Communicating the BENEFITS OF THE URBAN FOREST in a municipal context

TOOLKIT PART 1

Green Infrastructure ONTARIO COALITION

Purpose

This toolkit was created to help urban forest managers communicate the benefits, or ecosystem services, provided by urban forests in Ontario to a municipal audience by using relevant and recent research. It presents several key messages, supporting references, and a list of useful resources that can be used to develop targeted communications campaigns.

When we effectively communicate the benefits of urban forests, we can help to generate funding for both the capital and operating costs of urban forestry. In turn, this can allow managers to leverage investment into better practices that will extend the lifespans of urban trees, thereby increasing the benefits they provide. A more complete understanding of the value of ecosystem services that flow from our forests can also inform discussions about the costs and expected outcomes associated with certain urban forest management practices.

While many municipalities in Ontario currently communicate the benefits that trees provide, the messaging has not necessarily translated into proactive management practices or desired outcomes. It is unclear if ecosystem service assessments alone are generating information relevant for decision-making[1]. Communications that connect the services provided by trees to the specific needs of a given municipality may ensure that the value of urban trees is more fully accounted for in decision-making processes. Ultimately, such information can be used by municipalities to make the case for trees as essential infrastructure that should be incorporated into asset management processes.

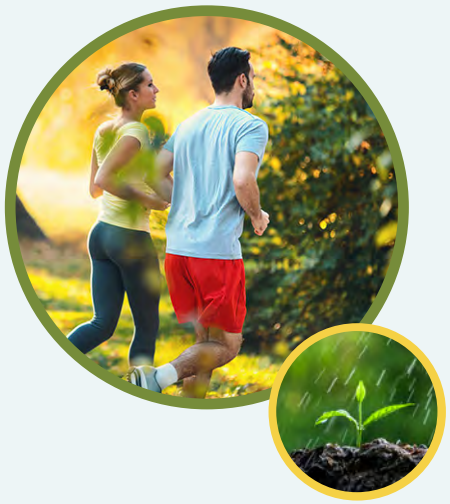
COMMUNICATING THE NEED FOR TREE PROTECTION AND STEWARDSHIP

Often decision makers focus on tree planting initiatives as the way to achieve urban forest benefits. The value of long-term tree protection and stewardship should be at the forefront of all communications about the benefits that trees provide.

[1] Martinez-Harms, M. J., Bryan, B. A., Balvanera, P., Law, E. A., Rhodes, J. R., Possingham, H. P., & Wilson, K. A. (2015). Making decisions for managing ecosystem services. Biological Conservation, 184, 229-238.

Using this tookit

Successful urban forestry campaigns have recognized the importance of targeting messaging to specific audiences. The economic, human health and environmental benefits of urban forests will appeal to different audiences. Care should be taken to consider the target audience, and adapt the message accordingly. This toolkit contains information that can be included in communication campaigns designed to generate greater support for urban forest management.



For more information on the strategies of different urban forestry campaigns, see the Sustainable Urban Forests Coalition's Scan of Urban Forestry Outreach Campaigns.

Ecosystem services provided by the urban forest

HEAT MITIGATION

Scientists project that by 2050, the average annual temperature in Ontario will increase by approximately 3.6°C, with more significant warming expected in Northern Ontario[2]. It is also expected that the frequency of **extreme heat days over 30°C will double by 2050** (12 to 26 days). These changes in temperature are expected to have significant human health impacts. For example, between 1996 and 2010, a 5°C increase in daily temperature in Ontario was correlated with 4 excess deaths daily[3]. Given future climate projections, there will be a greater need for municipalities to invest in strategies to increase resilience to extreme heat events.

A systemic review of recent studies found that trees are particularly crucial for reducing heat stress because of their ability to provide local/neighbourhood level cooling through evapotranspiration as well as shade[4]. Heat-related morbidity in the City of Toronto was found to be related to both tree canopy cover and hard surface cover[5]. This study demonstrated that even a marginal increase in canopy cover to 10% may reduce heat-related ambulance calls by up to 80%. Green spaces and treed areas in particular are one of the most promising heat stress mitigation measures in urban areas[6].

The heat mitigation and human comfort that trees can provide in an urban area, particularly in areas of high pedestrian use, will become even more important with climate change. Protecting and enhancing the urban forest is an investment in infrastructure that has the ability to provide known health benefits to citizens, particularly to the elderly and very young who are most vulnerable to extreme heat.

[2] https://www.ontario.ca/page/why-we-need-fight-climate-change [3] Chen, H., Wang, J., Li, Q., Yagouti, A., Lavigne, E., Foty, R., ... Copes, R. (2016). Assessment of the effect of cold and hot temperatures on mortality in Ontario, Canada: a population-based study. CMAJ Open, 4(1), E48–E58. http://doi.org/10.9778/cmajo.20150111 [4] David Suzuki Foundation (2015) http://www.ecohealth-ontario.ca/files/The_impact_of_green_space_on_heat_and_air_pollution_in_urban_communities_a_meta_narrative_systematic_review.pdf [5] Graham, D. A., Vanos, J. K., Kenny, N. A., & Brown, R. D. (2016). The relationship between neighbourhood tree canopy cover and heat-related ambulance calls during extreme heat events in Toronto, Canada. Urban Forestry & Urban Greening, 20(1), 180-186. [6] Yoshida A, Hisabayashi T, Kashihara K et al (2015) Evaluation of effect of tree canopy on thermal environment, thermal sensation, and mental state. Urban Climate 14(2):240–250. doi: 10.1016/j.uclim.2015.09.004

THERMAL BENEFITS OF THE URBAN FOREST

- shades grey infrastructure
- cools surface water
- cools air and land surface

- reduces heat stress on infrastructure
- reduces thermal pollution of waterways
- reduces the amount of heat absorbed by urban surfaces

- extends lifespan of grey infrastructure
- increases thermal comfort for humans
- decreases heat related illnessess

- reduces energy demand for air conditioning
- reduces pressure on healthcare system

Key Resources:

Adapting to Urban Heat: A Tool Kit for Local Governments (2012) - *Georgetown Climate Center*

The Impact of Green Space on Urban Heat and Air Pollution in Urban Communities: A Meta-narrative Systemic Review (2015) – David Suzuki Foundation

Reducing Urban Heat Islands: Compendium of Strategies (2014) – US EPA

Ontario Climate Change and Health Toolkit (2016) – Ontario Ministry of Health and Long-Term Care

STORMWATER

The urban forest provides the following stormwater benefits to municipalities:

- physically alters rainfall path and recharges groundwater
- retains rainfall in canopy at peak flow
- stabilizes soil
- reduces surface water contaminants

Climate change has caused an increase in rainfall events across Canada, with northwestern Ontario seeing a rainfall increase of up to 50% during the spring season. Summer rainfall in Ontario is expected to change significantly, and may range from 69 mm less to 48 mm more than baseline levels by the 2080s[7]. Furthermore, we can expect to experience much warmer winter temperatures (up to 10°C increases in northern Ontario) and more frequent and intense precipitation events in Southern Ontario by 2050[8]. These changes to the hydrological cycle will require proactive efforts by municipalities to protect water quality and prevent flooding in urban areas.

City	Change in Annual Precipitation (2020-2049)
Ottawa	-5% to 22.3%
Thunder Bay	-2.7% to 9.9%
Toronto	-0.4% to 13%
Windsor	-4.7% to 23.6%

Table 1: Projected changes in precipitation in for Ontario cities between 2020-2049 (Source: Ontario Climate Change Data Portal, 2016)[9]

Key Resources:

Urban Watershed Forestry Manual (2006) – United States Department of Agriculture
Stormwater trees technical memo (2016) – United States Environmental Protection Agency
Give me the numbers: How trees and urban forests really affect stormwater runoff (2017) – United States Department of Agriculture and San Antonio River Authority,
Stormwater to street trees (2013) – United States Environmental Protection Agency
Urban Stormwater Fees: How to pay for what we need (2016) – Environmental Commissioner of Ontario

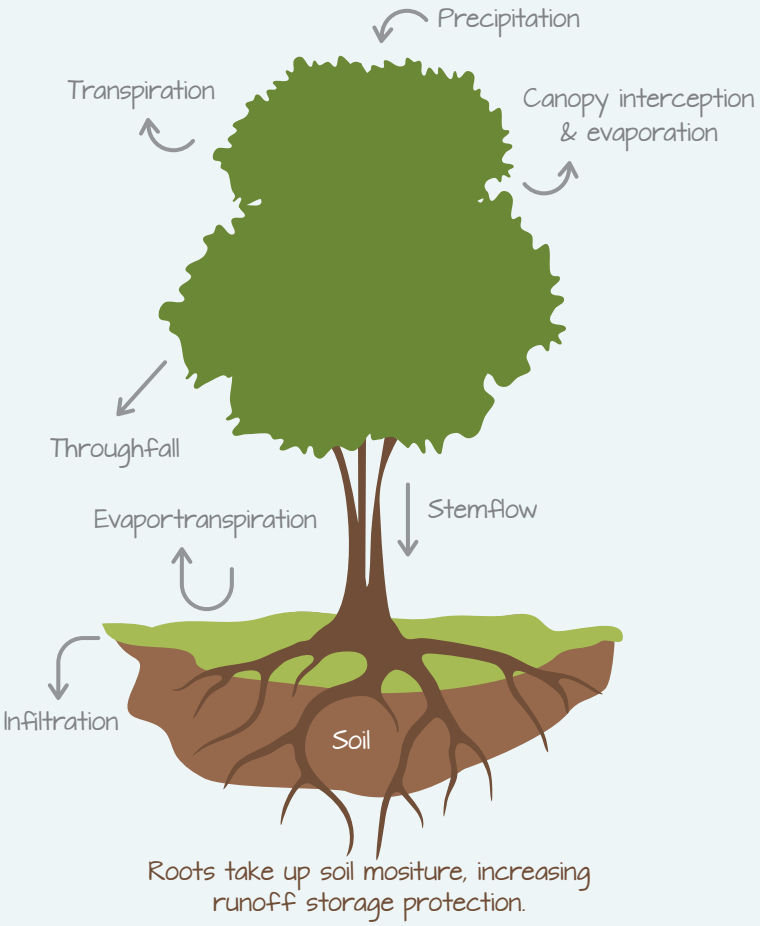
Urban trees and the soil they grow in impact rainwater and stormwater in many ways. Trees slow the rate of flow and reduce volume of rainwater transferred into municipal stormwater systems by rainfall retention in tree canopies, stemflow, throughfall, infiltration/percolation and transpiration. Urban soils are often highly compacted, leading to increased runoff. Tree roots allow water to penetrate the surface of compacted soil and can lead to infiltration increases of 69-354% under tree canopies. Incorporating trees into urban landscapes can substantially reduce stormwater runoff by improving infiltration. In experimental plots in Manchester, United Kingdom, tree pits containing small trees reduced runoff from asphalt control plots by 62%, and this reduction was largely attributed to infiltration into the tree pit[11].

[7] McDermid, J., S. Fera and A. Hogg. 2015. Climate change projections for Ontario: An updated synthesis for policymakers and planners. Ontario Ministry of Natural Resources and Forestry, Science and Research Branch, Peterborough, Ontario. Climate Change Research Report CCRR-44. [8] Ganguli, P., & Coulibaly, P. (2017). Assessment of Future Changes in Intensity-Duration-Frequency Curves for Southern Ontario using North American (NA)-CORDEX Models with Nonstationary Methods. arXiv preprint arXiv:1706.00122. [9] X. Wang, and G. Huang, (2013). Ontario Climate Change Data Portal. Website: http://www.ontarioccdp.ca [10] Kazemi Zadeh, M., & Sepaskhah, A. R. (2016). Effect of tree roots on water infiltration rate into the soil. Iran Agricultural Research, 35(1), 13-20.
[11] Armson, D., Stringer, P., & Ennos, A. R. (2013). The effect of street trees and amenity grass on urban surface water runoff in Manchester, UK. Urban Forestry & Urban Greening, 12, 282–286

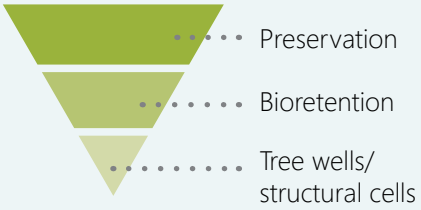
Larger trees provide greater stormwater benefits. Canopy size has also been linked to lag time between the capture of rainfall during storm events and the eventual throughfall to underlying surfaces[12]. Approximately 0.2 mm of rainfall can be held for every m^2 increase in leaf area[13].

Stormwater quality is also affected by the presence of trees. Nutrient pollutants such as Nitrogen and Phosphorous are taken up by urban trees, reducing the amount entering water systems. In one study, a treed area had stormwater concentrations (averaged over time) of Filterable Reactive Phosphorus (FRP) that were reduced by an average of 80% compared to unplanted control systems[14].

THE WATER CYCLE & TREES



The water cycle and trees. Adapted from US EPA's Stormwater to Street Trees, 2013



Recommended inclusion of trees in stormwater management best practices. Adapted from USDA and San Antonio River Authority (2017).

Municipalities in Ontario are facing a $6.8 billion stormwater management infrastructure deficit. The investments required to replace aging infrastructure are expected to be compounded by the added pressures of urban intensification and climate change. As infrastructure is replaced or repaired, municipalities should take every opportunity to incorporate trees and other forms of green infrastructure as part of an integrated approach to storm water management. The urban forest plays a key role in the hydrological cycle of cities and should be maintained as a critical infrastructure component of the urban water management system.

MINIMUM SOIL VOLUMES: DUAL BENEFIT FOR STORMWATER MANAGEMENT

It is well established that larger trees provide greater stormwater benefits. It is also known that to reach their full potential, trees require adequate soil volume and quality. A larger volume of quality soil is itself a tool for managing stormwater, making a strong case for municipalities to implement a minimum soil volume and soil protection policy.

[12] Livesley, S. J., B. Baudinette, and D. Glover. 2014. "Rainfall Interception and Stem Flow by Eucalypt Street Trees – The Impacts of Canopy Density and Bark Type." Urban Forestry & Urban Greening 13:192–97
[13] Teague, Aarin. "Give Me the Numbers: How Trees and Urban." San Antonio River Authority, https://www.fs.fed.us/research/docs/webinars/urban-forests/give-me-the-numbers/UFCFeb2017_TeagueSlides.pdf. [14] Denman, E. C., May, P. B., & Moore, G. M. (2016). The potential role of urban forests in removing nutrients from stormwater. Journal of environmental quality, 45(1), 207-214.

CO-BENEFITS

The strengths of urban forests as green infrastructure are not fully realized by considering their ability to address individual municipal infrastructure needs. It is just as important to highlight the co-benefits they provide to society at no additional cost. Depending on the audience, communicating a range of benefits of the urban forest may be useful. Listed here are a few of the many additional ecosystem services that urban forests provide.

CARBON STORAGE AND SEQUESTRATION

Urban forests in Canada removed approximately 662.8 kt C in 2012[15] and the cooling effect of trees may indirectly impact GHG emissions by reducing the demand for air conditioning during heat events[16].

AIR QUALITY

Every year, Toronto's urban forest intercepts 1,905 metric tonnes of air pollutants (valued at $16.9 million annually)[17].

SHADE

Shade from trees can help reduce the amount of UV-B reaching pedestrians and can be part of a municipal sun safety strategy[18].

[15] McGovern, Mark, and Jon Pasher. "Canadian urban tree canopy cover and carbon sequestration status and change 1990–2012." Urban Forestry & Urban Greening 20 (2016): 227-232. [16] Franco G, Sanstad AH (2008) Climate change and electricity demand in California. Climate Change 87(Suppl 1): S139–S151 [17] City of Toronto (2015) Tree Benefits (Sequestration) Information Staff Report to Parks and Environment Committee http://www.toronto.ca/legdocs/mmis/2015/pe/bgrd/backgroundfile-86019.pdf [18] Grant, Richard H., Gordon M. Heisler, and Wei Gao. "Estimation of Pedestrian Level UV Exposure Under Trees." Photochemistry and Photobiology 75.4 (2002): 369-376.

INTANGIBLES

Beyond physical health, urban forests provide many known benefits to human psyche and wellbeing. Even simple visual contact with plants and nature can improve human quality of life[19]. Time spent in greenspace has been shown to improve mental and physical wellbeing across a number of dimensions, from stress reduction to increased physical activity.[20, 21, 22, 23] Behavioral and therapeutic effects have been observed when exposing people with Attention Deficit Hyperactivity Disorder (ADHD), depression and dementia to nature[24, 25]. Increased feelings of happiness and lower diastolic blood pressure has be demonstrated among pedestrians walking through nature when compared to those walking along a city street[26, 27].

The study of our physiological response to green spaces and trees suggests that humans have evolved to have positive feelings toward the natural world. This theory, deemed *biophilia* by Edward O Wilson (1984), suggests that human evolution drives our desire to be around nature. With the known health and safety benefits of trees, there is strong support for this argument. Whatever the cause, the physiological and psychological responses of humans in nature is one of the greatest arguments for urban forest enhancement. A thriving urban forest makes for a more livable, enjoyable city.

Urban forests can also play a role in improving social health[28], i.e. the social connections within a community. As an example, the strength of social connections between neighbours has been linked to tree canopy cover, and the presence of trees can predict the amount of time that inner-city residents spend outside[29, 30]. The community building benefits that urban forests provide can make management of the urban forest easier, as a community's attachment to place can lead to more environmentally responsible behavior[31].

Key Resources:

A healthy dose of green – Trees Ontario (now Forests Ontario)
Examination of The Biophilia Hypothesis and its implications for Mental Health – Douglas Radmore, International Community for Ecopsychology
The human health and social benefits of urban forests – Dovetail Partners Inc

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[19] Grinde, B., & Patil, G. G. (2009). Biophilia: does visual contact with nature impact on health and well-being?. International journal of environmental research and public health, 6(9), 2332-2343. [20] Jiang, B., Chang, C.Y., & Sullivan, W.C. (2014). A dose of nature: Tree cover, stress reduction and gender differences. Landscape and Urban Planning, 132, 26-36. [21] Ohri-Vachaspati, P., Lloyd, K., Delia, D., Tulloch, D., & Yedidia, M. J. (2013). A closer examination of the relationship between children's weight status and the food and physical activity environment. Preventive Medicine, 57(3), 162–7. doi:10.1016/j.ypmed.2013.05.009 [22] Richardson, E. A., Pearce, J., Mitchell, R., & Kingham, S. (2013). Role of physical activity in the relationship between urban green space and health. Public Health, 127(4), 318–324. [23] White, M. P., Alcock, I., Wheeler, B. W., & Depledge, M. H. (2013). Would you be happier living in a greener urban area? A fixed-effects analysis of panel data. Psychological Science, 24(6), 920–928 [24] Clark, P, et al, 2013, Natural England Commissioned Reports, Number 137 53 [25] Kuo, F, et al, 2004, American Journal of Public Health, 94(9), 1580 – 1586 [26] Bird, W, (2007). Natural Thinking: Investigating the Links Between the Natural Environment, Biodiversity and Mental Health [27] Pretty, J, et al, 2005, International Journal of Environmental Health Research, 15(5), 319 – 337 [28] Nesbitt, L., Hotte, N., Barron, S., Cowan, J., & Sheppard, S. R. (2017). The social and economic value of cultural ecosystem services provided by urban forests in North America: A review and suggestions for future research. Urban Forestry & Urban Greening. [29] Holtan, M. T., Dieterlen, S. L., & Sullivan, W. C. (2015). Social life under cover: tree canopy and social capital in Baltimore, Maryland. Environment and behavior, 47(5), 502-525. [30] Coley, RL, FE Kuo, and WC Sullivan. 1997. Where Does Community Grow? The Social Context Created by Nature in Urban Public Housing. Environment and Behavior 29, 4:468-492. [31] Vaske, J. J., & Kobrin, K. C. (2001). Place attachment and environmentally responsible behavior. The Journal of Environmental Education, 32(4), 16-21.

Other Toolkits and Resources

ICLEI - Local Governments for Sustainability's TALKING TREES An Urban Forestry Toolkit for Local Governments

This document is a set of fact sheets on the benefits of the urban forest. Facts with citations for various end goals including air and water quality improvement. Key points for successful policy creation and management are included.

US Forest Service's Urban and Community Forestry Appreciation Tool Kit

This is another toolkit of communications surrounding the benefits of trees. The statistics sheets are good summaries of benefits and include citations. Much of the language used could be used for public education as well.

The Social and Economic Value of Canada's Urban Forest – A National Synthesis

This publication from the Canadian Forest Service and the University of British Columbia provides a high level overview of the social and economic values and benefits of urban forests in Canada.

Urban Green Infrastructure and Ecosystem Services

This recent brief (pdf link at bottom of page) released by the Parliamentary Office of Science and Technology in the UK discusses key ecosystem services in urban ecosystems and how to plan for green infrastructure.

Georgetown Law Toolkit for Green Infrastructure

This toolkit covers all green infrastructure but has a lot of urban forestry specific references. The toolkit is full of resources including a section on how to communicate green infrastructure strategies.

Using Plants to Provide Ecosystem Services

This how-to guide by Sustainable Plant Research and Outreach includes a lot of information about the ecosystem services that vegetation can provide and is a good source of support for both tree and non-tree components of the urban forest.

The Ontario Network on Ecosystem Services Guidance

This website is an inventory of guidance materials relevant to ecosystem services in Ontario.

The Sustainable Urban Forest

The section of this report on understanding urban forest benefits lists the many benefits of the urban forest and links to studies done on urban trees as Green Stormwater Infrastructure. It also provides a list of best management practices.

Urban Forestry/Urban Greening Research

This website has extensive information on ecosystem services that urban green spaces provide that can be used in funding proposals and reports relating to the many benefits of the urban forest.

Benefits of Trees and Urban Forests

A list of research on the benefits of the urban forest, with some summary statistics.

The value of Green Infrastructure

General benefits and economic estimates of tree planting on water, energy, air quality, climate change, the urban heat island and livability. Project examples included at the end of the document.

Why nature matters to health

An evidence review published by the City of Toronto. Discusses all green spaces, with some urban forest specific references.

Australia's 202020 Plan for 20% more green space by 2020

A fantastic compilation of communication resources for managers of the urban forest as well as the general public.

Case Studies

WASHINGTON DC

Washington DC provides credits toward stormwater fees for trees planted on private lands and trees preserved qualify for even higher credits. Both trees planted and preserved require a minimum soil volume of 1,500 cubic feet of rootable soil to be eligible for the credit.

PHILADELPHIA

The City introduced stormwater charges based on parcel size and amount of impervious surface. Part of the income from these charges pays for park staff who manage and educate on green infrastructure and urban forestry. By partnering with another department, the urban forestry department was able to make in-roads on private lands (through programs aimed at reducing impervious surface) and secure additional funding for staff.t.

BALTIMORE

The Baltimore Ecosystem Study is part of the The Long Term Ecological Research (LTER) Network that was created by the National Science Foundation (NSF) and is set up to obtain insight into the form and function of cities as ecosystems to better understand ecological services in cities.

Ontario groups working on Ecosystem services

ECOHEALTH ONTARIO

EcoHealth Ontario builds collaborations among the human health, social and environmental sectors with a common agenda to foster improved health and well being outcomes for Ontarians through the provision of better ecosystem quality, increased green space and enhanced access to nature.

SUSTAINABLE TECHNOLOGIES EVALUATION PROGRAM (STEP)

STEP is a multi-agency initiative developed to support broader implementation of sustainable technologies and practices within a Canadian context.

RAIN COMMUNITY SOLUTIONS

Rain Community Solutions work with municipalities, environmental groups, and property owners to reduce runoff and protect water quality by managing rain where it falls.

Green Infrastructure
ONTARIO COALITION

Let's make green infrastructure the new normal.

greeninfrastructureontario.org

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Growing Forward 2

AAC agricultural adaptation council

Ontario

Canada