Oakville's Urban Forest: Our Solution to Our Pollution Next Steps

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Forest Effect (UFORE) project: a partnership involving the Town of Oakville, U.S. Forest Service, Faculty of Forestry, University of Toronto and Tree Canada. The results of this project are reported in "Oakville's Urban Forest: Our Solution to Our Pollution." The key message is that the urban forest provides ecological services valued at $2.1 million per year. Oakville Town Council approved the report in 2006 http://www.oakville.ca/forestry.htm. This UFORE report was a key background document for the Urban Forest Strategic Management Plan (UFSMP), approved by Council in 2008 http://www.oakville.ca/Media_Files/forestry/2008UFSMPappendices.pdf This UFSMP included discussion of urban forest canopy cover targets; a key initiative from our Mayor's Office was an urban forest canopy cover target for the community of 40 % in 50 years. Analysis The UFORE GROW-OUT Module was used to evaluate two long-term urban forest canopy cover goals: a 30% scenario - status quo - and a 40% scenario which is a significant increase for the community. Applying our canopy cover challenge has included two of the major influences on tree habitat in Oakville: (1) Land Use Planning and (2) Engineering Design of roads. Land Use Planning may consider amending the Town's Zoning By-law for Employment, Commercial (excluding C3R zone), and Industrial land use types as outlined in Recommendation # 61 from the UFSMP. Engineering design of roads may consider new techniques such as engineered soils for the standard engineering road cross section as outlined in Recommendation #27 of the UFSMP. Local planning trends have emphasized higher density development. Adequate consideration for the municipal tree is even more critical to accommodate the needs of the Corporation's green infrastructure- the municipal tree. Benefits of this investment in its green infrastructure by the municipality can be quantified by using tools for assessing and managing urban forests such as UFORE which is part i-Tree, developed by the U.S. Forest Service http://www.itreetools.org/ . Conclusion If municipalities want to move beyond simply talking about protecting urban forest canopy cover they must regulate it. This approach needs a systematic, science-based foundation using i-Tree linked to an Urban Forest Strategic Management Plan.

Introduction

In 2005, approximately 500 residents and businesses participated in the Town of Oakville's Urban Forest Effect (UFORE) project: a partnership involving the Town of Oakville, U.S. Forest Service, Faculty of Forestry, University of Toronto and Tree Canada. The results of this project are reported in "Oakville's Urban Forest: Our Solution to Our Pollution." Key messages include (a) the urban forest provides ecological services valued at $2.1 million per year and (b) Oakville's urban forest canopy cover (trees and shrubs) is 29.1%. Oakville Town Council approved the UFORE report in 2006 http://www.oakville.ca/forestry.htm.

The UFORE report was an important background document for the Urban Forest Strategic Management Plan (UFSMP) which was approved by Council in 2008 – http://www.oakville.ca/Media_Files/forestry/2008UFSMPappendices.pdf

The UFSMP includes a discussion on an urban forest **canopy cover target** that with the support of the Planning Department has been included in *Livable Oakville*, the new draft Official Plan of the Town of

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Oakville: a new Corporate objective is to increase Oakville's urban forest canopy cover from 29.1 % to 40 %. This would significantly increase the value of the annual ecological services provided by the urban forest.

For municipalities striving to increase their urban forest canopy cover a comprehensive strategy is described. It recognizes the critical linkages and interdependence between municipal departments which can collaborate to create improved tree habitat- the basis for a sustainable urban forest canopy cover. This linkage reflects the following relationship: (street) Tree Habitat is defined by Zoning and Engineering design. It reflects the critical role that municipal Planning and Engineering Departments contribute to creating and sustaining tree habitat. Important municipal Policy directions can be created through the Official Plan by the Planning Department; one method how a municipality can implement these policies is through innovative changes to the Zoning By-law to regulate a new area dedicated for growing trees: the tree growing area. The Engineering Department can approve road cross section designs which establish utility set-backs from the street tree to allow for future maintenance that respect a 'tree protection zone.' Together, these Planning and Engineering designs would accurately reflect the minimum volume of appropriate soil that must be dedicated for the use of the municipal tree. This approach respects the municipal tree as a piece of 'green infrastructure' that shares public space with 'grey infrastructure.' The urban forest manager plays a supporting role here and relies on these two other disciplines to create essential tree habitat through their business process.

In forging these Departmental synergies the concept of the "right tree in the right space" evolves- throughout the design process - to "the right space for the right tree." For municipalities striving to maximize the value of ecological services provided by the urban forest, the preferred 'right tree' is often a 'large- stature' tree: requiring a large volume of dedicated tree habitat to support a large canopy.

"To implement the Oakville vision for the urban forest, it is recommended that policy documents, regulations, processes and guidelines be amended to implement this goal……to increase the urban forest canopy cover"(Urban forest Strategic Plan, 2008).

Materials and methods

The Urban Forest Effects Model (UFORE) designed by the United States Forest Service has been used to quantify urban forest structure, function and values in numerous communities throughout the world. Randomly generated plots stratified by land use type combined with local pollution and meteorological data quantified the ecological benefits provided by trees and shrubs growing throughout Oakville, Ontario in 2005.

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Results in Oakville demonstrate how the urban forest can act as a local solution to a local pollution problem. Oakville's urban forest was responsible for filtering 172 tonnes (190 tons) of criteria pollutants in 2005; the criteria pollutant that most reduced was ground level ozone: 85 tonnes (94 tons).

Ground level ozone, when combined with particulate matter forms smog, a deadly risk to human health. This was the inspiration for the title of this paper, because Oakville's urban forest plays a role in reducing the risks to the health of Oakville's residents by reducing the amount of smog formed from the local emissions of criteria pollutants.

Air Pollution Control: The Tree Factor—Structure

Oakville has 1.9 million trees; most of the trees (57%) are privately owned. The average urban forest canopy cover is 29.1%. The top three species by leaf area are sugar maple (*Acer saccharum*), Norway maple (*Acer plantanoides*) and silver maple (*Acer saccharinum*).

Pollution Control: The Tree Factor—Functions

Oakville's urban forest filtered all (102%) of the local industrial and commercial emissions of particulate matter (PM_{10}) and 15% of $PM_{2.5}$ and over two times (243%) the amount of sulfur dioxide plus other criteria pollutants. A total of 22,000 tonnes (24,251 tons) of carbon dioxide were filtered and 6,000 tonnes (6,614 tons) of carbon were sequestered.

An alternative way to express the amount of pollutants filtered is that 16% of the local vehicle emissions of carbon dioxide and over four times (425%) the amount of PM_{10} emissions plus other criteria pollutants were filtered by Oakville's urban forest.

Carbon storage and sequestration are most affected by two main factors: size of tree and land use type. Large-stature trees are the most efficient at storing and sequestering carbon. 'Woodlots' is the land use type which is the most efficient air filter. The pattern of canopy cover in Oakville was found to be inversely proportional to the density of land use type.

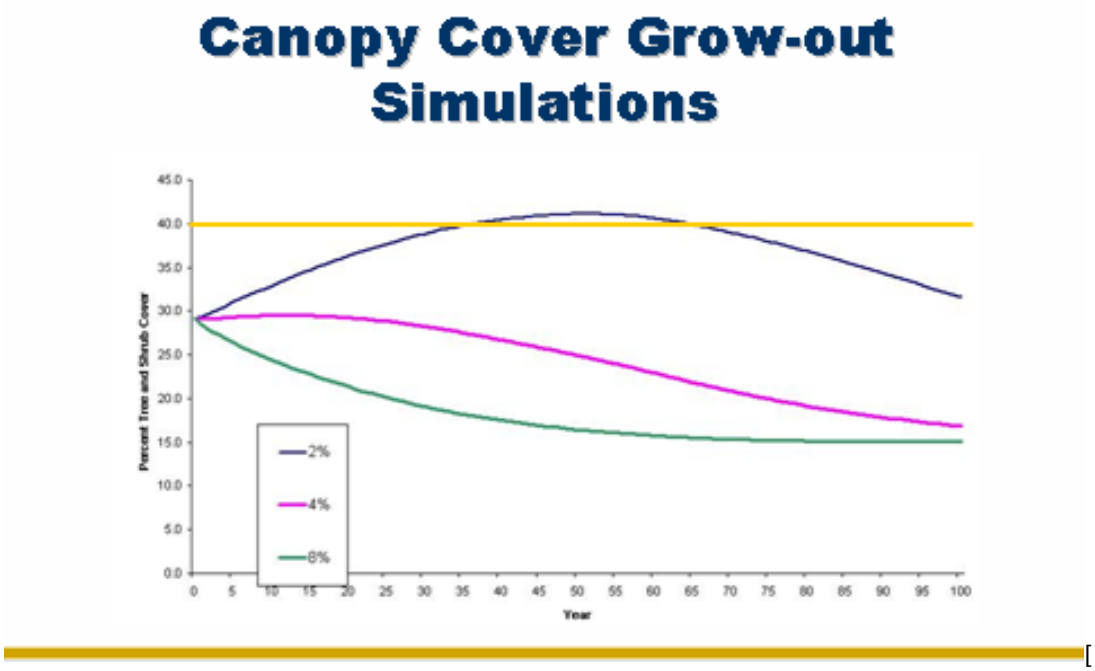
Air Pollution Control: The Tree Factor—Values

The value of the annual ecological services provided by trees within the Town of Oakville is $2.1 million. In addition, trees save local industry $1.1 million each year by avoiding the expenditure on mechanical methods to remove the 172 tonnes (190 tons) of criteria pollutants emitted at source. Trees save Oakville residents $812,000 annually in reduced energy bills. The annual revenue potential through trading the Town's qualifying carbon credits was $5,191 on the Chicago Climate Exchange on June 21, 2006. This proves the concept that the urban forest functions as a 'biogenetic utility,' saving energy, saving lives and saving the buildup of greenhouse gases.

Implications for Urban Forest Management

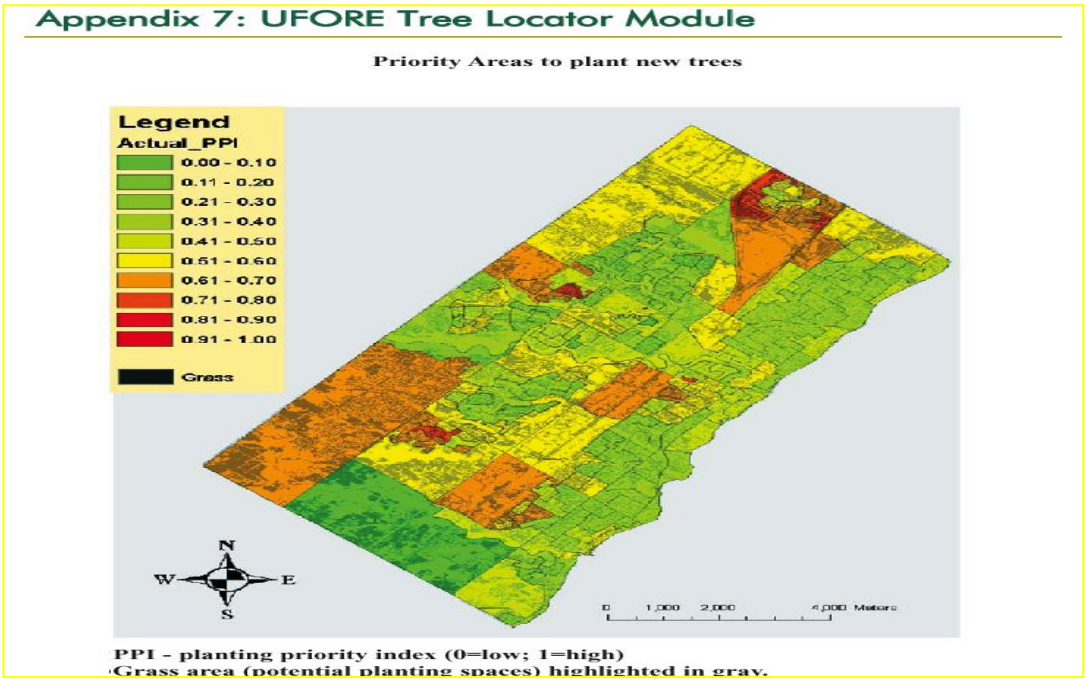
There are several important management and planning implications resulting from this project:

The UFORE Grow-out Module was used to establish a canopy cover baseline target for Oakville by looking at the future effects of tree mortality, tree planting, tree growth and land use change. The model simulated a 100-year canopy cover projection for Oakville. This indicates that the Town can attain an overall average of at least 40% urban forest canopy cover in 2046 (Graphic # 1) assuming a tree mortality rate of 2%, no re-planting and no land use change. Further work will be undertaken to refine these projections including a sensitivity analysis on the effects of tree planting and mortality rates on canopy cover. Mortality rate will be measured when the UFORE Project is repeated. According to the Strategic Plan for the Town of Oakville 2007-2010 this Project is planned for 2010. UFORE will also be re-measured every 5 years thereafter. In this way canopy cover has become one of the "performance measures" to track progress in attaining our Corporate Vision "to be the most livable town in Canada."



Graphic # 1: UFORE Grow-out Module. Mortality rates- 2%, 4%, 8% affect percent of tree and shrub cover

The UFORE Tree Locator Module indicates the best locations to plant trees in order to improve air pollution filtration as part of the Town's Street Tree Planting program. Forestry staffs use the UFORE Tree Locator Module in combination with the "Best Species for Air Quality Improvement" table that UFORE developed for Oakville to identify priority planting locations for our Park Naturalization program (Graphic 2). The top three species for air quality improvement in Oakville are tulip tree (*Liriodendron tulipifera*), American basswood (*Tilia americana*) and Japanese zelkova (*Zelkova serrata*)



Graphic # 2: UFORE Tree Locator Module.: Highest Priority areas for planting in red

Identifying the best locations and supplying the best species relies on proper tree habitat for success. "The urban forest canopy must be considered as an equal partner in the community infrastructure at the time of planning and not as an "add on" after the hard surface and utilities are accommodated" (Kenney, 2000). Sadly, this is not the case for the majority of urban sites throughout the Greater Toronto Area. Instead, urban trees are too often planted in a nutrient poor, compacted medium that is too small in volume to sustain large-stature trees: sometimes called 'tree coffins.' Compounding this challenge is the fundamental influence that the planner and the engineer have on tree habitat.

Forestry staffs have developed the following 'formula' when discussing UFORE results with these other municipal professionals:

(street) Tree Habitat = Zoning* + Engineering**

...where *Zoning is density and front yard setbacks and **Engineering is the municipal road cross section.

A paradigm shift in municipal urban form and engineering road designs can help contribute to Corporate urban forest objectives by leveraging the important role that these professional disciplines have on tree habitat. The *Planning Act* of the Province of Ontario requires that an official plan "contain goals, objectives and policies established primarily to manage and direct physical change and the effects on the social, economic and natural environment of the municipality. "The main policy document giving guidance as to what kind of place Oakville wishes to be – the character and quality of the Town - is the Oakville Official Plan. The policies relating to trees in the current plan are extensive and have served the Town well in the past. However, amendments to these policies are necessary to encourage enhanced tree cover in the future and to be specific as to how the objectives of enhanced tree cover will be achieved" (Urban Forest Strategic Management Plan, 2008). *Livable Oakville*- draft of the new Official Plan for the Town of Oakville, Section 12.10 states: "The Town considers its municipally-owned urban forest as green infrastructure."

Results and Discussion

A step forward to this end was the approval by Council of the Urban Forest Strategic Management Plan in 2008. This document established 24 Criteria and Performance Indicators for sustainable urban forest management. These Indicators will be used to track progress towards short term and long term objectives. These will be used to measure, monitor and evaluate implementation of the UFSMP at the end of each 5 year management plan period and update Town Council accordingly. One of the Indicators is "Canopy Cover." The long-term objective is for the Town to move towards achieving the "Optimal" level of Performance that is defined in the UFSMP as "75-100 % of the potential." Results from simulations of the UFORE Grow-out Module to assess "optimal" levels of urban forest canopy potential has lead to the creation of the following new Corporate Objective in *Livable Oakville*- draft of the new Official Plan for the Town of Oakville, Section 10.1.1(e):

"to progressively increase the urban forest to achieve a canopy cover of 40% Town-wide beyond the life of this Plan." (http://www.oakville.ca/Media_Files/planning08/Part_C_Making_Oakville_Livable.pdf)

This example of the dialogue within municipal Departments, which has been encouraged by both the UFORE and UFSMP Projects, demonstrates the power of synergy created by urban forestry and planning professionals.

"The Zoning By-law is primarily a mechanism to control land use. The Zoning by-law creates a number of zones or classes of land. The by-law establishes a range of uses permitted in each zone. In addition, the by-law establishes regulations that are applicable to each zone……. The Town shall establish regulations in the Zoning By-law that will require minimum planting areas capable of growing trees. This regulation will be applicable to commercial, employment, and institutional uses that are subject to site plan control. The planting area may be on lands used for parking and other hard surfaced areas, but if this were the case, the soil in the tree planting area would be amended with technically advanced products designed to support trees such as structural soils…

Development of land in urban situations typically has three components, all of which are regulated in the zoning by-law

- the area for building(s),
- the area for driveways and parking, and
- the landscape area

The landscape area consists of walkways, detention ponds, buffers, end islands associated with parking lots, and space adjacent to the buildings and it is the space to which trees are generally relegated. For many land use classifications, the landscape area is a relatively small component of the site (10%), and in some cases, the landscape area is "left-over" space, which may not be well suited to the planting of trees. Technological innovations with respect to tree habitat and soils now permit trees to be planted in areas where they traditionally have not been expected to survive and grow well. The use of products such as structural soils allows trees to be planted in parking lots and close to sidewalks and driveways. To achieve increased tree canopy cover, there is an opportunity to plant trees in and adjacent to parking lots. Unless the soils are amended, the long-term survival of trees in these locations is doubtful. With the introduction of structured soils and other measures to provide appropriate growing conditions for trees, the long-term health and survival of the tree is enhanced.

With respect to the objective of progressively increasing forest canopy to 40% across the Town, it is recommended that the Zoning By-law be changed to provide increased opportunity for the growing of trees. These changes would apply to land use classes that typically have extensive hard surface areas (for parking and driveways, etc) and consequently do not achieve significant tree cover. The change to the Zoning By-law would initially apply to commercial, employment and institutional zones that generally have relatively low proportions of tree cover. It may be appropriate to extend this regulation to medium and high density residential uses but it is recommended that further research be undertaken on recently approved site plans to determine a reasonably standard.

It is recommended that a zoning regulation be established to achieve a minimum tree cover canopy of the lot area. Initially it is suggested that the minimum tree canopy cover be established at 30% but that this be monitored over time to determine if 40 % is feasible. It is not recommended that the actual growing of trees be a provision that is regulated in the Zoning Bylaw. However, the Zoning By-law should have a regulation for "planting area for trees". This would be similar to other regulations such as a landscape area, parking space, and building area that are currently required in the by-law.

To minimize the impact of this provision on the viability of sites from a development perspective, it is recommended that the "planting area for trees" also permit uses that typically would not be expected to co-exist with trees. With the use of structural soils, trees could be planted in parking lots and adjacent to

driveways. The placement of trees in the parking area would have the effect of shortening the length of the parking space, which could be addressed in the Zoning By-law by providing a regulation for "short cars". Other than a reduction in the parking space length, no other negative effect on the number of parking spaces is expected.

The application of the "planting area for trees" regulation would apply to various land use classifications. Generally, the zoning provision requiring a "planting area for trees" could apply to any land use that is subject to site plan control. Initially it is suggested that this regulation would apply to employment, commercial and institutional zones, although it may be appropriate to also apply a similar standard to medium and high density residential zones." (Urban Forest Strategic Management Plan, 2008).

It is expected that over the next three years the Town's Zoning By-law will be reviewed. By having regard for tree habitat a municipal Zoning By-law can help achieve a Corporate Canopy Cover objective. To do so, it must adopt a paradigm shift that reflects an approach which reflects the following approach: "begin with the end in mind." The UFORE project measured Oakville's canopy cover by Land Use type (Graphic 3).

Percent of lot area for " Tree Growing Area" in each Land Use type

No.	Land use	Minimum % of lot area for " Tree Growing Area" *
1	Residential Low Density	47.8
2	Residential Medium Density	27
3	Residential High Density	27
4	Open Space (excluding woodlots)	26.9
5	Agriculture	10.2
6	Employment	7.4
7	Commercial	6.7
8	Parkway Belt	26.9

* A proxy for canopy cover

Table 5, page 19 Urban Forest canopy cover and available plantable space by Land use type, UFORE (Our solution to our pollution) report

Table16, page 24, Estimated increase in tree cover by 2086 in the Town of Oakville, Assessing urban forest effects and values, USDA

Graphic 3. Canopy Cover by Land Use type

For example, the current canopy cover for the existing Commercial Land Use type is 6.7% (No. 7) . An Urban Forest Policy contained in *Livable Oakville*, Section 10.1.1(d) is: "to maintain the existing urban forest." One way to help accomplish this is to consider the current canopy cover as a proxy for the "minimum percent of lot area for (the) 'tree growing area'" - which will be referred to as the "planting area for trees. By introducing a new regulatory term – the planting area for trees- planners can work towards drafting Zoning By-law regulations that contribute towards Corporate Canopy objectives. This can be accomplished by working backwards from an over-all Corporate canopy cover objective to calculate how much each Land Use Type must contribute in order to arrive at the weighted average canopy cover for the community. In other words, begin with the end in mind. The following example demonstrates how to apply this approach assuming an objective of "maintain the existing urban forest."

The current process is summarized as follows:

(A) ZONE	(B) Landscaping Regulation: Min. portion of lot area for "Landscaped Area" %	(C) "Landscaping" or "Landscaped Area" –Part B, General Provision applying to all Zones %	(D) (B) X (C) Result of Regulation: Minimum % of Lot reserved for trees
Commercial			
C1	10	10	1

For Commercial, C1 lands, the current Zoning By-law's Landscaping Regulation requires that a 'minimum portion of the lot for the purpose of Landscaping be 10%'; however, the definition of 'landscaping' includes such hard surface features as interlock pathways - only 10% of 'Landscape Area" must be treed. Overall, this results in only 1% of Commercial, C1 lands being reserved for trees.
Consider a paradigm shift which reverses the sequence as follows:

(A) ZONE	(B) (D) X (C) "Tree Growing Area" Regulation: Min. portion of lot area for "Tree Growing Area" - %	(C) "Tree Growing Area", General Provision applying to all Zones - %	(D) Result of Regulation: Minimum % of Lot reserved for trees
Commercial			
C1	6.7	100	6.7

Begin with the desired end result: 6.7% of Commercial, C1 lands must be reserved for trees in order to contribute to the Corporate Objective "maintain the existing urban forest." In this case the objective is a canopy cover of 29.1%. In this scenario, a new "tree growing area/ planting area for trees" is defined for exclusive use of the tree (100% utilization); therefore, an amended Zoning By-law could be drafted to regulate that Commercial C1 lands must have a minimum of 6.7% of the Building lot dedicated for a "tree growing area/planting area for trees." By repeating this exercise for selected Land Use types a plan to meet the corporate objective can been created.

This planning approach made reference to need for "Technological innovations with respect to tree habitat and soils…. The use of products such as structural soils [and Silva cells] allows trees to be planted in parking lots and close to sidewalks and driveways." This recognizes that the engineering profession can play a significant role in achieving the Corporate objective to increase canopy cover. The Town has two pilot street tree habitat projects using CU-(Structural) Soil. Future design efforts will look at the applicability of specifying engineered soils in standard drawings for a range of applications such as parking lots, public open spaces and road allowances.

Conclusions

The UFORE project helped established a baseline ‘performance measure’ for the Corporate Strategic Plan. In combination with the Urban Forest Strategic Management Plan 2008-2027 a solid policy foundation was built in the Town’s Official Plan in order help contribute towards meeting the Corporate Vision — "To be the most livable town in Canada." This demonstrates the influential role that the urban forest plays not only in promoting healthy communities but in contributing to a municipal government’s strategic planning. It also recognizes the synergies that can be attained among the planning, engineering and urban forest management professionals.

References

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