long term actions to manage the impacts of extreme weather on the City's services and infrastructure, among other things. The strategy acknowledged that actions aimed at expanding the tree canopy through maintenance, protection and planting activities will provide shade, lessen the urban heat island effect, and reduce storm water runoff and other effects of climate change.

Other City policies and guidelines that influence and affect urban forestry in Toronto include:

- the *Toronto Green Standard*[30] for building which includes mandatory requirements for tree planting as part of project design and approvals, and
- the *Design Guidelines for Trees in Surface Parking Lots*[31] recommend a minimum number of trees per parking space in new developments

These and other policies are implemented through the planning process in consultation with Urban Forestry staff.

## Provincial Policies and Legislation

Many of the trees within the city's urban forest are also part of the city's natural heritage system. These include trees in forested ravines or valley lands, upland forests, meadows, swamps and shorelines. These resources are protected through provincial policies, as well as the municipal policies cited above. At the provincial level, one of the key vehicles for implementation of a natural heritage protection system in Ontario is the *Planning Act*. Section 2 (a) of the *Planning Act* requires that planning approval authorities have regard to matters of provincial interest including, "*the protection of ecological systems, including natural areas, features and functions*", as well as natural hazards for which conservation authorities have commenting authority on behalf of the province. The provincial interest in natural heritage is further outlined in Section 2.1 of the Provincial Policy Statement[32], which sets out protection requirements for identified natural heritage features and areas. Specifically in relation to the terrestrial natural system, Section 2.1.2 of the Provincial Policy Statement states: "*The diversity and connectivity of natural features in an area, and the long-*

[29] http://www.toronto.ca/teo/adaptation/index.htm

[30] http://www.toronto.ca/planning/environment/greendevelopment.htm

[31] http://www.toronto.ca/planning/urbdesign/greening_parking_lots.htm

[32] Ontario Ministry of Municipal Affairs and Housing. *Planning Act.* Provincial Policy Statement, 2005.

*term ecological function and biodiversity of natural heritage systems, should be maintained, restored or, where possible, improved, recognizing linkages between and among natural heritage features and areas, surface water features and ground water features.*"

Provincial statutes like the *Endangered Species Act* are also in effect and protect certain species of trees that occur in the city of Toronto. A recent example is the listing of butternut (*Juglans cinerea*) as an endangered species so that removal of butternut trees is now regulated by the Ontario Ministry of Natural Resources (OMNR).

### Role of the Federal Government

Two agencies of the federal government have mandates related to urban forestry issues - the Canadian Forest Service of Natural Resources Canada and the CFIA of Agriculture and Agri-Food Canada. The Canadian Forest Service is a science-based policy organization that produces and shares knowledge through research and outreach or technology transfer. The CFIA develops policy and programs aimed at preventing the introduction and spread of regulated pests in Canada. Through the *Plant Protection Act*[33] the CFIA seeks to detect, control and eradicate designated pests. The City of Toronto, through the Urban Forestry branch has been and continues to be, a partner with both federal organizations on issues related to pest management.

For example, the City partnered with the Canadian Forest Service in the development of a branch sampling technique now widely utilized in the detection of EAB, an invasive insect known to attack ash trees. Since 2003, the City has also been a partner with the CFIA in an effort to eradicate an Asian Long-horned Beetle (ALHB) (*Anoplophora glabripennis*) outbreak in Toronto and Vaughan. To date, the eradication effort has been successful with no viable life stages of the insect being detected within the regulated area since 2007. Systematic surveying and monitoring will be discontinued in 2013 unless new positive detections are made prior to that time.

## 4.2 Historical Context

The City of Toronto was built on an area once largely covered by forest. In a little more than 200 years it has become the fifth largest metropolis in North America.

### Toronto's Ravines

The development of Toronto was greatly influenced by the city's extensive ravine system. The system of deep river valleys that divides Toronto's geography on a north-south axis played an important role in trade and commerce prior to and after European settlement. Ravines influenced the city's growth, with the steep-sided river valleys creating physical barriers to development as the city expanded in the late 19th and early 20th centuries. For about a century and a half, Torontonians did their best to bury the ravines, with varying degrees of success, by overlaying them with sidewalks, streets, bridges, highways and rail lines.

**Figure 1 - Toronto's Brickworks in the Don River Valley, 2006.**

[33] Plant Protection Act SOR/95-212 http://laws-lois.justice.gc.ca/eng/regulations/SOR-95-212/page-1.html

Figure 2 - Construction of the Bloor Viaduct, 1917.

Several small rivers and creeks in the downtown area were routed into culverts and sewers and the land was filled in above them. This is related to the historical use of these smaller tributaries as open sewers and dumping grounds, which led to a serious public health issue. The burying and covering of tributaries also included the removal of trees in many of the ravines in the downtown area.

Today, ravines are no longer seen as technological obstacles. Today the ravines are celebrated as natural assets that provide meandering green corridors in an otherwise predictable city grid. Citizens of Toronto are fortunate to be able to experience the solitude of urban wilderness within a few minutes walk of many of Toronto's neighbourhoods and business areas.

## Toronto's Streetscapes

Many of the trees that lined Toronto's streets 80 to100 years ago were remnant trees from the original forest, planted hedgerows from agricultural uses, or were purposely planted to line streets. Some of these large trees still define neighbourhoods like the Beach. On main streets like University Avenue, Jarvis or College Streets, trees were removed as a result of road widenings needed to service a fast growing city. Street tree removals were compounded by the loss of most of the city's mature elms to Dutch Elm Disease (*Ophiostoma ulmi)* in the 1960's and 1970's.

Figure 3 - College Street near Yonge Street, Toronto Archives, 1912

The nature of development in the city following the Second World War reflected changes in technology associated with construction. Large earth moving equipment was able to grade sites easily and stripped much of the native vegetation and soils. During this period, transportation and servicing was the major concern for City planners and engineers and trees were considered an encumbrance to road construction and maintenance, as well as potential hazards in relation to utilities. Where permitted, trees were typically planted in raised concrete planters, so they could be moved easily if required.

Much has changed since the 1960's exclusive focus on infrastructure as the benefits of trees in urban areas are now well documented and understood.

# 4.3 Biophysical Context

Toronto's climate is influenced by Lake Ontario and the many valleys and ravines that cut through the area (Etobicoke Creek, Mimico Creek, Humber River, Don River, Highland Creek, Taylor Massey Creek

and Rouge River). The city is bordered on the north by the Oak Ridges Moraine and on the west by the Niagara Escarpment. It lies in an ecological transition zone between two forest regions, the Great Lakes-St. Lawrence region to the north, and the Carolinian region to the south. Terrestrial natural cover is mainly deciduous and mixed forest, interspersed with tracts of wetland, native meadow and Great Lakes coastal habitats.

Prior to European settlement and the clearing of forests for agriculture, approximately 90% of southern Ontario is estimated to have been covered with forest. Recent analyses indicate that the Toronto area has experienced one of the highest deforestation rates in the province as a result of the high levels of urban development[34].

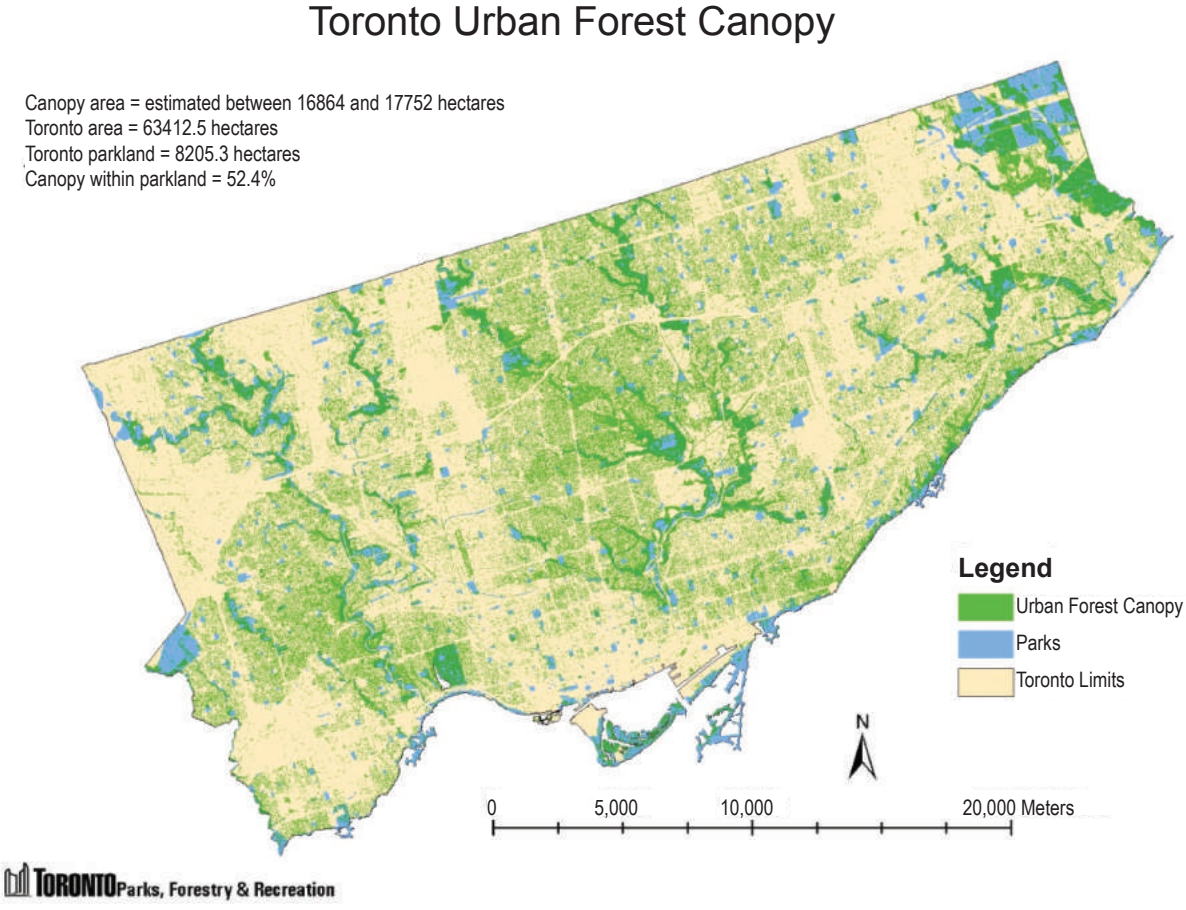



**Figure 4 - City of Toronto's urban forest canopy in relation to its parkland**

The current terrestrial natural heritage system is largely confined to the valley systems of the urban landscape. Several remnant natural places shape the character of the urban landscape, including:

- the rivers and their tributaries whose valley lands function as vital green corridors within the urbanized area,
- Rouge Park, Canada's largest and one of the largest urban natural heritage parks in North America,

[34] Ontario's State of the Forest Report 2006 (Chapter 4: Indicators of Forest Sustainability – Criterion 4) http://www.mnr.gov.on.ca/en/Business/Forests/2ColumnSubPage/STEL02_179267.html

- the shoreline of the post-glacial Lake Iroquois, a major rise in elevation that extends from east to west across the region inland from and parallel to Lake Ontario,
- the Scarborough Bluffs, Toronto Islands, and other Lake Ontario beaches and bluffs,
- forests and wetlands that are large and intact enough to support species and communities characteristic of the region before European settlement, some of which are now regionally uncommon or rare such as black, red and white oak forests, and
- tallgrass prairie and oak savannah communities, such as those in High Park which are rare in North America

Today, the remaining treed areas are largely concentrated in the city's valleys but also include some upland woodlands as well as wetland and shoreline habitats. In terms of land ownership, the majority of Toronto's urban forest is found in the city's parklands, on residential properties and along city streets. Each of these management components of the urban forest have different management requirements that are addressed under a variety of programs provided by the City.

# 5. STATE OF THE FOREST RESOURCE

The baseline data used in the preparation of this Plan comes from two current documents:

- *Every Tree Counts: A Portrait of Toronto's Urban Forest* which provides a comprehensive assessment of the forest resource within Toronto, and
- *Assessing Urban Forest Effects and Values, Toronto's Urban Forest*, a further tree canopy analysis conducted by the USDA Forest Service and to be published later in 2012[35], provides an additional in-depth look at the state of the forest resource in the City of Toronto, including a review of canopy estimating methodologies and a canopy change analysis over a 10 year time frame

These analyses found that Toronto's urban forest has approximately 10.2 million trees. About 40% of these are on City lands (i.e., 34% or 3.5 million trees are located in City parks, ravines and natural areas and 6% or 600,000 trees are on City streets with the remaining 60% (6.1 million trees)) located on private property.

The structural and functional values of Toronto's urban forest have been estimated by the USDA Forest Service researchers based on the study data, as follows:

- the structural value of the urban forest, which represents the value of the trees themselves, is an estimated $7 billion with an associated carbon storage value of $25 million,
- the annual functional value (which represents the combined environmental benefits accrued from air pollution removal, energy savings through heating/cooling associated with temperature moderation from trees adjacent to buildings, avoided carbon related to energy conservation and carbon sequestration) is $28.2 million

The USDA's study also highlighted some concerns. For example, despite the City's stated objective to expand its tree canopy, the net effect of current policies and programs has been that tree cover only increased marginally between 1999 and 2009 from about 25.3% to about 26.6%. An additional concern is that a high proportion of the forest leaf area is composed of species, particularly maple (*Acer spp.*) and ash, that are currently under immediate threat from invasive insect pests. Efforts to eradicate ALHB, which presents a threat to maple, among other species of trees, have been successful to date in the Toronto area, however this pest still represents an ongoing forest health care concern. EAB is killing ash trees within the city and could eliminate 8.4% of the city's trees (i.e., the total ash tree population) within the next decade.

The value of Toronto's urban forest combined with the identified challenges in enhancing the current canopy cover provides important justification for the Urban Forestry programs of maintenance, protection, planting and planning (described in more detail in Section 6).

## 5.1 Urban Forest Biodiversity

The studies completed to date have reported that Toronto maintains a reasonably healthy and diverse complement of tree species despite increasing urbanization and development. Although Toronto has many exotic invasive species issues to contend with, Toronto's urban forest is primarily composed of species native to North America with a large percentage of species native to Ontario (Figure 5).

[35] Nowak, David. J., et al. 2012 in press.

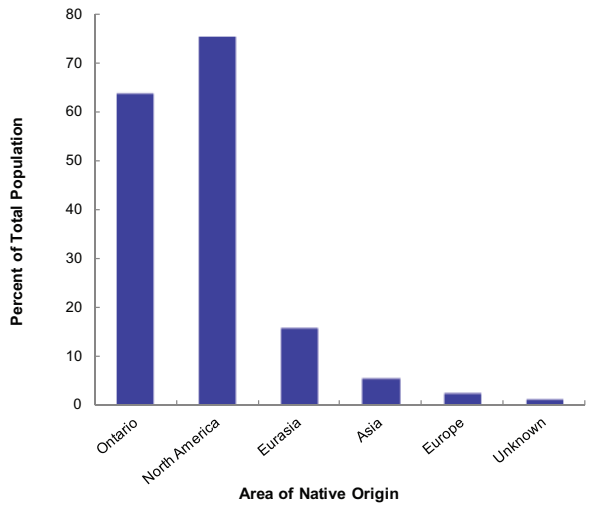



**Figure 5 - Place of origin of tree species within Toronto's urban forest**

Norway maple (*Acer platanoides*), is a common invasive species that has been planted in urban areas throughout eastern North America. Norway maple still dominates the tree canopy in some parts of Toronto and has a significant presence across the city (Figure 6), however, its numbers are decreasing because of the City's concerted efforts to limit the planting of Norway maple, combined with targeted removals in natural areas and the education of residents.

Institutional and low-density residential areas were found to have the highest ratio of native to invasive species as compared to industrial, commercial and utility and transportation land uses.

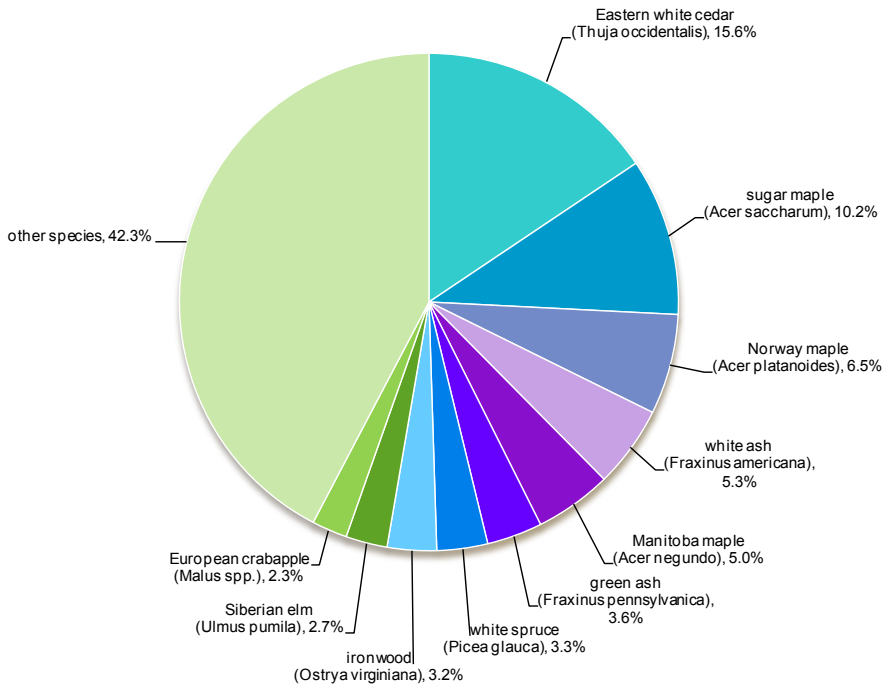



**Figure 6 - Composition of the urban forest with the 10 most common species within Toronto**

## 5.2 Urban Forest Structure

Toronto's urban forest includes a significant population of young trees that, with the appropriate maintenance and care, will mature into the city's future tree canopy. However, the current size structure is less than ideal (Figure 7), with a small percentage of large trees. Large trees provide exponentially more benefits than small trees and from an urban forestry perspective, a healthy proportion of large diameter trees is desirable. This understanding of the forest size structure within Toronto also helps further emphasize the need for tree protection by-laws.

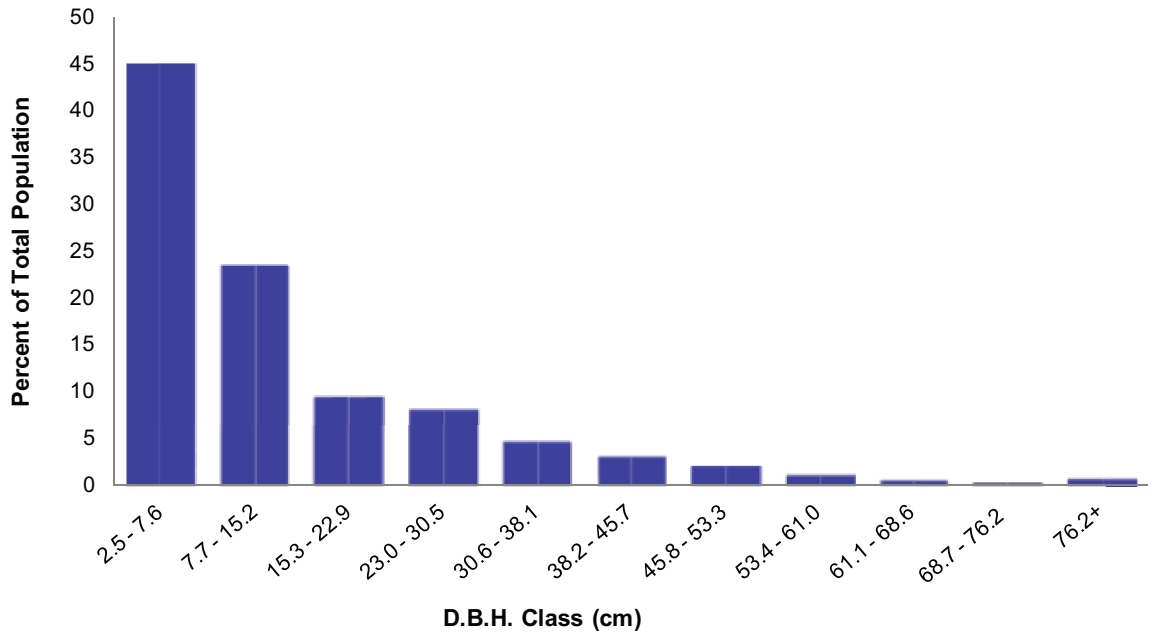



**Figure 7 - Percent of total tree population by stem diameter (dbh) class within Toronto**

## 5.3 Urban Forest Distribution

University of Vermont Spatial Analysis Laboratory assisted in the *Every Tree Counts* study by using remote sensing techniques with satellite imagery to map the urban forest. This technique created land

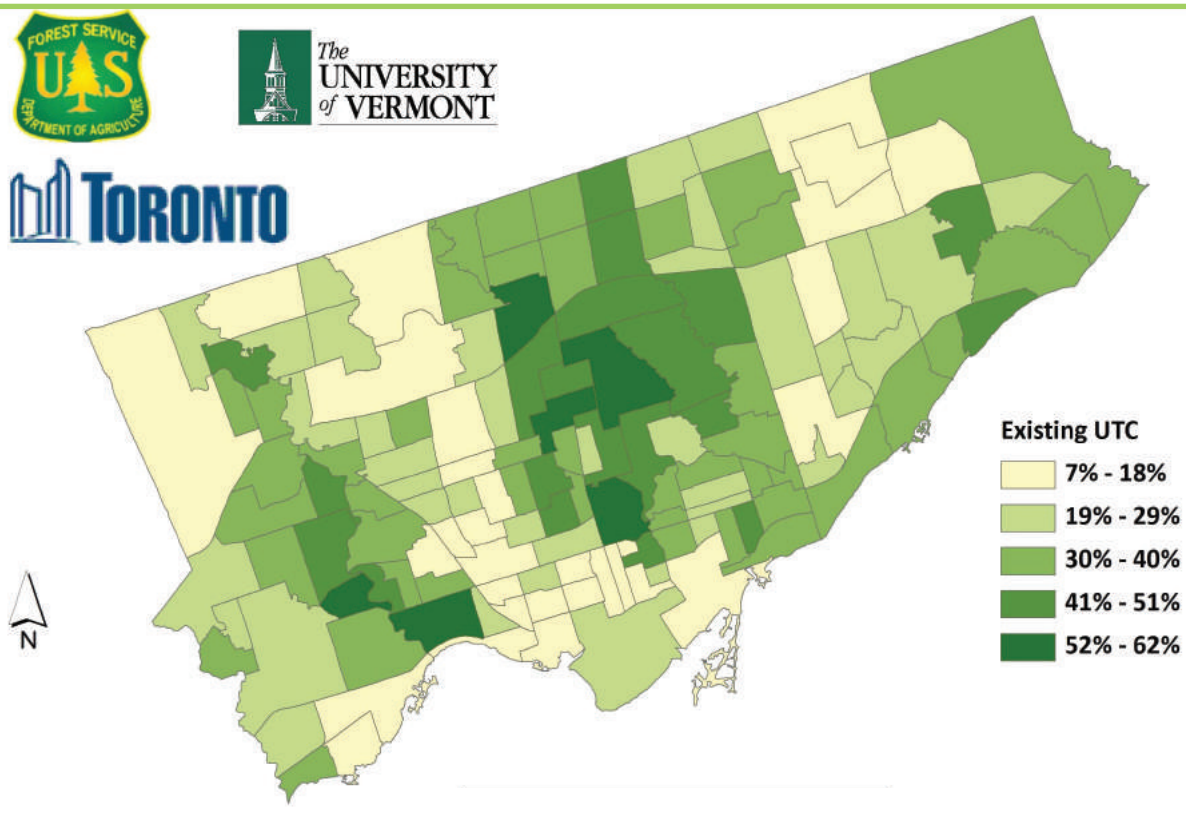



**Figure 8 – Average tree cover by Toronto neighbourhood (Spatial Analysis Laboratory, University of Vermont and USDA Forest Service).**

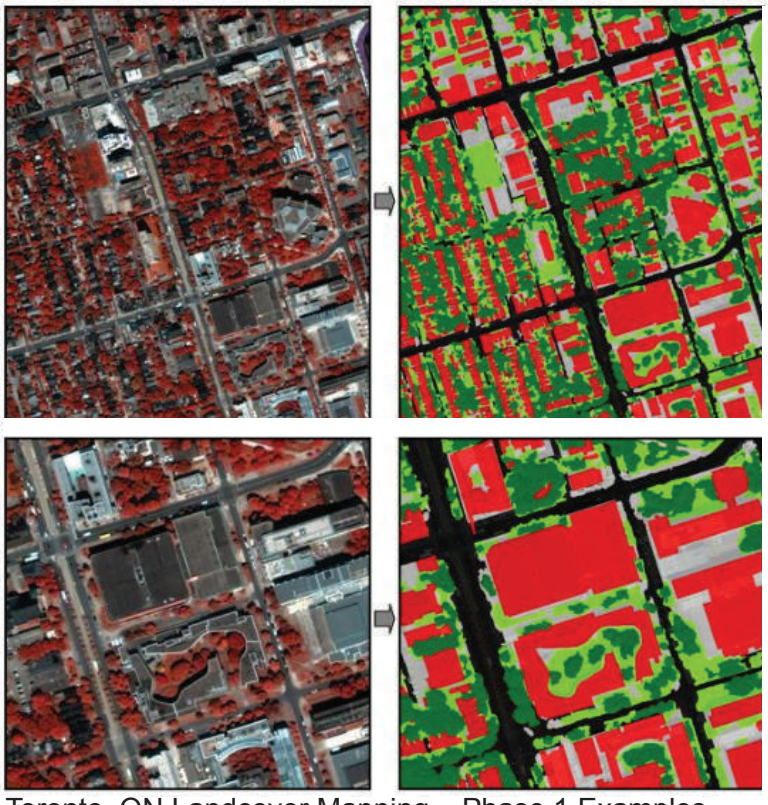
cover classifications, with one of these classifications being tree cover. Tree cover is shown to be highly variable across the city, with much of the tree canopy cover (approximately 10%) located in the city's valley systems and ravines.

The land cover analysis found, for example, that:

- up to 3% of the open space available for tree planting is within the City's road right-of-ways, and
- the parks land use had over ten times more tree cover on average (at 48% to 52%) than industrial land use areas (at 4.1%)

## 5.4 Analysis of Plantable Spaces

The University of Vermont Spatial Analysis Laboratory detailed canopy cover mapping city-wide also allows for planning strategic canopy expansion by land use type. This is based on a review of the existing canopy by land use and considering the potential for increased canopy cover. As shown below, dark green illustrates where there is current canopy, light green illustrates where there is open space (that is not paved or a building) that could potentially accommodate one or more trees and red represents impermeable surfaces. Notably, this mapping has some limitation as it does not take into account planning considerations (i.e., future development) or site-specific limitations (e.g., the presence of underground infrastructure or above ground wires).



Toronto, ON Landcover Mapping – Phase 1 Examples
UVM Spatial Analysis Laboratory, Contact: Keith Pelletier (kpelleti@uvm.edu) or Jarlath O'Neil-Dunne (joneildu@uvm.edu)

**Figure 9 - Satellite imagery (left) and related land cover classification imagery (right)**

These recent analyses specifically identified some of the areas of opportunity for increasing tree canopy in the city based on an analysis of available open area for tree planting.

Table 4 illustrates how, on a coarse level, the recent analysis supports the possibility of a 40% canopy cover and identifies in which types of land uses the potential opportunities are greatest for canopy cover expansion.

**Table 4 - Potential canopy expansion by land use category**

| | Estimated Existing Canopy Coverage | Estimated Possible Additional Canopy Coverage | Total Possible Canopy Coverage |
|---|---|---|---|
| Single Family Residential | 31% | 10% | 41% |
| Multi-family Residential | 18% | 2% | 20% |
| Commercial | 6% | 2% | 8% |
| Industrial | 4% | 3% | 7% |
| Institutional | 17% | 3% | 20% |
| Utilities & Transportation | 11% | 1% | 12% |
| Other | 15% | 1% | 16% |
| Open Space 1 (Parks & TRCA lands) | 52% | 3% | 55% |
| Open Space 2 (Commercial Landscaped Areas/ Recreation/ Agriculture) | 26% | 2% | 28% |
| TOTAL[36] | 28% | 18% | 40% |

Sustaining the urban forest and expanding tree canopy coverage to 40% over the next 50 years has been modeled by the USDA Forest Service to require the annual establishment of 570,000 trees, considering an estimated 3% average mortality rate[37]. This includes planting on all lands (private and public property) and natural regeneration. Appendix 2 provides an example of how this information was used to develop preliminary annual planting targets for the City. Simply using the quantity of trees planted is not a preferred performance measure because it does not measure the number of successful plantings, or the size or type of plantings. However, until better measures are available to track progress, generalized planting numbers assist in providing part of the story of meeting canopy goals.

Continued GIS mapping using data layers for land uses and forest canopy, as well as other land cover types, will progressively enable more detailed analyses of areas to be considered for planting and the development of canopy targets by land use, in consultation with City Planning.

[36] Total is calculated by using 2008 Satellite imagery GIS layers and calculating by land use area total area and summed. The potential canopy is based on same methods with other canopy cover layers used (pervious and imperviouss except roads and buildings)

[37] Nowak, David. J., et al. 2012 in press.

### *Methodologies to Identify Planting Opportunities and Monitor Forest Cover Change*

One of the key indicators used by municipalities to assess the state of the urban forest resource is tree canopy cover. Measuring forest cover change over time helps managers assess the effectiveness of forestry programs as well as the City's policies for supporting the goal of expanding the urban forest.

As part of a comprehensive tree canopy study, the City has collaborated with the USDA Forest Service to develop a methodology that uses available city aerial imagery to conduct an assessment of forest and land cover change over time. The sample uses 10,000 geo-referenced random sample points and successive years of imagery to assist managers in developing trend information. Tree canopy levels are expected to fluctuate over time as there are many factors (e.g., insect infestations) that will affect Toronto's canopy in the short-term and long-term. Repeated monitoring and evaluation is key to establishing reliable long-term trend data. This methodology provides a simple and cost-effective tool for tracking the urban tree canopy in Toronto. It also adds value to other program areas as it provides a measure of relative land cover (e.g., impervious to pervious surface ratio) for City planners and further stratifies change by general land use categories.

**Figure 10 - An example of land cover change in the High Park area of Toronto, Bloor Street West. top - 2002 (City of Toronto), 2009 (Bing Maps)**

# 6. KEY URBAN FOREST MANAGEMENT CHALLENGES AND SOLUTIONS

There are many complex issues affecting the long-term sustainability of the urban forest that must be addressed as part of this Plan. Everyday decisions made by City planners and individual property owners can have serious implications for the future of the city's urban forest. In this context, recognizing the tension between urbanization and preservation of the urban forest in Toronto is a useful first step toward finding solutions. Other emerging forest management issues include invasive pests, climate change, and impacts related to recreational activities (such as the introduction and spread of invasive species). These challenges can, however, be addressed through sound and proactive tree maintenance practices and improving community awareness and engagement of a wide range of partners in stewardship activities that help sustain and enhance the urban forest. These examples illustrate the range of issues affecting the long-term sustainability of the urban forest that this Plan addresses.

The following issues are the key challenges that the City of Toronto is currently facing in achieving a healthy, sustainable urban forest:

1. **Forest Health Threats**
2. **Tree Maintenance Requirements and Expectations**
3. **Balancing Urbanization Impacts and Sustaining the Urban Forest**
4. **Climate Change Impacts**
5. **Recreational Pressures on the Urban Forest**
6. **Increasing Public Awareness of the Value and Sensitivity of the Urban Forest**

These challenges and the recommended actions identified to address them over the next ten years are described in more detail in the following sections.

## 6.1 Forest Health Threats

### 6.1.1 Forest Health Threats: Current Practices and Challenges

The Urban Forestry branch identifies and manages forest health issues through integrated pest management which includes monitoring and treatment using the most appropriate method. Pest infestations often spread across political boundaries, therefore partnerships with other agencies on urgent forest health issues are maintained to allow for collaboration. Where applicable, property owners receive information and advice on the treatment of common tree pests and diseases.

Forest health issues are classified based on the level of risk to the urban forest.

- LOW: forest health issue represents a cosmetic nuisance and generally does not cause tree mortality, e.g., Eastern Tent Caterpillar (*Malacosoma americanum*) or maple tar spot (*Rhytisma acerinum*),
- MEDIUM: forest health issue may cause mortality through repeated impacts on tree health if not controlled, e.g., European Gypsy Moth (*Lymantria dispar*), and

- HIGH: forest health issue may cause rapid and widespread tree mortality if not controlled, e.g., ALHB, EAB

The Urban Forestry branch deals with a number of medium and high risk forest health issues on an ongoing basis. In addition to the anticipated threat of EAB, the Urban Forestry branch continues to deal with an ALHB infestation in northwest Toronto and has had outbreak conditions of the European Gypsy Moth within the past five years. Examples of integrated forest health care responses are described below.

***European Gypsy Moth***

The European Gypsy Moth is an introduced defoliating insect that is considered a widespread pest in North America. The caterpillar, or larval stage of the insect, eats the leaves of trees making them more susceptible to disease and damage from other insects.

In 2007 and 2008, the City of Toronto undertook an integrated pest management program to control the European Gypsy Moth outbreak. This program included aerial and ground spray programs to control the outbreak levels in selected areas of the city. Other control measures such as tree banding and vacuuming of egg masses with portable vacuum cleaners were also used. The program involved extensive public consultation to inform residents of the purpose and safety of the methods being used. The ability of the City to carry out an aerial spray program in a highly populated urban area speaks to the value of community support for forestry programs in the city.

European Gypsy Moth will always be present in the landscape at varying levels with populations rising and falling in cycles dependent on natural controls and the weather. In 2012, levels of European Gypsy Moth were seen to rise in some areas of the city. Control measures, including ground based and aerial spraying of the biological control agent *Bacillus thuringiensis* subspecies *kurstaki* (Btk) have been implemented successfully in the past and will be utilized in the future to control high population levels of this insect.

**Figure 11 - Urban Forestry and Asian Long-horned Beetle management team of municipal partners and the Canadian Food Inspection Agency. (photo: CFIA)**

### *Asian Long-horned Beetle (ALHB)*

The ALHB eradication program that began in September 2003 in the Greater Toronto Area is an example of exceptional cooperation between all levels of governments to achieve a common objective. The CFIA, Canadian Forest Service, OMNR, USDA, Regional Municipality of York, TRCA, City of Vaughan, City of Toronto and others have worked together to implement an aggressive eradication campaign.

A comprehensive database to research the beetle's biology and ecology has been established through intensive data collection. Research focused on development of new information supports the eradication effort and serves as a guideline for potential future infestations. The City of Toronto, as part of the Collaborative Science Group for Insect Eradication, received the *Ontario Federal Council Leadership in Science and Sustainable Development Award in 2006.*

### *Emerald Ash Borer (EAB)*

The number one forest health threat facing Toronto today is EAB, which was first confirmed in the city in 2007. EAB is a beetle native to Asia that was accidentally introduced to the United States. Since its introduction, EAB has killed millions of ash trees in southwestern Ontario, Michigan and the surrounding states. EAB attacks and kills all species of ash and poses a major economic and environmental threat to urban and rural forested areas in both Canada and the United States. Federal regulations currently prohibit the movement of specific materials including any ash material and firewood of all species from specific areas of Ontario and Quebec.

Unlike the recent ALHB infestation, which is now being controlled, there are no known control methods to prevent widespread EAB damage. It is expected that ash tree mortality in Toronto will approach 100% within the next decade. To put it in perspective, Toronto will potentially lose all of its ash which represents 8.4% of its tree population (about 860,000 trees) as a result of EAB. This is estimated to reduce the canopy cover by 2.2% – 2.3% (based on current estimates of total canopy cover).

Urban Forestry is mobilizing the resources needed to mitigate public risk, protect selected trees, plant replacement trees and inform Toronto residents of concerns. Toronto continues to work in cooperation with other agencies and researchers to identify best practices in forest health care management.

While there is no way to eradicate this pest, individual trees may be protected through tree injection with products registered in Canada for use against EAB. The City of Toronto has expanded its tree injection program using TreeAzin™ against EAB in selected park and street trees; injecting over 4,000 ash trees in

**Figure 12 - Ash lined Toronto street before Emerald Ash Borer infestation**

**Figure 13 – Same Toronto street after Emerald Ash Borer removals**

2012 and identifying thousands of additional candidate trees for potential injection in subsequent years. However, the City of Toronto will be required to remove thousands of dead and dying trees on streets, in parks and in natural areas. All street trees and a significant number of park trees lost to EAB will be replaced.

### 6.1.2 Forest Health Threats: Solutions

In response to forest health care challenges, the City is mobilizing resources to manage public risk and protect as many trees as reasonably possible. The Urban Forestry branch is also educating and informing residents about steps they can take to improve the health of their trees and to protect against forest pests and other health care threats.

***Actions for Addressing Forest Health Threats:***

- communicate comprehensive pest management strategies as needed through media, meetings and outreach programs,
- obtain required funding to maintain an appropriate response to EAB, including monitoring and mapping EAB tree removals, and
- maintain consistent funding to city-wide forest health care and pest management programs and initiatives and refine the forest health care strategy going forward based on the effectiveness of current programs and initiatives and industry best practices

## 6.2 Tree Maintenance Requirements and Expectations

### 6.2.1 Tree Maintenance Requirements and Expectations: Current Practices and Challenges

The Urban Forestry branch is responsible for maintaining approximately four million trees growing along City streets and within the City's parks, ravines and natural areas. Maintaining these trees in a safe and healthy condition is a primary concern for staff and represents a significant proportion of Urban Forestry's workload. Trees in streetscapes and parks generally have different maintenance requirements than trees in natural areas. Maintenance and management involves a wide range of activities, described briefly below:

- maintenance pruning of street and park trees is performed to eliminate dead or hazardous limbs or branches to encourage good form and healthy growth, and to maintain the structural integrity of the tree,
- management of forested and natural areas includes silvicultural forestry operations such as prescribed burns and invasive species control,
- tree risk assessment is a tool for scheduling and prioritizing work, allowing for a greater degree of workload management efficiency and flexibility. Tree risk assessment involves examining a tree for structural defects, associating those defects with a known pattern of failure and rating the degree of risk. This involves consideration of three components: 1) a tree with the potential to fail, 2) an environment that may contribute to that failure, and 3) a person or object that would be injured or damaged (i.e., a target should the tree fail). By definition, a hazardous tree requires the presence of both a defective tree and a target[38]. The Urban Forestry staff understand the

[38] Methany, P.N., and Clark, R.J. *A Photographic Guide to the Evaluation of Hazard Trees in Urban Areas*. Illinois:International Society of Arboriculture,

tremendous benefits to the urban environment of larger trees and therefore do not take removing a mature tree lightly. Trees are only removed when they are dead or can no longer be maintained in safe condition, thereby creating a safer environment and reducing liability to the adjacent property owners,

- other essential activities includes the clean-up of failed tree limbs and other tree debris following severe weather, and
- new tree maintenance to support proper establishment through structural pruning, watering and mulching is extremely important for the short and long term success of young trees

These wide ranging maintenance and management activities require co-ordination with others. For example, Urban Forestry works in collaboration with Parks staff through the Hazard Tree Abatement Program to identify and remove the most extreme risks identified within the highest use areas. A Parkland Tree Risk Management Policy and Procedures Guide for staff use will be completed to support this work. Some examples of innovative programs and best practices in progress are highlighted below.

### *Parkland Tree Risk Management*

The task of managing trees within large parklands where the trees are not individually identified in the existing tree maintenance management system can be difficult, particularly when considering the expansive area of Toronto's parkland system (over 8000 hectares). A pilot program was launched in 2010 to develop a method of identifying hazardous trees in these areas and mapping their locations so work crews could easily find and eliminate the hazards (as shown in Figure 14). City arborists inspected areas and gathered the required data. An evaluation form was developed to assist inspectors in assessing risk and to prepare maps as needed. As a result of the pilot project, efficient and effective procedures have been developed and refined. As part of this process over seventy staff were trained in tree risk assessment during a one day intensive class held in June 2010.

**High Park – Northwest Corner Tree Maintenance Map**


**Legend**

▲ High Park trees needing maintenance

Data prepared: Adam Wright

Site Visit: Spring 2011

0 12.5 25 50 75 100 Meters

N

Figure 14 - Detail inspection map for hazard tree pilot

Staff in Urban Forestry work in collaboration with Parks staff to identify and remove the most extreme tree risks identified within the highest use areas of individual parks as part of a parkland tree risk management strategy. Urban Forestry will be finalizing a parkland tree risk management policy and procedures guide for staff use.

***Area Tree Maintenance***

Prior to 2009, maintenance of the city's urban forest had largely been done on a reactive basis whereby trees are maintained in response to requests by members of the public. Although the backlog (service delay) in performing required tree maintenance in this way has been significantly reduced over the last few years, the Urban Forestry branch has found that this type of complaint-based reactive service is not efficient and does not adequately meet public expectations. Reactive maintenance also reduces the opportunity to perform corrective pruning or other preventative maintenance activities, resulting in more frequent storm breaks and shortened tree life spans.

A proactive maintenance approach has been used by the Urban Forestry branch in selected areas of the city since 2009. It provides staff with geographic areas (city sub-grids) to systematically assess and maintain on a regular cycle. This approach has been shown to be more efficient, result in well maintained trees, reduce the risk of tree failure, reduce complaints, and improve customer service.

Although the proactive approach is known to be more effective and efficient, the resources needed to implement such a program on a city-wide basis are not currently available. As a result most tree maintenance is still done reactively with a significantly smaller portion of maintenance completed proactively.

## Integrating Technology in the Field and Office: Notebook Computers and GPS

Until recently, information from tree inspections was tracked on paper forms while in the field and later manually entered into the forestry work management database. Not only was this process inefficient but it created a delay in information transfer and introduced added opportunity for human error.

In 2009, the City's Urban Forestry branch started to deploy laptop computers to forestry field staff. Data is now collected on the job site and a wireless connection permits live updates to the forestry work management database. This has improved management efficiencies and eliminated the lag time between inspection completion and reporting and thus helped to improve customer service. In ongoing work, Urban Forestry is planning to add a spatial dimension to the current tree inventory and database to integrate with improved mapping technologies and tools as they become available.

**Figure 15 - Forestry data collectors using mobile technology for data entry on site.**

## 6.2.2 Tree Maintenance Requirements and Expectations: Solutions

Preliminary results from an analysis of the recently implemented Area Tree Maintenance Program confirm that there are cost efficiencies, as well as forest health benefits to be derived from a systematic approach to tree care and maintenance. Ongoing research about the benefits of maintaining green infrastructure in cities will also help inform decision making to assist Toronto in achieving its ambitious environmental and growth objectives.

Proactive tree maintenance and forest management must continue to be prioritized and advanced in order to ensure the health and sustainability of the urban forest today and into the future. While some requests for reactive maintenance will always be a reality because trees are living, changing entities and the extent of the resource in the City of Toronto is so vast, an overall proactive approach is considered the most effective and efficient approach and the best practice to which the City should be aspiring. A 5 to 10 year maintenance cycle is an acceptable industry standard for tree maintenance. As Urban Forestry transitions to full implementation of an area maintenance service, the number of service requests from the public will be reduced. This will result in a decreased number of site inspections and work backlog, allowing Urban Forestry to progressively meet resident expectations.

***Actions for Managing Tree Maintenance Requirements and Expectations:***

- continue to progressively implement city-wide proactive area tree maintenance, a program which is estimated to bring the average pruning cycle to approximately 7 years,
- continue implementation of the newly planted tree maintenance program to provide early and proactive maintenance to protect the City's tree planting investment and the potential benefits these trees bring to the community,

**Figure 16 - Urban Forestry staff at work.**

- reduce mortality in new street tree plantings by:
  - completing a detailed mortality survey of newly planted street trees with a goal to identifying key factors causing mortality,
  - reviewing and revising stock sourcing procedures to improve planting stock, and
  - reviewing and revising planting and early maintenance procedures to improve survival,
- reduce tree service delay for reactive maintenance from the current 6 to 9 months, to 3 to 6 months,
- develop and implement a parkland tree risk management policy and program city-wide, and
- improve public awareness of:
  - proper planting, watering, mulching and tree protection techniques, and
  - tree risk situations (e.g., under specified weather conditions, high traffic areas)

# 6.3 Balancing Urbanization Impacts and Sustaining the Urban Forest

## 6.3.1 Balancing Urbanization Impacts and Sustaining the Urban Forest: Current Practices and Challenges

The city of Toronto continues to grow and redevelop previously urbanized areas to their highest and best use. While this puts pressure on the City's treed resources (Table 5), land use intensification and achieving the city's tree canopy objectives should not be considered as necessarily conflicting or mutually exclusive. They can be successfully integrated through cooperation and coordination between property owners/developers and various City divisions (City Planning, Toronto Water, Transportation Services and Parks, Forestry and Recreation) to implement policies and practices that are supportive of tree canopy objectives.

Urbanization, even in an established major city, is continually progressing resulting in a variety of impacts on the urban forest.

**Table 5 - Examples of the ways urbanization can impact canopy cover and tree health**

| CONCERN | EFFECTS |
|---|---|
| **Forest Fragmentation** | 1. Increased development pressure results in fragmentation of suitable available habitat for tree growth, (resulting in fewer trees planted and those planted not able to reach their maximum potential size). |
| **Soil Quality and Volume** | 2. Increased density of development (resulting in less soil volume for root growth and less height/ width for crown spread). |
| | 3. Increased salt levels in soils as a result of de-icing roads with salt in winter months (causing dehydration in trees). |
| | 4. Increased soil pH as a result of lime based aggregate used for sidewalks, roads and paths. |
| | 5. Conflicts with utilities/infrastructure (resulting in less area for tree growth, poor conditions and stress for trees in close proximity). |
| **Air Quality** | 6. Increased particulates and volatile organic compounds near roads and development sites. |
| **Storm water** | 7. Stream channel erosion and erosion of stream valley slopes and forest soils caused by increased volume and intensity of run-off from increased urbanization. |
| | 8. Reduce the amount of surface water available for infiltration. |

***Tree By-laws***

The City of Toronto has various by-laws in place[39] to protect and preserve trees, as well as associated natural land features. These by-laws have been developed in response to a growing understanding of how trees are damaged, as well as an increasing awareness of the loss of benefits that result from tree damage.

These by-laws are implemented primarily within an education/compliance model, rather than a regulatory/ enforcement model. This means that Urban Forestry and other City staff, together with the private tree care industry, use these by-laws primarily as opportunities to advise homeowners, developers, and builders on how best to protect trees and natural areas. This has resulted in the preservation of trees that may otherwise have been injured or destroyed. Where preservation is not possible, the by-laws require replacement planting, ensuring the maintenance of canopy cover along with its many benefits.

[39] http://www.toronto.ca/trees/bylaws_policies.htm.

The Urban Forestry branch will continue to collaborate with City Planning on the merits of using satellite imagery in monitoring land cover change to better understand the implications of city growth on various land use types and neighbourhoods. Land cover classification mapping at regular intervals will provide Urban Forestry and City Planning with an essential tool for reviewing changes to the urban forest and integrating growth strategies.

### *City's Existing Canopy Cover*

The overall target for city-wide canopy coverage for Toronto is 40%. Urban foresters recommend tree cover for urban areas of between 30% and 40%, to maximize the social, economic and ecological benefits derived from trees. The range (rather than a fixed number) is appropriate because urban forests are dynamic systems composed of a diversity of tree species that will naturally go through periods of growth and decline and also respond differentially to stressors such as pest infestation. As a result, the percent of canopy cover will fluctuate.

Tools for assessing canopy cover have been evolving very rapidly over the past few years and in Toronto three different methods and sources of imagery were used to try and get the most accurate value ((1) leaf-off aerial imagery random point sampling, (2) leaf-on aerial imagery random point sampling and (3) city-wide land cover classifications developed from leaf-on satellite imagery). More details are provided in *Every Tree Counts*[40], but the bottom line is that the results ranged from 19.9% to 28% tree canopy cover, depending on the method used. In *Every Tree Counts*, the most conservative value of 19.9% canopy cover was chosen as the baseline measure of tree canopy cover for the city against which progress could be measured in the future.

**Palmerston Avenue 1908 (left) and 2002 (right)**

Through this exercise Urban Forestry staff gained a better understanding of the advantages and disadvantages associated with the different methods of estimating tree canopy. The different methods of estimating tree canopy have been compared and Urban Forestry has concluded that leaf-on satellite imagery will be utilized to develop city-wide land cover classification on a go forward basis to analyze long term trends in canopy change within the city. Using leaf-on satellite imagery with sufficient resolution to allow accurate land cover classifications is the emerging standard set by municipalities in the GTA that have completed urban forest canopy studies. Adopting this methodology in Toronto allows for regional comparisons and regional collaboration towards canopy expansion. The baseline tree canopy cover for Toronto is 28% using this methodology.

[40] *Every Tree Counts: A Portrait of Toronto's Urban Forest,* 2010. Appendix 4: Methodologies for Estimating Canopy Cover.

Expressed as a range, tree canopy cover for the City of Toronto is 26.6% to 28%. This estimation is based on analysis of leaf-on aerial and satellite imagery.

The tree canopy expansion goal of reaching 40% canopy coverage is achievable but over the term of this strategic plan canopy expansion will be delayed. Resources for planting are not anticipated to be progressively increased to respond to the 8.4% tree population mortality anticipated due to the impact of EAB. It is expected that nursery stock and contracted tree planting services will be in limited supply, resulting in a longer period of time to achieve canopy replacement. Funding for EAB related planting must also increase to achieve replacement targets, (see Appendix 2).

***Working Towards the City's Canopy Cover Targets***

While the desktop analyses are very useful for planning purposes, they do not address the challenges of successfully establishing trees in urbanized environments on the ground. Efforts to grow trees along city streets as well as in new subdivisions can be hampered by the severely altered soils following site development. The expanding areas of development limit permeability and soil moisture available for tree growth. Site preparation generally involves the complete removal of remaining natural topsoil profiles. The typical result is site conditions that may limit the growth of large-stature trees and many sensitive native species that support biodiversity in the city.

**Figure 17 - Example of large scale removal of natural soil during site development**

In addition to protecting as many of the trees and forested areas that occur within the city as possible, replacing trees removed through development, as well as trees removed as a result of disease, injury or condition is also critical for sustaining the urban forest. In an urbanized setting, extensive efforts must be made to (a) utilize available planting spaces, and (b) improve planting conditions in order to provide newly planted trees with the elements required to support mature growth (i.e., quality soil, water, oxygen and room to grow) both above grade and below.

**Figure 18 - Parkland naturalization**

A consideration in natural areas is that invasive tree species, such as Norway maple or Manitoba maple (*Acer negundo*), are likely naturally regenerating (and contributing to canopy cover) more rapidly than some of the native plantings. To improve the long term sustainability and quality of the urban forest, as well as to preserve the ecological functions associated with natural areas, continued management of invasive species, including replacement plantings, is required.

Many areas of the city's landscape are covered with hard, impermeable surfaces, reducing opportunities

and presenting challenges for tree planting. For planting in hard surfaces to be successful, the design must provide:

- a sufficient volume of un-compacted, good quality soil for each tree (the quantity of soil that is considered sufficient is the amount required to grow a 40 cm diameter, large canopy shade tree)[41]. The scientific data available on the relationship between tree size and soil volume indicates that 30 cubic meters of soil is required to support growth of a large canopied tree,
- a method of supporting the sidewalk that does not result in compacting the soil,
- easy access for maintaining or installing a new utility service, and
- a method of repairing the sidewalk while restoring the uncompacted soil conditions

Figure 19 - Street tree planting

There are three design solutions that the City of Toronto is currently employing to address these design requirements: (1) open planting beds, (2) continuous soil trenches with reinforced concrete panels, and (3) continuous soil trenches with soil cells. A general description of each illustrated with an example from a recent project in the city is provided below.

***(1) Open Planting Beds***

The easiest, most cost effective way of providing good growing conditions for trees is to plant them in open planting areas. Unfortunately, there is usually too little space within a typical city sidewalk to provide all the soil required to successfully grow a mature tree using an open planting bed. However, an open planting bed can be used in conjunction with either of the designs described below and is feasible for very wide sidewalk areas (Figure 20). A shared solution whereby the tree is planted within a smaller planting area within the public right of way but has access to additional soil volume located on private property can also work. This requires an agreement between the City and the adjacent property owner to create a solution that is mutually beneficial.


Figure 20 - Open planting beds on Bloor Street east of Avenue Road

***(2) Continuous Soil Trenches with Reinforced Concrete Panels***

To construct a sidewalk that provides a safe and reliable walking surface capable of supporting snow removal equipment, while still maintaining uncompacted soil below, requires structural engineering solutions. This approach involves constructing a trench filled with good quality, uncompacted soil that is spanned with a reinforced concrete slab which rests on footings on either side of the trench (Figure 21).

[41] A 40 cm diameter tree provides some of the many benefits that trees can contribute to the urban environment

Figure 21 - Roncesvalles Boulevard during sidewalk reconstruction and after

This design allows for an air-space under the concrete. This continuous soil trench allows trees planted along its length to share soil volume and for the tree roots to intersect with each other, as trees tend to do in a forest or a park setting.

Because the reinforced slab spanning the 2 metre wide soil trench is made of precast concrete, it is possible to remove and restore individual concrete panels in the event that access is required for the installation or repair of a utility. It also allows for the replacement of soil in the trench as well as the sidewalk surface, potentially eliminating the need for temporary asphalt patches to accommodate a utility installation or repair.

Figure 22 - Soil Cells. Queensway pilot project in collaboration with Toronto Water. Water from road and sidewalk diverted to soil cells from storm sewer and analyzed for quality.

### *(3) Continuous Soil Trenches with Soil Cells*

A soil cell is the generic term used for products made of a strong plastic with voids or spaces that can be filled with soil. Soil cells support the sidewalk so that good quality un-compacted soil can be used. The individual soil cell units are easy to handle and can be vertically stacked and arranged horizontally to create an area of good quality soil below hard surfaces such as sidewalks (Figure 22). The cells collectively make a structural matrix filled with soil that is strong enough to support vehicles. The finished surface over the soil cells can be concrete, unit pavers or asphalt.

The City has undertaken a multi-divisional project that details best practices for urban redevelopment

of streets to enable optimal tree growth. A final report on the project is anticipated to be released in 2013.

The Urban Forestry branch is working with City Planning and other City divisions to assess and monitor the effects of development policies and infrastructure projects on the tree canopy, as well as the success of trees installed using these new technologies.

### 6.3.2 Balancing Urbanization Impacts and Sustaining the Urban Forest: Solutions

City growth and urban forest canopy expansion are not mutually exclusive. Continued progress in planning and a supportive regulatory framework are absolutely critical for supporting the city's natural heritage resources, including the urban forest. This includes:

- protecting the existing urban forest through appropriate policies and by-laws,
- identifying canopy expansion areas,
- collaborating with a wide range of appropriate parties to ensure trees are planted in those areas wherever possible,
- working towards targets for tree planting that will result in canopy expansion rather than maintenance of the existing canopy coverage, and
- maintaining (or in some cases recreating) healthy soils and site conditions that can support large-stature tree growth in the urban environment

As noted above, one of the fundamental aspects of increasing tree canopy cover across the city is the protection of existing resources. Currently, this is being accomplished through implementation of various tree and natural feature protection policies and by-laws. The by-laws in particular serve as opportunities to educate the public on the benefits and importance of trees within an urban setting.

City Planning and Urban Forestry staff continue to consult on establishing canopy targets based on land use. Currently there are significant differences in tree cover, tree sizes and tree species between land use types which can be minimized with collaborative planning. The Urban Forestry branch also continues to work on identifying opportunities for replacing (as needed) and enhancing the current canopy cover. These initiatives need to be continued.

Sustaining canopy and maximizing expansion will involve planting trees not only by the City and its many tree planting partners, but by private property owners as well. The responsibility for achieving canopy goals is a collective goal to be understood and implemented by private landowners as well as other public land owners in combination with the City. Public lands (including TRCA lands, institutional lands, provincial lands and school boards, as well as City owned lands) account for less than half of the land area in the city and not all of this land area is suitable for planting as some of it comprises hard surfaces (e.g., roadways, buildings).

It is estimated that between 57,000 to 114,000 trees need to be planted annually on publicly owned land (with an equivalent number planted on private land), to achieve about a 10% increase in canopy cover over the next several decades (see Appendix 2). This number includes large shrubs as well as trees. Large shrubs are included in the urban forest canopy and natural cover within Toronto and are particularly relevant for natural slope stability and habitat for birds and other wildlife. The Urban Forestry branch will continue to monitor the progress of planting achievements through a combination of measurements taken annually, including planting numbers and area planted.

Parks, Forestry and Recreation will also be continuing ongoing management in many natural areas to

increase biodiversity and improve slope stability by removing invasive non-native species (Figure 23). Areas prioritized for management include those identified by City Planning as Environmentally Significant Areas or potential Environmentally Significant Areas.

The Urban Forestry branch may also shift from natural area plantings to more road allowance and parkland plantings with larger stock sizes in smaller numbers over the next several years as part of the EAB tree replacement strategy to try and offset some of the canopy cover losses related to this pest.

Additionally, as trees require access to adequate amounts of quality soil to support mature growth, Urban Forestry will collaborate with others on opportunities for developing policy related to soil conservation on development sites.

### *Slope Enhancements Support Storm Water Management, Water Quality, and Biodiversity*

Across the City of Toronto, storm water run-off travels down steep ravine slopes to water courses. The storm water can cause significant soil erosion over time and steepen these slopes. This is most prominent in areas where native vegetation has been eliminated and understory trees, shrubs, herbs and grasses no longer exist as a result of competition with invasive, non-native species such as Norway maple.

Management of these slopes involves removing the invasive trees and allowing any suppressed native trees the opportunity to flourish. Tree removal is also followed by planting a dense combination of native, large-growing tree species, understory trees, shrubs and ground level grasses and herbs. The resulting slope has more biodiversity and functions as an anchor for existing soils.

As a result, the biodiversity of the ravine itself is improved (thereby providing habitat for a wider range of species), and the water quality in the nearby water course is improved due to a reduction in sediments from erosion (thereby protecting the habitat for fish and other aquatic fauna). This type of restoration also helps proactively resolve the need for expensive structural solutions which are typically required when slopes are eroded to the point where they can no longer support vegetation, and contributes to effective storm water management in the city.

**Figure 23 - Kimbark Coldstream ravine slope prior to restoration works in fall 2005 (left), and following restoration works in spring 2011 (right).**

***Actions for Balancing Urbanization Impacts and Sustaining the Urban Forest:***

- increase compliance with tree protection requirements through interaction with the development industry and enhanced monitoring of tree by-law applications,
- improve tree by-law effectiveness by tracking and measuring key performance indicators, to inform by-law and implementation improvements,
- work with the relevant City divisions to complete a review of land use, planning and zoning policies to identify regulatory constraints to achieving canopy expansion and a sustainable urban forest,
- utilize all available tree planting locations and where possible strive to improve planting conditions, providing adequate soil, water and oxygen to support mature growth,
- develop mapping systems that:
  - support planting activities
  - ensure the currency of data recording
  - facilitate effective communication of information to stakeholders,
- assess the state of the forest every 10 years through analysis of leaf-on satellite imagery and field sampling to:
  - verify the urban forest species composition
  - verify the urban forest size composition
  - monitor change in overall city canopy coverage,
- undertake strategic planting prioritized in the areas of most need, as follows:
  - residential boulevards where trees have been removed
  - public lands outside of planned infrastructure work areas and within priority storm water management areas identified by Toronto Water
  - parkland and on streets in neighbourhoods where the canopy is significantly lower than the city average
  - where ash trees occur in relatively high concentrations
  - areas of high heat vulnerability (as identified by Toronto Public Health)[42],
- collaborate with City divisions and agencies (e.g., TRCA) on opportunities for developing policy related to soil conservation on development sites,
- continue to collaborate with Toronto Water and Transportation Services to identify strategic planting areas that:
  - increase storm water management (by providing water uptake by trees)
  - shade streets and bikeways
  - reduce erosion and improve the stability of ravine slopes through naturalization,
- use land cover data in cooperation with City Planning, TRCA and other agencies to assess impacts on canopy goals by:
  - tracking land use and forest cover change city-wide
  - monitoring change in canopy by land use, watershed or neighbourhood,
- centralize tree planting functions and pilot new models for planting services in residential areas, assessing a variety of stock types,
- market the City's free residential tree planting program for front yards,
- cultivate new relationships with green community organizations with a focus on realizing canopy targets in communities and neighbourhoods, and
- design and implement a pilot study in cooperation with Urban Design, Business Improvement Areas and private businesses to increase tree cover in selected commercial and industrial areas

[42] http://www.toronto.ca/legdocs/mmis/2011/hl/bgrd/backgroundfile-39469.pdf

# 6.4 Climate Change Impacts

## 6.4.1 Climate Change Impacts: Current Practices and Challenges

According to Natural Resources Canada, climate change is expected to have some of the following impacts in the coming decades[43].

- warmer winter temperatures and longer growing seasons,
- changes in the quantities and seasonal timing of precipitation,
- increased frequency and severity of storm events, including increased wind velocity, and
- more extreme weather events such as droughts and heavy rainfall

The Toronto Environment Office recently commissioned a study (Toronto's Future Weather and Climate Driver Study)[44] to support the City's climate change policies. In addition, improving the level of understanding and certainty about climate related weather changes will help to guide the City's decisions with respect to investment in infrastructure and service provision. Among other things, the study was aimed at providing the City of Toronto with a better understanding of what drives Toronto's current weather and climate and what weather and climate can be expected in the future.

The study went beyond existing global and regional climate models and used a new, innovative approach to understanding localized climate and weather. The result is a model that is capable of operating at fine spatial resolution and allows climate and weather projections to be established for small areas within Toronto. The model also provides new information about such things as the future "extremes" of weather rather than the future "means" of climate. Some of the changes Toronto is predicted to experience in the time period 2040-2049 include:

- marked rainfall increases in July (80%) and August (50%)
- extreme rainstorm events will be fewer in number but more extreme
- average annual temperatures increase by 4.4°C
- the projected average winter temperature increase by 5.7°C
- the projected average summer temperature increases by 3.8°C

Although the exact nature of the impacts of climate change on Toronto's urban forest are not known, certain management implications and related effects on required resources can be anticipated. These include the following:

- increased operating resources (or dedicated reserve funds) to deal with extreme weather events and storm response,
- expanded forest health care monitoring and control programs in response to a greater diversity of and more persistent pests,
- increased need for watering and maintenance of drought-stressed and heat-stressed trees, and
- expanded education and emergency planning

Maintaining a diverse and resilient urban forest, as well as the management flexibility to respond quickly to change, are key elements in being able to adapt to the anticipated impacts of climate change.

Decision-makers at all levels of government, locally and around the globe are increasingly recognizing that cities are highly vulnerable to climate change and that it is time to put adaptive measures in place

[43] Climate Change Impacts and Adaptations: A Canadian Perspective. Natural Resources Canada. http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca.earth-sciences/files/pdf/perspective/pdf/report_e.pdf

[44] Toronto's Future Climate: Study Outcomes. http://www.toronto.ca/legdocs/mmis/2012/pe/bgrd/backgroundfile-51552.pdf

### *Identifying Planting Priorities in Relation to Heat Vulnerability*

As part of the canopy cover analyses completed for the City, land cover classes for forest canopy, such as turf and bare soil were extracted from the satellite image and can be used as GIS layers to locate planting priorities where turf and bare soil exist in parklands that have high heat vulnerability. In the example (Figure 24), the pink areas indicate where high heat vulnerability exists, square hatching indicates residential land use and the turf and tree canopy are visible under the transparent heat vulnerability layer. This information is being shared with partner organizations and is being used by the City to encourage tree planting and retention on private property. Similar maps will be created for parklands to prioritize planting in areas that have been identified as having highest heat vulnerability.

**Figure 24 - Detailed view of high heat vulnerability mapping with forest canopy, residential land use (light blue square hatching) and priority neighbourhood area (diagonal stripe)**

including rethinking urban design and the enhanced role the urban forest and green spaces play in reducing the impacts of climate change. Urban forests are extremely valuable in this regard because they both mitigate some of the impacts of climate change (i.e., through carbon sequestration and storage) and support human adaptation to it (e.g., provision of shade, temperature moderation). The cooling, air pollution reduction, and storm water management control functions that the urban forest provides all contribute to making Toronto a healthier, more livable city. These functions have an even more pronounced role in the context of climate change.

Examples of City initiatives that make connections between sustaining and enhancing the city's urban forest and addressing impacts related to climate change include:

- *Toronto's Green Standard*[45] and the *Toronto Green Roofs* initiative[46], which will help to reduce urban heat island effects and promote vegetated (rather than paved) surfacing, tree canopy, and soil preservation, and
- the Toronto Public Health initiated *Shade Guidelines Summary* and the *Shade Guidelines Supplement* which promote health in the context of climate adaptation[47]

An example of an adaptive strategy that has multiple benefits for the city is the redirection of storm water runoff for use in watering trees. The Queensway Sustainable Sidewalk Study, which was implemented in 2009, highlights this type of innovative application for irrigation through filtered storm water. Trees were planted within a continuous soil trench which used soil cells to maximize soil volume. Prior to storm water uptake by tree roots a majority of the larger and smaller solids and contaminants are removed through catch basin and weeping tile distribution pipes. The soil and microscopic organisms filter out even smaller

[45] http://www.toronto.ca/planning/environment/index.htm

[46] http://www.toronto.ca/greenroofs/index.htm

[47] http://www.toronto.ca/health/resources/tcpc/pdf/guidelines_supplement.pdf; http://www.toronto.ca/health/resources/tcpc/pdf/guidelinessummary.pdf

solids and contaminants. Benefits include improved water quality and reductions in velocity and volume of storm water reaching streams during storms. Monitoring to assess the benefits of this design is ongoing.

## 6.4.2 Climate Change Impacts: Solutions

Solutions to mitigate climate change involve all levels of government (i.e., municipal, provincial and federal) as well as other stakeholders and special interest groups. For example, the Green Infrastructure Ontario Coalition recently released a report which advocates using green infrastructure for its many benefits including energy savings[48].

The Urban Forestry branch is collaborating on climate change solutions as they relate to the urban forest and needs to continue to do so as the nature and extent of the impacts become more apparent. While many of the other actions in this Plan align well with climate change mitigation and adaptation, the Urban Forestry branch must ensure that these actions explicitly consider the anticipated effects of climate change in identifying appropriate measures to increase the resiliency of the urban forest and are revised in response to new information as it becomes available.

For trees outside of natural areas, generally recommended species diversity targets are to have no more than 5% of Toronto's trees of one species, no more than 10% one genus and no more than 20% one family. The intent of this target is to increase the urban forest's resilience to stressors such as species or genus-specific pests, as well as climate change that may affect some species more than others. A number of the actions related to climate change will be working towards achieving this target.

***Actions for Addressing Climate Change Impacts:***

- continue to work with other agencies (e.g., TRCA, Natural Resources Canada, OMNR) to highlight and address information gaps with respect to urban forests and climate change (e.g., tree species response to climate change in the urban environment) by:
  - monitoring species composition over time (through the urban forestry database system and i-Tree Eco permanent sample plots)
  - evaluating planting success by species in different settings (e.g., naturalization areas, parks and streets)
  - adapting species mix based on diversity criteria and planting success (as per the monitoring plan)
  - using monitoring data to refine species planting lists
  - pursuing partnerships with research institutions or other organizations to refine planting lists with a focus on climate change adaptation,
- promote new standards for tree planting in hard landscapes that accommodate adequate soil volume and moisture retention, mature tree growth and facilitate required utility access,
- continue to refine watering programs as needed to respond to prolonged droughts that are anticipated in future,
- continue to increase and adapt tree species planting lists to include more species, particularly those that have demonstrated urban resilience to extreme conditions and native species from slightly warmer climates, and
- develop a database with mapping of large, robust populations of native species for seed collection and continued biodiversity

[48] http://www.greeninfrastructureontario.org/sites/greeninfrastructureontario.org/files/Health,%20Prosperity%20and%20Sustainbility_The%20Case%20for%20Green%20Infrastructure%20in%20Ontario_printable%20version.pdf

A number of the actions in the preceding section under “Balancing Urbanization Impacts and Sustaining the Urban Forest” also directly address climate change, particularly those that speak to species diversity selection and monitoring, as well as focused plantings in identified urban heat island areas.

### *Tree Seed Diversity Project*

Currently, much of the tree planting stock available in Toronto consists of commercial cultivars or clones, which when overused reduce the genetic diversity and long-term health of the urban forest. As cloned trees are genetically identical, stands of clones are highly vulnerable to threats from insects and disease. In addition, the selection of clones from the same climate zone further increases vulnerability. Recognizing this, Trees Ontario and the Urban Forestry branch developed an innovative pilot project whereby locally adapted seeds of native species are propagated and the young trees are used in tree planting projects to increase the genetic diversity of the urban forest. The program has planted a total of 1,300 trees over the past three years.

Specific Project Goals:

- increase the genetic diversity of native trees planted in Toronto’s natural areas,
- produce 1,500 seedlings annually from seed collected from healthy native trees in Toronto’s parks and ravines, and
- expand the seed bank for Toronto’s native species to help ensure that seed will be available in poor seed years (as per natural cycles of good seed crops)

Partnership Agencies:

Toronto Hydro, City of Toronto Urban Forestry, Trees Ontario, the Forest Gene Conservation Association, and OMNR

**Figure 25 - Urban Forestry crews planting trees grown from seed sourced from natural areas in Toronto**

## 6.5 Recreational Pressures on the Urban Forest

### 6.5.1 Recreational Pressures on the Urban Forest: Current Practices and Challenges

Within urban areas, public parks and green spaces provide an important refuge from the busy built environment. Vegetated areas and in particular treed areas are shown to contribute to the improved physical and mental health of city residents (see Section 1 of this Plan). Toronto's ravines and natural heritage system are exceptional compared to many large cities, as many of these green spaces continue to support a diversity of wildlife and native plant species. However, increasing pressures on the city's natural areas have degraded the natural environment, including many of the treed natural areas. It is expected that uncontrolled recreational uses in these areas will continue to be a serious and widespread issue as the city's population increases.

The City plays a key role in protecting urban natural areas. The effects of sustained and intensive use of natural areas in urban centres include:

- soil compaction from repeated foot traffic,
- trampling of ground cover species and tree saplings (resulting in a loss of vegetation and forest structure),
- disturbance to wildlife (particularly in the breeding season), and
- the introduction and increased dispersal of invasive species

Examples of the soil compaction and trampling effects can be seen in many local ravine areas (Figure 26), where sustained human and pet traffic on steep ravine slopes has led to high levels of erosion and habitat disturbance.

**Figure 26 - Glen Stewart Ravine with impacts from intensive use on unsanctioned paths**

Invasive species also pose a significant threat to the native biodiversity of Toronto and many parts of southern Ontario. Examples of significant losses to native forest diversity as a result of introduced pest species include:

- the loss of American chestnut (*Catanea dentata*) to Chestnut Blight (*Cryphonectria parasitica*),
- the loss of American elm to Dutch Elm Disease (*Ophiostoma ulmi*), and
- the imminent loss of ash species to EAB

The sustainability of the city's forested natural areas is under threat as a result of invasive plants. On the forest floor, garlic mustard (*Alliaria petiolata*), dog strangling vine (*Vincetoxicum rossicum*) and European buckthorn (*Rhamnus cathartica*) continue to displace the native flora in Toronto's forested areas. The recent *Every Tree Counts* report indicated that approximately 22% of the total leaf area of shrub species in Toronto is accounted for by invasive species. Invasive species spread aggressively and can out number native plant species, impacting a wide range of ecological functions in the natural areas in which they occur.

Urban Forestry staff works with agencies such as TRCA, OMNR and other City divisions such as City Planning to implement habitat restoration and improvement projects in natural areas throughout the city. Ideally, every natural area should receive regular management intervention. However, budgets are limited and resources are allocated based on known priorities and threats. Locations for rare species (identified and mapped through work undertaken by the City, TRCA, or OMNR) are used to help screen the most important areas for continued management. For example, High Park is identified as an ecologically significant area and requires intensive management to maintain the existing complement of rare species[49]. Crothers Woods, Earl Bales Park, Glen Stewart Ravine, Marie Curtis Park, Milne Hollow, Sherwood Park and Taylor Creek Park are examples of other areas where restoration management plans provide guidance for restoration of the forest, enhancement of infrastructure for recreational uses, and protection of the forest resources.

Some of the challenges inherent to efforts to minimize or prevent degradation of parks and natural areas include:

- lack of public awareness of the sensitivity of these areas,
- limited opportunities for public recreation in some areas of the city, leading to misuse and overuse of certain parks, and
- insufficient recreation/trail infrastructure to direct activity appropriately outside of sensitive sites

## 6.5.2 Recreational Pressures on the Urban Forest: Solutions

Recreational impacts on the urban forest are a direct result of misuse or overuse of the city's forested natural areas. Therefore, the primary solution lies in expanding outreach to the natural area users and engaging them in proper stewardship of these areas. The other important part of this solution is implementing management strategies to prevent, minimize and mitigate the various stressors.

Urban Forestry staff are currently involved in the stewardship of many ecologically sensitive sites across the approximately 4,000 ha of City managed natural heritage lands. Efforts are focused on:

- maximizing habitat connectivity,
- supporting and encouraging native biodiversity, and
- working with stewardship groups and other City divisions to undertake various restoration and naturalization activities

[49] http://www.toronto.ca/trees/pdfs/HighParkMgmtPlan.pdf

Staff work with stewardship groups at key restoration sites and with contractors to complete invasive tree management projects. In addition, Urban Forestry staff who administer the *Ravine and Natural Feature Protection By-law* work closely with property owners to ensure that the ravine and natural heritage system has net gains regarding ecosystem management wherever possible – this often includes enhancement plantings.

### *Design Solutions for Improving Resource Protection and Increasing Accessibility*

Toronto's ravine and natural area system is increasingly required to support recreational uses as the city's population grows and more people choose to spend time in proximity to nature. This benefit, however, places added pressure on sensitive areas which, by their very nature, have limited carrying capacities and are vulnerable to the effects of overuse. One way to respond to the demand for increasing use and access is through design solutions that minimize user impacts and direct users away from the most sensitive portions of a site.

Implemented in 2012, the Glen Stewart Ravine project provided a boardwalk for more inclusive access for pedestrians over a ground water seepage area, while enabling unimpeded flow of water between the seepage area and the groundwater-fed Ames Creek. The railings encourage users to remain on the boardwalk, thus minimizing impacts on the sensitive vegetation. The boardwalk helps improve water quality, minimize soil erosion, and enhance user access and safety, while still protecting sensitive vegetation. Cedar post and paddle fencing also keep users on the main path system, protecting sensitive slopes that have highly erodible sandy soils.

**Figure 27 - Glen Stewart Ravine boardwalk and staircase designed to limit user impacts on seepage area and sandy slopes.**

***Actions for Managing Recreational Pressures on the Urban Forest:***

- develop policies aimed at restricting inappropriate land uses and preventing further habitat fragmentation in significant natural areas,
- collaborate with the Parks branch and TRCA to create a natural environment framework that identifies, selects and prioritizes natural area management sites, with a focus on improving habitat size and shape, use of native species, and improving linkages between habitats,
- explore options for securing strategic land acquisitions with a view to improve key linkages between parkland sites and protect natural areas from future development,

- continue to develop and implement projects to mitigate invasive species and recreational impacts in cooperation with partner agencies in consideration of these key actions:
  - selecting native species for planting using locally propagated trees and shrubs from native seeds collected within Toronto parkland, (e.g., expanding Tree Seed Diversity Project)
  - protecting and managing natural areas through the strategic placement of trail systems, design solutions for resource protection and by-law enforcement
  - continuing to work internally and in cooperation with other agencies to ensure species selection is consistent with the species diversity targets for Toronto
  - eliminating existing invasive plants utilizing a combination of manual or chemical control methods,
- use Environmentally Significant Area mapping:
  - to prioritize management of natural areas based on levels of risk/threats
  - as a basis for future mapping updates (in coordination with City Planning and TRCA),
- continue engagement of the public through programs supporting private land and garden naturalization and education by Tree Protection and Plan Review staff,
- maintain existing stewardship programs (in particular invasive plant management) to support investments in past restoration projects on flagship and other sites. Expand stewardship and work with the Parks branch to enable more volunteer stewardship in public natural areas

## 6.6 Increasing Public Awareness of the Value and Sensitivity of the Urban Forest

### 6.6.1 Increasing Public Awareness of the Value and Sensitivity of the Urban Forest: Selected Current Practices and Challenges

***Increasing Awareness***

One of the greatest challenges for urban forest managers in Toronto to date has been communicating the value of trees as public assets to not only the public, but to policy and decision-makers in the City as well. In part, this has to do with the historic lack of tools to evaluate and assign value to trees in the urban landscape.

In Ontario and across Canada, forest resources are widely recognized as having immense commercial value as lumber, pulp, value-added products like furniture and more recently, biofuels. Historically, forests have been a significant part of what drives the resource-based economy of this country and in many parts of the country forests continue to provide an important source of income today. However, the substantial value of a mature, living tree is often overlooked. Many people do not recognize the significant dollar value of the services provided by a mature tree, or the more intangible values related to trees such as aesthetics, recreation, shade, and community health (as described in Section 1 of this Plan). Different cultural perspectives on trees as either liabilities or assets also influences how much they are valued.

Initiatives being undertaken to expand the current levels of awareness include information posted on the City's website, various public outreach and education events (such as the Colonel Sam Smith Spring Bird Festival), and various tours, talks and workshops for schools and community groups. The Urban Forestry web site and publications are continually improving by providing the public and decision-makers with better information about forest values and the community benefits they provide. Various stewardship initiatives, described below, also play an important part in increasing awareness.

### *Increasing Stewardship*

Toronto has by-laws to protect the existing forest resources on City and private property. However, the extent to which the City can influence maintenance and replacement of trees on private property is limited. At the same time, residential areas present some of the greatest areas of opportunity for maintaining and expanding the city's tree canopy because of the extent of yard space. Industrial areas, by comparison, tend to be more extensively paved.

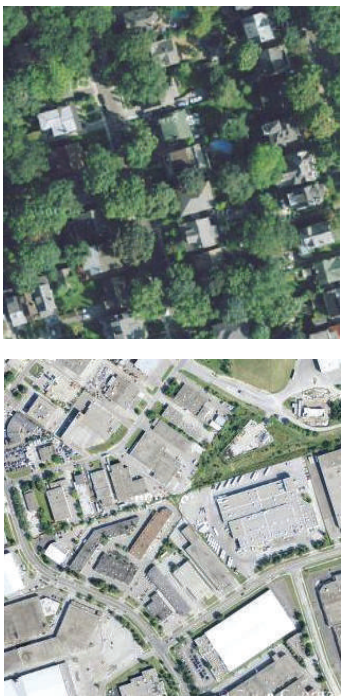


**Figure 28 - Aerial view of different canopy cover in different land uses: residential (top) and industrial (bottom)**

The benefits of trees in commercial areas are also well-documented (see Section 1 of this Plan). Recognizing the value of a welcoming urban streetscape, some Toronto Business Improvement Areas (BIAs) have successfully partnered with the City to improve commercial business areas. Additional opportunities for improving the growing environment in commercial areas may arise during the course of infrastructure renewal projects and improved coordination has begun between City divisions, BIAs and the Urban Forestry branch to take advantage of these opportunities as they arise.

The Urban Forestry branch is tasked with meeting the increasing demand within the city for public outreach and stewardship related to urban forestry issues. This is typically done through two program streams: (1) the Parkland Naturalization Program and (2) the Community Stewardship Program. Both programs operate on public land, typically throughout Toronto's ravine and natural environment parks.

#### *(1)The Parkland Naturalization Program*

The Parkland Naturalization Program implements various restoration projects with the engagement of volunteers and other partners. The signature event of this program is Trees Across Toronto, an annual volunteer tree planting event held in the early spring. This large-scale event is supported by Parks, Forestry & Recreation and other divisions including Social Development, Finance & Administration (Communications), and the City Clerk's Office. Thousands of native trees and shrubs are planted at multiple sites across Toronto at this one event through the assistance of volunteers and with the financial support of various corporate partners.

#### *(2) The Community Stewardship Program*

The Community Stewardship Program engages volunteers through meaningful and on-going maintenance, monitoring and restoration activities at identified sites. Activities include invasive plant removal, watering planted vegetation, collecting litter, planting native vegetation, putting up and maintaining bird boxes, creating habitat brush bundles and monitoring specific conditions of the site.

The purpose of the Community Stewardship Program is to involve the community in the long-term stewardship of naturalization sites throughout the city and to support these sites in becoming functional ecosystems within the natural environment parklands system. This program plays an important part in educating the community about the natural environment while also training them in proper restoration techniques. A knowledgeable, skilled base of volunteers is invaluable, as they are capable of maintaining sites independently by using best management practices.

The main objectives of the program are to:

- provide meaningful educational opportunities to community volunteers
- promote the importance of restoration and naturalization
- restore native plant communities
- manage invasive plants
- enhance habitat features
- monitor vegetation and wildlife

The work completed through the program has contributed to improved natural habitat and enhanced the ecological value of the City's natural environment parklands. It also uses an effective and innovative feedback system, so that the program can continue to grow and strengthen. Annual feedback shows great dedication and satisfaction with involvement in the program and most importantly high volunteer retention. Since 2008, the program has also made gains in engaging the diverse cultural communities of Toronto.

Best practice examples of other stewardship initiatives currently in place in the city are highlighted in the following text boxes.

### *Crothers Woods Trail Management Strategy*

An informal network of trails was created over several decades of use in Crothers Woods, a 52 hectare ecologically significant mature maple-beech-oak woodland located in the Don River Valley. Unfortunately, most of the Crothers Woods trails were never planned and as a result were unsustainable and were degrading the environment[50].

**Figure 29 - Crothers Woods Trail**

In response, Urban Forestry developed and implemented the innovative Crothers Woods Trail Management Strategy in cooperation and consultation with trail users and stakeholders. The Strategy brings together trail enthusiasts and land managers in an effort to develop an integrated, responsive plan that addresses the recreational needs of users and protects the natural features in this ecologically sensitive area. Interactive mapping and a brochure is available at the Crothers Woods website http://www.toronto.ca/parks/projects/crothers.htm.

The lessons learned and partnerships developed from experiences in Crothers Woods will soon be applied throughout the city with the development of a city-wide *Natural Environment Trail Management Strategy* in 2012. The strategy will identify the opportunities, constraints, planning, policies and management principles required to balance the protection of the City of Toronto's natural areas with provision of safe and enjoyable recreational opportunities for all.

[50] http://www.toronto.ca/trees/pdfs/CrothersWoodsTrailManagementStrategy.pdf

### *Regeneration of Sensitive Habitats Using Prescribed Burns in High Park*

Urban Forestry undertakes a series of "prescribed" burns in the black oak savannah of High Park each year there are favourable conditions for doing so. A prescribed burn is a deliberately set and carefully controlled fire that burns low to the ground and consumes dried leaves, small twigs and grass stems but does not harm larger trees.

Black oak savannahs, a habitat at risk of extinction throughout North America, are dependent on fires to control competing vegetation, enrich the soil and promote growth and germination of rare species[51]. Urban Forestry started this restoration technique in 1997, following the recommendations of a 1992 report that confirmed the black oak trees in Toronto were approaching 200 years of age without signs of successful regeneration. Prescribed burning was proposed as a possible solution to encourage oak regeneration and to re-establish the prairie grasses and herbaceous plants that should be part of the black oak woodland plant community. Since the first test plot burns in 1997 and 1998, nine controlled burns have been successfully completed.

Prescribed burn management, in combination with native species planting and invasive species management, has produced tremendous results. Oak regeneration has increased and populations of prairie grasses and wildflowers have expanded. For more information and answers to commonly asked questions please see http://www.toronto.ca/trees/pdfs/Prescribed_Burn_Fact_Sheet_5.pdf

**Figure 30 - High Park black oak savannah management – prescribed burn**

## 6.6.2 Increasing Public Awareness of the Value and Sensitivity of the Urban Forest: Solutions

There are already a number of urban forestry initiatives and programs underway for improving awareness and stewardship of the urban forest, as described above. These programs need to be continued and, in some cases, improved and expanded.

[51] http://www.toronto.ca/trees/pdfs/HighParkMgmtPlan.pdf

***Actions for Increasing Public Awareness of the Value and Sensitivity of the Urban Forest:***

- increase public education regarding natural area management activities, trail systems and appropriate trail user conduct to protect natural areas. Tools to be investigated for use include:
  - the production of marketing materials
  - website education
  - alignment with Parks branch communication and education
  - coordinating with the Recreation branch on awareness posters, brochures, and maps in community recreation centres,
- proceed with a natural and paved surface trail study and network with other divisions and stakeholders to explore the funding potential for the development and management of a multi-purpose trail system, including:
  - interpretive signage
  - wayfinding signage
  - trail enhancements,
- explore the potential for fund creation by private partners to finance land stewardship of privately owned sites adjacent to public property where there is opportunity for contiguous canopy benefits,
- support staff resources to expand the Community Stewardship Program to meet the demand for stewardship activities, and
- continue to make City street tree data available to individuals and community groups to facilitate neighbourhood studies of local forest conditions

**Figure 31 - Parkland Naturalization Program planting event – Trees Across Toronto**

# 7. MONITORING PROGRESS AND MEASURING SUCCESS – CRITERIA AND INDICATORS OF FOREST SUSTAINABILITY

Good urban forest management requires:

1. sound information about the resource,
2. identification of desired goals and objectives,
3. a roadmap for how to achieve the preferred urban forestry outcome,
4. programs to educate, inform and engage the community in support of forestry goals, and
5. a feedback and monitoring framework to measure success.

The vision and desired goals of this Plan are presented in Section 3. A roadmap for how to achieve the desired urban forestry outcome is laid out in the actions presented in Section 6 of this Plan. Section 6 also includes an overview of outreach and stewardship programs that are already in place, as well as identification of several actions for improving and expanding these programs.

This section provides the monitoring framework to measure success.

Urban forest sustainability is fundamental to achieving the vision for Toronto's urban forest and the strategic goal of 40% canopy cover. A sustainable urban forest is defined as "the naturally occurring and planted trees in cities which are managed to provide the inhabitants with a continuing level of economic, social, environmental and ecological benefits today and into the future"[52]. It is generally accepted that achievement of urban forest sustainability is founded on the following three components:

- the vegetative resource (i.e., the trees themselves),
- appropriate management of the resource, and
- a strong community framework

The monitoring plan as shown in Table 6 incorporates these three components and identifies a comprehensive set of criteria and corresponding indicators of success that are aligned with these components and were selected with consideration for the following factors:

| | |
|---|---|
| **SIMPLICITY** | Criteria and indicators of success should be understandable to those without formal training in forestry. |
| **COST-EFFECTIVENESS** | Information must be able to be collected under existing management and reporting systems. |
| **RELIABILITY** | Indicators selected must provide useful information on progress towards improving the sustainability of the forest resource. |
| **OBJECTIVITY** | Indicators selected must provide an objective measure that is not affected by interpretive bias. |

The criteria are designed to assess all aspects of urban forest sustainability and the corresponding series of easily measurable indicators of success will serve to assess progress towards urban forest sustainability and evaluate success.

This Plan allows the City to track successes and also allows for the identification of areas where success has been limited. Monitoring progress and measuring success will allow Parks, Forestry and Recreation

[52] Clark, J.R., Matheny, N.P., Cross, G. and Wake, V. "A Model of Urban Forest Sustainability." *Journal of Arboriculture* 21, (1997):17-30. Print.

to determine if the actions outlined in this Plan are effective at addressing the challenges facing the urban forest and are contributing to achievement of the Plan's strategic goals. This information can then trigger the development and implementation of new or revised actions which, over time can better address challenges and meet strategic goals.

The baseline conditions listed are drawn from 2011 data, as indicated. In some cases the baseline condition is unknown and will therefore need to be determined as part of future initiatives.

Fiscal restraint has been a reality for the past decade and it is not anticipated that this will change in the near future. Setting immediate priorities, monitoring of progress and strategic use of available resources will allow for efficient and cost effective management of Toronto's urban forest.

**Table 6. Criteria and indicators of urban forest sustainability for Toronto[53]**

| | Criterion | Tactical Objective | Indicator | Baseline Condition (2011) | Data source/ Methodology/ Responsibility | Frequency of Measurement |
|---|---|---|---|---|---|---|
| ***Vegetative Resource (Health of the Forest)*** | | | | | | |
| 1. | Overall species composition | A diverse mix of species including native trees<br><br>Increase native biodiversity and increase resilience to pests generally through increased species diversity | Species composition of the urban forest<br><br>No species to represent more than 10% of the tree population<br><br>Assessment of diversity using i-Tree Eco modeling of Simpson Diversity Index[54] | Species with highest populations:<br><br>Acer saccharum 10.2%<br>Acer platanoides 6.5%<br>Fraxinus americana 5.3%<br>Thuja occidentalis 16%<br><br>Simpson's Diversity Index – tree species diversity by land use:<br><br>Single Family Res. – 23.7<br>Institutional – 17.7<br>Open Space – 10.7<br>Industrial – 8.3<br>Multi-family Res. – 8.3<br>Utility & Transp. – 5.5<br>Commercial – 4.4 | i-Tree Eco permanent sample plots | Every 10 years to do sample plots using i-Tree methods for random field samples |
| 2. | Street tree species composition | Achieve the "5-10-20"[55] rule<br><br>No more than 5% of one species, 10% of one genus and 20% of one family | Species composition of City-owned street trees | Species ≥ 5%<br>Acer platanoides 22%<br>Genus ≥ 10%<br>Acer 34%<br>Family ≥ 20%<br>Aceraceae 33% | Urban Forestry database, GIS mapping of areas of interest with species diversity analysis | Every 5 years to prepare UF diversity maps |
| 3. | Native biodiversity | Reduce overall non-native, invasive tree and shrub species populations in Toronto. Native species are encouraged | Percent non-native invasive trees and shrubs city-wide<br>Target:<br>< 10% for trees<br>< 20% for shrubs | Trees: approx. 12%<br>Shrubs: 22% non-native invasive species. | i-Tree Eco permanent sample plots | Every 10 years |
| 4. | Overall tree size class distribution<br><br>0 -15.2 cm dbh<br>15.2 - 30.6 cm dbh<br>30.6 cm + dbh | Provide for uneven size distribution. Increase the percentage of mid-large sized trees (30.6 cm+) | Percent of population within the following size classes: 0 -15.2 cm dbh<br>15.2 - 30.6 cm dbh<br>30.6 cm + dbh | 14% of trees are > 30.6 cm in diameter<br><br>68% = 0 -15.2 cm dbh<br>18% = 15.2- 30.6 cm dbh<br>14% = 30.6 cm + dbh | i-Tree Eco permanent sample plots | Every 10 years |

[53] Adapted from: Kenney, W.A., van Wassenaer, Philip J.E. and Satel, A.L. "Criteria and Indicators for Strategic Urban Forest Planning and Management." *Arboriculture & Urban Forestry* 37.3 (2011):108-117. Print.

[54] Simpson's Diversity Index, www.countrysideinfo.co.uk/simpsons.htm

[55] Raupp, M.J., Buckelew Cumming, A. and Raupp, E.C. "Street Tree Diversity in Eastern North America and Its Potential for Tree Loss to Exotic Borers." *Arboriculture & Urban Forestry* 32.6 (2006):297-304. Print.

| | Criterion | Tactical Objective | Indicator | Baseline Condition (2011) | Data source/ Methodology/ Responsibility | Frequency of Measurement |
|---|---|---|---|---|---|---|
| 5. | Street tree size class distribution<br><br>0-15.2 cm dbh<br>15.2 -30.6 cm dbh<br>30.6 cm + dbh | Increase the percentage of mid-large sized trees (30.6 cm+) | Percent of population within the following size classes:<br>0 -15.2 cm dbh<br>15.2 -30.6 cm dbh<br>30.6 cm + dbh | 25% of trees are >30.6 cm<br>47% = 0-15.2 cm dbh<br>28% = 15.2 -30.6 cm dbh<br>25% = 30.6 cm + dbh | Urban Forestry database | Every 5 years, prepare region size class maps |
| 6. | Overall tree condition ratings | Increase percentage of trees in excellent/good condition | Percent of population in good – excellent condition<br>Target: > 80%<br><br>Percent of population in fair - poor condition<br>Target: < 20% | 81% rated excellent/good | i-Tree Eco permanent sample plots | Every 10 years |
| 7. | Street tree condition ratings | Increase percentage of trees in good - excellent condition | Percent of population in good – excellent condition<br>Target: > 70%<br><br>Percent of population in fair - poor condition<br>Target: < 30% | 49% rated excellent/good | Urban Forestry database | Every 5 years or less |
| 8. | Establishment of newly planted street trees | Increase the rate of survival of trees ≤ 15 cm dbh | Percent of street trees replaced within 3 yrs of planting<br>Target: < 5% | 670 trees ≤ 15 cm dbh were removed<br>Represents 3.8% of the 17,546 newly planted street trees | Urban Forestry database | Annually |
| 9. | Establishment of newly planted trees in natural areas | High rate of success for newly planted trees | Percent of tree survival during first 5 years<br><br>Target: > 75%<br><br>As measured through monitoring on 10% of planting sites annually | Unknown | Urban Forestry database | Annually |
| 10. | Tree canopy cover | 40% canopy cover<br><br>Approximate increase of 7,600- 8,500 ha of canopy city-wide<br><br>Estimated 57,000-114,000 trees to be planted annually on public lands | Percent tree canopy cover for the city<br><br>Area of additional canopy cover<br><br>57,000-114,000 trees planted annually on public lands | 26.6 - 28%[56] canopy cover<br><br>An estimated 16,864 ha – 17,752 ha of canopy exists city-wide<br><br>Annual average = 100,000 trees planted (last 5 years) | High resolution leaf-on aerial and satellite imagery<br><br>GIS mapping Urban Forestry Database | Every 10 years – Land cover classification with leaf-on satellite imagery<br><br>Annual review of new planting areas |
| ***Management of the Resource (Evaluating Effectiveness)*** | | | | | | |
| 11. | Street tree maintenance | Reactive maintenance service wait times:<br>3-6 months<br><br>Proactive maintenance service wait times:<br>7 year cycle | Wait times for service<br><br>7 year cycle for proactive maintenance | Reactive maintenance wait time: 6-9 month<br><br>Maintenance wait time: 20 year cycle | Urban Forestry Database | Annually |

[56] Nowak, David. J., et al. 2013.
*Every Tree Counts: A Portrait of Toronto's Urban Forest*. Appendix 4: Methodologies for Estimating Canopy Cover.

| | Criterion | Tactical Objective | Indicator | Baseline Condition (2011) | Data source/ Methodology/ Responsibility | Frequency of Measurement |
|---|---|---|---|---|---|---|
| 12. | Tree protection | To increase net trees protected<br><br>75% applications meeting development review application corporate standards for review time frames | Wait times for tree by-law permits<br><br>Response time frame for development review applications | Untracked at this time<br><br>Tracked quarterly = 71% averaged city-wide | Urban Forestry Database | Annually |
| 13. | Management of publicly owned natural areas, protection of significant ecological features | Management of significant ecological features - 10% of ESAs managed | Percent of the total area of ESAs actively managed | GIS mapping layers for ESAs<br><br>13.4%[57] of ESAs managed | City of Toronto Environmental Planning ESA criteria | Annual mapping to determine area |
| 14. | Comprehensive inventory of urban forest resource | Update a city-wide inventory every 10 years | Availability of current inventory information to describe the forest resource | Last city-wide inventory (i-Tree Eco) completed 2008 Analysis completed and report published in 2010 | i-Tree Eco permanent sample plots | Every 10 years.<br><br>Next update to be completed 2019-2020 |
| 15. | Street tree inventory | Update street tree inventory as management occurs – continually improve accuracy of database | Availability of current inventory information to describe street tree population | Continually updated | Urban Forestry database<br><br>Street tree inventory updated continuously | Quarterly |
| 16. | Spatial distribution of urban forest | Update a digital forest cover map every 10 years, available in the City's integrated geospatial environment | Availability of high resolution forest cover map for planning purposes | Last digital cover map produced in 2008 using 2007 imagery | High resolution leaf-on satellite/aerial imagery | Every 10 years: Next update to be completed 2019-2020 |
| 17. | Urban forest management plan | Maintain a publicly available strategic forest management plan | Current urban forest management plan for the city | First Plan completed in 2012 | Various data sources: Urban Forestry database, i-Tree Eco, GIS. | Every 10 years |
| 18. | Operational plan (service plan) | Annually updated operational plan (service plan) | Comprehensive operations plan with detailed components on all areas: Area Tree Maintenance, EAB, etc. | Updated each year with budget request | Approved Operating and Capital budgets | Annually |
| ***Community Framework (Community Engagement)*** | | | | | | |
| 19. | Awareness of urban forestry programs | Increase number of requests for front yard trees under the City's free residential tree planting program<br><br>Promote tree benefits through tree by-laws | Number of requests under the residential tree planting program | Untracked at this time | Urban Forestry database | Annually |
| 20. | Communication of forestry information | Increase awareness of urban forestry programs and benefits of trees | Number of and attendance at Urban Forestry workshops/ information sessions<br><br>Number of educational items posted on Urban Forestry website | Unknown | Urban Forestry | Anually |

[57] This includes ESAs as per current Official Plan, with ESAs expected to increase significantly with Official Plan revision this percentage would decrease significantly. Areas managed include plantings and burn areas by staff, City contracts, and partners.

| | Criterion | Tactical Objective | Indicator | Baseline Condition (2011) | Data source/ Methodology/ Responsibility | Frequency of Measurement |
|---|---|---|---|---|---|---|
| 21. | Community participation/ coordination with community groups | Meet demand for the number of community groups looking for stewardship/ forest education<br><br>Conduct systematic outreach<br><br>Coordination between groups and the City to meet common goals | Number of community volunteers and/or groups participating in stewardship activities<br><br>Number of community tree planting and/ or maintenance initiatives | Gap: staff cannot currently meet demand for groups wanting to participate in stewardship | Urban Forestry staff to track numbers for both those who attend programs and those who cannot be accommodated<br><br>Urban Forestry to develop a survey for gaining feedback from partner groups | Annual tracking of participation<br><br>On-going informal review annually |
| 22. | Municipal coordination | Collaborate and coordinate with City Divisions and agencies on a project-specific basis towards achievement of the City's urban forestry goals and objectives | Number of mutually beneficial projects and initiatives completed in partnership | Ongoing partnerships and collaboration with City Planning, Transportation Services, Toronto Water, Technical Services, Toronto Environment Office and Toronto Public Health | Urban Forestry | Annual tracking of participation |
| 23. | Regional coordination | Collaborate and coordinate with municipalities within the GTA and/or other municipal jurisdictions on common urban forestry goals | Regional planning and coordination of management plans, studies regarding the urban forest, policies, best practices and emerging issues affecting forest sustainability | Coordination with TRCA on various projects including GTA tree canopy studies.<br><br>Collaboration and partnership with Federal and Provincial agencies regarding forest health care issues | Urban Forestry | Annual tracking of participation |

# 8. CONCLUSION

Toronto has large, connected natural areas that provide the core of the city's forest system. The urban forest represents a tremendously valuable resource to the city and the people who live, work and play in it. The structural value of the urban forest is approximately $7 billion, while the ecological services it provides to the city in terms of air pollution filtration and temperature moderation are estimated at over $28.2 million. These calculations do not even capture the value of the urban forest in terms of the direct economic and community benefits it provides (such as increases in property values and mental health) or the value of its other ecological services (such as habitat for a high diversity of native and migratory species). Toronto's urban forest plays an increasing role in biodiversity conservation while it enhances air quality, provides shade and reduces local energy consumption.

Although many people may think of trees as being able to essentially take care of themselves, in an urban setting a range of management strategies are required to deal with the various challenges faced by trees and the urban forest as a whole. Key challenges faced by Toronto's urban forest include: threats to the resources health from invasive pests, the need for ongoing and proactive maintenance of this extensive resource, competition with urbanization and related infrastructure for space, stressors associated with climate change, impacts associated with recreation in the city's natural areas and the need to continually increase awareness of the value of the urban forest and the importance of its stewardship.

As a result of these challenges, this extensive natural resource requires management in order for it to be sustained and enhanced. The goals of this plan, to increase canopy cover, achieve equitable distribution, increase biodiversity, increase forest awareness, promote stewardship and improve monitoring reflect the direction received from City Council. Some of the management approaches and tools employed by the Urban Forestry branch places Toronto among world leaders in this sector. The resources to continue to provide this level of management and to work with various partners in both the public and private sectors are needed to maintain this status and sustain the resource itself. Furthermore, it is important that this resource be protected, maintained and expanded to enable continued enjoyment of the city's shady streets, parks and natural areas. The urban forest is a big part of what makes Toronto a very livable city; a "city within a park".

Through the implementation of this Plan, the City is showing its commitment to effectively maintaining, protecting, planting and planning to sustain and expand the urban forest so that it can provide the maximum possible value to the community. The full value of this resource cannot be reaped without ongoing funding to address the challenges of pest management, proactive maintenance, natural area management and sustained outreach services.

Although this Plan will be led by the Urban Forestry branch, its full and effective implementation depends on the support and cooperation of various City divisions as well as partners in the public and private sectors, including members of the community. With approximately 40% of the resource in public ownership and the remaining 60% in private ownership, internal and external partnerships are fundamental to making progress towards the goal of expanding the quality and quantity of the urban forest across the city.

# 9. GLOSSARY OF TERMS

**Area Tree Maintenance** – a program for providing proactive scheduled tree maintenance on City-owned trees within a predefined geographic area.

**Best Practices** – innovative techniques that may support more effective management of the resource. They are not necessarily best management practices, which are a prescribed method for a specific type of program, however in some instances they conform to best management practices as well.

**DBH** – tree stem diameter measured at breast height, 1.4 metres above grade.

**Ecological Land Classification (ELC)** – a system developed by the Ontario Ministry of Natural Resources to delineate ecological units on the basis of soil, climate, physiography, and corresponding vegetation. TRCA staff have used this system to delineate and differentiate natural areas within Toronto.

**Environmentally Significant Area (ESA)** – areas identified by the City of Toronto that have local and regional environmental significance. These areas are protected by the City's Official Plan (OP). A map of Environmentally Significant Areas (map 12) is contained within the OP and further study is underway to identify additional ESAs across the City.

**Continuous Soil Trench** – a trench where uncompacted soil is continuous under a sidewalk or other hard surface. These zones can accommodate the root systems of multiple trees and allows for a shared soil volume over a continuous unobstructed area below grade.

**Geographic Information Systems (GIS)** – a system that has been designed to capture, store, manipulate and analyze geographically referenced data. GIS merges cartography, statistical analysis and database technology.

**Grey Infrastructure** – traditional built elements found within urban settings constructed from concrete or asphalt such as roads, sidewalks, bridges, sewers or retaining walls.

**Green Infrastructure** – living infrastructure such as trees, forests, bio-engineered slopes, bio-swales, and green roofs. Also described as an interconnected network of green space that conserves natural ecosystem values and functions.

**Heat Vulnerability** – refers to the ability to withstand the effects of extreme heat. Toronto Public Health has prepared several reports on the topic of heat vulnerability. They conducted a complex weighted analysis with multiple variables to determine areas of the city where populations were considered at higher risk for heat related health issues. Factors included age, income, housing type, distance to shaded parkland and surface temperature. The research was shared with Urban Forestry with the request of using the data to prioritize tree planting as a way to minimize further heat vulnerability. These issues are summarized in the July 26, 2011 Board of Health Decision, http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2011.HL6.3.

**i-Tree Eco** – previously called UFORE, or the Urban Forest Effects model, I-Tree Eco is a modeling using a combination of field data and GIS analysis to calculate ecological services provided by trees within a defined area. This tool quantifies the urban forest and can be used for making effective resource management decisions or developing policy. This system was developed by USDA Forest Service Northern Research Station http://www.itreetools.org/eco/index.php

**Land Cover Classification** – a system of categorizing land according to the material that covers its surface. Satellite imagery is used to help determine the area and percentage of land within each category. For urban areas the categories include buildings, asphalt, concrete, turf, bare soil and tree canopy.

**Leaf Area Percent** – a calculation of tree canopy that includes consideration for the volume and density of leaves and is modeled through the i-Tree Eco method with different values associated with different tree species. For example in Toronto's urban forest there is a greater number of sugar maple trees (Acer saccharum) by stem counts, but Norway maple exceeds sugar maple in terms of its leaf area percent in the city.

**LiDAR (Light Detection and Range technology)** – a remote sensing technology that uses light to determine distance and other feature attributes. LiDAR provides an opportunity to aquire far more accurate urban forestry data through the capture of tree elevation and volume data. LiDAR requires extensive point data collection and therefore has a prohibitively high cost based on the specialized technology and skills associated with it.

**Naturalization** – the process of planting with native species of shrubs, trees and ground covers to transform an area into a natural landscape. It can also refer to the natural succession of an unvegetated or sparsely vegetated open space to a more well-vegetated landscape that may include a variety of plant types, including shrubs and trees.

**Restoration** – the process whereby natural areas that have been degraded (e.g., due to dominant populations of invasive species) are rehabilitated by managing or removing the immediate source of the degradation (e.g., invasive species) and planting with native species.

**Satellite Imagery** – an image taken from a satellite containing pixel based data in a grid that can be analyzed and converted from a raster format to a vector format. Vector format data (of points, lines and shapes) can be readily analyzed for land use classification.

**Stewardship** – natural area management where native species and native plant communities and habitat types are managed, often with the support of external partners and/or community groups.

**Silviculture** – the cultivation of trees and forested areas undertaken to control the establishment, growth, composition, structure and quality of forest vegetation in order to meet predefined forest management objectives.

**Structural Value** – a replacement value estimated for trees based on their size, species and condition. The standard used for estimating this value has been established by the Council of Tree and Landscape Appraisers. For more information refer to http://treelink.org/joa/2002/july/05Nowak.pdf. For the purposes of this report, field data and aerial imagery estimates have been used to model the structural value for the total tree canopy.

**Tree Hazard** – a significant defect of size, condition or structure that when coupled with tree species, location and use level poses a risk of damage or injury requiring immediate action to be taken to eliminate the perceived threat. A tree hazard must have both a defect and a target. A defect without a target is not a hazard.

**Urban Forest** – population of trees, shrubs and other flora and their habitat, growing in an urban area. In Toronto the urban forest includes trees and other vegetation growing along streets, in parks, ravines and natural areas, in front and back yards of homes, and in landscaped open spaces.

**Urban Forest Canopy** – an area of leaves and branches that provide shade, contribute to energy reduction and water retention and attenuate and intercept rain fall. It can include large shrubs as well as trees of all sizes depending on the method used to determine canopy. For a more detailed review of various methods that have been used to estimate canopy in Toronto see *Every Tree Counts: A Portrait of Toronto's Urban Forest*.

# Appendix 1 – Urban Forest Species Composition

| Urban Forest Species Composition including species, genus and family information | | | | | | Potential Pest | | | |
|---|---|---|---|---|---|---|---|---|---|
| Genus | Species | Family | Common Name | % Pop. | % Lf. Area | ALB | GM | EAB | DED |
| Abies | balsamea | Pinaceae | balsam fir | 0.1 | 0.1 | | | | |
| Abies | concolor | Pinaceae | white fir | 0.1 | 0.1 | | | | |
| Acer | campestre | Aceraceae \| Sapindaceae | hedge maple | 0.1 | 0.1 | o | | | |
| Acer | ginnala | Aceraceae \| Sapindaceae | amur maple | 0.1 | 0.1 | o | | | |
| Acer | negundo | Aceraceae \| Sapindaceae | boxelder | 5 | 5.5 | o | | | |
| Acer | nigrum | Aceraceae \| Sapindaceae | black maple | 0.5 | 1 | o | | | |
| Acer | palmatum | Aceraceae \| Sapindaceae | Japanese maple | 0.3 | 0.1 | o | | | |
| Acer | platanoides | Aceraceae \| Sapindaceae | Norway maple | 6.5 | 14.9 | o | | | |
| Acer | rubrum | Aceraceae \| Sapindaceae | red maple | 0.2 | 0.8 | o | | | |
| Acer | saccharinum | Aceraceae \| Sapindaceae | silver maple | 0.9 | 4.5 | o | | | |
| Acer | saccharum | Aceraceae \| Sapindaceae | sugar maple | 10.2 | 11.6 | o | | | |
| Acer | x freemanii | Aceraceae \| Sapindaceae | Freeman maple | 0.1 | 0.3 | | | | |
| Aesculus | hippocastanum | Hippocastanaceae \| Ulmaceae | horsechestnut | 0.1 | 0.2 | o | | | |
| Ailanthus | altissima | Simaroubaceae | tree of heaven | 0.7 | 0.7 | | | | |
| Alnus | glutinosa | Betulaceae | European alder | 0.2 | 0.1 | o | | | |
| Alnus | incana | Betulaceae | grey alder | 0.4 | 0.1 | o | | | |
| Amelanchier | alnifolia | Rosaceae | western service berry | 0.1 | 0 | | | | |
| Amelanchier | arborea | Rosaceae | downy serviceberry | 0.5 | 0.1 | | | | |
| Amelanchier | canadensis | Rosaceae | eastern service berry | 0.3 | 0 | | | | |
| Amelanchier | laevis | Rosaceae | smooth service berry | 0 | 0 | | | | |
| Aralia | spinosa | Araliaceae | devils walking stick | 0.1 | 0 | | | | |
| Betula | alleghaniensis | Betulaceae | yellow birch | 0.2 | 0.4 | o | | | |
| Betula | nigra | Betulaceae | river birch | 0 | 0 | o | o | | |
| Betula | papyrifera | Betulaceae | paper birch | 1.4 | 2.5 | o | o | | |
| Carpinus | caroliniana | Betulaceae | American hornbeam | 0.2 | 0.1 | | | | |
| Carya | cordiformis | Juglandaceae | bitternut hickory | 0.3 | 0.8 | | | | |
| Catalpa | speciosa | Bignoniaceae | northern catalpa | 0.3 | 0.3 | | | | |
| Celtis | occidentalis | Ulmaceae \| Cannabaceae | common hackberry | 0 | 0.1 | | | | |
| Chamaecyparis | lawsoniana | Cupressaceae | Port Orford cedar | 1.5 | 0.1 | | | | |
| Cornus | alternifolia | Cornaceae | alternateleaf dogwood | 0.1 | 0 | | | | |
| Cornus | florida | Cornaceae | flowering dogwood | 0 | 0 | | | | |
| Cornus | mas | Cornaceae | cornelian cherry | 0 | 0 | | | | |
| Crataegus | calpodendron | Rosaceae | pear hawthorn | 0.3 | 0 | | | | |
| Crataegus | chrysocarpa | Rosaceae | fireberry hawthorn | 0.1 | 0.1 | | | | |
| Crataegus | crus-galli | Rosaceae | cockspur hawthorn | 1 | 0.4 | | o | | |
| Crataegus | mollis | Rosaceae | downy hawthorn | 0.1 | 0.1 | | o | | |
| Cydonia | oblonga | Rosaceae | quince | 0 | 0 | | | | |
| Elaeagnus | angustifolia | Elaeagnaceae | Russian olive | 0.1 | 0.1 | o | | | |
| Euonymus | atropurpureus | Elaeagnaceae | eastern wahoo | 0 | 0 | | | | |
| Euonymus | europaea | Elaeagnaceae | European spindle tree | 0 | 0 | | | | |

| Urban Forest Species Composition including species, genus and family information | | | | | | Potential Pest | | | |
|---|---|---|---|---|---|---|---|---|---|
| Genus | Species | Family | Common Name | % Pop. | % Lf. Area | ALB | GM | EAB | DED |
| Fagus | grandifolia | Fagaceae | American beech | 0.7 | 0.5 | | | | |
| Fagus | sylvatica | Fagaceae | European beech | 0.2 | 0.2 | | | | |
| Fraxinus | americana | Oleaceae | white ash | 5.3 | 2.7 | o | | o | |
| Fraxinus | excelsior | Oleaceae | European ash | 0.1 | 0.2 | o | | o | |
| Fraxinus | pennsylvanica | Oleaceae | green ash | 3.6 | 5 | o | | o | |
| Ginkgo | biloba | Ginkgoaceae | ginkgo | 0 | 0 | | | | |
| Gleditsia | triacanthos | Fabaceae | honeylocust | 1.5 | 1.2 | | | | |
| Hamamelis | virginiana | Hamamelidaceae | witch hazel | 0.1 | 0 | | o | | |
| Hibiscus | syriacus | Malvaceae | rose-of-sharon | 0 | 0 | o | | | |
| Juglans | cinerea | Juglandaceae | butternut | 0.2 | 0.6 | | | | |
| Juglans | nigra | Juglandaceae | black walnut | 0.2 | 0.7 | | | | |
| Juniperus | chinensis | Cupressaceae | Chinese juniper | 0 | 0 | | | | |
| Juniperus | communis | Cupressaceae | common juniper | 0.1 | 0 | | | | |
| Juniperus | pinchotii | Cupressaceae | Pinchot juniper | 0 | 0 | | | | |
| Juniperus | virginiana | Cupressaceae | eastern red cedar | 0.7 | 0.2 | | | | |
| Larix | laricina | Pinaceae | tamarack | 0 | 0.1 | | o | | |
| Ligustrum | lucidum | Oleaceae | Chinese privet | 0.1 | 0 | | | | |
| Magnolia | acuminata | Magnoliaceae | cucumber tree | 0.2 | 0.1 | | | | |
| Magnolia | x soulangeana | Magnoliaceae | saucer magnolia | 0.1 | 0 | | | | |
| Malus | angustifolia | Rosaceae | southern crabapple | 0 | 0 | o | o | | |
| Malus | baccata | Rosaceae | Siberian crabapple | 0.1 | 0.3 | o | | | |
| Malus | coronaria | Rosaceae | sweet crabapple | 0.2 | 0.1 | o | o | | |
| Malus | sylvestris | Rosaceae | European crabapple | 2.3 | 1.5 | | | | |
| Malus | tschonoskii | Rosaceae | crabapple | 0.2 | 0.2 | o | o | | |
| Morus | alba | Moraceae | white mulberry | 0.5 | 0.3 | | | | |
| Morus | nigra | Moraceae | black mulberry | 0.2 | 0.2 | | | | |
| Morus | rubra | Moraceae | red mulberry | 0 | 0 | | | | |
| Ostrya | virginiana | Betulaceae | eastern hophornbeam | 3.2 | 2.4 | | o | | |
| Other | species | | other species | 0.8 | 0.4 | | | | |
| Picea | abies | Pinaceae | Norway spruce | 1.2 | 1 | | | | |
| Picea | glauca | Pinaceae | white spruce | 3.3 | 4.6 | | | | |
| Picea | pungens | Pinaceae | blue spruce | 0.6 | 1.4 | | | | |
| Pinus | nigra | Pinaceae | Austrian pine | 1.4 | 2.7 | | | | |
| Pinus | resinosa | Pinaceae | red pine | 1.1 | 0.3 | | | | |
| Pinus | strobus | Pinaceae | eastern white pine | 1.5 | 0.9 | | | | |
| Pinus | sylvestris | Pinaceae | scotch pine | 0.6 | 0.4 | | | | |
| Populus | balsamifera | Salicaceae | balsam poplar | 0.4 | 0 | o | o | | |
| Populus | deltoides | Salicaceae | eastern cottonwood | 0.3 | 0.4 | o | | | |
| Populus | grandidentata | Salicaceae | bigtooth aspen | 0.5 | 0.6 | o | o | | |
| Populus | tremuloides | Salicaceae | quaking aspen | 2 | 1 | o | o | | |
| Populus | x canadensis | Salicaceae | Carolina poplar | 0.1 | 0.3 | o | | | |
| Prunus | americana | Rosaceae | American plum | 0.2 | 0.1 | o | | | |

| Urban Forest Species Composition including species, genus and family information | | | | | | Potential Pest | | | |
|---|---|---|---|---|---|---|---|---|---|
| Genus | Species | Family | Common Name | % Pop. | % Lf. Area | ALB | GM | EAB | DED |
| Prunus | armeniaca | Rosaceae | apricot | 0.1 | 0.1 | o | o | | |
| Prunus | avium | Rosaceae | sweet cherry | 0.6 | 0.6 | o | | | |
| Prunus | domestica | Rosaceae | common plum | 0.3 | 0.1 | o | | | |
| Prunus | pensylvanica | Rosaceae | pin cherry | 0.1 | 0 | o | | | |
| Prunus | persica | Rosaceae | nectarine | 0 | 0 | o | | | |
| Prunus | sargentii | Rosaceae | sargent cherry | 0 | 0.1 | o | | | |
| Prunus | serotina | Rosaceae | black cherry | 2.3 | 1.8 | o | | | |
| Prunus | virginiana | Rosaceae | common chokecherry | 1.9 | 0.9 | o | | | |
| Pyrus | communis | Rosaceae | common pear | 0.7 | 0.4 | o | | | |
| Quercus | alba | Fagaceae | white oak | 1 | 2 | | o | | |
| Quercus | macrocarpa | Fagaceae | bur oak | 0.2 | 0.1 | | o | | |
| Quercus | robur | Fagaceae | English oak | 0 | 0.1 | | o | | |
| Quercus | rubra | Fagaceae | northern red oak | 0.6 | 1.3 | | o | | |
| Rhamnus | cathartica | Rhamnaceae | European buckthorn | 1.6 | 0.5 | | | | |
| Robinia | pseudoacacia | Fabaceae | black locust | 0.2 | 0.9 | o | | | |
| Salix | alba | Salicaceae | white willow | 0.3 | 1.5 | o | o | | |
| Salix | babylonica | Salicaceae | weeping willow | 0.1 | 0.5 | o | o | | |
| Salix | discolor | Salicaceae | pussy willow | 0.1 | 0 | o | o | | |
| Salix | nigra | Salicaceae | black willow | 0.1 | 0.6 | o | o | | |
| Sorbus | americana | Rosaceae | American mountain ash | 0.1 | 0 | | o | | |
| Sorbus | aucuparia | Rosaceae | European mountain ash | 0 | 0 | | o | | |
| Sorbus | decora | Rosaceae | showy mountain ash | 0 | 0 | | | | |
| Syringa | reticulata | Oleaceae | Japanese tree lilac | 0 | 0 | | | | |
| Syringa | vulgaris | Oleaceae | common lilac | 0.2 | 0.1 | | | | |
| Taxus | baccata | Taxaceae | English yew | 0.3 | 0.1 | | | | |
| Taxus | canadensis | Taxaceae | Canada yew | 0.4 | 0.1 | | | | |
| Thuja | occidentalis | Cupressaceae | northern white cedar | 15.6 | 2.8 | | | | |
| Thuja | plicata | Cupressaceae | western redcedar | 0 | 0 | | | | |
| Tilia | americana | Tiliaceae | American basswood | 1.4 | 1.5 | o | o | | |
| Tilia | cordata | Tiliaceae | littleleaf linden | 0.8 | 1.1 | o | o | | |
| Tsuga | canadensis | Pinaceae | eastern hemlock | 0.2 | 0.5 | | | | |
| Ulmus | americana | Ulmaceae | American elm | 1.5 | 3.7 | o | | | o |
| Ulmus | pumila | Ulmaceae | Siberian elm | 2.7 | 2.3 | o | | | |
| Ulmus | rubra | Ulmaceae | slippery elm | 0.2 | 0.3 | o | | | o |

# Appendix 2 – Development of Preliminary Planting Targets

The total area of the city is 63,412.5 ha, of which approximately 45% (28,536 ha) is in public ownership.

Assuming a current canopy cover of 26.6% to 28%, the analyses undertaken by the USDA Forest Service for the City of Toronto indicates that approximately 570,000 trees are required to be established annually in order to achieve a 40% canopy goal. This is calculated based on an average tree mortality rate of 3% and includes estimated impacts associated with EAB.

***Preliminary target calculations:***

570,000 trees / 63,412.5 ha = 9 trees/ha annually established
570,000 trees x 45% (percentage of land in public ownership) = 256,500 trees on publicly owned land.

Assuming natural regeneration rates are proposed to be 5 to 7 trees/ha, based on Toronto's climate zone and extensive natural system and that estimated land available for planting by the City and other public partners is 28,536 ha (45% of 63,412.5 ha).

***Lower Natural Regeneration Scenario (5 trees/ha):***

28,536 ha x 5 trees/ha established through natural regeneration = 142,680 trees/year.

To estimate how many trees the City would be required to plant in excess of natural regeneration:

256,500 (number of newly established trees required on public property)
–142,680 (number of trees expected to regenerate naturally on public property)
=113,820 (number of trees to be planted on public property)
or approximately 114,000 trees/year

***Higher Natural Regeneration Scenario (7 trees/ha):***

28,536 ha x 7 trees/ha established through natural regeneration = 199,752 trees/year.

256,500 (number of newly established trees required on public property)
-199,752 (number of trees expected to regenerate naturally on public property)
= 56,748 (number of trees to be planted on public property)
or approximately 57,000 trees/year to be planted on publicly owned land

**Therefore based on the above-noted assumptions, between 57,000 – 114,000 trees/year would need to be planted on publicly owned land to achieve a 40% canopy cover goal by 2060.**

Additional assumptions:

1. Natural area management would be done in areas of highest priority, recognizing that plantings in natural areas do not contribute significantly to this general calculation on a city-wide basis.
2. Parks, schools and areas adjacent to roadways would be planted to compensate for the lack of suitable planting area on roadways, bikeways and other transportation surfaces.

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