

A framework for strategic urban forest management planning and monitoring

Abstract

With global climate change, ever-increasing urban populations and rapidly spreading invasive species and pests, the challenges facing urban forests today are immense. To address these challenges and achieve true sustainability, urban forest management programmes need to transition from a reactive maintenance approach to one of proactive management. The clear solution is collaborative, long-term, strategic urban forest management planning. This paper outlines a three-tiered planning framework comprising a high-level, 20-year strategic plan, with four five-year management plans, and 20 annual operating plans. The concept of active adaptive management is firmly embedded in this framework, providing managers with the opportunity to review the successes and shortcomings of their management activities on a systematic basis, and integrate new approaches or address new issues as required. The framework is further supported by a comprehensive set of criteria and indicators for performance assessment. These 25 criteria and indicators support the process of adaptive management by providing clear and consistent measures by which progress can be gauged, and are positioned as tools for improving the development and implementation of urban forest management plans over time. Finally, the flexibility of the framework and its applicability at different scales is highlighted with several case studies, including the development of strategic urban forest management plans for municipalities and golf courses.

Introduction

The benefits provided by healthy and well-managed urban forests are far-reaching and extensively documented (e.g. Dwyer *et al.*, 1992; McPherson, 1994; Simpson, 1998; Kuo, 2003; Wolf, 2004; Donovan and Butry, 2010). There are, however, many challenges currently facing trees in urban and peri-urban areas. Generous estimates suggest that the average lifespan of a typical urban tree is 32 years and that many newly planted trees do not survive their first year (Moll and Ebenreck, 1989). A number of factors contribute to such dismally short lifespans and, as a result, few urban trees are ever able to reach their full genetic potential to provide important social, economic and environmental services for urban residents.

Cities and their surrounding areas are complex and dynamic entities. A wide range of decision makers, stakeholders and interest groups are active in setting the agenda in most communities, and urban forest managers must compete with other interests for limited resources. In spite of the additional challenges posed by invasive species, development intensification, climate change and other stress factors, a solution to effective urban forestry in this context lies in good planning that balances the need for immediate action with the need for a long-term vision. Effective planning can support the development and implementation of proactive, as opposed to reactive, management approaches in a strategic and collaborative fashion. Proactive management leads to tangible results in the form of increased operational efficiency, risk reduction, increased urban forest canopy and leaf area, and, perhaps most importantly, the sustained provision of ecological, social and economic benefits to urban residents and the greater environment.

The first part of this paper outlines the context for urban forest management planning and presents an effective 20-year planning framework for use in the development of urban forestry strategies. The second part builds upon the work of Clark *et al.* (1997) and demonstrates how a comprehensive and practical set of monitoring criteria and indicators tailored to assess urban forest sustainability can improve management planning and

Keywords:

adaptive management, canopy cover, criteria and indicators, municipal planning, relative canopy cover, sustainability, urban forestry

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implementation. Finally, the paper explores how these tools have been applied in southern Ontario, Canada, to work towards achieving true urban forest sustainability in communities of various sizes.

The context for urban forest management today

The challenges to growing and maintaining healthy urban forests are numerous and, by necessity, must be addressed on a long-term horizon. Urban foresters must remember that they work on 'tree time'. Trees are a long-term investment, and successes and failures are rarely realised overnight because trees can take years to respond to stress factors or improvements designed to promote their health and longevity.

From a basic biological perspective, cities are difficult places to grow trees. Unlike in forests (where we all too often forget that trees come from), urban soils are typically of poor quality, limited in volume, and can be effectively sterile or even contaminated. Often heavily modified, urban tree rooting environments are typified by low biological activity, poor nutrient availability, compacted pore space and a number of other problems (Urban, 2008). Simply put, good soil is in short supply. Furthermore, trees must compete for space with various forms of built infrastructure, such as roads, buildings and sewers. In many jurisdictions, these grey infrastructure components take precedence over trees and other forms of green infrastructure, which are seen as additional niceties to be included in urban designs where feasible and when budgets permit.

Compounding the difficulties associated with poor-quality growing sites and inadequate soils is the reality of urban intensification and development. In 2011, the world population is expected to exceed seven billion, with over half now residing in towns and cities (UNFPA, 2010). This influx of urban citizens places increasing stresses on existing trees and makes urban land a premium commodity. In many areas, planning regulations require intensification in urban centres and settlement areas in an attempt to curb urban sprawl. Paradoxically, this leaves little room for trees in the very places where they are most beneficial.

Finally, the additional stress factors presented by climate change will continue to affect urban forests (2degreesC, 2007; Colombo, 2008; Galatowitsch *et al.*, 2009). In highly urbanised communities, climate change-related events such as periods of extended drought, extreme winds, high temperatures and shifting species distribution patterns for

both native and invasive species will further strain already thin operating budgets.

The challenges outlined above, including poor urban soils, intensification and climate change, are just three of many factors weighing against urban forest sustainability. Others include invasive species, pests and pathogens, limited knowledge of proper tree care practices, poor public perception of trees, and inadequate maintenance and management practices, among others. No matter what the threat, it is clear that attention needs to be given to planning for the future health and enhancement of the urban forest resource in any community, as was previously noted by van Wassenauer *et al.* (2000).

Any efforts to proactively manage urban forests to provide the greatest amount of benefits requires a targeted, strategic approach that is collaborative in nature and considers the wide range of stakeholders with interests in urban forest sustainability. Providing a framework for such a planning approach is one of the central objectives of this paper.

A strategic framework for urban forest management planning

While the pace of daily life in urban areas is often accelerated, trees in cities can be relatively slow to respond to physical damage and environmental changes, whether they are negative or positive. Similarly, municipal governments are rarely, if ever, able to quickly summon the financial and human resources necessary to make meaningful changes to urban forest operations and management. As a result, a long-term planning horizon is needed in order to outline required action items, prioritize implementation and accommodate long-term budget planning. Even with the best laid plans, unexpected occurrences such as long-term droughts, invasive pests, or worsening economic circumstances may force significant reprioritisation of short- and medium-term operations. Planning on a longer time horizon can ensure that strategic objectives are still met.

Planning horizon and temporal framework

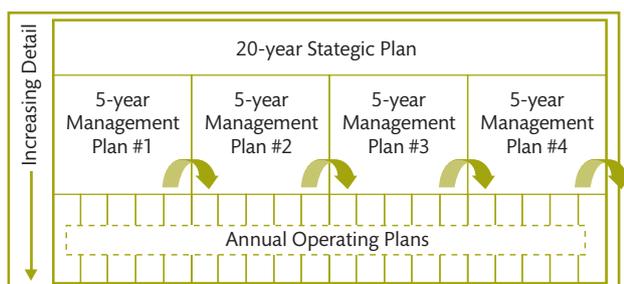
A number of municipalities in southern Ontario, Canada, have determined that a 20-year horizon is appropriate for planning a sustainable and healthy urban forest, and have developed plans using this framework. This timeframe enables short- and medium-term financial and organisational planning, while maintaining an established overall strategic direction that will remain unchanged and

thus enable the community's vision for its urban forest to become realised.

While a long-term planning horizon is necessary to achieve urban forest sustainability, shorter-term objectives and day-to-day operations must be supported by more readily implementable directives. Therefore, an effective urban forest management plan must make clear links between long-term strategic directives, medium-term priorities, and day-to-day operational activities such as tree pruning or establishment.

This can be achieved through a three-tiered temporal framework (Figure 1) for urban forest management planning, wherein a 20-year strategic plan is divided into four five-year management plans, which are further subdivided into annual operating plans.

Figure 1 Temporal framework for a strategic urban forest management plan.



The highest level of the urban forest management plan sets out the vision, goals and objectives to be achieved by the end of the planning horizon. This 20-year strategic plan can be developed as a separate document from lower-level plans, and should provide connectivity to other relevant strategic documents and policies in the community. A vision, strategic objectives and guiding principles should be developed in consultation with municipal staff, community members and other stakeholders such as local land developers, environmental groups and organisations, and representatives of other levels of government (e.g. regional councils). These goals and vision should guide the overall direction of plan development, and must therefore be developed early on in the process.

Effective urban forest management requires an end goal – a reason to justify the expense and complexity associated with the undertaking. While every community will develop its own vision for what its urban forest should look like and what benefits its residents will enjoy, a workable guiding objective is presented below, stating that the goal of any community's urban forestry programme should be:

To optimise the leaf area of the entire urban forest by establishing and maintaining a canopy of genetically appropriate (adapted and diverse) trees (and shrubs) with minimum risk to the public, and in a cost effective manner.

Nested within the 20-year strategic plan are four five-year management plans. Each of these will be the first level of operational planning and represents the link between high-level strategic objectives and on-the-ground management activities. This level of planning also presents the opportunity to implement active adaptive management, defined by the Millennium Ecosystem Assessment project (2005) as:

A systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices. In active adaptive management, management is treated as a deliberate experiment for the purpose of learning.

This concept recognises that urban forests are complex, dynamic entities and that while managers may not always be able to predict changes they must be prepared to accommodate such changes while still working towards broader goals for the management of the resources in their care. Through active adaptive management, a problem is first carefully assessed and a strategy or approach is designed and implemented to address it. The results of the approach are then monitored in a systematic manner and any adjustments are made based on the experience gained and new information that has become available. The adjusted approach is implemented and the evaluation cycle continues for as long as is necessary to accomplish the goals or to accommodate changing environmental, social, or policy directions. This is achieved through the review of each five-year management plan near the end of its planning horizon, and subsequent five-year management plans are based upon the results of these reviews. Therefore, the intention is not to attempt to develop all four plans at once, but to develop them sequentially in response to lessons learned and, if applicable, changing priorities. This is represented graphically by the arrows connecting each five-year management plan shown in Figure 1.

The final level of planning is the annual operating plan, which directs day-to-day operations and can be used to project budget requirements for all aspects of maintaining the urban forest. Each annual plan may include detailed plans for tree establishment, pruning, removals, inspections and maintenance of the tree inventory. Such activities should be guided by directions outlined in the strategic and five-year plans. Initially, annual operating plans will need to

address priorities derived from a community's tree inventory, but, as these are addressed over time, more effort can be focused on proactive management objectives. Annual operating plans can be integrated with a community's asset management system and GIS information technology to optimise resource allocation. For example, planting locations can be mapped on a municipal GIS to inform all related staff about the future location of street or park trees to help plan future maintenance activities.

Key urban forest management elements

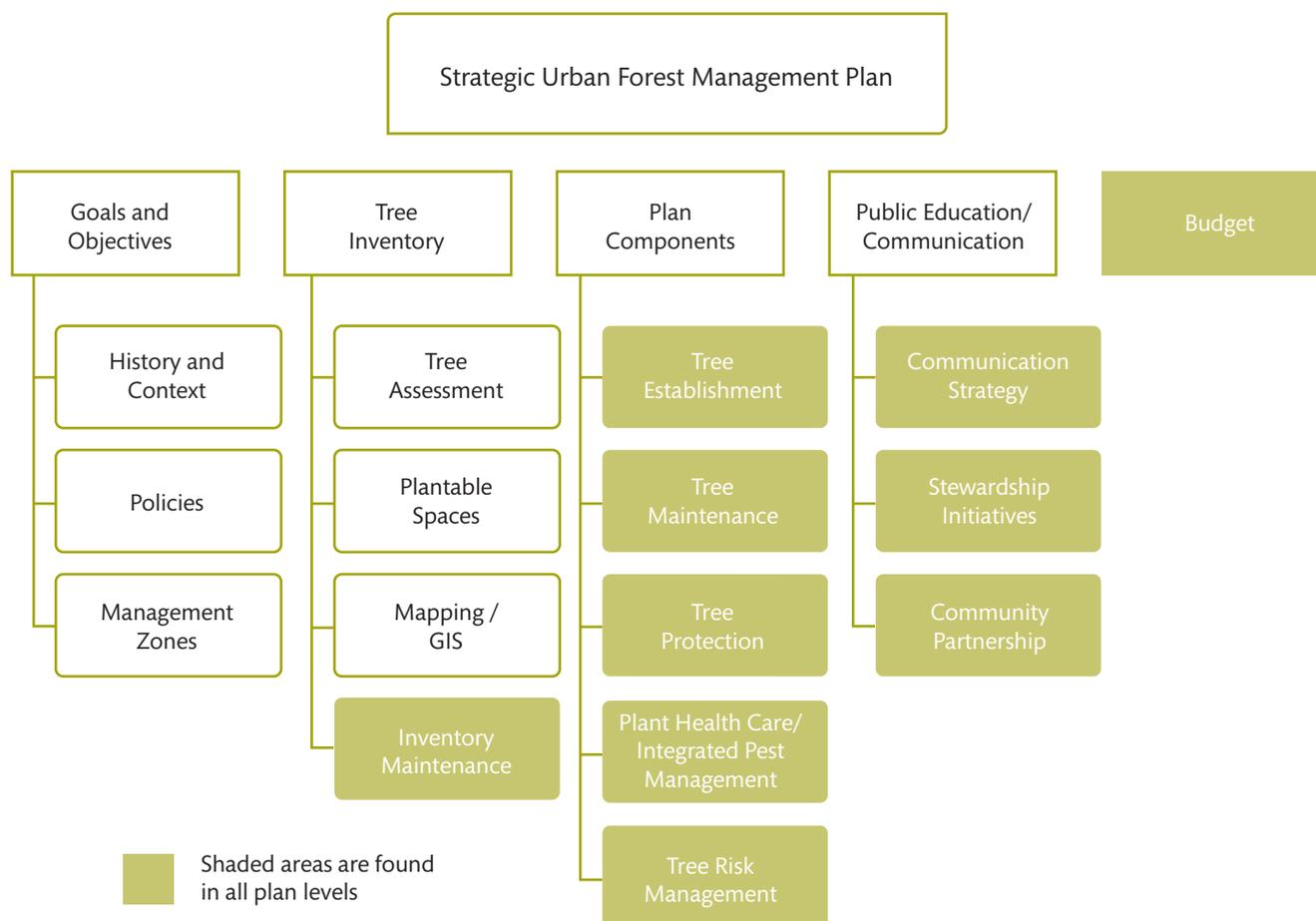
Several key themes and issues should be addressed as components of any urban forest management plan, and some must be addressed at all three (20-year, five-year and annual) planning levels. The content and scope of each plan component can vary depending on a variety of factors specific to the community undertaking the planning process. These factors may include the community's urban forest objectives; its historical, current and anticipated land use cover; the degree to which it has already begun to

undertake urban forest management; available resources; the level of stakeholder and community interest; and the willingness of the community and its residents to invest in the local urban forest.

Figure 2, below, represents the basic structure of a typical urban forest management plan developed using the framework outlined in this paper. The top row (the overall plan) is divided into five key components, which are further subdivided into different topic areas, or planning components. As stated, these will vary and should be tailored to each municipal context.

As noted above, some of these components (shaded in Figure 2) are addressed at each planning level. To illustrate how these components can be addressed at each level, let us consider the example of tree establishment. On a long-term horizon (20-year strategic plan), the plan can set long-term objectives such as increasing species diversity, developing improved tree planting standards, or increasing tree canopy cover through tree planting. At the medium-term (five-year management plan) level, the plan can commit to implementing pilot projects to test new tree

Figure 2 Typical components of a strategic urban forest management plan.



species or planting methods, or might identify particular locations for targeted planting to provide specific benefits (e.g. more trees in urban heat island areas). At the annual operating plan level, operations staff might prepare planting lists and locations for next year's plantings to ensure adequate budget and staff allocations that address the mid and long-term objectives.

Conversely, other components (not shaded in Figure 2) may or may not need to be addressed at each planning level. For example, there may not be a need to plan for coordination with higher level management policies during day-to-day operations, and these would therefore not be considered in the development of an annual operating plan.

In order to effectively develop and support recommendations designed to improve urban forest management, each plan component must contain four elements to inform the recommendations. The first element is a review of current management practices and policies in the community, with regard for the particular subject area in question. The second is a review of relevant 'best management practices' from scientific and technical literature and precedents from other jurisdictions. The third component should compare the current status to best practices, and identify gaps and opportunities for improvement. Finally, the fourth component should review and consider input and ideas from the various internal and external stakeholders, typically garnered through a multi-part consultative process. This information provides the background and rationale for recommendations and resource requirements proposed in the management plan.

The key sections of a typical urban forest management plan are outlined in more detail, below.

Urban forest/tree inventory

As is the case with any renewable resource, an inventory is an essential tool for the development of management strategies. It will identify details of the structure of the urban forest, which are necessary for the planning of management activities to achieve specific goals. These details may include species composition, the mixture of native and non-native species, age structure, tree condition, location, size, management history and habitat. Inventories may also reveal other valuable assets such as the presence of rare or endangered species that may otherwise be overlooked. A wide range of inventory options are available, from basic street tree assessments to broader urban forest resource analysis studies (e.g. i-Tree Eco), which can provide a better understanding of urban forest structure and function in both

the public and private realm. The type of inventory used may also vary depending upon the extent of urban forest management in a given area. For example, intensively managed zones such as streets may have a higher level of inventory detail (e.g. individual tree assessment) than extensively managed zones such as natural areas (e.g. forest stand inventory or ecological classification).

Communities with well-developed inventories may develop much of the management direction based upon the results of such studies in this section of the plan. Communities with limited or no inventories may direct the plan towards collecting such data in order to inform future management. A key component of the tree inventory section should also be an inventory maintenance plan, outlining how the inventory will be updated and used to its fullest capacity on an ongoing basis.

Tree establishment

At the level of the strategic plan, tree-planting priorities should reflect overall objectives with respect to tree cover, species distribution, tree replacement policies, stock specifications, habitat requirements and other considerations. At the management plan level, planting plans can be drawn up once an accurate assessment of the plantable spots is determined from the inventory or from other means of spatial analysis. Innovative approaches to providing suitable tree habitat should also be identified and recommendations to implement them should be developed.

Tree maintenance

At the level of the strategic plan, the plan should establish overall goals for tree maintenance such as pruning, and define the minimum standards to be applied. Objectives to enable a transition from reactive to proactive management, including grid pruning, regular inspection, etc., should be developed. In the medium-term management plan, the plan should identify the areas in which tree maintenance will take place over the five-year term.

Tree protection

This section should review current practices and threats related to tree protection and the municipal development approval process (if applicable) with respect to trees and tree protection. This section may also discuss existing, proposed or potential tree protection by-laws as well as tree-related guidelines for protection during the construction process.

Plant health care and integrated pest management

The urban environment is hostile to the long-term health of trees and shrubs. Environmental stresses both above and below ground weaken natural defence systems and leave plants prone to insect infestations and diseases. Plant Health Care (PHC) and Integrated Pest Management (IPM) planning should be an integral part of any strategic plan. PHC is a proactive approach to tree management that strives to increase the health and vigour of trees such that their natural defence mechanisms will protect them. IPM includes similar aspects, with a focus on reducing pesticide use and managing and monitoring pest populations. Some aspects of PHC and IPM are:

- Proper tree selection: the right tree in the right place;
- Early pruning of young trees to establish strong structure for long-term stability;
- Fertilisation and watering according to the soil conditions and the species requirements;
- Structural support systems;
- Utilising an array of cultural practices and biological controls to reduce the use of fungicides, pesticides and herbicides;
- Pest vulnerability analysis;
- Regular monitoring and reporting;
- Active adaptive management.

Tree risk management

Liability is a major concern for urban forest managers. At the strategic level, the plan should commit to developing a tree risk management strategy if one is not already in place, tailored to available resources and tolerance for risk. At the five-year management plan and annual operating levels, the plan should identify risk trees and outline implementation of mitigation practices.

Outreach and public engagement

Effective communication is a vital part of urban forest management. In most jurisdictions, the urban forest is an 'unknown' entity that both the public and administrators take for granted rather than recognise as an important municipal and community asset. In many communities most of the urban forest is privately owned. Therefore, an educational communications and outreach programme for the community should be developed and implemented in order for urban forest management to be effective. This component should also outline existing and potential partnerships and funding sources.

Budget

At the strategic level, items that must be considered in management and operational plans will be ascertained. The initial budget available to the urban forest management process will help to focus or prioritise the issues that can be addressed. Sources of funding, as well as opportunities for resource sharing, should also be identified. It is important to note that while recommendations should be realistic from a budgetary standpoint, current available resources should not limit or guide the direction of the plan, or prevent the development of progressive initiatives and recommendations.

Monitoring

This section of the plan should include mechanisms for monitoring the implementation of the plan's recommendations and assessing successes and shortcomings. It is recommended that a criteria and indicators based approach to monitoring, as outlined in the following section of this paper, be used at the end of every management plan (i.e. five-year) cycle. This section should also include the baseline criteria and indicators-based analysis to provide a benchmark of the state of the urban forest prior to the development and implementation of the plan.

Recommendations

In keeping with the proposed plan framework, it is suggested that recommendations to be implemented within the first five years be supported with accurate budget forecasts, clear priority rankings, delineation of responsibilities, and other supporting information such as potential partnerships, funding sources, etc. Recommendations for implementation in the remaining years of the strategic horizon can be supported by a priority ranking or a time range (e.g. 2015–2019), or can be slotted into one of the future five-year management plans (e.g. within 3rd planning cycle).

Integrating criteria and indicators into strategic planning

A progressive urban forest management plan should include recommendations that improve the effectiveness and efficiency of a community's urban forestry programme, moving it from reactive maintenance to proactive management. However, the concept of active adaptive management embedded in such a plan necessitates regular monitoring to ensure that progress is being made towards

urban forest sustainability. A means of defining sustainability is also required. For these reasons, the framework of criteria and indicators of urban forest sustainability, developed by Clark *et al.* (1997) and refined and updated by Kenney *et al.* (2011), is well suited for integration into the development and implementation of an urban forest management plan for any community.

The publications referenced above have discussed criteria and indicators in detail, and they will not be greatly expanded upon in this paper. In summary, this approach to planning includes 25 distinct criteria under three general topics (Vegetation Resource, Community Framework and Resource Management Approach). A community's current standing relative to each criterion is assessed by means of four indicators, ranging from low through moderate, good or optimal. Each indicator refers to a key objective; moving along the scale from low to optimal for each criterion places the community closer to achieving a sustainable urban forest. Table 1 shows three example criteria and their related indicators and key objectives.

A major strength of the criteria and indicators approach is that it enables an in-depth and comprehensive assessment of the current status and progress of an urban forest management programme. It also challenges the all-too-prevalent notion that overly simplistic metrics such as canopy cover percentage or the number of trees planted per year are, in and of themselves, good indicators of urban forest sustainability. Moreover, a criteria and indicators

assessment illustrates the strengths of a community's urban forest management programme and, more importantly, clearly highlights opportunities for improvement. This in turn enables managers to more effectively allocate limited resources with the objective of moving towards optimal performance levels and sustainability.

Criteria and indicators are most useful at two stages of the management planning process. Firstly, they can be used to undertake a baseline assessment of the current status of a community's urban forest and forestry operations. Secondly, they are an invaluable tool for tracking the successes and shortcomings of each of the five-year management plans discussed in the previous section, in order to inform goal setting and prioritisation for each subsequent planning horizon.

As a method for undertaking a baseline assessment, criteria and indicators are typically reviewed at the outset of the management planning process by a community's head urban forester, or preferably by an inter-departmental committee including staff such as engineers, planners, communications personnel and information technologists. Outside the municipal realm, criteria and indicators can be reviewed by the various stakeholders who are in a position to inform and improve the indicators. Completing the level of assessment required to determine the appropriate indicator for each criterion may take some time and effort, but is an effective way to set the priorities for the strategic management plan. Once the baseline performance assessment is completed, the

Table 1 Three example criteria for urban forest sustainability with associated indicators and key objectives.

Criteria	Performance indicators				Key objectives
	Low	Moderate	Good	Optimal	
Relative canopy cover	The existing canopy cover equals 0–25% of the potential.	The existing canopy cover equals 25–30% of the potential.	The existing canopy cover equals 50–75% of the potential.	The existing canopy cover equals 75–100% of the potential.	Achieve climate and region appropriate degree of tree cover, community wide.
General awareness of trees as a community resource	Trees seen as a problem, a drain on budgets.	Trees seen as important to the community.	Trees acknowledged as providing environmental, social and economic services.	Urban forest recognised as vital to the community's environmental, social and economic well being.	The general public understanding the role of the urban forest.
Tree habitat suitability	Trees planted without consideration of site conditions.	Tree species are considered in planting site selection.	Community-wide guidelines are in place for the improvement and the selection of suitable species	All trees planted in sites with adequate soil quality and quantity, and growing space to achieve their genetic potential.	All publicly owned trees are planted in habitats which will maximise current and future benefits provided to the site.

planning effort may focus on moving the lowest assessed criteria towards the optimal range. Alternately, managers can choose to prioritise management to address the key objectives that are most closely in line with broader community strategic objectives. Finally, the assessment may serve as an information-gathering exercise; simply going through a collaborative assessment process will provide managers with invaluable insight into the state of the urban forest and the perspectives of other stakeholders.

Criteria and indicators are also a key component of the active adaptive management cycle. Near the end of each five-year management plan's scope, urban forest managers can use the criteria and indicators to evaluate the strategic plan by tracking in which direction the indicators for each criterion have transitioned on the scale, if at all. Then, by comparing where recommendations and resource allocations were initially focused relative to successes and shortcomings, alternative strategies can be developed as required.

Practical applications of the strategic planning framework

To date, the strategic management planning framework and criteria and indicators have been adopted by several municipalities in southern Ontario, Canada, as part of the process of developing each community's urban forest management plan. Each community's experience has been unique, and the differences in each case highlight the flexibility of the conceptual and temporal framework presented here.

Two distinct examples of the application of the strategic planning framework are the Town of Ajax and the City of Burlington. Located to the east and west, respectively, of the most populous city in Canada – Toronto – both municipalities have dedicated and skilled urban forest managers, but differ in terms of the resources available for urban forestry, with Ajax having the smaller urban forestry programme. Both municipalities undertook the plan development process in 2010, albeit with markedly different approaches.

Ajax's focus was strongly geared towards developing a medium-term plan to improve on-the-ground operations within the first five years, with fewer long-term strategic objectives or recommendations. To this end, much of the up-front consultation, such as visioning sessions and goal-setting, was undertaken by municipal staff internally and with key stakeholders well in advance of developing the plan. In Ajax, the plan development had the benefit of being informed by a recently completed urban forest study that collected and analysed data on overall urban forest cover,

structure and species composition. This study developed its recommendations in the context of the urban forests sustainability criteria and indicators (Kenney *et al.*, 2011) and highlighted gaps in areas such as tree inventory, canopy cover and leaf area assessment. Criteria and indicators were then recommended for use as part of the urban forest monitoring programme, to be implemented towards the end of the first five-year management plan to inform the subsequent plan.

The City of Burlington adhered more rigorously to a three-level strategic planning framework, with a focus on both short- and medium-term operational improvement as well as more long-term strategic objectives. Consultations were held throughout the planning process, with internal and external stakeholders being given an opportunity to participate extensively in the visioning process, development of strategic priorities and review of recommendations. There was also a strong desire to maintain consistency with the direction of the City's overall strategic plan, which is updated every four years. Unlike in Ajax, a preliminary criteria and indicators assessment was undertaken at the outset of the project, and helped inform the direction of the plan by highlighting key gaps and issues to be addressed. As in Ajax, criteria and indicators also form the main component of the active adaptive management strategy to measure the success of plan recommendations in promoting urban forest sustainability.

Overall, the experiences of developing urban forest management plans for the two communities discussed above, as well as the final products, were quite different. Both municipalities tailored the framework requirements to better suit their needs, illustrating the flexibility of the strategic model. Whereas one community focused more on short- to medium-term operational improvements, and the other on long-term strategic objectives, in neither plan were any key urban forestry issues overlooked or given less than the necessary level of attention or detail. This is due in part to a strategic framework that clearly identifies the important items for all urban forest managers to consider, and outlines the appropriate planning horizons to enable effective management actions to be implemented.

Although this paper focuses on the use of the planning and monitoring framework in the municipal realm, it can also be applied in other urban forest management contexts. The same plan framework has been successfully tailored by other stewards of the urban forest, which, although they manage fewer trees, contend with many similar issues. These have included large landholders such as golf and country clubs. Issues such as cyclical maintenance, tree

establishment, protection and risk management, invasive species, and even community stewardship and public awareness, are equally relevant and pressing for such institutions as they are for municipalities, albeit on a smaller scale. Planning horizons may or may not be as long as for municipalities; some courses have elected to shorten their long-term plans to ten years, while others have maintained a 20-year frame of reference.

In the context of golf course tree management, a number of criteria may not be useful, applicable or practical. For instance, assessing the relative canopy cover on golf course grounds has little utility since landscaping needs typically take precedence on such lands and obtaining full canopy cover is not practical. Many other criteria, however, remain as important as they do for municipalities. These include tree species diversity, cooperation with local governments and community buy-in into tree management, among others.

Adoption of this strategic framework and monitoring approach by smaller institutions and landowners further highlights the model's flexibility. Similarly, the framework has been implemented by at least one municipality to neighbourhood scale planning, with city staff and resident representatives working jointly on a steering committee to develop and implement plan recommendations. This pilot project is still in its infancy and the success of this application is yet to be determined, but it holds promise, and the process itself is a good opportunity for neighbourhood residents to become more engaged in their part of the urban forest. The same community is looking for ways to tailor the criteria and indicators approach to undertaking a gap analysis for management of a significant natural area. It is anticipated that many of the current criteria will need to be replaced, while some will be equally applicable as they are to urban forest management.

Concluding remarks

In this paper, we have presented a temporal and contextual framework for strategic urban forest management planning and reviewed how a comprehensive monitoring framework can be integrated into the plan development and review process.

The three-tiered framework is well suited to addressing the challenges faced by urban forests through planning for at least three reasons. Firstly, it enables real linkages between long-term, high-level strategic objectives and daily on-the-ground management and maintenance activities, by way of intermediate management plans. Secondly, it is

flexible enough to enable a community, or others involved in planning, to tailor it to suit their needs, while ensuring that important issues are not overlooked. Thirdly, with built-in mechanisms to ensure adaptive management by way of management plan review, progress towards achieving urban forest sustainability is, if not ensured, then greatly enhanced. With the integration of criteria and indicators, this planning approach effectively addresses urban forest management and sustainability issues on a long-term horizon.

The challenges to urban forests are clear and undeniable. It is our hope that more communities, institutions and landowners recognise the value of a strategic and collaborative approach to urban forest planning so that future generations might enjoy all of the important benefits that trees provide us with today.

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