ORRSC Periodical

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Urban Forests

An analysis of benefits, challenges, and municipal considerations.

An urban forest is the total inventory of trees and other vegetation within an urban area. Green assets provide a wide-ranging assortment of both quantifiable and intangible benefits to humans. These benefits, known as ecosystem services, are poorly understood by many, and as a result, trees are often undervalued by the public. Additionally, various development and environmental pressures threaten the well-being of Alberta's urban forests.

Oldman River Regional Services Commission

Introduction

Trees are ubiquitous natural assets that provide humans with a host of physical, environmental, and psychological benefits. The absorption of stormwater, mitigation of the urban heat island effect, dampening of noise pollution, fostering of biodiversity, sequestration of greenhouse gases and the beautification of urban areas are a few of the many benefits that trees can provide. These ecosystem services are inconspicuous in nature and are often overshadowed by some of the more visible drawbacks, such as the maintenance required for fallen leaves, the hindrance of views or the perceived risk they pose to structures. This periodical aims to summarize the benefits of urban trees along with the threats they face, and to inform municipalities about the land use implications of urban forests.

Ecosystem services

An urban forest is the total collection of trees, shrubs, grass, and other vegetation within a given urban area. Although every part of an urban forest is important, trees can be considered the workhorses of urban forests in terms of benefits provided and will be the focus of this periodical. Trees can be sorted into two general categories—coniferous and deciduous. Coniferous trees are identified by their small, needle-like leaves that remain all year round. Deciduous trees bear flat, broad leaves that change colour and fall off annually. In an urban setting, coniferous trees are beneficial because of their ability to screen properties from dust, noise, and other disturbances, on a year-round basis. The value of deciduous trees is found in their expansive leaf and canopy area, and because the magnitude of ecosystem services provided by individual trees is largely determined by the canopy size and total leaf area, deciduous trees deliver more ecosystem services per tree than their coniferous counterparts.

Ecosystem services are tree functions that enhance and support human existence. Certain ecosystem services such as stormwater absorption, carbon dioxide sequestration and air pollution removal can be assigned a dollar value because the same function would otherwise have to be delivered by engineered infrastructure with a known cost. The USDA Forest Service developed MyTree, part of its i-Tree suite, to quantify the empirical benefits of individual trees by assigning a dollar value for each service. MyTree uses species, trunk diameter, and condition as the input parameters to estimate each function. Generally, the level of ecosystem services provided by individual trees is dependent on both their total leaf area and canopy area; mature, large trees, with large leaves, offer the highest level of ecosystem services. While MyTree can be useful for small-scale evaluations, the overall benefit provided by urban forests is better conveyed by Urban Tree Canopy (UTC) coverage, which measures the percentage of ground area covered by tree crowns when viewed from above. This metric is useful because it indicates the general level of ecosystem services provided by an urban forest in a given area. Municipalities commonly set UTC targets to track urban forest growth progression (e.g. increasing UTC from 13% to 20%).

MyTree Benefits

Over 20 years.

American elm, *(Ulmus americana)*

Serving Size: 48.00 in. diameter
Condition: Excellent
Location: Lethbridge, Ab, Canada
Expected i-Tree benefits over 20 years: $52.79

Carbon Dioxide Uptake	**$40.36**
Carbon Sequestered[1]	1,113.58 lbs
CO_2 Equivalent[2]	4,083.11 lbs
Storm Water Mitigation	**$9.47**
Runoff Avoided	1,059.56 gal
Rainfall Intercepted	509,934.88 gal
Air Pollution Removal	**$2.96**
Carbon Monoxide	0.53 oz
Ozone	492.69 oz
Nitrogen Dioxide	31.82 oz
Sulfur Dioxide	0.41 oz
$PM_{2.5}$	14.88 oz

Benefit estimates are based on USDA Forest Service research and are meant for guidance only. Visit www.itreetools.org to learn more.

Pictured above is the estimated dollar value of ecosystem services provided by a large American elm tree in Lethbridge, over a period of 20 years, as calculated by MyTree (figures in US dollars). It should be noted that while the benefits provided by individual trees may not be overwhelming, the number of trees in an urban forest can range from thousands up to several million in large urban areas.

Image credit: Gilles Beaudry

Ruelles vertes (green alleyways) are select alleys in Montreal that have been revitalized with trees, grass, and vertical plants. These projects are approved by local governments but carried out by residents. The alleyways remain functional for vehicular traffic while helping mitigate the urban heat island effect.

Urban heat island effect

The built environment of urban centres provides a host of goods, services, housing, and the ability to easily travel between these opportunities via transportation networks. However, a symptom of the proliferation of hard surfaces in urban areas is heightened temperature. Impermeable materials like asphalt and concrete have a propensity to absorb and radiate the sun's energy. This phenomenon is known as the urban heat island (UHI) effect. The surface temperature of developed areas with high concentrations of grey infrastructure such as commercial and industrial districts, has been shown to be upwards of 10 degrees Celsius warmer than nearby land with higher levels of vegetation coverage. The heat saturation of urban areas during extreme heat events has pushed far beyond the realm of discomfort. An upward trend of illnesses and deaths related to extreme heat events prompted the federal government to identify urban heat islands as a public health risk. Published in 2020, "Reducing urban heat islands to protect health in Canada" is Health Canada's guidebook for public health professionals and urban planners to help address the adverse effects of urban heat islands through various green infrastructure initiatives. The guidebook establishes UHIs as a threat to human health, and highlights case studies in municipalities across Canada that utilize urban forests and other green infrastructure to mitigate externalities related to extreme heat.

While the document references some experimental and innovative solutions to cool cities, such as green alley initiatives in Montreal, there are also several examples of one of the quintessential aspects of urban forests—boulevard trees. Boulevard trees (i.e. street trees) are planned rows of medium to large deciduous trees that parallel streets on centre medians or road right-of-ways. In southern Alberta, American elm (Ulmus americana) trees are commonly found in boulevards because of their expansive, umbrella-like canopy, and hardiness towards the region's difficult climate. At full maturity, evenly spaced trees can easily provide shade for an entire residential-sized street. The cooling effect of shade cover is easy to understand and experience; the canopies of trees intercept and prevent the sun's radiation from directly warming people and impermeable surfaces. Additionally, evapotranspiration—the process of moisture migrating from plants and permeable surfaces into the atmosphere—works simultaneously with shade cover to provide a more habitable environment in urban areas during times of intense temperature and sunlight.

Historical context

Whether it be large cities in Alberta such as Edmonton, Calgary, or Lethbridge, or smaller urban centres like Brooks, Nanton, or Barons, a common feature of the mature neighbourhoods in these municipalities is the abundance of trees. Generously sized lots, front yards, and grass boulevards provided ample room to plant large-species trees on both private and public

land. Many of the trees planted prior to WWII are still alive today, and provide the bulk of the ecosystem services in the municipalities where they stand. The emphasis on integrating nature into urban areas was a purposeful reaction to the unhygienic and melancholy living conditions experienced in rapidly industrializing cities throughout the latter half of the 19th century. The "Garden City" planning movement, initiated by Ebenezer Howard in 1898, was seen as a solution to many of the hardships experienced in industrialized cities. Howard's Garden City concept emphasized the integration of urban development with natural landscapes to create healthy, self-contained communities. Its design principles included abundant green spaces, tree-lined streets, parks, and agricultural belts that surround and connect neighbourhoods.

The Town of Magrath adopted "The Garden City" as its official motto, a name it shares with the movement that was taking shape in Britain during the same period. Although Magrath's layout of 10-acre blocks in a grid pattern is more emblematic of the traditional 'Plat of Zion' planning philosophy used in Mormon communities, the town emphasizes the confluence of natural and urban environments espoused by Garden City planning, through highly treed areas, abundant green spaces, expansive recreation networks, and varying housing densities. While urban areas designed specifically around the Garden City philosophy are rare in Alberta, the impact the movement had on the formation of urban areas across the province is evident. Neighbourhoods developed in the early 20th century almost universally have the highest share of tree canopy coverage within their respective municipality. A strong urban forest is reliant on mature deciduous trees. Species with expansive canopies provide the bulk of ecosystem services, shade, and ultimately, the feeling of being in an urban forest. Because of the purposeful planting of trees carried out by previous generations, the concentration of canopy coverage in urban municipalities across Alberta is heavily skewed towards older neighbourhoods.

Threats and challenges

A challenge experienced by communities throughout Alberta is the inverse relationship between tree canopy coverage and the era in which a neighbourhood was developed; the younger a neighbourhood is, the less UTC coverage it tends to have. The decline of urban forests in newer neighbourhoods can be attributed to two factors. Foremost, new neighbourhoods generally do not have boulevard trees. There is no permeable buffer separating the sidewalk from the road, and often there is no sidewalk. Trees have been pushed out of the road right-of-way to accommodate more asphalt. In the absence of boulevard trees, the burden of providing canopy coverage lies with private landowners. This leads to the second issue: private landowners and developers are not planting large canopy trees. The argument that new neighbourhoods have low rates of UTC coverage because the trees have lacked sufficient time to reach maturity is only a partial explanation. Developers and landowners have been intentionally planting smaller species trees and shrubs because they

A feature of trees atypical of conventional infrastructure is that their value and usefulness increase exponentially with age. Large species deciduous trees require several decades (20–40 years) to reach full size and maturity. Trees' reliance on time underscores the importance of long-range urban forestry planning and preserving mature trees.

The Hargrave Tree was planted in 1888 by pioneer James Hargrave. This towering plains cottonwood (Populus deltoides) has lived well beyond the typical life expectancy for its species and is believed to be the first tree planted in the City of Medicine Hat. It is one of several heritage trees in the City recognized by the Alberta Heritage Tree Project. The value of certain trees to the urban society they inhabit is indisputable, and where a tree warrants formal recognition, a municipality can opt to designate it by bylaw as a municipal historic resource in accordance with the process established in the Historical Resources Act.

Examples of mature street trees in the Town of Nanton (top) and the Willow Creek Business Park (bottom). Planted decades ago, these trees now form continuous canopies over entire blocks—providing shade during the hottest weeks of summer along with a level of ecosystem services that would take a newly planted streetscape half a century to replicate. Commercial and industrial areas are often without the benefit of trees—exacerbating the effects of the dust, noise and smells typical of these areas. All land use areas, not just residential developments, have the opportunity to benefit from a municipality's persistence in developing and maintaining tree canopy.

require less maintenance, water, and space. Low-maintenance greenery has been deemed more favourable by developers than the expansive canopy trees that adorn the neighbourhoods of previous generations. Trees in new neighbourhoods are seen as beautification tools, not providers of ecosystem services. Living harmoniously with nature has been overshadowed by increasing development pressures.

Besides maximizing canopy coverage, another challenge that arises in maintaining and growing an urban forest is ensuring diversity within the municipal tree inventory. This is because urban forests with strong species diversity are more resilient to disease, pests, and extreme weather conditions. Dutch elm disease, a fungal pathogen, and emerald ash borer, an invasive wood-boring beetle, have devastated elm and ash populations across eastern Canada and the United States. A historical overreliance on ash and elm trees leaves Alberta exposed—more than one-third of Lethbridge's urban forest is made up of these species. A diverse forest is less likely to be overwhelmed by a single environmental threat.

What municipalities can do

Municipalities are often the largest single owner of their jurisdiction's urban forest through the possession of assets such as parks, boulevard trees, and other green spaces. The stewardship and growth of the public portion of an urban forest is relatively straightforward; municipalities can formalize their commitment to protecting publicly owned trees by implementing policies, bylaws, or programs that protect and augment their urban forest. Strathcona County, directly east of Edmonton, utilizes a public tree management directive to establish its stance on urban forests. The directive is a simple, three-page document that outlines the importance of urban forests and clearly states when the removal of trees will and will not be considered. Improving views, reducing shade, avoiding fall leaves and insects, and deterring wildlife activity are not deemed valid reasons to remove public trees, including in Sherwood Park, the County's urban hamlet.

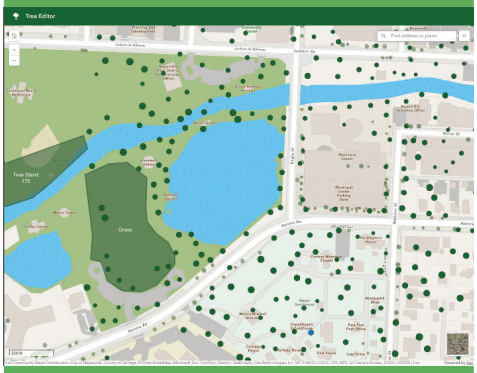
The City of Edmonton has embedded the goal of increasing its urban forest by two million net trees in its municipal development plan. The City hopes to achieve this goal with its Public Tree Bylaw and its grassroots tree-planting program, Root for Trees. The program is largely volunteer-driven and attempts to plant 35,000 trees per year on publicly owned land. As in many municipalities, the City's public inventory of roughly 400,000 trees only represents a fraction of the approximately 12.8 million trees that make up its urban forest. Consequently, protecting urban forests becomes the shared responsibility of hundreds of thousands of private landowners. Municipalities are hesitant to introduce private tree protection bylaws or policies because of fears of impeding development and infringing on landowners' rights. Although municipalities stringently regulate most forms of land use and development, trees are often not addressed, even in landscaping standards sections of the land use bylaw. One exception is the Town of Claresholm, where at least one tree must be planted in front

yards of low-density residential districts. While the species or size of trees planted is not explicitly stated, additional regulations such as requiring a 50:50 proportion of coniferous and deciduous species, and a mix of tree sizes, compound with each other to promote tree diversity at the individual lot level. Reinforcing tree quantity regulations with size and species requirements can help ensure that small ornamental trees are balanced out with large canopy species. The Municipality of Crowsnest Pass adopts a different approach by listing "tree felling" as a discretionary use in its land use bylaw. Within certain land use districts, the removal of trees within the prescribed minimum setback requires a development permit. Regulating the removal of trees near streets, but not in the buildable area of a parcel, aims to strike a balance between preserving the public benefit of trees and granting landowners autonomy over the development of their land. Whether through land use bylaws or through planning policy, municipalities have many options available to influence tree canopy in both the public and private realms.

If a municipality decides that preserving and growing its urban forest is valuable, an increasingly common approach is to adopt an urban forest management plan (UFMP). These plans often contain an estimate of total tree canopy coverage, a summary of species, goals, challenges, and an overall direction to grow and maintain the urban forest. The City of Lethbridge's UFMP is a strong regional example of what a tree management strategy can incorporate. Alongside the usual contents, Lethbridge's UFMP includes details about meteorological challenges distinct to southern Alberta, such as extreme wind and frequent drought conditions. The combination of extreme heat, intense wind, and low precipitation results in challenging growing conditions that prevent many species from thriving and can frustrate the objective of maintaining a diverse urban forest.

Concluding remarks

Urban forestry is a complex and relatively new field of study with dozens of tangential topics. While not a comprehensive review, this publication aims to shed light on the benefits, issues, and municipal considerations that urban forests face. Large, mature trees continue to prove their value by helping urban areas cope with increasingly severe rainfall and heat events. Despite this, large species trees are on the decline in many new neighbourhoods because of the desire for less maintenance, and possibly because of the lack of awareness of the benefits they provide. Undertaking an inventory of existing tree assets is a first step to providing a framework necessary to analyze what exists now and its change over time. The visioning, goal setting and policy development aspects of a municipal development plan process then provide an opportunity to entrench a municipality's position on urban trees, after which an implementation approach can be explored through the land use bylaw and other documents. Ultimately, municipalities have the ability to regulate, maintain, and bolster their urban forest in a variety of ways if urban forestry is deemed a priority.



The ArcGIS Tree Management Tool is an example of a typical tree inventory system. Attributes of each tree such as trunk diameter, species, and condition are recorded by field technicians and then uploaded to the inventory. Knowing the quantity, type, and location of all public trees gives municipalities a strong starting point to manage their urban forest.

For more information on this topic contact admin@orrsc.com or visit our website at orrsc.com.

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