

PLANNING FOR AND IMPLEMENTING AN EMERALD ASH BORER-INDUCED FOREST RESTORATION PROGRAM IN MUNICIPAL WOODLANDS IN OAKVILLE, ONTARIO

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Abstract.—Oakville is an urban municipality with 846 ha of woodland. Management priorities are to maintain forest health, environmental health, and safety; wood production is a minor objective. The town developed a comprehensive strategy to plan for emerald ash borer (EAB; *Agrilus planipennis*) induced ash mortality and forest restoration. Oakville has begun implementing its forest management program focusing on removing and salvaging dead and dying ash from its woodlands and supporting forest regeneration. This management plan is described in this paper along with some of the challenges of its implementation.

INTRODUCTION

The town of Oakville is located on the coastal plain of the north shore of Lake Ontario west of Toronto and east of Hamilton (Fig. 1). Oakville has been a leader in urban forest health management in Ontario since dealing with catastrophic oak decline in several of the town's woodland parks (Williams and Schwan 2013). Since then, threats from other insects such as gypsy moth (*Lymantria dispar*), emerald ash borer (*Agrilus planipennis*), and Asian longhorned beetle (*Anaplophora glabrapennis*) have required monitoring and action.



Figure 1.—Oakville, Ontario location map.

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Emerald ash borer (EAB) was discovered in Oakville in 2008 and since then the town, like many, has worked diligently to manage the EAB crisis. While the town has protected most ash in developed parks and along streets, currently (2015) most ash in Oakville woodlands are dead or heavily infested with EAB. The town is required to mitigate hazardous situations on their property. So while forest health management and planning was underway in Oakville prior to 2008, EAB presented an urgent need to develop and implement plans to deal with the crisis and try to maintain healthy forests and a safe environment.

Forest Management Policy

Oakville has had a progressive policy of woodland acquisition since the 1980s, and its woodlands were acquired as part of the development process where hazard lands, parks, or other areas were conveyed to the town. As an area developed, forests on these lands were subsequently planted or developed naturally. The town currently owns 821 hectares (2029 acres) of woodland on 154 properties (larger than 0.5 ha) and 25 hectares of smaller groups of trees on 118 parcels. Other woodlands may have been acquired as a purchase or transfer from another public agency.

Oakville was one of the first municipalities in Ontario to employ professional foresters as urban forest managers starting in 1978. Management of the town's urban and natural forests has benefitted greatly by employing four registered professional foresters, in part because of the amount of private and public forest in the town, but primarily because of the training in tree and forest health and the strategic approach to forest management that are foci of the forestry profession.

While the town was successful in retaining a significant urban forest complex, the forest has been lightly managed as the primary management objectives were environmental protection, outdoor recreation, and wildlife habitat. This changed in 2002 when several significant woodland parks were affected by catastrophic oak decline (Williams et al. 2013). This situation focused attention on the need to increase forest and tree health and take action to keep it healthy. Management since then has focused on restoration after the oak decline, gypsy moth survey and management, and activities associated with EAB and other invasive pests.

After review of forest management procedures used to deal with the oak decline problem, Oakville made the commitment to manage its forests according to internationally recognized guidelines developed by the Forest Stewardship Council (FSC) and to certify its woodlands as well-managed through the FSC/Smartwood Certification program. The FSC has developed the most rigorous criteria for ensuring that other values are considered in forest management. Although wood production and sale are not important management objectives for the town, forest certification recognizes that wood products generated as a by-product of management activities come from well-managed woodlands. Wood generated by activities such as salvaging wood from trees cut for safety or forest health reasons will be responsibly harvested and marketed as a principle of sustainable forest management, to help maintain aesthetic qualities and to recover some of the cost of management activities.

Policy formulation, planning, and implementation sometimes proceeded concurrently because of the rapidly developing problems with EAB infestation. Strategic treatment of street and park ash with TreeAzin[®] systemic insecticide (azadirachtin; Canadian Forest Service and BioForest Technologies, Sault Ste. Marie, ON, Canada) was initiated to protect trees from EAB; this action started immediately after EAB was found, but in the meantime, broader strategies and policies were developed.

EAB MANAGEMENT PLANNING

Oakville began developing an EAB Management Strategy in 2008. The EAB Management Strategy (Bioforest 2009) was never officially adopted by the town but most of its strategic recommendations for EAB and ash management were implemented. These recommendations included an inventory of the ash resources in the town, the development of an EAB management plan, and a multi-year budget allocation to effectively carry out defined management strategies and tactics. EAB management plan recommendations include:

- Surveys
 - Street and park tree inventory
 - Forest resource inventory
 - EAB delineation survey
 - Annual EAB monitoring surveys (branch sampling, etc.)
- Ash Reduction
 - Removing infested trees
 - Establish EAB sinks to attract and then kill EAB
 - Treatment with TreeAzin[®] to protect high value ash
 - Phloem reduction by removing ash prior to infestation
- Collaborative Research and Development
 - Work with agencies regarding wood movement restrictions
 - Collaborate with Natural Resources Canada (NRC) and Ontario Ministry of Natural Resources (OMNR) experts and researchers
- Effective communications plan to the public and staff
 - Annual review of EAB research
 - Annual review of EAB management plans and refinement
 - Development of a decision support model (DSM)

Most of the recommendations were effectively implemented. For the Ash Reduction strategy (listed above), only the TreeAzin treatment was effectively implemented. Proactive ash removal and other interventions to reduce EAB and ash populations provided too many communication challenges. A strategic choice was made to protect as many ash street and park trees over 20 cm d.b.h. as possible. Effective implementation of the treatment program required accurate EAB delimitation information, proactive ash protection, and an accurate street and park tree inventory.

Oakville partnered with Natural Resources Canada to participate in the development of the EAB branch-sampling methodology (Ryall 2013), which showed greater reliability than EAB survey procedures.

Oakville's current EAB management program has six components:

- **Canopy Conservation:** treatments to save 75 percent of the municipal ash canopy on the street and in parks using TreeAzin[®] for trees 20 cm d.b.h. and greater
- **Roads and Active Parks Hazard Abatement:** removal of dead and dying ash along roads and in active parks (i.e., those trees not in the canopy conservation program)

- **Woodlands Hazard Abatement:** removing dead and dying ash throughout woodlands over a 10-year period
- **Canopy Replacement:** replanting of trees lost due to EAB
- **Quality Assurance:** strategic analysis, review, and guidance through mapping, treatment strategy, monitoring of insect populations, and efficacy reporting
- **Community Engagement:** public relations, advertising campaigns, and a communications advisor

FOREST MANAGEMENT PLANNING

Many of the town's forest health management activities have been in response to critical forest issues such as oak decline (2002) (Williams et. al. 2013), gypsy moth (2007), EAB (2008 and ongoing), and invasive plant management. The town developed a strategic urban forest management plan in 2008 (Urban Forest Innovations and Kenney 2008), prior to the discovery of EAB infestation. However the strategic planning process was partially supplanted by the EAB find and associated planning and management.

Draft forest management plans were initially developed for properties affected by oak decline and some closest to EAB infestations. However, these plans were never finalized but instead were incorporated into a new planning process where a general Forest Management Plan (FMP) (Oakville 2013) was developed that outlined forest management strategies, procedures to assess and monitor the forests, and methods to implement site-specific prescriptions for forest management and restoration activities. The FMP applied to forested sites, not to small patches of trees and the urban forest in developed areas.

Forest management planning was underway before EAB was discovered in 2008 as a requirement for FSC certification. However, EAB imparted urgency to the process because significant ash mortality was expected over the next 5 to 10 years in the area.

A forest resource inventory (FRI) of town woodland properties began in 2010. The FRI, including all GIS mapping, compartment delineation, and layer creation, was completed in 2012. This provided data to define compartments or stands within woodlands. The woodland management pilot project (WMPP) assessed methods of removing dead, dying, and hazardous ash in 2012.

A general forest management plan (FMP) described the Oakville's woodland management goals, and objectives. It outlined procedures for 5-year operating plans (OPs) and annual operating plans (AOPs); introduced critical issues associated with EAB infestation; and included ash management and forest regeneration strategies for ash stands in Oakville.

Woodland Management Pilot Project

The woodland management pilot project (WMPP) assessed methods of removing ash from 11 woodland properties where there were imminent safety concerns. This experience helped to refine operational strategies into four approaches: natural processes, arboricultural strategy, and harvest strategies (two levels). In practice, the strategies are often combined on a property. The approaches are as follows:

- **Natural Processes:** Recommended in areas where the dead ash are left to break down by natural processes. This strategy can be used when the ash are very small, where they

are not near trails, property lines, other public use areas and/or otherwise do not pose a moderate or high risk to the public.

- **Arboricultural Strategy:** Recommended in locations where the ash are near trails, property lines, or other public use areas; are small and can easily be handled manually; where there is little usable wood from the ash; or where access to the property is not appropriate for the harvest approach.
- **Harvest Strategy:** Recommended where there are significant ash numbers and sufficient wood volume to warrant salvaging for lumber or firewood. Salvaging helps expedite the work, save costs, results in less debris/waste, and provides revenue to offset the cost of removal. The salvage strategy requires a reasonable volume of wood, and a work location (landing) with access for large trucks and harvesting equipment and an area for log piling. Various equipment (e.g., conventional skidders/forwarders, small-scale equipment and horses) will be considered for use in each property, and the approach used on a particular property will depend on site characteristics, access, weather, public use, and contractor availability.
- **Modified Harvest Strategy:** Recommended for areas with larger trees and limited access for equipment or trucks. This strategy may be used for cutting trees and moving wood within the forest, but the wood will not be removed from the property. Generally, the harvesting equipment will be used to help fell trees and move the wood and debris away from the trails or more visible areas, but left in the forest to break down.

Ash Management and Forest Regeneration Strategies

The FMP outlined several ash removal strategies to be used in forest operations. These were based primarily on safety and the regeneration strategies to be used following EAB infestation. Stand assessments conducted for the silvicultural prescriptions (SP) provide current and more detailed information on stand composition and structure, existing regeneration, and competition potential from invasive plants (e.g., buckthorn). The SP considers the viability of natural regeneration and its implications for forest development considering stand disturbance from EAB-induced ash mortality and/or ash removals. Based on this consideration, the SP identifies potential regeneration sites and strategies for stands or parts of stands.

The FMP suggests up to 15 percent of the forest area affected by ash removals will be actively regenerated and that forest development in the remaining area will be left to natural processes. Two active regeneration strategies were developed for allocation to woodland sites considered appropriate for the approach. The regeneration strategies are:

- **Natural Processes:** Specified where no active regeneration will be implemented and the forest will rely on natural processes for woodland development. This option is to be used in areas where the residual stand and regeneration is sufficient to continue as, or develop into a healthy woodland; and where poor access, dominance of invasive shrubs, public considerations, and/or limited resources precluded active regeneration efforts.
- **Regeneration Enhancement:** Encourages the development of desirable forest trees where a stand has some good natural regeneration or is not entirely dominated by buckthorn. This strategy includes strategically planting trees where they are most likely to survive and controlling buckthorn that is competing with existing natural regeneration or planted seedlings.
- **Prime Sites:** For sites that are accessible, where regeneration efforts are likely to succeed with acceptable costs and efforts, and where planting and tending can be supported by community participation. Prime Sites include more intensive site management and,

where appropriate, site preparation (e.g., soil tillage to remove competing weeds and provide a clean site for planting; control of buckthorn and other invasive undesirable plants; and tending and replanting to ensure adequate stocking for up to 5 years).

Twenty regeneration sites were established in the eleven forest properties involved in the WMPP using strategies and assessment procedures described below.

WOODLAND OPERATIONS PLANNING

Woodland Property Prioritization

Oakville selects and prioritizes its woodlands for management by using the decision support model (DSM) developed through a combination of staff expertise and a consultant/contractor. The DSM uses the FRI and information on public use, local EAB populations, and other factors to suggest which woodland parks are more likely to present public safety concerns associated with the dying ash, and these sites are given a higher priority.

Branch sampling surveys and active trapping of EAB using green volatile pheromone traps (Ryall 2013) are used to assess where insects have reached peak or are past peak and not declining as the EAB moves to alternate locations. Both survey methods have been used to quantify densities of the insects to create delimitation maps for planning purposes. The areas where ash removals are currently being implemented are where EAB was first discovered, and these areas coincide with the delimitation mapping.

Tree Removals

Removal strategies are chosen based on the size and amount of ash in the stand, access, and its proximity to a maintained trail or woodland edge. Arborist strategies are incorporated near trails and woodland edges (i.e., where the woodland edge is near public use areas such as playgrounds, maintained park or private property). All ash and other trees that represent potential hazards over 10 cm (4 inches) d.b.h. and within a tree length of a maintained trail or woodland edge are marked for removal using a harvest strategy or for pruning using an arboriculture strategy. Using criteria in the Forest Operations Manual (Oakville 2013), ash and other trees near trails, property lines, or other public use areas that are judged to be unsafe to be removed by Certified Arborists and forest technicians are marked with orange paint for removal or pruning by an arborist contractor. Those that are judged to be safe to be removed by harvesting crews are marked for removal with yellow paint.

Trees to be removed to improve forest health include trees suppressing good oaks and thinning some trees in denser patches. Trees to be removed using arboricultural methods (e.g., climbing with ropes) to minimize damage to property or other trees were marked in orange as required in the Forest Operations Manual.

Monitoring

Once contractual arrangements have been made, work will be initiated within the acceptable time frames outlined in the prescriptions and contract. Regular monitoring will be conducted by Oakville forestry staff and contractors to ensure that work is done according to requirements and that variances from the specifications are approved and/or documented. From time to time, alterations may be made to alter the work specifications in response to changes in weather, equipment availability, and/or new instructions from the town.

FOREST REGENERATION

Forest Regeneration activities were started at 18 sites covering 10.6 ha (26.5 acres) on the 11 properties. The procedures for regeneration prescriptions, planting, competition control, testing, and assessments were tested/developed through this experience.

Active forest regeneration activities are implemented on up to 15 percent of the forest area subject to ash removal operations. Active regeneration includes regeneration enhancement, and prime site strategies and practices are documented in a regeneration prescription developed for each property.

Opportunities for forest restoration are reassessed during operations planning and implementation. Where active regeneration strategies are identified (e.g., Enhancement or Prime Site), a regeneration prescription (RP) will be developed that describes site preparation, planting, and tending activities. Once completed, the recommendations in the prescriptions will be used to adjust the list of properties for operations in each AOP.

Regeneration Prescriptions

Regeneration prescriptions include a map showing regeneration strategies for each woodland. This identifies parts of properties or compartments where an Enhancement or Prime Site strategy will be used to facilitate forest regeneration and where natural processes will be allowed to occur on property. The RP will describe site conditions (i.e., soils and vegetation) and will recommend site-specific procedures for regeneration and plans to achieve “free to grow” (FTG) status of acceptable seedling numbers through an establishment/maintenance period of 5 years.

A RP using a regeneration Enhancement Strategy would include limited competition control and/or site preparation, tree planting, and perhaps limited follow-up planting or tending. The Enhancement Strategy will be used to augment existing seedlings where there are short-term planting opportunities caused by ash mortality, limited natural regeneration, and shrub density where it may be possible to help the forest regeneration by planting trees that will increase the number and variety of young trees, with limited tending and investment.

A RP using a Prime Site strategy would include more intensive invasive plant control (e.g., buckthorn), site preparation (e.g., brush or debris removal, soil amendment), replanting, tending, and assessment. These sites will be assessed and tended annually for 5 years with FTG assessments at years 3 and 5. These assessments will determine the success of the forest regeneration efforts.

Stocking and Free To Grow Assessments

The RP describes activities on active regeneration sites to achieve an “acceptable” stocking level of 700 to 1000 FTG seedlings per ha (280 to 400/acre) that have reached FTG status within 5 years. A tree that meets FTG criteria is a well-established desirable tree with little competition free from nondesirable species; is at least 1.0 m from other FTG trees; and has a good likelihood of developing into a mature tree. Desirable seedling and FTG stocking classes and downstream tending and replanting are determined using adjusted stocking levels that add 250 seedlings/ha to the stocking for each of 4 (0 to 3) canopy closure classes for two layers of canopy: 2 to 5 m and >5 m height.

Sites are monitored annually to plan tending activities and each site is subject to FTG assessments in years 3 and 5. The need for significant tending or replanting efforts is identified

in the 3-year FTG assessment. The 5-year FTG assessment will determine whether the stocking objectives have been met. After the 5-year assessment, work may be discontinued whether or not the objectives have been met; however a supplemental planting may be recommended if that alone planting will help meet objectives.

The 18 established regeneration sites received their 3-year stocking and FTG assessments in October 2015. The assessment revealed that 16 of the 18 properties had acceptable stocking or better of desirable seedlings and that four sites had achieved acceptable stocking of trees that had reached FTG status. The assessment suggested that buckthorn control, other tending, and additional planting were recommended at 7, 13, and 4 sites respectively. It is anticipated that most sites should achieve acceptable FTG Stocking levels in 2017.

Regeneration Contracting

Contracts were developed for regeneration efforts; these contracts are then modified for each tendering process. The regeneration contract included buckthorn control, site preparation, supplying genetically-appropriate plant materials, planting, and tending (including watering where required). The initial contract was for a single year to get started, and it is hoped that a multi-year contract format can be developed.

FOREST HEALTH AND HAZARD MONITORING

Forest health monitoring work began in 2014 when 90 woodlands were surveyed and 30 areas had forest monitoring plots installed. Forest monitoring plots generally used the same plot centers as FRI plots. Pest detection surveys will be conducted in all town woodlands over a 3-year cycle (approximately 90 per year) and reported annually. Oakville has 127 km of trails through forest compartments and 277 km of woodland perimeters that bound adjacent properties or town land used for other purposes (e.g., open parks, parking). Tree hazard assessment along trails and property lines are scheduled so that 81 km of trails and woodland perimeters are assessed each year on a 5-year cycle, in concert with other forest operations. That being said, assessment findings or contingencies often cause schedules to be changed in response to issues like forest health problems (e.g., gypsy moth infestations) or other critical issues such as storms (e.g., ice or wind damage to trees).

SUMMARY

Oakville has begun implementing its forest management program in earnest, mainly focusing on removing and salvaging dead and dying ash from its woodlands and supporting forest regeneration. Ash removals on 19 properties were completed by arboricultural and harvest contractors during the fall/winter of 2015. Additional properties are targeted for 2016. Tree removal costs were lower and regeneration costs higher than anticipated. A good understanding of the challenges associated with removal operations has been achieved, but challenges remain in the economical implementation of regeneration programs. Particular challenges include the costs associated with buckthorn control and brush cleanup, browsing by rabbits and deer, and the complex planting arrangements that use many species and sizes.

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