

YORK REGION
**Emerald
Ash Borer**
MANAGEMENT PLAN



Prepared by Kenneth R. Marchant, B.Sc. (Hons.), MPM,
For the Regional Municipality of York: August 29, 2011



PREFACE

This report was authored by Kenneth R. Marchant, Plant Health Consultant for use by the Regional Municipality of York (Ontario). Its purpose is to provide the client with a summary of the status of the Emerald Ash Borer (EAB) in North America, its anticipated impacts on York Region and a range of options which could be employed, at the discretion of the Region to manage this invasive alien insect pest and mitigate its impact.

DISCLAIMER

The information contained in this report has been compiled through: personal interviews with research scientists, regulators, city foresters and others; extensive consultation with local conservation authorities and municipalities; and reviews of literature, research papers, and media reports. The author has also relied extensively on his hands-on experiences and knowledge of the issue gained in his former capacity as EAB Lead Specialist for the Canadian Food Inspection Agency, and as a private consultant. This report has been designed to meet the Terms of Reference specified at the outset of the project by the client and incorporates suggestions and recommendations from the working group consisting of: James Lane, R.P.F. (Area Forester) and Ian Buchanan (Manager) with Natural Heritage & Forestry Services, Regional Municipality of York.

While considerable research has been conducted on EAB since it was first discovered in North America in 2002, there remains a paucity of information on its biology and other critical information and for this reason there needs to be some latitude with respect to predicting its impact and the overall effectiveness of the management option selected by the client. The information and recommendations contained in this report are based on the most current scientific information and regulatory requirements as of July, 2011.

This report, in its entirety or in part, and all opinions expressed therein, remain the property of the author, and the client and should not be copied without their consent.

ACKNOWLEDGEMENTS

I would like to thank the members of the working group for their guidance and contributions to this report and to the numerous persons who have provided me with the information on which it is based.

In addition to the working group members, the author was required to consult extensively with scientists, regulatory and quarantine experts, municipal officials and numerous others involved in managing or regulating EAB in Canada and the United States. Their cooperation in providing me with the information to develop this report is greatly appreciated.

Some data (where noted) have been extracted from a Report entitled “Emerald Ash Borer Threat Assessment in York Region” August 5, 2011, prepared by Silv-Econ Ltd., Newmarket, Ont. for York Region.

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EXECUTIVE SUMMARY

The Emerald Ash Borer (EAB), *Agrilus planipennis* Fairmaire, is considered to be one of the worst invasive alien forest pests to ever be introduced to North America. EAB has killed or infested, by some reports as many as 70 million ash trees since it was first detected in Michigan, and south-western Ontario in 2002; an estimated 10 billion ash trees in Canada and the US are at risk of infestation and death. Both Canada and the US consider EAB to be a pest of quarantine significance. Slowing its spread and protecting the North American ash resource is a top priority for both countries.

Despite aggressive control, regulatory and communication measures aimed at slowing its spread, new populations continue to be found at numerous locations in both Canada and the US and EAB has greatly extended its range in Ontario (mostly as a result of human activities). As of July, 2011, EAB has now been confirmed in most southern Ontario counties and Regional Municipalities and more sites are likely to be detected in 2011. Widespread mortality is already being experienced in several areas of the province. As of March, 2011, the Regional Municipality of York (York Region) is included in a newly expanded federally regulated area (quarantine zone) along with most counties and Regional Municipalities in southern Ontario (refer to Figure 1). Under the provisions of the Ministerial Order applicable to the area, the movement of ash nursery stock and forest products, as well as all species of firewood from the regulated area is restricted.

Over the past few years, there has been considerable progress made with respect to early detection and control. Despite this, the major obstacles to the effective management of EAB continue to be the difficulty of reliably detecting it at low population levels early in the infestation and treating trees in woodland or forest settings. While several pest control products such as TreeAzin™ (a natural pest control product derived from the Neem tree), Confidor 200SL and Acephate (ACECAP® 97), an organophosphate product are now registered for use in Canada and can protect some trees from infestation, there are limitations to their effectiveness; it continues to be costly and unrealistic to treat large numbers of woodland trees.

The Canadian Food Inspection Agency (CFIA) is the lead agency in Canada with respect to enacting quarantine and slow-the-spread measures. Despite repeated requests from affected municipalities, current federal and provincial government policy is to not provide financial assistance to affected municipalities in off-setting the costs of dealing with EAB.

This document provides a summary of the pest's history in North America, and a forecast of its anticipated impact on York Region. A range of feasible management options is identified with associated estimated costs and impacts, and a recommended option is presented.

Assuming that EAB continues to infest and kill trees at its present rate, that biological control organisms do not emerge as a major control factor and that the current limitations on pesticide efficacy do not change, it can be expected that EAB will become pervasive throughout York Region over the next 10 years and kill most of the ash trees there. While some of the management options listed in this document may delay the on-set of widespread mortality there is little that can be done at this time to prevent this from happening.

The major impacts on York will be both aesthetic and environmental with significant economic consequences. While ash represents, on average only 8% of the woodland overstorey in the Region, it comprises 20% of mixed swamplands (primarily in the northern part of the Region) and 20% of the understorey regenerating in its maturing red pine plantations.¹ York Region has an estimated 65,000 ash trees growing in its Regionally owned woodlands (collectively known as the York Regional Forest). The removal of trees in the York Regional Forest which pose a hazard to trail users and underplanting activities to regenerate the forest are estimated to cost \$1,250,000. As well, York has 1,084 km of roads that it maintains along which 9625 ash trees grow. While most of these trees would have to be cut when they die, the Region's priority will be to replace trees along the urban portion. The estimate cost for road-side hazard tree removal and replacement is \$8,750,000.

Recent ecological studies in the US indicate that EAB is likely to have a significant and long-lasting impact on ash regeneration as ash seed banks become depleted in infested areas. This will result in the loss of genetic diversity within the genus *Fraxinus* and could heavily impact the ability of ash to ever regain its niche in Ontario forests.

¹ *Draft Report: Emerald Ash Borer Threat Assessment in York Region, Silv-Econ, April, 2011*

In recent years there have been significant scientific advancements in the areas of detection and pest control. This presents an opportunity to review cost/benefits and consider the protection of selected ash trees for extended periods. While not a panacea, registered pesticides such as TreeAzin could be useful in managing the pest in some areas and preserving high value/heritage trees.

Over the long term, it is hoped that biological control will play a key role in bringing EAB into equilibrium before genetic diversity is lost forever. To this end, considerable research has been conducted in the US and Canada on the role that biological control organisms play. Three exotic species of parasitoids have been released in the US by the United States Department of Agriculture that specifically prey on EAB. Native species of parasitoids have also been observed to attack EAB in increasing numbers which is seen as very encouraging.

In developing management options for consideration by York Region, the author engaged other municipalities in Ontario with similar pest, land use, forest and infrastructure profiles in order to provide a comparison. The results of this survey are contained in Appendices III and IV to this report.

Management Options

Four viable management options were developed in consultation with York Region staff. These are designed to compliment (rather than supplant) EAB management plans being developed by local municipalities (York) and to allow for efficiencies in terms of delivery and implementation. These options reflect the latest science around EAB as well as analyses of the various strategies employed by US and Canadian cities to manage EAB.

The Options are:

1. Do Nothing/Minimal Management
2. Active Management
3. Pre-Emptive Management
4. Aggressive Management

1. **Do Nothing/Minimal Management:** With this option, ash trees would be treated the same as any other tree genus. As such they would receive no special consideration for conservation or protection and would be removed where they are deemed to be hazardous or an obstruction. No surveys would be conducted by the Region to detect and/or monitor the spread of EAB, and

no control actions would be undertaken. Tree replacement would be minimal and confined to high impact areas. Notwithstanding, there would still be a considerable financial impact with this option as hazard trees along roadways and woodland trails would have to be removed as they die. The estimated cost for this option is \$3-4 million over a ten year period;

2. **Active Management:** The objective of this option is to manage and potentially off-set the impact of EAB. The Region, in cooperation with its municipalities would conduct detection surveys to locate new infested sites and possibly conduct delimitation surveys around these and currently known infested sites. Infested trees on Regionally owned roadways and those adjacent to woodland trails would be removed with the on-set of mortality as cost-effectively as possible. Replacement would be prioritized towards trees growing along regionally owned urban roads with minimal replacement in rural areas. Protection of high value or selective trees with pesticides such as TreeAzin would not be a major component of this option. Communication and public education initiatives would be focussed on utilizing existing resource materials and delivery mechanisms. Assistance to private land owners would be minimal and focussed on private land tree-planting programmes. However, there could be recognition of adaptive management and flexibility to consider including funding for tree planting programmes to off-set the observed impact on private trees and woodlots. The expected cost of this option over a ten year period is \$10-12 million;
3. **Pre-emptive Management:** This option is similar to Active Management but there would be greater emphasis placed on surveys, public education and communications, tree protection (i.e., maintaining tree canopy) and increased incentives for private land owners to plant trees. As with other options, the Region could elect, at its discretion, to treat specific high value, publicly owned trees with registered pest control products. The estimated cost for this option is \$14-18 million over a ten year period;
4. **Aggressive Management:** The objective of this option is to save a greater proportion of ash trees and protect the ash component of the canopy. Survey activity of both woodland and roadside trees would be intensified as compared to the other options in order to detect new outliers and delimit spread around these. This option would also see enhanced assistance to private landowners through existing programmes such as the York Natural

Planting Partnership and the Backyard Tree Planting Program. While pesticides would be used to protect some high value trees there would be an acknowledgement that not all trees, especially those in woodlands could be saved. There is no expectation that EAB can be eradicated or that this strategy will suppress population build-up but this option is likely to prolong the lives of some high value trees, retain canopy and could possibly off-set some long-term management costs. The estimated cost for this option is \$21-24 million over a ten year period.

Summary of Management Options and Associated Costs (10 Year Forecast Period)

Option/Activity	Removal	Replacement	Public Ed. and Outreach	Monitoring	Tree Protection	Private Land Incentives	Est. cost over 10 yrs (\$millions)
Minimal	M	N/A	L	N/A	N/A	N/A	3-4
Active	M	L	L	L	L	L	10-12
Pre-emptive	M	M	M	M	M	M	14-18
Aggressive	H	H	H	H	H	H	21-24

Note: H=High Resources/funds required, M=Medium resources/funds required and L=low resources/funds required

In consultation with York Region staff, **Active Management** (Option 2) is recommended as the preferred option.

The benefits of this option are:

- Accepts the reality that most ash trees in York Region will perish over the next 10 years
- A more pro-active, responsible approach to managing costs and resources than option 1
- Annual surveys will permit the early detection of outliers and allow the dispersal around these to be delimited and monitored. This information will help inform and prioritize operational decisions
- Prompt detection and removal of infested trees will minimize hazards, improve aesthetics and possibly result in some efficiency of scale with respect to removal activities
- Tree replacement in priority areas (e.g., urban areas) will help to maintain urban canopy and improve aesthetics
- Actions (e.g., surveys, tree replacement etc.) will raise public awareness

- Providing incentives for private landowners through the York Region Greening Strategy will assist with tree replacement and lessen the overall environmental impact

The negative aspects of this option are:

- Minimal mitigation of environmental impacts resulting from EAB outbreaks
- Some woodland areas with high percentages of ash trees will be heavily impacted
- Loss of biodiversity in woodlands
- Permanent loss of genetic diversity for genus *Fraxinus*

Discussion:

The objective of the **Active Management** option is to actively manage and potentially off-set or mitigate the impact of EAB rather than to try to manage the pest *per se*. It is recognized that the management of EAB in York Region will need to be flexible and adaptive. The recommended adaptive management approach will allow for the Region to adjust and respond to the anticipated exponential rate of EAB spread and corresponding tree mortality and also, to respond to increased expectations with respect to landowner awareness and engagement. Active Management is cost-effective, science-based, environmentally responsible and compatible with current best management practices employed by the Region, its municipalities and its partners.

1.0 INTRODUCTION AND BACKGROUND

1.1 Discovery in North America

The Emerald Ash Borer (EAB) was first confirmed in North America in July of 2002, after it was found in declining trees in the Detroit, Michigan area exhibiting “disease” symptoms. Prior to this, EAB was essentially unknown to the western world and had not been considered by Plant Quarantine experts to be a high risk species for entry to North America. A follow-up survey by US state and federal authorities confirmed EAB to be present at numerous sites in the greater Detroit area. It was also confirmed to be in the Windsor area of Canada by the Canadian Food Inspection Agency (CFIA) in August of 2002, where it had apparently been present for many years and was now killing trees. In the summer of 2002, a pest risk assessment (PRA) conducted by the CFIA, concluded that EAB would likely be a serious and damaging pest of quarantine significance in North America.

1.2 Dispersal and Establishment

At the time of its discovery in North America EAB was already well established. Research has confirmed that it arrived in the Detroit area of Michigan in the early 1990s, probably with infested packaging and crating materials from China. The role that human activities played in the spread of EAB was not fully appreciated at that time and there is now evidence that it was already well established by 2002 at numerous locations throughout the mid-western US and Ontario.

While EAB can fly well and will disperse naturally, much of its distribution within North America can be directly attributed to the movement of ash nursery stock and forest products, especially firewood. It is important to note that it may take as long as five years after it has been introduced to an area before signs and symptoms are manifested in the tree (which greatly limits the effectiveness of any control actions which may be taken against it). Early (and timely) detection remains the bane of EAB management. Many outliers in Canada and the US have been confirmed to have been established long before quarantines and other control measures were enacted by either country and more are being reported weekly. As many as 70 million ash trees are now estimated by some authorities to have been killed or infested in North America since 2002, with 9-10 billion trees at risk.

1.3 Hosts

Research has confirmed that while EAB attacks other genera of trees in Asia including elms and walnuts, only ash (*Fraxinus* spp.) are attacked in North America. While all North American ash species are considered to be susceptible, the blue ash

(*Fraxinus quadrangulata*), a rare species in the wild in Canada but often planted as an ornamental, is considerably more resistant to attack and is surviving in some areas of south-western Ontario. Of particular concern in Ontario is the fate of the pumpkin ash (*F. profunda*), an extremely rare Carolinian species only confirmed to be present in Canada in the early 1990s (and not believed to naturally occur in York Region). Mortality in Ontario pumpkin ash stands is now approaching 100 percent and there is concern that this species may be extirpated from Canada in the very near future with its inherent genetic diversity lost forever. The European ash, (*F. excelsior*), very commonly planted in urban areas of eastern Canada, is also susceptible to EAB attack. Asian species such as the Manchurian ash (*F. mandshurica*), which are sometimes planted in Canada and have been crossed with native species to produce ornamental cultivars, have co-evolved with EAB and are relatively resistant to attack when planted in North America. Unfortunately, all hybrids currently in use are very susceptible to EAB.

1.4 Distribution in North America

As of July, 2011, EAB now generally infests much of southern-western Ontario where most ash trees are now dead or dying (See *Figure 1*). Localized, but expanding infestations are now present at numerous locations in Ontario, including Sault Ste. Marie and several sites in eastern Ontario and Québec; presumably the result of human activities and natural dispersal around introduction sites (outliers).

EAB was confirmed in the Toronto area in the fall of 2007, and, York Region and several other areas around the greater Toronto area in 2008. In 2009, EAB was found in Hamilton, (at several locations), St. Catharines and Welland, Ontario. In 2010 many new counties and Municipalities in southern Ontario such as Burlington, Wellington, Oxford and Perth Counties and the Region of Waterloo were determined to be infested. In March of 2011, the CFIA amended the Ministerial Orders in force under the Plant Protection Act to include these new areas. York Region is now part of a greatly expanded quarantine zone that includes much of southern Ontario (*refer to figure 1*). It is apparent that EAB is now well established at many locations and more finds are anticipated in these and other areas.

Despite aggressive control measures including eradication efforts in the state of Maryland (where it was introduced on illegally moved nursery stock in 2002), State and Federal quarantines, and public relations blitzes, EAB continues to be found in new areas of the US weekly. EAB now infests much of the central and eastern areas of the country (See *Figure 2*). As in Canada, most of the new infestations are

attributed to past human activities such as the movement of infested firewood and forest products, and natural dispersal around these.

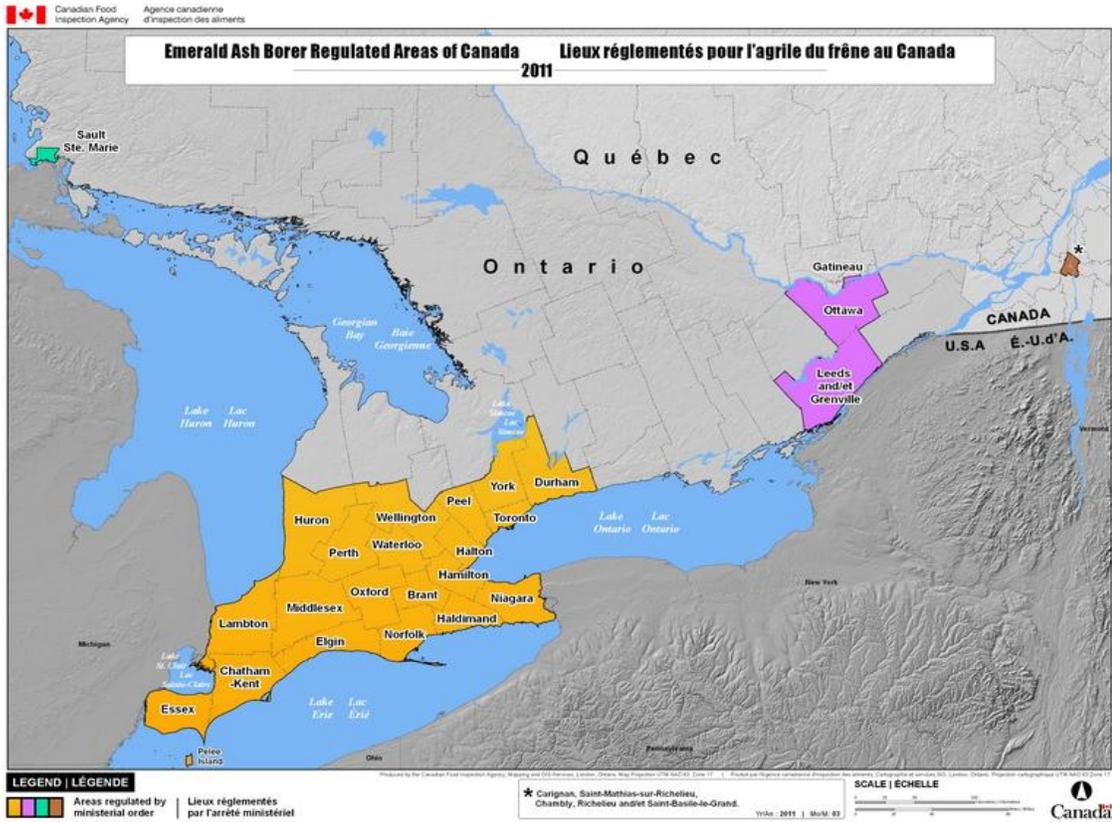


Figure 1: EAB Regulated Areas of Canada

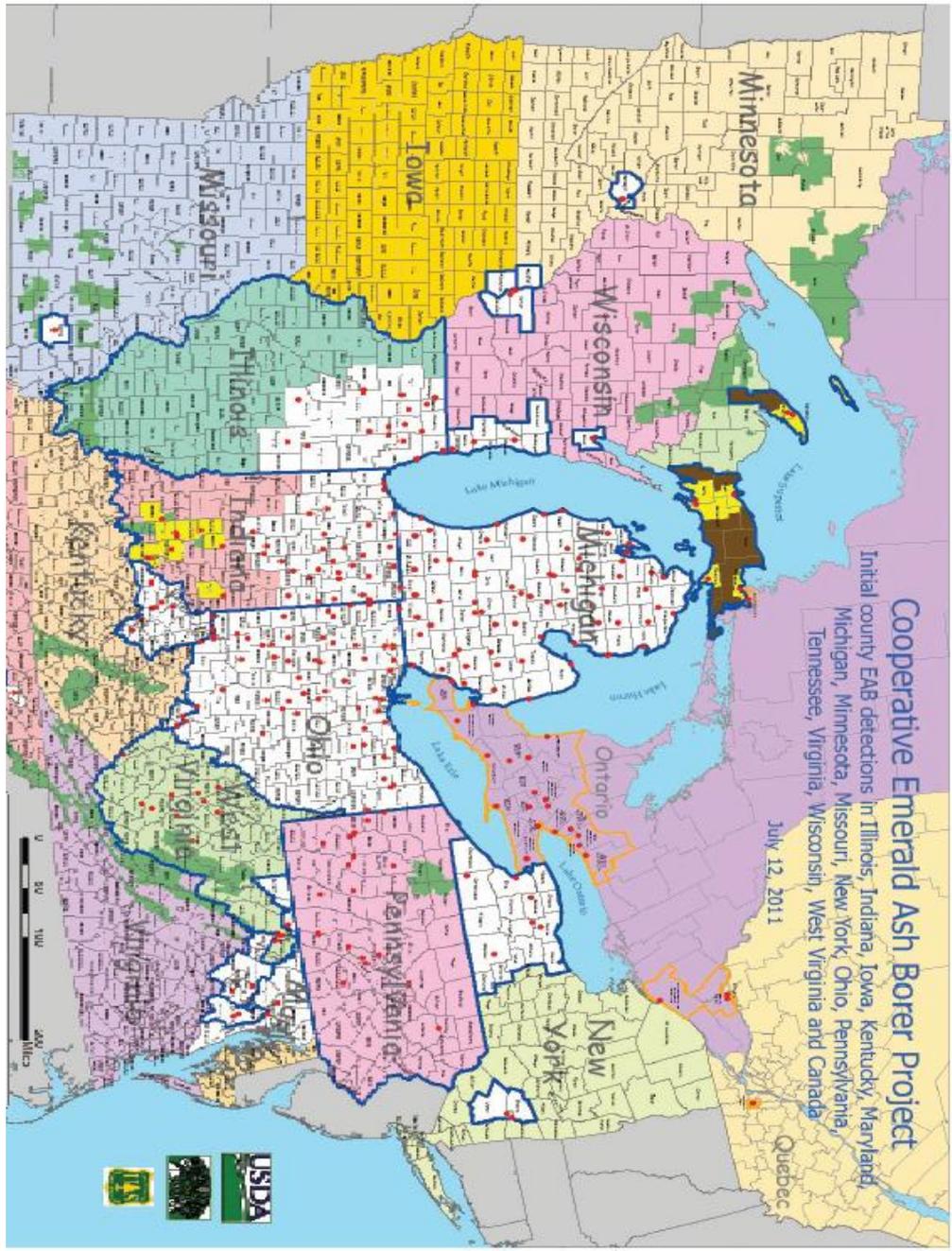


Figure 2: EAB Infested and Regulated Areas of North America

2.0 REGULATORY AUTHORITIES AND RESPONSIBILITIES IN CANADA

2.1 Canadian Food Inspection Agency

Canada is a signatory to several international treaties under which it is required to report, monitor and take appropriate actions against pests of quarantine significance such as EAB. Failure to do so could result in economic sanctions being taken against Canada, loss of access to markets for agricultural and forestry products, and other penalties.

Under the Canadian Food Inspection Agency Act, the Canadian Food Inspection Agency (CFIA) has been designated Canada's official national plant protection (and quarantine) organization and is the lead agency in Canada with respect to developing regulatory policies for forest and agricultural pests of quarantine significance such as EAB. The CFIA is empowered under the Plant Protection Act and Regulations which give it the authority to enact and enforce regulations and policies to protect Canada's agricultural and forestry production base, environment and natural resources and to take all necessary actions to exclude, eradicate or otherwise manage invasive pests of quarantine significance. To this end, the CFIA works in close cooperation with other Canadian federal and provincial government partners as well as the United States Department of Agriculture (USDA) to develop science-based import, and domestic movement regulations as well as inspection, surveillance and suppression strategies for EAB and other quarantine pests.

2.2 Provincial Governments

In Canada, provincial governments are responsible for the management of natural resources such as woodlands and forests, as well as environmental protection. Additionally they must approve the use of registered pesticides. While provincially enacted legislation is not permitted to contradict or limit federal legislation, Provinces have the authority to put in place laws to strengthen or augment federal acts and regulations where they see the need. In Ontario, the Ontario Ministry of Natural Resources (OMNR) has taken a major, albeit non-regulatory role in combating EAB. With specific reference to EAB, they have provided assistance in training CFIA inspectors (and others) on detection and surveys, sponsoring and overseeing scientific research, and with public education and awareness initiatives. OMNR biologists sit on several EAB advisory panels which have provided advice to the CFIA on policy development, research prioritization and regulatory issues. The OMNR Parks Section has been a key partner in limiting the spread of EAB to

provincial parks and campgrounds through pre-screening, restrictions on firewood and other activities. Additionally, the OMNR provided considerable funding in 2003 for conservation authorities in south-western Ontario to plant non-host trees in areas devastated by EAB.

Other Provinces have been even more aggressive in protecting their ash resource. Manitoba recently proclaimed “The Forest Health Protection Act”, whose purpose it is to protect Manitoba's forests from invasive alien pests such as EAB.

2.3 Municipalities

Municipalities and counties are responsible for managing their street trees, forests and woodlands and play a major role in protecting these from invasive alien species (IAS) such as EAB. Most cities, counties and regional municipalities in Ontario have briefed their respective councils on the impact that EAB will have locally and have provided training to their parks and forestry personnel on detection and recognition. Many cities such as Ottawa, Burlington, Hamilton, Toronto and Oakville have already drafted response plans, while several others are in the process of completing plans.

Many urbanized areas of southern Ontario have a multi-tiered municipal structure, with municipalities sharing responsibilities for management of forests, woodlands and roadside trees with the county or Regional Municipality in which they are situated. Forests and woodlands are not managed on a consistent basis from region to region and the degree of internal cooperation with respect to managing EAB and other forest pest issues varies considerably. Many regions (especially those without a Regional Forester) leave it up to their constituent municipalities to manage woodlands, especially where these are located in or near urban areas. Despite managing sizeable tracts of woodlands in some instances, conservation authorities are not always integrated into the decision making matrix at the county or regional municipality level.

York Region has a highly integrated, interactive team composed of representatives from each of its municipalities. Decisions with respect to the management of invasive forest pests such as the Asian Long-horned Beetle (ALHB) and EAB are made after extensive consultation and collaboration with its municipalities, Conservation Authorities² and other levels of government. York Region has an excellent track record with respect to managing invasive alien species, and along with other partners was recognized with a national award (Ontario Federal Council

² The Toronto Region Conservation Authority and the Lake Simcoe Region Conservation Authority

Leadership Through Collaboration Award) for its cooperative, harmonized approach to managing the ALHB.

Hazard tree removal in urban areas is non-discretionary; dead ash trees pose a hazard and a legal liability and must be removed promptly. At present there are no federal or provincial monies available for this and many municipalities will be severely impacted by EAB with the potential cost for tree removal alone running into the hundreds of millions of dollars over the next ten years. To this end, most major municipalities in Ontario, and elsewhere in Canada have petitioned both the federal and provincial governments for additional funding, to offset these costs³.

Private property owners in urban areas will also be heavily impacted (the average cost for removal of a mature urban or street tree is around \$2500).

3.0 THE DECLINE OF ASH

Ash has been extensively planted in urban environments as a street tree, and as part of reforestation initiatives. In some Canadian cities such as Ottawa, over 25 percent of the urban canopy is ash, specifically red/green ash (*F. pennsylvanica*). In addition, most species of ash thrive in disturbed habitats and are often grossly over-represented in both urban and woodland communities as a result of over-planting and past human activities such as logging, animal husbandry or agriculture (ash is thought to have represented only around three percent of the pre-settlement forests of southern Ontario). One of the reasons EAB has had such an enormous impact in Ontario and parts of the US is the large ash component of woodlots, especially in low-lying areas. For instance, prior to the EAB epidemic, it was not uncommon for the ash component of many woodlots in south-western Ontario to exceed 50 percent, with some low-lying woodlots being over 90 percent. This situation has greatly exacerbated the impact of EAB. With the anticipated death of millions of ash trees in south-western Ontario alone, EAB is likely to “normalize” the composition of many

³ A petition was forwarded to federal and provincial politicians in April 2011 by the Association of Municipalities of Ontario, the Federation of Canadian Municipalities and the Northwestern Ontario Municipal Association

Ontario woodlots and forests which, in turn will impact on the epidemiology of EAB. Many experts predict EAB populations will sharply decline with the loss of ash and future outbreaks are likely to be far less damaging. EAB is not likely to disappear however, and populations are likely to rebound with the recovery of the ash component of our forests in future years.

In addition to being a major forest pest, EAB has seriously impacted urban forests and streetscapes. According to a recent US study⁴, it is estimated that nearly 38 million ash grow on developed land in at-risk US states and are expected to perish over the next decade. The annual cost to treat, remove, and replace dead trees in these areas will exceed \$1 billion per year for the next 10 years. If all dead ash trees in developed areas were removed and replaced, the costs would exceed \$25 billion for the same period.

Lastly (and perhaps most importantly), EAB has already had an enormous impact on the genetic diversity of the genus *Fraxinus*. As with other trees genera, our native ash are the result of millions of years of evolution and natural selection and trees are often well suited to local climate and soil types. The anticipated death of hundreds of millions of ash is expected to impact the gene pool and will greatly limit the ability of our native ash to rebound once EAB comes into natural balance with the ecosystem. Ash seed has a very limited viability and there is evidence that natural seed banks in heavily infested areas will soon be depleted, limiting the ability of ash to recover its former prominence.

4.0 BIOLOGY AND LIFE CYCLE

The Emerald Ash Borer (*Agrilus planipennis* Fairmaire) is a beetle belonging to the family Buprestidae (flat-headed or metallic wood-boring beetles). The adult is usually green with black eyes, (although ruby coloured and golden eyed “morphs” have been observed) approximately 10 to 13 mm long, with a metallic, iridescent lustre, especially on its ventral surface (underside).

There are four life stages: egg, larva, pupa and adult (*Figures 6-10*). The adults, which fly well, begin to emerge in late May and can fly up to 5 km at a time with

⁴ K.F. Kovacs et al. Ecological Economics (2009)

average dispersal being 10 km/year. Most, however, only disperse a short distance (100m) from where they emerged if suitable host material is present in the vicinity.

It is the larval stage which damages the tree by feeding on, and destroying, the phloem and outer xylem layers of the tree under the bark. Larvae feed unseen under the bark and disrupt the flow of vital nutrients throughout the tree including the roots; heavily infested trees soon starve to death. By the time signs and symptoms develop the tree is usually in serious decline and may die soon afterwards. In areas with established EAB populations trees can be mass attacked and killed in one or two seasons.

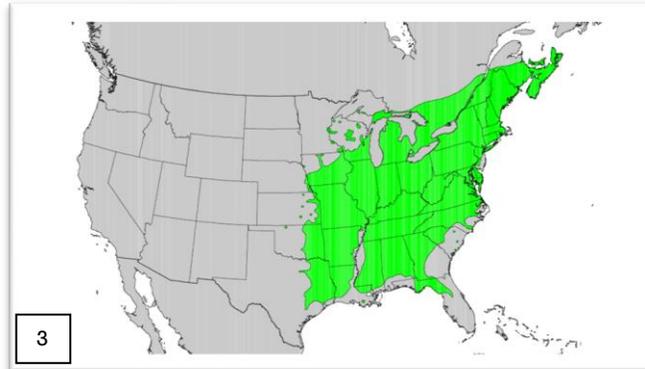
Eggs, which are extremely small, are only laid on ash trees from June to late August. These soon hatch into tiny larvae which then mine through the outer bark into the cambial layer below where they rapidly grow and undergo four larval stages (or instars). EAB overwinter under the bark as either immature larvae or in a pre-pupal larval stage. Pupation takes place from early spring until early summer. Peak emergence of adults in Canada is from mid- to late June. Adults are rarely observed after mid-August.

Depending on the time of year they were laid, tree health and heat-units during the summer, the life cycle may be either one, or two years. In general, healthier trees in the early stages of infestation or those subjected to low EAB populations are better able to resist attack and the life cycle may take in excess of one year to complete. Where eggs are laid later in the season, the beetle is less likely to complete its life cycle within a year. In colder areas such as northern Michigan and northern Ontario, the two year life cycle appears to be prevalent.

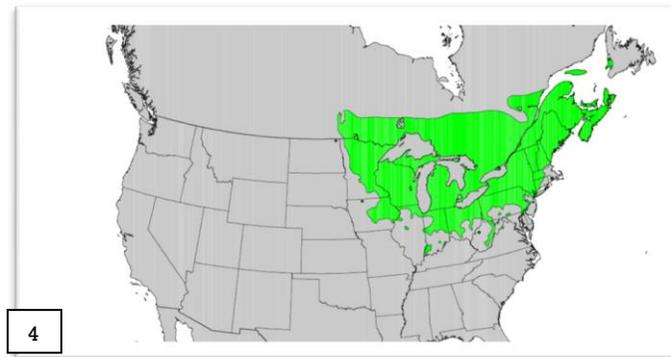
In its natural range of eastern Asia, EAB occurs in areas of extreme temperatures and is very cold tolerant. Research has confirmed that EAB is capable of surviving anywhere in Canada where ash will grow and there is no reason to believe that climate will limit its ultimate range in North America (*figures 3-5*).

Figures 3-5⁵

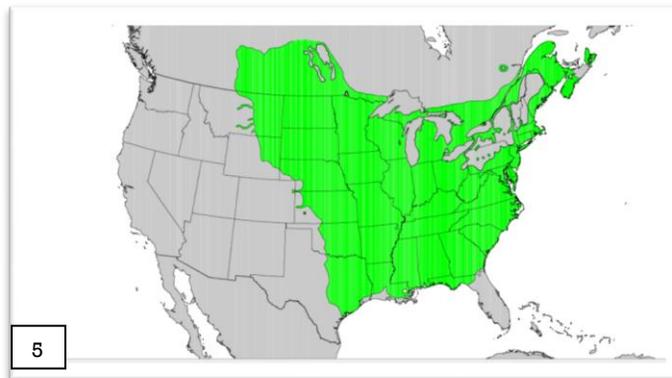
North American Range of White Ash, (*Fraxinus americana*)



North American Range of Black Ash (*Fraxinus nigra*)



North American Range of Red (Green) Ash (*Fraxinus pennsylvanica*)



⁵ USDA-FS

5.0 SIGNS AND SYMPTOMS OF INFESTATION

EAB populations are usually at low levels following its introduction into a new area and it is extremely difficult to detect. Once established, populations build up exponentially to epidemic levels but it is usually four years or more after the initial infestation before signs and symptoms are reliably manifested in the host tree and EAB can be reliably detected. Recent research⁶ confirms that attack is often initially confined to branches in the canopy and that no signs of EAB may be evident in the trunk until later in the infestation when populations are much higher. This is a major limitation to early detection and management.

5.1 Signs of EAB infestation are:

- Presence of EAB life stages (adults, larvae, pupae) (*Figures 6-10*)
- Serpentine galleries (often in evidence beneath cracks) (*Figure 13*)
- Presence of D-shaped adult emergence holes in the bark (*Figures 14, 15*)
- Evidence of larval feeding by woodpeckers and squirrels

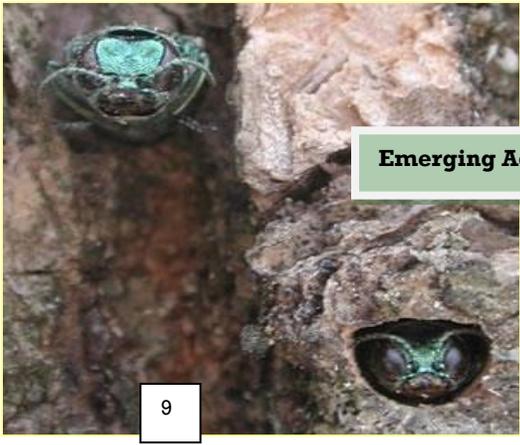
5.2 Symptoms of EAB infestation are:

- Death of tree or parts thereof
- Thinning and yellowing of crown, especially late in the summer (*Figure 11*)
- Cracks in the bark along trunk and branches (*Figure 12*);
- Presence of epicormic⁷ shoots on stems and branches (*Figure 16*)

⁶ (Krista Ryall, *Detection of Emerald Ash Borer in Urban Environments Using Branch Sampling, 2010. Natural Resources Canada, Canadian Forest Service, Technical Note 111*)

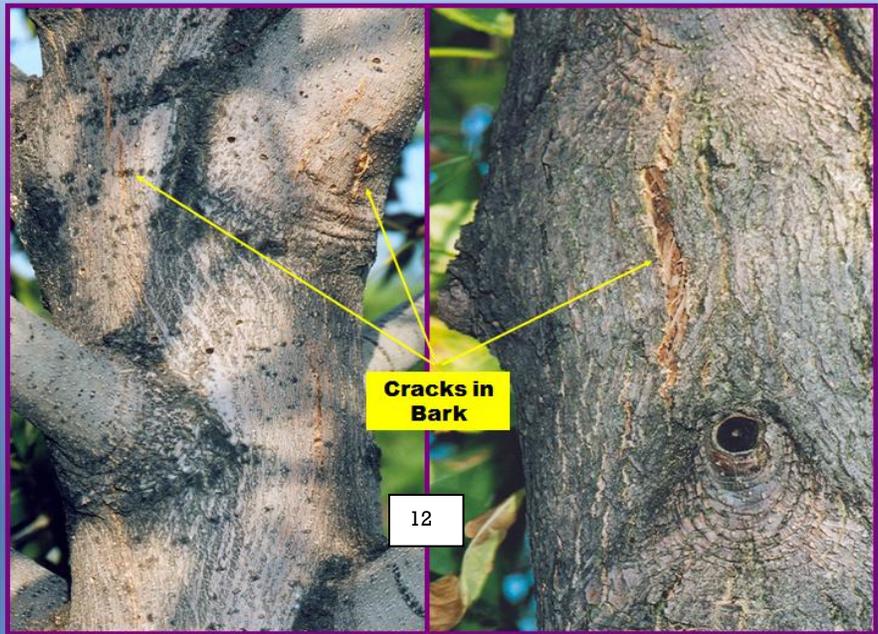
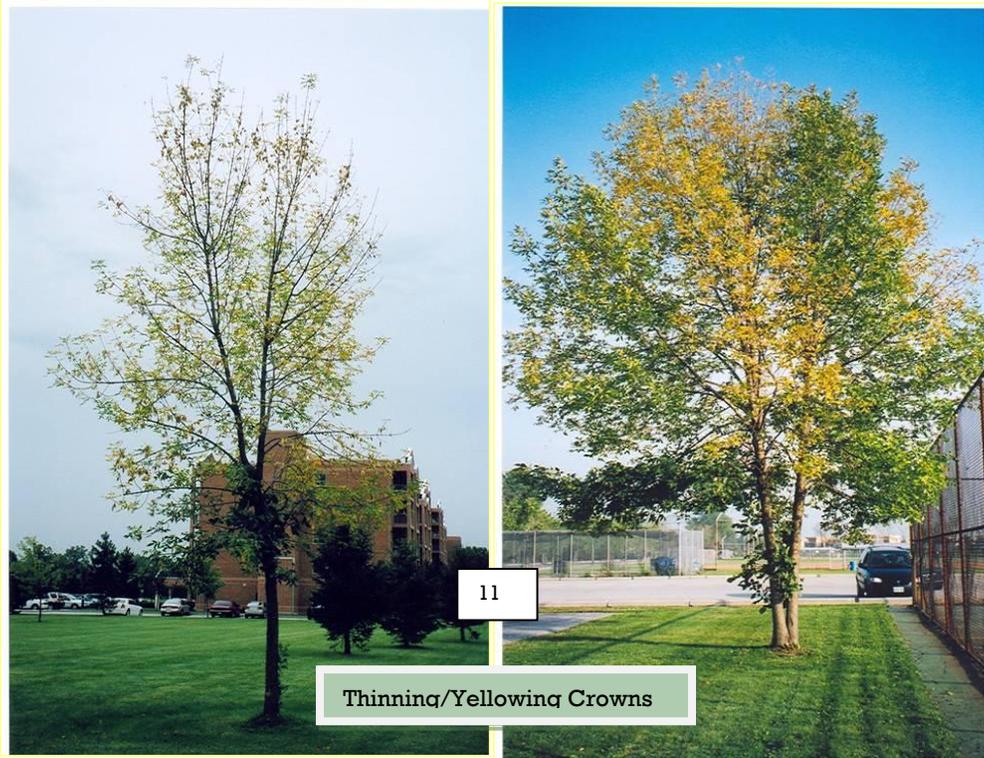
⁷ *Shoots which grow directly from the stump, stem or branch of a tree, usually in response to an injury*

Figures 6-10... EMERALD ASH BORER LIFE STAGES



All Photos courtesy of B Lyons, CFS, except as noted

(Figures 11-12)... EAB SIGNS AND SYMPTOMS



All photographs – K.R. Marchant

(Figures 13-15)... EAB SIGNS AND SYMPTOMS



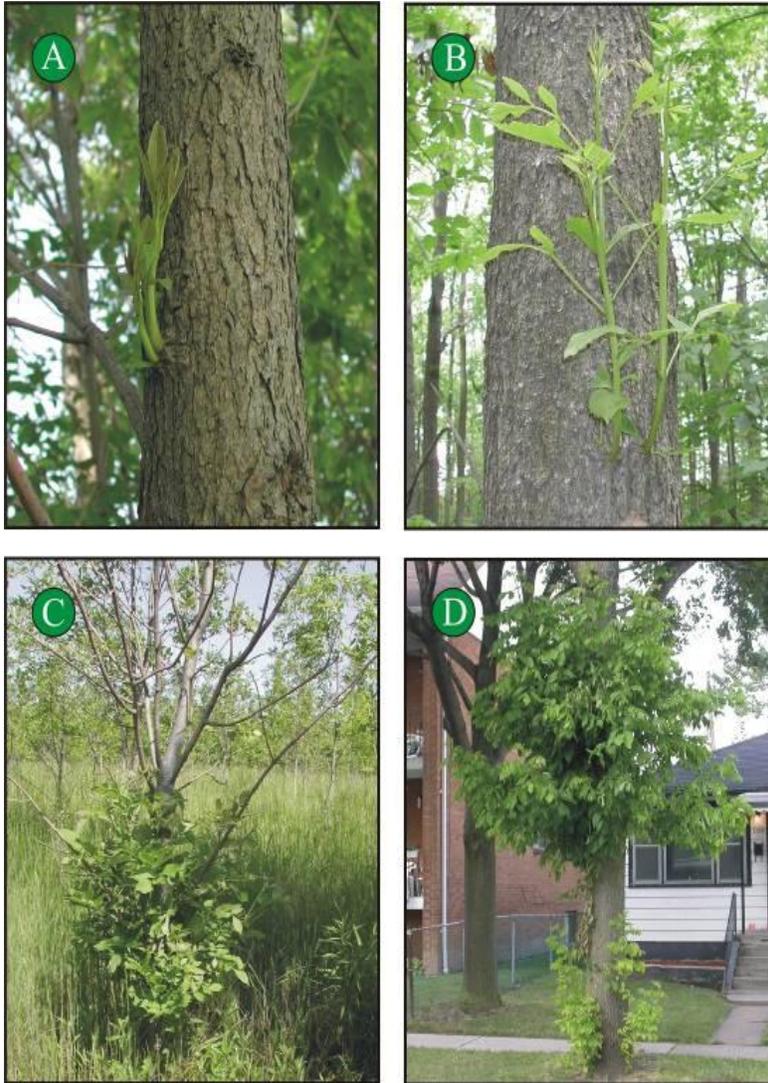
Serpentine Galleries
under Bark



D-shaped Emergence
Holes

Photographs courtesy CFIA/CFS

Figure 16 – EXAMPLES OF EPICORMIC BRANCHING



Photographs courtesy Barry Lyons, CFS

6.0 STRATEGIES TO COMBAT INVASIVE ALIEN PEST SPECIES

Numerous strategies are employed by plant quarantine specialists and agencies to combat invasive alien species (IAS), such as EAB. Ideally, these are science based and rely on Pest Risk Assessments (PRA) to score out the potential for an organism to become a damaging pest in a new area. Strategies to mitigate the impact of potential plant pests include but are not limited to:

6.1 Exclusion

This entails the elimination of pathways for the introduction of a potential pest to a new area through the enactment of stringent import regulations which may prescribe treatment of the commodity (such as heat or pesticides), or outright prohibition of the commodity in its raw form. Exclusion is often the most effective of the mitigation options but is often influenced by political considerations and can lead to retaliatory actions by trading partners if there is not the science to justify it;

6.2 Eradication

This strategy entails the eradication of a potential pest prior to it multiplying and spreading in a new area. This is the preferred option where introduced pests are encountered but often can't be realized as rigid criteria must be met in order for it to be successful (e.g., the target pest must be readily detectable and treatable, and preferably slow moving);

6.3 Suppression

With this strategy, actions are taken to keep the population at low levels through intervention. This action greatly lowers the risk of spread to new areas and can leave the door open to future eradication of the pest and can protect natural resources and the environment;

6.4 Containment

This strategy entails the taking of pro-active measures to prevent the movement of pests through enactment of quarantine measures and targeted control measures. This is the strategy of choice for slow-moving and/or non-vectored pests for which it is not possible and/or cost effect to eradicate;

6.5 Slow-the-Spread

This is a specific strategy which combines regulatory initiatives such as quarantines with targeted control actions. Although similar to containment, there is no expectation with this strategy that the advancement of the pest can be stopped

indefinitely. Generally speaking, there would have to be merit in slowing its spread (such as the protection of woodlands, maintaining access to export markets and buying time for new detection and management strategies to be developed). This is the option of choice for many regulatory agencies for well established IAS of quarantine significance such as EAB, Japanese beetle and Gypsy Moth;

6.6 Management

This strategy entails living with the pest but mitigating its potential for damage and dispersal on a localized basis through best management practices including biological, chemical or other controls, integrated pest management, public awareness and effective partnerships. Most damaging agricultural and forestry pests (many of which are long established) fall into this category. Not all pests lend themselves to effective management;

6.7 No Action

For most exotic organisms (many of which are benign or even beneficial, or whose impact has been attenuated through biological control) there is no need to take aggressive action to contain or otherwise manage them. Many exotic plants and animals in Canada are long established with little or no economic or environmental impact. Some examples of beneficial or benign exotic organisms are honey bees, earth worms⁸ and most of our field crops, fruit trees and ornamental plants. Most ornamental plants used in Canada are introduced from elsewhere; some of these such as buckthorn, garlic mustard, autumn olive, honeysuckle and dog-strangling vine can be very serious woodland pests on occasion.

7.0 MANAGEMENT TOOLS

7.1 Surveillance

Having a spatial inventory of its ash resource and determining where EAB is present will allow a municipality to focus its management and/or impact mitigation activities. Despite considerable scientific advances in recent years in surveillance technology and methodology, there is still no reliable method for early detection of EAB at low population levels. While essential to successful management programmes this is likely to remain a limiting factor for the foreseeable future. To this end, the public

⁸ Earthworms can be a serious pest when introduced into woodlands but are generally considered beneficial

and other stakeholders need to be engaged and encouraged to report any suspect finds to the authorities. Some US municipalities have developed interactive on-line software packages which allow residents to self-identify: that is, to identify ash trees and signs and symptoms of EAB infestation and to report suspect infestations to municipal officials for confirmation.

Two complementary surveillance strategies are commonly used in the management of quarantine pests such as EAB, namely: **detection**, and **delimitation**. Technical details for conducting these surveys can be found in Appendices V and VI.

7.1.1 Detection Surveys

Detection surveys are used to determine the presence or absence of a pest in a target area. They are not generally useful in determining epicentres of infestation or the intensity or age of the infestation.

Detection surveys are designed to gather qualitative, rather than quantitative data; it is generally not important to regulatory officials to know how many insects are present in an area, just whether they are present or not. On the basis of these data, quarantines may be imposed on defined areas (such as counties or Regional Municipalities). Statistical significance can be an issue, especially where traps (or other methodologies) are unable to consistently detect the presence of the target organism at low levels (there is a population threshold at which the statistical accuracy is low, and false negatives occur). Conversely, insects may be blown or otherwise transported into the target area, resulting in false positive results.

EAB detection surveys (usually conducted by regulatory agencies such as the CFIA) are most often predicated on finding physical evidence of a life stage of the insect in a host tree. This is extremely labour intensive work and has a high probability of failure; attacks are often confined to the upper canopy of the tree and signs and symptoms can easily be overlooked in their initial stages. Since 2002, the CFIA has relied on risk-based “smart” surveys; that is, targeting high risk areas where EAB is likely to have been introduced through human activities, and doing intensive surveys around these.

High risk sites are:

- campgrounds and trailer parks
- sawmills and firewood purveyors
- tree nurseries and garden centres
- traffic corridors (such as rest-stops along major highways)

Targeted detection surveys have proven quite effective in detecting some outlier infestations and have helped the CFIA and other regulatory agencies focus often limited resources on key result areas.

In recent years, the CFIA has incorporated the use of prism traps into its detection survey protocol.

7.1.2 Delimitation Surveys

Delimitation surveys are used to determine how far a population has spread from, or around an established outlier or point of introduction. Delimitation surveys are generally used in areas known to be infested and are designed to gather quantitative data. For this reason they are best suited to situations where it is important to determine the density and distribution of the pest around what is perceived to be the point of introduction to the area (an outlier), or conversely, determine the leading edge of an infestation. While delimitation surveys are more accurate with respect to determining the age and severity of an infestation, they are far more labour-intensive and expensive to conduct than detection surveys. They are potentially useful to municipalities and others wishing to monitor EAB population build-up and dispersal and to target areas for treatment. Several Ontario municipalities are now conducting delimitation surveys in conjunction with tree protection programmes.

As with detection surveys (and with specific reference to EAB), delimitation surveys become statistically inaccurate below a certain population threshold and are unlikely to detect low level infestations.

7.1.3 Survey Methodology

Four survey methodologies are currently employed in Canada and the US for EAB:

- Prism traps baited with plant volatile lures and short range or contact pheromones
- Visual (examination of trees for signs and symptoms of EAB such as emergence holes, galleries and canopy decline)
- Branch sampling⁹
- Aerial and Hyperspectral Imagery

⁹ (Krista Ryall, *Detection of Emerald Ash Borer in Urban Environments Using Branch Sampling, 2010. Natural Resources Canada, Canadian Forest Service, Technical Note 111 (see Appendix VII)*)

7.1.3.1 Prism Traps

The CFIA and CFS currently recommend the use of green prism traps to detect EAB. These are baited with chemical lures known to be attractive to EAB and are coated on their outside surface with a sticky substance to trap adults beetles.

Research conducted in Canada and the US has confirmed that prism traps are now relatively effective in detecting EAB prior to signs and symptoms being manifested in infested trees.

Prism traps are most effective when used in a detection context and for that reason are used by the CFIA and other quarantine agencies whose priority it is to ascertain the presence or absence of EAB in a given area. Data are not quantitative and the inconsistencies in the efficacy of the lures do not allow for comparison between areas, or different years¹⁰. While traps are unable to determine with any accuracy how many trees in a target area are infested, they are effective at determining the presence or absence of EAB in the area with a certain degree of statistical accuracy. At low infestation levels, there is a high risk of false negative data and it cannot be assumed a given area is free from EAB if no adults are captured. Conversely, adult beetles may be blown in or otherwise transported to the survey area resulting in false positive results.

When deployed in a grid pattern in urban areas or along the edge of woodlands, they can provide an indication and early warning as to the presence of EAB. The actual density of traps required to provide confidence that EAB is/is not present is still unknown and more research is required¹¹. Traps should only be placed in areas where ash trees are present and the density should be increased in areas deemed to be higher risk (such as around parks, sawmills, highway rest stops, firewood purveyors and campgrounds).

Detection thresholds have not been established for prism traps and their degree of attractiveness would vary from year to year and location to location¹².

To be effective, traps must be deployed immediately prior to the emergence of adult beetles (which is late May to early June in southern Ontario in most years) and checked at regular intervals. Traps must be removed at the end of the flight season (usually mid-August) and all suspect insects collected and identified at that time.

¹⁰ Personal Communication OMNR/CFS

¹¹ See ¹⁰

¹² See ¹⁰

Of note is that traps used in Canada are green and baited with (Z)-3-Hexenol (a green leaf volatile compound known to be attractive to Buprestids and other insects) and short range or contact pheromones; the US uses a purple version of the trap baited with manuka and/or phoebe oils. Trapping is the detection methodology of choice in the US which plans to deploy over 1 million of these in 2011.

Regulatory agencies stress that an added benefit of the traps (especially the purple variety) is that they are highly visible to the public (resulting in free “PR”).

7.1.3.2 Visual

Visual surveillance entails the examination of trees for EAB infestation from the ground or/and or canopy level. It relies on the physical manifestation of signs and symptoms in the tree which may not be apparent for as long as five years after the initial attack and can easily be missed in their initial stages.

Visual surveillance is ponderous and time consuming and, when compared to other survey methodologies such as branch sampling is far less accurate. It is often impractical to inspect all trees in an area, and for this reason, regulatory agencies which rely on visual surveys select trees which are deemed higher risk by virtue of the being situated adjacent to lumber yards, campground, parks sawmills or firewood purveyors.

Sample size is an issue. EAB does not randomly attack trees. There is little or no statistical data by which to determine confidence intervals and scientists have yet to determine the threshold for providing confidence that EAB is not present in the target area.

7.1.3.3 Branch Sampling

The delimitation tool of choice in Canada is now branch sampling, using a technique recently developed by Natural Resources Canada-Canadian Forest Service (CFS). This technology entails the sampling and dissection of several branches from the crown of at-risk ash trees. While the statistical accuracy of the methodology is still being worked out, research conducted by the CFS has confirmed that this technique is far more accurate with respect to early detection of EAB than visual inspection for signs and symptoms and allows EAB to be detected and quantified in an area several years earlier than previously experienced.

While considerably more labour intensive (and expensive) than deploying traps or conducting visual surveys, branch sampling provides information on the severity

and age of the infestation and the potential distribution and dispersal of EAB around the outlier's epicentre (generally the point of introduction).

It can, however, be integrated with routine maintenance activities conducted by municipal forestry departments and peeling and debarking operations (which should optimally be done indoors) can be scheduled for non-peak periods. For this reason it is recommended for use by municipalities interested in managing, mapping or otherwise determining the extent of confirmed EAB infestations and protecting trees.

It is conceded that more research is required in order to standardize the interpretation of data collected from branch sampling, especially when it is used for determining whether trees should be removed or treated¹³.

Many of the experts contacted believe a strategy combining both trapping and branch sampling is preferable where management is the desired objective.

7.1.3.4 Hyperspectral Imagery (HSI)

The Natural Resources Canada-Canada Centre for Remote Sensing defines Hyperspectral Imagery as: "The simultaneous acquisition of images of the same area in many (usually 100 or more), narrow, contiguous, spectral bands. The detailed spectrum resulting from hyperspectral imaging allows the comparison of the remotely-acquired spectrum to the spectra of known materials".

Plainly speaking, HSI is a type of remote sensing whereby data are collected for specific bandwidths of reflected light (usually infrared), rather than the multispectral (visual light) images acquired from satellites or aircraft. While still in its developmental stage and highly proprietary, HSI could prove to be a useful tool to identify and map trees and other vegetation from the air, and to possibly differentiate healthy from unhealthy trees. With specific reference to EAB, HSI has recently been assessed in both Milwaukee, WI, and Oakville, Ontario (2010).

For HSI to work as a tree identification tool, it first requires spectral data to be collected by a handheld recorder from several individual trees of a target species. Each species is believed to have a unique spectral signature and with the aid of advanced software, "algorithms" are developed for each species which allow them to be mapped.

¹³ Personal Communication OMNR/CFS

The second phase of the operation is the collection of aerial data using low flying aircraft equipped with specialized sensors. Numerous flight paths are required to collect sufficient data and there are many variables such as time of day, and season which have to be taken into account. Current technology allows for the collection of high resolution spectral images which can be superimposed on visual maps, correlated with the data collected by handheld recorders and then integrated with GPS (and LIDAR¹⁴) data. Theoretically, it could be possible to accurately identify street and woodland trees from the air without the need for extensive ground-truthing.

The major issues (and barriers) with respect to recognizing HSI as a valid tool at the present time is the paucity of empirical data published in peer-reviewed journals and cost. Much of the research being done on HSI is industry-driven, with the technology being developed and evaluated being both cutting edge and highly proprietary. Of note, is that the USDA-FS is involved in a trial conducted in Oakville in 2010 and has agreed to analyze data collected there. Preliminary results from the Oakville trial show HSI to have been around 80 percent accurate in the identification of ash trees from the air (which meets the original target accuracy set at the outset of the trial).

In conclusion, while HSI is an exciting, cutting edge technology holding lots of promise, it has yet to be proven to work well enough to be used by municipalities or others interested in managing EAB or other forest pests. Furthermore, it is expensive, with these costs being fixed, and even if it can be confirmed to work, municipalities and other jurisdictions in Canada may wish to opt for more cost effective and proven methods of data collection with respect to the management of urban forests and woodlands. For these reasons, HSI cannot be recommended at this time for use in either identifying ash, or as a detection tool for EAB.

7.1.4 Biological Survey Tools: *Cerceris fumipennis*

In addition to sticky traps, the CFIA and other regulatory agencies are currently assessing the use of a native wasp species, *Cerceris fumipennis* to detect EAB adults in newly infested areas. This wasp actively searches out EAB and its North American relatives (genus *Agrilus*) and may be of use in detecting low-level infestations in the future. Colonies of this wasp can be moved from one location to another and research is continuing in both Canada and the US on using it as a detection tool.

¹⁴ LIDAR is an acronym for Light Detection And Ranging

7.2 Proactive Tree removal

While tree removal would have a minimal impact with respect to reducing overall EAB populations in a broadly infested area, it can mitigate long-term costs and liabilities associated with passive or reactive management strategies. All major cities interviewed in conjunction with this study reiterated that having a management plan which included proactive tree removal would result in considerable cost-efficiencies as well as reducing the potential for hazards and liabilities¹⁵.

7.3 Treatment with Registered Pest Control Products

Pesticides have been proven to be relatively effective in prolonging the life of some infested trees if administered to the tree in the initial stages of infestation. They may also be effectively used on a prophylactic basis for non-infested trees in high risk areas. In order to be effective, pest control products used against wood boring insects need to be systemic and the most effective means of getting these into the tree is to inject them under pressure (several systems are available)¹⁶. For this to work, the tree has to be in good health and have a relatively intact vascular system to permit translocation of the product. Unfortunately, by the time EAB infested ash trees express symptoms such as crown thinning or die-back, they are usually heavily infested with extensive damage to their vascular tissues and they cannot be successfully treated. Furthermore, the continued use of some pressurized injection systems has been shown to damage the tree around the injection site and can predispose it to rot inducing organisms and other mortality factors.

At the present time, there are only three products specifically registered in Canada for EAB. ACECAP[®] 97, an organophosphate systemic insecticide implant received a label extension in 2010 from Health Canada-PMRA to include EAB, and the label for Confidor 200SL was extended by PMRA in May 2011. Azadirachtin (TreeAzin[™]), a natural product insecticide sold by BioForest Technologies Inc., currently has an emergency registration until August 31, 2011 and full registration is pending. TreeAzin[™] may only be administered using the Ecoject[®] injection device.

There is now, published, peer-reviewed data that confirm that TreeAzin[™] can provide good protection against EAB for a two year period. Furthermore, injections with this product do not appear to be as damaging as other injectable pest control

¹⁵ Recent studies indicate that it is often cheaper to treat trees over a ten year period than to remove them

¹⁶ Some products such as Imidacloprid can be applied by way of a soil drench but this formulation is not registered in Canada at present for use against EAB and research confirms it to be of limited efficacy

products and it only needs to be applied every second year to afford the tree an acceptable level of protection.

As of May 2010, TREE-äge™ (Emamectin Benzoate) has full registration in the US as a restricted use pesticide and is widely used in nine states with EAB infestations. Research conducted in the US confirms that it is highly effective for two years (and possibly three) making it a cost-effective alternative to cutting. Its drawbacks are its relatively high mammalian toxicity, when compared to TreeAzin, and its high residual activity. Despite its efficacy, it is not registered for use against EAB in Canada at this time; registration costs are high and Canada is perceived to be a small market with little potential for return on investment. While interest has been expressed by some parties in pursuing registration, this is not likely to take place in the near future.

7.4 Consultation, Public Education and Outreach

Recent interviews conducted with US and Canadian officials stressed the importance of public education and outreach programmes. It is vitally important to have the public and other stakeholders, including property owners, industry, and public interest and environmental groups made aware of the perils of EAB and brought on-side. This is best accomplished through effective messaging and consultation where appropriate with affected parties. Depending on the management option selected, it may be desirable to conduct public meetings to explain what actions are required and how these will affect property owners.

7.5 Staff Awareness and Education

Parks, forestry and other maintenance personnel who work with trees need to be able to identify ash trees as well as the signs and symptoms of EAB infestation. Training should be provided by municipalities to this end.

7.6 Managing Trees on Private Property

In most instances, municipalities rarely take responsibility for the removal of trees on private properties. Exceptions are where trees pose a hazard of falling and causing injury or property damage, or where a tree encroaches on both municipal and private property. In this instance action may be taken under property standards legislation to remove the hazard tree. Generally, the property owner is liable for all costs related to treatment or removal of dead or damaged trees.

7.7 Regulatory

In support of its preferred management strategy, the Region (or its municipalities) may wish to explore the possibility of enacting new, or alternatively, strengthen existing by-laws to provide for the right of employees/inspectors to enter upon private property for the purposes of inspecting, treating or removing trees infested with EAB or other IAS.

8.0 SELECTING THE APPROPRIATE STRATEGY

For newly established plant pests of potential quarantine significance, Regulatory Agencies such as the CFIA are generally required to complete a pest risk assessment (PRA) which outlines the risk posed to the country by an organism. PRAs take into consideration such factors as: potential pathways, potential to inflict damage, potential to establish in the country, climatic suitability, impact on markets, environment, etc. Prior to making a decision on the appropriate strategy, it is common practice for the regulatory agency to establish expert panels consisting of scientists and regulatory specialists from government, industry and academia to provide it with advice. The selected action must be:

- Science-based,
- Transparent,
- Easily communicated and understood,
- Defendable,
- Cost effective and
- Legal within the purview of the Plant Protection Act and Regulations, and other applicable legislation

As a general rule, if the CFIA or other regulatory agency elects to undertake proactive measures such as eradication, containment, slow-the-spread etc., there must be a realistic chance for success, and/or measurable results of mitigating the impact of the IAS. An integral part of the decision making process is an environmental assessment of the potential impact of the pest, as well as any proposed actions to manage it. For these reasons, control actions are generally not

taken against many IAS pests; it is simply not cost effective to do so, and there is little likelihood of a successful outcome.

In 2002, both Canada and the US established EAB advisory committees comprising scientists, quarantine and regulatory specialists to provide science-based advice to their respective lead regulatory agencies on policy, survey design, risk mitigation and research.

9.0 SITUATION REPORT: YORK REGION

9.1 General Comments

The Regional Municipality of York (York Region) comprises the municipalities of: Aurora, East Gwillimbury, Georgina, King, Markham, Newmarket, Richmond Hill, Vaughan and Whitchurch-Stouffville. York Region is governed by a Regional Council which consists of 20 elected representatives from each of the constituent towns and cities in the Region, including each of the nine mayors and 11 regional councillors who are elected from the constituent municipalities. Council is presided over by a Regional Chair.

In addition to the lands directly managed by the Region, many forested areas are managed by York's constituent municipalities with others managed by the Lake Simcoe Region Conservation Authority and the Toronto Region Conservation Authority. The Region employs a Natural Heritage and Forestry Manager and six foresters and forest technicians while several of the constituent municipalities employ urban foresters.

York Region has a highly integrated, interactive team composed of representatives from each of its municipalities. Decisions with respect to the management of invasive forest pests such as the Asian Long-horned Beetle and Emerald Ash Borer are made after extensive consultation and collaboration with its municipalities and other levels of government. York Region has an excellent track record with respect to managing invasive alien species and along with other partners was recognized in 2004 with a national award (Ontario Federal Council Leadership Through Collaboration Award) for its cooperative, harmonized approach to managing the Asian Long-horned Beetle.

The York Region EAB management plan has been developed in the context of a support and reference document for individual municipalities preparing their own EAB management plans. The intent is for the York Region plan to act as an “umbrella” and to facilitate the integration the various plans. For that reason it is designed to be collaborative and informative, rather than prescriptive.

9.2 Infestation Status

Emerald ash borer was first detected in York Region in 2008 in the City of Vaughan where it was well established at the time of its detection. Other known infestation sites are: the south end of Richmond Hill, and Markham-both in 2011. Based on epidemiological studies in similar municipalities it is highly unlikely that these sites represent natural dispersal from only one established outlier and are more likely the result of past movements of infested firewood or nursery stock which have resulted in the establishment of numerous outliers. For this reason, it is expected that more infested sites will be added to the list as a result of detection surveys being conducted in 2011 by York Region and its municipalities.

9.3 Woodland Composition

9.3.1 Woodlands and Rural Forest

York Region has 39,965 ha of woodland (or 22.5 percent of its landbase); the Region manages 21 forest tracts (collectively known as the York Regional Forest) comprising 2,300 ha, much of it in former agreement forests¹⁷.

York Region estimates that it has 2.1 million ash trees in its woodlands. This represents eight percent of all trees in the woodland overstorey. While EAB will have a significant ecological impact on woodlands, an overall decrease in the percent forest cover is not anticipated.

Ash is a major understorey component of York’s cultural plantations, (consisting primarily of red pine); many of which are evolving to mixed forests. The ash component of these woodlots is estimated at 20 percent and is becoming increasingly significant as these woodlots mature.

The bulk of York’s woodland ash trees (70 percent) are located in the northern end of the Region, primarily in East Gwillimbury and Georgina. While these locations are approximately 20-50 km from known infestations in the southern portion of the Region, it cannot be assumed that other, more northerly EAB outliers have not

¹⁷ Under the Ontario Forestry Act (1990) the OMNR enters into an agreement with landowners such as municipalities and conservation authorities to co-manage forest lands

already been established through the movement of infested forest products such as firewood. Based on the epidemiology of EAB in similar areas, it can be expected that EAB will be pervasive in the Region within the next five years and that heavy mortality will be evident within the next ten years.

9.3.2 Urban Forest

There are an estimated 700,000 ash trees in the Region's urban forests (comprising public and private lands). This represents eight percent of all trees in the urban forest. As many of these are adjacent to structures, roadways or trails, they will pose a significant financial impact with mitigation costs likely in the hundreds of millions of dollars¹⁸.

9.3.3 Regional Assets

9.3.3.1 Regional Street Trees

There are over 9600 planted and naturally occurring ash trees in Regional Road Allowances representing 13.5 percent of Regionally owned street trees in urban areas. Where these die, they would have to be removed; the estimated costs for this are \$3,600,000 with replacement costs estimated at \$5,100,000. Priority would be given to trees in urban areas.

9.3.3.2 York Regional Forest

There are an estimated 65,000 overstorey ash trees in the York Regional Forest. This represents 5 percent of all overstorey trees. Additionally, there are an estimated 4 million ash trees in the understorey.

10,000 overstorey ash trees are within 20 m of public use trails and would become hazardous and have to be removed upon death. The estimated cost for felling and removal is \$300,000. Additional costs to under plant and other mitigation activities is \$960,000. In addition to financial costs, EAB will have significant ecological and aesthetic impacts on these areas.

9.4 Summary: Potential Impact of EAB

While ash is a common and valuable genus in York Region and EAB will have serious ecological, economical and aesthetic impacts (especially in low-lying areas in the north), these are likely to be less severe than in other areas of the Province with much higher ash populations (such as south-western and eastern Ontario).

¹⁸ The Region is not responsible for removal costs for trees on private properties

In addition to the loss of woodland and street trees, EAB will have a considerable impact on streetscapes and urban canopies in its municipalities (not addressed in this report).

9.5 Surveillance

To this point, no official surveys have been conducted by York's lower tiers. In 2011, the Region deployed 250 green, sticky prism traps baited with a chemical lure in parts of Vaughan, Markham, Richmond Hill, King, Whitchurch-Stouffville and Aurora and Newmarket. The results of this survey are pending.

While the Region currently conducts aerial surveys in support of enforcement of its Forest Conservation By-law, York does not see this as a practical means of assessing EAB damage. Additionally, there are no plans to use HSI as it has yet to be proven useful for EAB surveys in the Region's opinion and is expensive on a large scale.

10.0 MANAGEMENT OPTIONS

Four management options were developed in consultation with York Region staff. They reflect the latest science around EAB as well as synopses of the various approaches employed by US and Canadian municipalities to manage EAB.

The Options are:

1. Do Nothing/Minimal Management
2. Active Management
3. Pre-Emptive Management
4. Aggressive Management

Option 1: Do Nothing/Minimal Management

Elements:

Ash trees would be treated the same as any other tree genus. As such they would receive no special consideration for conservation or protection and would be removed where they are deemed to be hazardous or an obstruction.

- No surveys would be conducted
- No control action would be undertaken
- Tree replacement would be non-existent or minimal
- Communication and public education activities would be minimal
- No incentives for private land owners specific to ash mortality/replacement
- The expected cost is \$3-\$4 million over a 10 year period

PROs:

- Spending on EAB would be kept to a minimum
- Little impact on expected outcome (which is ~100% ash mortality over the next 10 years)
- Public acceptance? This policy is easily defended

CONs:

- Trees along regionally owned roadways and adjacent to woodland trails would die, become hazardous and would have to be removed notwithstanding... where large numbers of trees have to be removed it is often more cost effective to do this proactively, rather than reactively
- The absence of survey data will make it harder to plan for efficient detection and removal of hazard trees or to provide advice to property owners
- No mitigation of environmental impact
- Loss of biodiversity
- Permanent loss of genetic diversity for genus *Fraxinus*
- Aesthetic considerations... thousands of dead trees along roadways and in woodlands

Discussion:

Irrespective of what option is selected, most of York's urban, roadside and woodland ash trees will die over the next 10 years. The best that can be hoped for is to save some high value urban trees and preserve the urban canopy. Replacing roadside trees has merit from aesthetic and environmental perspectives.

Option 2: Active Management

Elements:

- **Survey:** The Region, in cooperation with its lower tier municipalities would deploy prism traps in conjunction with annual detection surveys to locate previously undetected infested sites. Detection surveys would focus on high risk sites such as sawmills campgrounds etc. as identified in the CFIA survey protocol (Appendix V). As well, traps would be deployed in grids in the northern part of the Region. While the Region would not undertake branch sampling to delimit the extent of new sites of infestation the option would exist for lower tier municipalities to do this.
- **Tree Removal:** Trees along regionally owned roadways and those adjacent to York Regional Forest trails would be removed once they were determined to be infested (or at risk of imminent infestation due to their proximity to a known infested site). This would be done once signs and symptoms are manifested and preferably prior to the on-set of mortality thus allowing for more efficient management of the problem
- **Replacement** would be focused on those ash trees growing along regionally owned roads in urban areas, but some trees along rural roads may be replaced as well as some woodland trees in significantly impacted areas
- While the option to treat some high value and heritage trees exists, this would not be a major component of this option
- Potential for salvage logging or other cost-recovery activities to mitigate overall costs
- Communications and public education initiatives would be based on existing resource materials and delivery mechanisms
- Assistance to private land owners would be minimal and focussed on private land tree-planting programmes; there would be however, recognition of adaptive management and flexibility to consider increased funding for planting programmes to off-set the impact on private trees and woodlots
- The expected cost is \$10-\$12 million dollars over a 10 year period

PROs:

- Accepts the reality that most ash trees in York Region will perish over the next 10 years
- A more pro-active, responsible approach to managing costs and resources than option 1
- Annual surveys will permit early detection of outliers and allow for the impact that EAB will have in the affected area to be assessed more accurately
- Prompt detection and removal of infested or at-risk trees will improve aesthetics and possibly result in some efficiency of scale with respect to removal activities
- Tree replacement in urban areas will help to maintain urban canopy and improve aesthetics
- Incentives to private property owners to plant other species of trees will lessen the impact on the loss of ash from the canopy

CONs:

- No mitigation of environmental impacts or overall epidemiology of EAB outbreak
- Some woodland areas with high percentages of ash trees will be heavily impacted
- Loss of biodiversity in woodlands
- Permanent loss of genetic diversity for genus *Fraxinus*

Discussion:

This has been identified by York Region as their **preferred option**. The objective of this option is to manage and potentially off-set the impact of EAB, rather than try to manage the pest *per se*. It is cost-effective, science-based, environmentally responsible and compatible with current best management practices employed by the Region and its partners

Option 3: Pre-emptive Management

Elements:

While similar to Active Management, this option would see greater emphasis placed on surveys, communications and public education, as well as tree protection, replacement and greater incentives for private land owners to plant trees.

- Survey strategy would be similar to that of Active Management but would entail the placement of more traps in a tighter grid and with more comprehensive delimitation surveys around infested sites
- Tree removals along roadways and woodland trails would be more aggressive and would entail the removal of at-risk trees prior to the on-set of signs and symptoms
- Tree replacement would be enhanced and would entail the replacement of roadside trees in rural areas, and an increased number of woodland trees and remediation of some highly impacted woodland areas
- Potential for salvage logging or other cost-recovery activities to mitigate overall costs
- Communications and Public Education initiatives would be ramped up considerably as compared to Active Management; this would likely entail more public workshops, and the production of additional education materials
- Tree protection and preservation are viable, cost-effective options and the Region may elect to treat specific publicly owned high value or heritage trees with pesticides;
- Private land restoration initiatives would be increased from those of active management, with the goal of getting more trees in the ground on private properties
- The estimated cost is \$14-\$18 million over a 10 year period.

<p>PROs:</p> <ul style="list-style-type: none"> • Accepts the reality that most ash trees in York Region will perish over the next 10 years • Intensified annual surveys will permit early detection of outliers and allow for the impact that EAB will have in the affected area to be assessed up front • Prompt detection and removal of infested or at-risk trees will improve aesthetics and possibly result in some efficiency of scale with respect to removal activities • Tree replacement in urban areas will help to maintain urban canopy and improve aesthetics • Incentives to private property owners to plant other species of trees will lessen the impact on the loss of ash from the canopy
<p>CONs:</p> <ul style="list-style-type: none"> • Intensified actions will have no real impact on the build up of EAB in the Region and the outcome will be the same as with other options • Little added value when compared to Active Management even though more expensive to implement and maintain
<p>Discussion:</p> <p>This is a viable option. There would be little added benefit however, commensurate to the additional cost expenditures. As with other options, there would be no impact on EAB populations or overall ash mortality over the 10 year period. There are data to support the position that treating trees over a 10 year period is cheaper than cutting and removing them. It is however, not practical to treat large numbers of trees, especially those in woodlands</p>

Option 4: Aggressive Management

<p>Elements:</p> <p>The objective of this option is to save as many trees as possible and retain the ash component of the canopy. This would be accomplished through:</p> <ul style="list-style-type: none"> • Intensified detection and delimitation surveys • Aggressive removal or treatment of known infested trees and those within a prescribed radius around them • Enhanced tree replacement programmes... all trees cut along roadways would be replaced as well as those in heavily impacted woodland settings • Potential for salvage logging or other cost-recovery activities to mitigate overall costs • Considerable emphasis would be placed on expanded communications, outreach and public education programmes • While TreeAzin would be used to protect some high value trees there would be an acknowledgement that not all trees, especially those in woodlands can be saved • Private land restoration incentives would be further enhanced
<p>PROs:</p> <ul style="list-style-type: none"> • Could delay the build-up and spread of EAB somewhat and allow time for other options to be implemented
<p>CONs:</p> <ul style="list-style-type: none"> • Expensive, with little payback (EAB would still spread and ash mortality would occur) • Woodland trees cannot be adequately or cost-effectively protected at the present time • Because of York's proximity to Toronto and other infested areas there is little point (or payback) in spending the extra dollars to protect at-risk trees • Not defensible from either a scientific or financial perspective

Discussion:

This strategy is more applicable to urban areas with high numbers of treatable ash trees and to areas where there is merit in suppressing or even eradicating known populations (such as western Ontario or Canada). There are data to support the position that treating urban trees over a 10 year period is cheaper than cutting and removing them. However, most of York's trees are in woodland or roadside allowances and this option is not practical or cost effective; it is not a good fit for York

The chart below summarizes the available management options described in this document, their primary elements and a range of anticipated costs for each. Comparisons can be made with other Regional Municipalities (see chart, page 44).

TABLE 1:**Summary of Management Options and Associated Costs (10 Year Forecast Period)**

Option/Activity	Removal	Replacement	Public Ed. and Outreach	Monitoring	Tree Protection	Private Land Incentives	Est. cost over 10 yrs (\$millions)
Minimal	M	N/A	L	N/A	N/A	N/A	3-4
Active	M	L	L	L	L	L	10-12
Pre-emptive	M	M	M	M	M	M	14-18
Aggressive	H	H	H	H	H	H	21-24

Note: H=High Resources/funds required, M=Medium resources/funds required and L=low resources/funds required

TABLE 2: SUMMARY OF EAB MANAGEMENT INITIATIVES (ONTARIO REGIONAL MUNICIPALITIES AND COUNTIES)

Municipality/ Respondent	EAB Man. Plan			Actively Treating Woodland Ash?		Tree Removal		Comments
	Yes	No	U/D ¹⁹	Yes	No	Yes	No	
City of Ottawa			X		X		X	<ul style="list-style-type: none"> • The “new” City of Ottawa includes former Carleton County and is considered a Regional Municipality • Currently under EAB quarantine • Significant woodlands with a very high populations of ash (25%/18,000 ha) • Will be very heavily impacted by EAB • No plans to treat or pre-emptively remove woodland ash but some urban street trees will be treated with TreeAzin
Durham Region		X			X		X	<ul style="list-style-type: none"> • Currently under EAB quarantine • 25% of Region is in forest • Regional forests managed by Lake Simcoe Region Conservation Authority • Ash component is 10-20% • No plans at present to develop a management plan. • By-law in place for private woodlands > 1 ha. • Forest By-law enforcement officer is a contract position
Halton Region	X				X		X	<ul style="list-style-type: none"> • Currently under EAB quarantine • 23% of the Region is in Forest • Estimated ash in urban areas is 8% • Estimated ash in woodlands is 10% (but much higher in some upland areas) • No intent at Regional level to manage EAB... hazard trees will be cut where warranted • Burlington and Oakville have EAB Management plans and will preserve some high-value urban ash trees along streets and in parks
Oxford County		X			X		X	<ul style="list-style-type: none"> • Infested and now included in EAB quarantine zone • 10-13% Forest Cover (26,703 ha) • Ash component is 30-50% • No full-time county forester

¹⁹ Under Development (... being drafted or under consideration)

Municipality/ Respondent	EAB Man. Plan			Actively Treating Woodland Ash?		Tree Removal		Comments
	Yes	No	U/D	Yes	No	Yes	No	
Peel Region			X*					<ul style="list-style-type: none"> • Currently under EAB quarantine • Peel is a highly urbanized, multi-tiered Regional Municipality without a Regional Forester. Most of the authority to undertake woodland and urban tree management initiatives lies with the municipalities rather than Peel Region <i>per se</i> and for that reason the priority appears to be to protect its urban street trees. There is no indication that the Region has any interest in undertaking any actions to protect its woodland ash trees from EAB.
Perth County		X			X		X	<ul style="list-style-type: none"> • Infested and now included in EAB quarantine zone • No full-time County Forester • No County owned woodland... most in private ownership with remainder C/A land • Declining forest cover (only 7%/19,000 ha.) • Ash is ~35% of this... so remaining woodlands will be heavily impacted by EAB
Waterloo Region		X			X		X	<ul style="list-style-type: none"> • Infested and now included in EAB quarantine zone • Highly urbanized but with urban and rural woodlands (some with very high ash population (70% in some woodlands)) • 13% Forest Cover (18,171 ha) • Regional Forester on staff as well as Municipal Foresters in Kitchener, Cambridge and Waterloo, and the GRCA • While no actions are planned for Regional woodlands, Kitchener is developing a Management Plan which will entail detailed surveys, tree removal and use of pesticides to save high value trees
Wellington County			X		X		X	<ul style="list-style-type: none"> • Infested and now included in EAB quarantine zone • No County Forester (OMNR district office in Guelph) • 17-18% Forest Cover (44,875 ha) • 20-30% ash (over 90% in some) • County manages 460 ha • Wellington does NOT include the City of Guelph • EAB likely to have devastating impact on County woodlands

11.0 ACTION PLAN-YORK REGION: OPTION 2 (ACTIVE MANAGEMENT)

11.1 Preamble

Following a review of the data and a detailed analysis of the various options available to it, York Region, in collaboration with its Municipalities, consultant and regulatory authorities has selected option 2 (Active Management) as the best option to mitigate the expected impact from EAB.

Rationale supporting decision:

- Regardless of human intervention, EAB will likely become pervasive throughout York Region (as well as adjacent Regional Municipalities and counties) over the next 10 years and most unprotected ash trees will die during that period²⁰
- Many of the vulnerable areas with large percentages of ash cannot be saved as there is no effective way of protecting large numbers of woodland trees, or those in riparian settings
- Despite recent advances in survey and treatment science and technology, there are still no effective strategies for detecting EAB early enough to protect woodland areas
- This option places the emphasis on maintenance of the woodland canopy, and mitigation of long-term ecological and environmental impacts
- It is compatible with current Best Management Practices employed by the Region vis-à-vis land stewardship, partnership with private property owners and interaction with its lower tier municipalities
- It is the most cost-effective option available... cost analyses conducted by similar municipalities support the implementation of a conservatively proactive approach as less expensive over a 10 or even a 20 year period than a re-active (do-nothing) approach.

11.2 Monitoring and Surveillance

11.2.1 Description

As previously discussed in this document, there are two different survey strategies employed in the management of quarantine pests such as EAB: namely, **detection** and **delimitation**. Details pertaining to the methodology for these strategies are

²⁰ While populations of some invasive pests can decline rapidly due to biological control, there is no expectation amongst scientists and regulatory experts that this will occur anytime soon with EAB

included on page 27 and 28 with technical details in Appendices V and VI to this document.

Objectives	Activities Required to Meet Objectives
Detect outlier populations outside of generally infested areas	In cooperation with its municipalities deploy prism traps at strategic locations throughout the region in densities sufficient to provide statistical confidence that EAB is NOT present
Through the use of delimitation surveys monitor the extent of EAB dispersal and the rate of spread around known outliers	Conduct visual surveys for signs and symptoms such as crown decline (on-going throughout the growing season) ²¹

11.2.2 Cost (Financial Forecast)

Estimated by York Region at \$400,000, over a 10 year period

11.2.3 Comments

Accurate inventory and survey data are paramount with respect to making informed management decisions. Early detection of EAB outliers will allow for targeting of tree removal and replacement programmes, and will help private property owners with managing their woodlands and mitigating future financial and environmental impacts.

11.3 Tree Protection

11.3.1 Description

With specific respect to EAB, tree protection means treatment with registered pest control products to prolong the life of a tree that would otherwise be killed by EAB. It is anticipated that close to 100% of York’s woodland, park, York Regional Forest, roadside and urban ash trees will be killed over the next 10 years. There are now data to show that the timely application of pest control products such as TreeAzin can effectively save at-risk trees and that over a 10 year period treatment can be less expensive than removing urban trees. Under the terms of registration for this product, it may only be applied by certified applicators using the EcoJect system

²¹ York Region has no plans to conduct branch sampling at this time

under patent to BioForest Inc. This is the only pest control product recommended in Canada at present.²²

The use of pesticides by York Region will be restricted to the protection of high value and/or heritage trees. The reasons for this are:

- Many of the trees managed by York Region are woodland trees and it is not practical or cost-effective to treat large numbers in woodland settings
- Most roadside ash are not considered high value, and can be replaced as necessary with other species

Notwithstanding, York’s lower tier municipalities and private property owners may elect to treat municipally owned trees at their expense. Detection surveys will help focus control programmes on at-risk areas and encourage cost-effectiveness.

Estimates on the number of candidate trees are not available at this time.

Objectives	Activities Required to Meet Objectives
Detect and determine extent of EAB populations in York Region	<ul style="list-style-type: none"> • Develop and conduct surveys to ensure early detection and delimitation of infested sites • Harmonize survey approach with lower tier municipalities • Share data with municipalities
Selection of trees for protection	<ul style="list-style-type: none"> • Develop criteria for selecting trees of merit • Develop inventory of woodland and roadside ash trees owned by the Region • Identify and map candidate trees • Develop operational plan for treatment
Cost benefit analysis of: treatment vs. non-treatment	<ul style="list-style-type: none"> • Determine costs for treatment of candidate trees bi-annually and extrapolate costs over 10, and 20 year periods • Compare costing for option 2 to that of other options • Compare York Region’s approach with those developed by other Regional Municipalities and counties (refer to pages 46-47 and appendices III and IV of this document)
Ensure a harmonized approach with York’s lower tier municipalities	<ul style="list-style-type: none"> • The intent is that York Region’s approach act as a template or synergist for EAB mitigation activities conducted by its lower tier municipalities, rather than an edict • Continued consultation, communication and data sharing are paramount to a harmonized cost-effective approach

²² While both ACECAP® 97 and Confidor 200SL are currently registered in Canada by the PMRA they are not recommended by the Provincial Forester or the author as effective pesticides against EAB

Ensure public is kept informed of EAB infestation status and mitigation activities in the Region	<ul style="list-style-type: none"> • Develop a public communications plan/strategy • Post on York Region website • Develop Fact Sheets/Q's and A's etc. • Provide contact information for public wishing to provide feedback or seeking advice
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11.3.2 Cost (Financial Forecast)

Protection of candidate trees is projected to cost \$200,000 over a ten year period; this will allow for the protection of an estimated 200 trees at current rates. Treatment would not preclude loss from other (primarily non-insect) mortality factors.

Application and chemical costs could likely change over the 10 year window thereby affecting the projected costs. New and less expensive control products may become available over this period. Additionally, biological control may play a more prominent role in mitigating ash mortality.

11.3.3 Comments

It is recommended that the *status quo* position be maintained; that is, that no attempt will be made to treat or otherwise protect woodland ash trees from EAB. No other Regional Municipality or county in Ontario is attempting to treat woodland ash trees. Notwithstanding, the Region, and its lower tier municipalities retain the flexibility with this option to treat high value trees if they deem it necessary.

For municipalities actively treating street trees with TreeAzin, the average cost is \$200 for a 20-30 cm tree. The cost of treating larger trees (>40 cm) is considerably higher as more product and time are required (average cost is \$400 and may exceed \$1000 for very large trees).

Irrespective of the management option selected, having accurate survey data and woodland species inventories are essential to managing woodlands and natural areas.

11.4 Removal

11.4.1 Description

Removal refers to cutting ash trees as a direct result of current or impending EAB infestation. Removal may entail:

- Felling the tree *in situ* without removal from the area

- Removal of the branches and trunk of the tree (leaving the stump)
- Total removal of all parts of the tree including stumps
- Chipping, slabbing and/or burning to destroy all EAB life stages
- Salvage logging in regionally or privately owned woodlands and roadsides

This can be done in the context of:

- Hazard tree removal (removing those trees along roadsides or adjacent to woodland trails which are, or will be hazardous)
- Pre-emptive removal (removing trees prior to infestation and/or death, regardless of health status)
- Selective tree removal (removing specific trees in conjunction with an over-all management programme to limit or mitigate EAB induced mortality)
- Other... such as the pre-emptive removal of trees as part of a woodland management programme (irrespective of EAB status)

Objectives	Activities Required to Meet Objectives
Identify and determine the number of potential hazard trees along York Region pathways and trails	<ul style="list-style-type: none"> • Conduct inventory of at-risk trees along York Region trails and pathways • Categorize as to risk potential • GPS or otherwise map
Identify and determine the number of Regionally owned roadside ash trees	<ul style="list-style-type: none"> • Consultant's report ("Emerald Ash Borer Threat Assessment in York Region" August 5, 2011, prepared by Silv-Econ Ltd.) • Inventory • GPS or otherwise map
Evaluate potential for salvage and/or cost recovery	<ul style="list-style-type: none"> • Determine potential for larger woodland trees to be salvage logged (cost recovery from this activity could offset costs for other mitigation activities) • Woodland inventories (trails and woodlands <i>per se</i>) • Develop salvage protocol for York Region
Develop site-specific ash tree removal policies and protocols for York Region	<ul style="list-style-type: none"> • Develop and cost removal strategies specific to: <ul style="list-style-type: none"> ○ Site (e.g., trails, pathways, woodlands, road allowances etc.) ○ Size classes (e.g., small trees would be felled and left on site, while larger trees may have to be sectioned and/or removed from site)

<p>Cost Analysis (specific to removal)</p>	<ul style="list-style-type: none"> • Estimate the number of potential ash tree removals specific to various sites (roadway vs. YRF) • Determine appropriate removal method for the site (e.g., cutting and removal vs. felling <i>in situ</i>) • Establish unit costs for removal and disposal • Determine costing for 10 and 20 year periods • Determine replacement costs (see section 11.5) • Determine potential for cost recovery through salvage logging and other risk mitigation activities • Compare costs to those of other management options
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11.4.2 Cost (Financial Forecast)

\$3.5-4 million over a ten year period

11.4.3 Comments

Standing dead ash trees rapidly decompose and may become hazardous within a year or two after death. Woodland trees killed by EAB generally do not have to be removed (or felled) unless they abut roads, public pathways or trails or otherwise pose a hazard. Irrespective of the option selected or available funding, this activity is non-discretionary due to the inherent liability associated with leaving standing dead trees. For this reason, there needs to be a contingency plan for dealing with dead or dying trees in Regional road allowances, and those adjacent to York Regional Forest pathways and trails and other areas where they pose a liability. Removals can be staged over a multi-year period based on risk and efficiency of removal. Annual surveys will help the Region assess risk. Data collected from these along with tree inventories will allow the Region to predict where mass mortality is likely to occur and which sites need to be prioritized for imminent removals.

Where significant numbers of at-risk woodland ash are present, or pre-emptive cutting has been deemed necessary, the option exists for salvage logging by which some costs can be recovered.

While this plan pertains only to Regionally owned trees, elements of it may be applicable to private land owners, many of whom will be greatly impacted by EAB.

11.5 Tree Replacement and Restoration

11.5.1 Description

“Replacement and restoration” entails the replacement of trees which have died or been removed (specifically for EAB). In some cases, it may also include site remediation activities where large numbers of ash trees have died or there has been physical damage to the site through removal activities.

Objectives	Activities Required to Meet Objectives
Prevention of canopy reduction due to EAB	<ul style="list-style-type: none">• Develop an accurate, up-to-date tree and land use inventory• Detection Surveys: up-to-date EAB survey data required• Develop or build on existing criteria or protocols governing tree replacement and site restoration for the various categories of trees (e.g., roadside, woodland, park and other)• Collaboration with lower tier municipalities and private groups
Mitigation of environmental/ecological impact	<ul style="list-style-type: none">• Identify areas where ash plays a vital role in the ecology of site (e.g., riparian areas where sedimentation or reduction in water quality may result from mass mortality)• Develop a plan to mitigate damage to these sites (could include underplanting with non-host species in some instances)

11.5.2 Cost (Financial Forecast)

\$5-6 million over a ten year period

11.5.3 Comments

Most Ontario municipalities see tree replacement as a non-discretionary item and have committed to maintaining or increasing the relative percentage of their urban canopies; many have developed Strategic Urban Forest Management Plans to provide a framework for this. Having a management plan in place allows municipalities to plan and focus removal, restoration and replacement activities and to budget accordingly.

With specific respect to York Region, many of the trees which will be killed by EAB are in rural regional road allowances or in the YRF and are deemed to be less important than urban street trees. Notwithstanding, the various species of ash are a

vital component of the ecosystems of some environmentally sensitive sites such as wetlands and riparian areas and their loss could have significant and long lasting impacts on these areas. The loss of ash could greatly degrade vulnerable habitats through increased erosion, sedimentation, and stream warming as well as a loss of browse and habitat for animals. Furthermore, these areas would also be more vulnerable to colonization by invasive alien plant species such as buckthorn.

The Region needs to identify which sites will be most impacted and develop strategies to off-set the damage. These could include underplanting with non-host trees or physical alterations to the site to deal with erosion and water quality issues.

11.6 Communications, Outreach and Public Education

11.6.1 Description

Develop and promulgate an effective EAB Communications Strategy; once urban and woodland ash trees start dying en masse, this will become paramount.

Objectives	Activities Required to Meet Objectives
<p>Working within the current budget allotted for EAB:</p> <ul style="list-style-type: none"> • Educate and engage the public on EAB identification and policy • Ensure support for EAB initiatives from lower tier municipal partners • Ensure favourable media exposure (and coverage) • Provide information for private property owners wishing to treat or otherwise preserve their trees 	<ul style="list-style-type: none"> • Define objectives • Designate Regional Spokesperson • Develop a strategic communications plan outlining time lines, key messaging, Q's and A's etc. • Develop or otherwise procure communications materials (pamphlets etc.) • Interactive on-line site linked to Regional and Municipal websites

11.6.2 Cost (Financial Forecast)

\$100,000 over a ten year period

11.6.3 Comments

The **Active Management Option** recommends that communications and outreach activities be delivered using currently available materials (pamphlets and handouts), and web technology.

11.7 Private Land Incentives

11.7.1 Description

Two programmes are currently available to residents of York Region:

- The York Natural Planting Partnership (YNPP) programme;
- Backyard Tree Planting Programme

11.7.2 Background/Details

11.7.2.1 York Natural Planting Partnership

- The YNPP was established to further the York Region Greening Strategy by increasing forest cover and promoting private land stewardship. It is directed at owners of properties larger than 0.8 hectares.
- The YNPP:
 - Provides technical expertise and assistance to the landowner in planning their planting project
 - Provides financial assistance to qualified property owners to help purchase and plant suitable trees and shrubs
 - Is administered through a partnership with local conservation authorities

11.7.2.2 The Backyard Tree Planting Programme

- The Backyard Tree Planting Programme:
 - Is administered by LEAF²³
 - Provides technical expertise and assistance to landowners in selecting, planting and maintaining their trees
 - Plants trees and shrubs at a reduced cost to landowners in order to create greener, healthier neighbourhoods in York Region.
 - Is focussed on backyards rather than larger properties

11.7.4 Cost

A total of \$1 million will be allotted for these programmes over a ten year period.

11.7.4 Comments

Both of these programmes have been very successful in maintaining urban forest canopy and forest cover and engaging the public and landowners. With the

²³ LEAF = Local Enhancement and Appreciation of Forests (a not-for-profit organization dedicated to the protection and improvement of the urban forest).

impending loss of most ash in the Region, it is important to maintain the relative percentage of canopy and get suitable replacement trees planted.

12.0 SUMMARY

EAB has behaved as a classic, albeit, worse case example of an invasive alien pest to this point. Many of the dire predictions made by scientists soon after its discovery in 2002 have proven very accurate and it is ranked as one of the worst pests ever introduced to this continent. It is a serious pest because:

- It is native to an area of the world (eastern Asia) with similar climate and host species to eastern North America... it arrived here pre-adapted to both our climate and ash species;
- EAB fills an ecological niche not currently occupied by any North American species;
- Its cryptic nature and the fact that it spends much of its life cycle under the bark of its host do not readily permit early detection or easy control... both critical elements of a successful management programme;
- Ash (genus *Fraxinus*) are very important woodland and urban trees in North America and are often over-represented in many areas as a result of habitat disturbance (they are early successional hardwoods and rapidly colonize disturbed areas), and overplanting in urban areas;
- There is a paucity of both native and introduced biological control organisms; it may be many years (or never) before these effect a level of control that will save ash trees.

In addition to the serious financial impact EAB has had (and will continue to have) on the forestry industry, municipalities and property owners (costs for removal and disposal of dead trees will easily reach into the billions of dollars in future years), its primary impact will be environmental. Much of the genetic diversity of ash in Canada and the US (the results of millions of years of evolution) will be lost forever, greatly affecting the ability of this genus to rebound from EAB. Additionally, ash-based ecosystems will be permanently damaged (ash is an early successional genus) and IAS “weeds” such as dog-strangling vine, autumn olive, honeysuckle,

buckthorn, and privet, will become more serious and pervasive pests in years to come.

Generally speaking, IAS such as EAB do not stay out of balance with nature forever and their impact will be attenuated over time through the emergence of naturally resistant trees and biological control of EAB. In the long term, ash trees which are genetically predisposed for resistance to EAB will be naturally selected for and will play an increasingly important role in the recovery of the genus.²⁴ Additionally, an apparent dearth of biocontrol organisms in the initial stages of an invasion by IAS can be overcome through the natural selection and emergence of endemic insects and diseases, or by the deliberate introduction and release of exotic biocontrol organisms. Biological “miracles” can happen and populations of damaging IAS can rapidly decline in the presence of effective biological control organisms. To this end, the USDA and its co-operators have released three species of exotic parasitoids collected in eastern Asia and specific to EAB at numerous US sites in the hope that these will become established in North America and effect control here. At present, this appears to have been a qualified success with there being evidence that two of the three species have successfully established.²⁵ As well, several species of native parasitoids which naturally attack North American relatives of the EAB have been recovered in large numbers in both Canada and the US over the past two years. It is uncertain what impacts these will have on EAB but IAS rarely sustain their epidemic phase forever and it is likely that EAB populations will crash or at least come into balance with their host at some time in the future. This may however, occur too late or be insufficient to sustain our ash species as viable components of our woodlands and urban forests. For this reason, there is considerable merit from pest management and quarantine perspectives in slowing the spread of EAB where this is possible.

Despite advances in the development of effective pesticides and application techniques in recent years, there is little hope that pesticides can ever be used to control EAB in woodland situations; at best, some of the urban ash canopy can be conserved through integrated pest management practices until such time as EAB comes into balance.

²⁴ Resistant trees have not been observed to date in significant numbers

²⁵ Personal Communication: Drs. Vic Mastro and Juli Gould (USDA-FS), Deb. McCullough (MSU), Barry Lyons (NRCan-CFS)

Barring a major change in the present circumstances, EAB cannot be eradicated from York Region. The loss of most of the ash in the Region will reduce species diversity and financially affect property owners with ash trees.

York Region's position is that it is not cost-effective or even possible to save most of these trees and that emphasis should be on off-setting the environmental impact through tree planting and canopy retention incentives, and saving high value and/or heritage trees. Regardless of any control or management actions to suppress the insect, EAB population levels are likely to increase exponentially over the next five to ten years and infest and kill most of the ash trees in the Region during this period. There will be considerable environmental, aesthetic and economic consequences for public and private property owners, loggers, sawmills and nurseries located in the Region.

The decision by the Region to NOT aggressively manage EAB through the removal or treatment of large numbers of infested trees is unlikely to influence the expected outcome. Ash is a major component in the natural succession of its woodlands (especially those planted to red pine) and the loss of this genus could tilt the balance in favour of less desirable species including IAS. Notwithstanding, York's woodland ash composition is less than that of many other southern Ontario counties and Regional Municipalities and the environmental and economic impacts resulting from EAB are likely to be less severe than in these areas.

EAB can only survive on ash and there is little indication that it will jump to other species when ash disappears. Accordingly, with the anticipated death of most ash trees in the area, it is expected that the overall EAB population will ultimately crash and EAB will come into balance with the ecosystem. This appears to be happening in areas with long established EAB populations such as Michigan and Essex County, Ontario where most, (but not all) of the ash trees have been killed. While EAB outbreaks would be expected to recur when ash populations rebound in the future, these would not be as severe as what is currently being encountered. Other factors such as the emergence of natural controls (which is already being observed), EAB resistant trees and human intervention will play a major role in the recovery of ash and it is hoped that the genus will regain some of its former prominence as an important forest and urban tree at some point in the future. Unfortunately, in severely impacted areas, this is unlikely to be any time soon.

Maintaining healthy streetscapes and forests is integral to the urban environment and every effort must be made to maintain or even increase the number of healthy

trees in urban and adjacent rural areas through visionary management, public education and replanting programmes.

Table 3: List of Appendices to York Region EAB Management Plan

#	Title/Description	# pages
I	Definitions/Glossary of Terms	2
II	A History of EAB Management in North America	6
III	EAB Status and Response Strategies in Select North American Cities	12
IV	A Summary of EAB Management Activities at the County and Regional Municipality Levels	12
V	CFIA EAB Survey Protocol	8
VI	CFS Branch Sampling Protocol	3
VII	How to Identify ASH (<i>Fraxinus</i>)	2
VIII	Procedure for preservation of EAB Adults and Larvae	2

APPENDIX I

Definitions/Glossary of Terms

Cambium/Cambial Layer:

A layer of cells that forms tissues that carry water and nutrients throughout the plant. On its outer surface, the vascular cambium forms new layers of phloem, and on its inner surface, new layers of xylem (see definitions).

Disparate/Disjunct Populations

With specific respect to the York Region EAB Management Plan these terms refer to populations which are separate from the general contiguous population of EAB; presumably outlier populations resulting from the introduction to a new area through natural dispersal or human activities.

D-03-08

Refers to CFIA Policy Memorandum D-03-08: “Phytopsanitary Requirements to Prevent the Introduction into and Spread Within Canada of the Emerald Ash Borer, *Agrilus planipennis* (Fairmaire)” [Oct. 27, 2010] <http://www.inspection.gc.ca/english/plaveg/protect/dir/d-03-08e.shtml>

Endemic:

Endemic means native to, or confined to an area. It can include long established (naturalized) organisms which are now considered part of the local flora and fauna.

Epicormic Shoots:

Shoots generally produced along the trunk or main branches of a tree, often as a response to an injury or damage to the underlying tissues. These are often long and vigorous.

Extirpated:

Refers to an organism that is extinct in an area where it formerly occurred, but is still present (extant) in other areas

Invasive Alien Species (IAS):

IAS are organisms which originate elsewhere and are not native to the area. Human involvement is implied in their introduction to the new area (either deliberate or accidental) and there generally has to be (the potential for) economic or environmental harm before they can be classified as IAS. This term is generally synonymous with and used in place of such words as: “exotic”, “foreign” or, “introduced and established” although not all exotic organisms would qualify as IAS, because they have minimal economic or environmental impacts.

Nested Quarantine:

This is a quarantined area, established within a larger quarantined area (or zone). It is a highly beneficial strategy for slowing the spread of pests of quarantine significance such as EAB, especially where they are difficult to detect in the early stages of infestation, and as well, protecting adjacent counties not believed to be infested.

Parasitoid/Parasitoidism:

A **parasitoid** is an organism (usually an insect) that spends a significant portion of its life cycle attached to or within a single host organism but which it ultimately kills (and often consumes) in the process.

Phloem:

This is tissue in a plant responsible for the active conduction of water, nutrients and metabolites throughout the plant and along with the **xylem** comprises the vascular area of the plant.

Pest Risk Assessment (PRA):

PRA is science based analysis of the potential of an organism to become a pest species. The assessment examines factors such as host and climatic suitability, pathways, vectors and potential environmental, ecological and environmental impact. Numerical scores are assigned to the pest permitting it to be ranked and compared. Canada and other developed counties use PRA as a decision making tool with respect to regulating potential pests or the commodities and pathways by which they could be introduced.

Quarantine Zone:

See Regulated Area.

Regulated Area:

With specific respect to the York Region EAB Management Plan, **Regulated Area** refers to areas of Canada regulated under Federal Ministerial Order for Emerald Ash Borer. By way of these orders, the regulated area is quarantined with respect to the pest and the movement of regulated articles such as ash forest products, trees, and firewood of all species which may spread EAB.

Xylem:

This refers to the supporting and water conducting tissue of vascular plants, consisting primarily of tracheids and vessels. It is generally woody tissue. The **xylem** and the **phloem** comprise the vascular region of the plant and are responsible for the movement of water and nutrients within the plant.

APPENDIX II

A HISTORY OF EAB MANAGEMENT IN NORTH AMERICA

Canada

Soon after the initial discovery of EAB in the Detroit area in 2002, the top regulatory specialists and quarantine scientists in North America met to develop strategies to address what they perceived to be a very serious threat. The conclusions from this meeting were that EAB would likely become a very serious and damaging urban and forest pest in North America with severe and lasting environmental and economic consequences. Additionally, it was forecast that there would be little chance of eradicating it or even containing it, but that every attempt should be made to do so. The strategy of choice was “Slow-the-Spread”, with the hoped-for outcome being that natural or introduced biological controls would eventually emerge or could be introduced from eastern Asia. This strategy would also allow for science to “catch up” with respect to survey technology and the development of effective insecticides or bio-controls. While it was believed at that time that EAB had likely spread beyond south-eastern Michigan and south-western Ontario, few experts realized at that time how widespread the actual infestation was.

2002-2003

From the out-set, the position of the CFIA and its Canadian partners was that EAB could not be eradicated but that there was significant merit in slowing its spread or even containing it within Essex County. Accordingly, the CFIA concentrated its efforts on western Essex, where it was believed EAB was confined. Additional measures taken to prevent the movement of potentially infested ash materials to other parts of Canada were:

- Issuance of a federal Ministerial Order (MO) by which the western portion of Essex County was placed under quarantine;
- Issuance of quarantine notices to property owners with infested trees;
- Removal of all ash trees within a 500m radius of infested trees (over 20,000 trees were removed in Essex County)
- Development of Policy Memorandum D-03-08 which outlined import and domestic movement restrictions
- Erection of notices along major highways
- Other communications initiatives to advise people of quarantine restrictions
- Investigation of the source of outliers

- Consultation with other government departments, USDA, affected municipalities, property owners and affected industries advising of impacts and recommended course of action

Ash Free Zone

In the fall of 2003, a decision was made by the CFIA on the advice of its Science Committee and with the full support of its partners, to establish an ash-free or “firebreak” zone on the western end of Chatham-Kent. This strategy entailed the designation of a defined geographical area to the east of what was perceived to be the leading edge of the EAB population at that time, and creating a barrier to its natural spread by removing all ash trees within the zone which could support brood populations. In order to achieve this, Federal Regulations were developed under the Plant Protection Act which mandated the removal of ash from private properties in the zone. This area was selected because of its extremely low percentage of forest cover (estimated at less than two percent), the presence of Lakes Erie and St. Clair which would act as natural barriers and because there was no physical evidence at that time that EAB was established in areas to the east of the zone. Work began on removing ash trees from the zone during the winter of 2003-04, and an estimated 85,000 ash trees were removed by contractors. Despite an endorsement from the CFIA’s partners and Ontario municipalities, a provision for compensation to affected property owners, and a generous tree replacement programme, the creation of the ash-free zone proved immensely unpopular with residents and property rights activists and received considerable bad press. It represented, what most scientists felt was the last chance to confine EAB to south-western Ontario and save the estimated billion ash trees in areas of Canada to the east. While it undoubtedly provided a significant barrier to the natural dispersal of EAB to areas east of the zone, it was very costly to establish and maintain. In 2004 and 2005 EAB was detected to the east of the zone in Chatham-Kent and an additional 50,000 trees were removed in support of the zone. With the finding of numerous well-established outliers of EAB in 2004 and 2005 in areas to the east of the zone including Lambton, Elgin and Chatham-Kent, the zone was deemed redundant and the Regulation by which it had been created was retracted. In 2005, tree cutting to slow the spread of EAB was officially abandoned as a strategy, although some trees around new outliers would continue to be removed in conjunction with scientific research conducted by the CFS and CFIA.

2005-07

In 2005 and 2006, the CFIA’s strategy shifted away from tree cutting with the new focus being on public messaging (“Don’t Move Firewood”) and quarantine actions to slow the spread. Two major components were:

- The use of nested quarantine zones¹ (5 km radial zones around known positive trees) to augment the quarantines already in place at the county level;
- Revisions to policy memorandum D-03-08 to relieve the burden on affected industries and property owners. This document outlined a detailed quality management programme to permit the movement of potentially infested ash materials to registered facilities in non-regulated areas, where the risk of EAB being moved had been mitigated through processing and other precautions.

While the overall effectiveness of these policies is difficult to quantify, the consensus of most quarantine specialists and research scientists is that they were highly effective in staunching the establishment of new outliers through natural dispersal and human activities.

Current Status

Limitations of Ministerial Orders (MOs)

In 2009, the CFIA abandoned the use of nested quarantines due to the expense of maintaining them and concerns regarding their overall effectiveness. Many experts believe that this change in policy is likely to exacerbate the spread of EAB in lightly infested counties and could threaten neighbouring counties which are currently free of the pest. The current CFIA policy is to amalgamate quarantine zones of presumed similar infestation status and associated risk under a single Ministerial Order (MO)². Their stated purpose is to limit the long-distance spread of EAB and protect other areas of Canada through movement restrictions on high-risk commodities. To this end, all municipalities in southern Ontario with contiguous populations of EAB (including York) are included in one regulated area under a single MO as of March, 2011. Refer to *Figure 1*.

Of major concern is that municipalities, conservation authorities and private property owners located in regulated areas and wishing to protect their ash resource are essentially on their own. There are no restrictions in place to prevent the movement of infested materials within the areas regulated by a single MO, even those apparently EAB free. Infested trees are no longer removed by the CFIA other than for research purposes and infested municipalities are not eligible for compensation or tree replacement initiatives from the CFIA for damages resulting from EAB.

¹ A quarantined zone within a quarantined or regulated area... designed to slow the spread of quarantine pests in otherwise uninfested areas

² A federal statute that designates a geopolitical area as infested and imposes restrictions on the movement of ash materials and firewood

Survey Policy

The current policy of the CFIA as it relates to non-regulated counties and municipalities is to conduct risk-based detection surveys with the emphasis on areas around campgrounds, sawmills, and parks. The CFIA has indicated that it will continue to assist the Natural Resources Canada-Canadian Forest Service (CFS) and other research organizations in assessing scientific research on new protocols such as traps and baits. Where EAB is detected in previously unregulated counties or municipalities, current CFIA policy will continue to be to:

- conduct delimitation surveys around the site to determine the extent of the infestation,
- place a Notice of Prohibition of Movement order on the affected property (which prohibits the movement of ash from the premises) pending the inclusion of the county or regional municipality in a regulated area

The decision to regulate a newly detected area under a MO is generally made by the CFIA when surveys have been completed for the season and the data analysed. Notices of Prohibition of Movement Notices are rescinded where counties are regulated under ministerial orders.

The CFIA does not conduct surveys in regulated or known infested areas.

Summary

While the CFIA has reiterated its commitment to slow the spread of EAB within Canada and maintain market access, there is no plan on its part to undertake any active control measures; it will continue to rely on surveillance, early detection, broad-based quarantine measures and public communications initiatives to achieve this goal.

Managing EAB in the United States

Since the initial discovery of EAB in the summer of 2002, Canada and the US have cooperated extensively on research and the development of science-based management strategies. From the out-set, there has been a full sharing of scientific data and an open dialogue with respect to the development of survey protocols and setting research priorities. Where the two countries have differed is their policies on the use of pest control products to combat EAB and on detection survey strategies.

Regulatory Framework and Responsibilities

In the US, the lead federal agency is the USDA -Animal and Plant Health Inspection Service (APHIS). As with the CFIA, APHIS develops national policies and frameworks for the management of IAS such as EAB and, in cooperation with their Forest Service and state co-operators, sets research priorities. Similar to the CFIA, APHIS relies on expert panels and

science committees to provide it with science-based advice and to ratify its regulatory policies and decisions prior to implementation.

Unlike Canada, the USDA has a cooperative agreement with State governments for the delivery of survey and pest mitigation activities for pests of quarantine significance. While these are federally funded for the most part, there is a fair amount of latitude on the part of the state as to how the programmes are interpreted and delivered. Where states do not deliver a national programme to federal specifications however, monies can be withheld.

State governments also have the option of funding their own programmes for quarantine pests as they see fit. States are empowered to impose their own quarantines and place restrictions on the intrastate movement of regulated pests and articles.

Pest Control Products

While the USDA has been in agreement with Canada that pesticides are relatively ineffective as a quarantine tool and have never officially advocated their use, several states have used pesticides such as Imidacloprid (various formulations including Merit, Imicide, Confidor, and Pointer) and other products in their response programmes. A key difference between Canada and the US is the general availability of these products for use by governments, tree service professionals and private citizens. While products used in both countries must be proven by the manufacturer to be safe, Canada's regulations are deemed to be more restrictive than those of the US and many products registered in the US and readily available there cannot be sold in Canada. Until recently, state programmes have relied on Imidacloprid based products. These are applied either as a soil drench around the roots of the tree, or injected into the tree under pressure. While, under some circumstances they can be effective in preserving the life of tree they are not effective where the tree's vascular tissues have been damaged by EAB or where the tree is under stress and its ability to uptake the chemical has been compromised. Furthermore, continued treatment via injection on an annual basis can damage the vascular area of the tree and provide entry sites for disease organisms.

As of May 2010, TREE-äge™ (Emamectin Benzoate) has full registration in the US as a restricted use pesticide and is widely used in 9 states with EAB infestations. Research conducted in the US confirms that it is highly effective for two years (possibly three), making it a cost-effective alternative to cutting. Its drawbacks are its relatively high mammalian toxicity, when compared to TreeAzin™, and its high residual activity. Despite its efficacy, it is unlikely that the product will be registered in Canada for use against EAB in the near future; registration costs are high and Canada is perceived by the manufacturer as a small market with little potential for return on their investment. There is, however, interest by some parties in getting this product registered as soon as possible.

The Early Years (2002-2004)

In the initial stages of the EAB emergency response, State governments relied heavily on intensive surveys in conjunction with tree cutting to slow the spread. Several states including Ohio initially attempted to eradicate EAB but soon abandoned this goal as more, well established outliers were found. Both Michigan and Ohio initially removed all ash trees within ¼ mile of known infested trees, which resulted in the destruction of hundreds of thousands of trees. In 2004, the US attempted to establish an adaptation of the Canadian Ash-Free Zone, but on a much larger scale. This initiative, which would have seen potentially millions of ash trees removed from around the perimeter of Michigan, was abandoned as a result of budget cuts and the discovery of EAB in numerous new areas well beyond the proposed zones.

Survey Strategies

While Canada relied on visual surveys during the early years of EAB, (examining trees for signs and symptoms), the official US federal policy was geared towards the placement of “trap” trees (trees which had been girdled in order to stress them and which were later cut down and analyzed). Despite initially cutting tens of thousands of detection trees in the early years, the US has since abandoned this strategy and now uses purple prism traps baited with lures as the centre-piece of its surveillance programme. APHIS and its state co-operators plan to deploy over one million traps in 2011. The purple traps are highly visible and result in free publicity for the agency.

Outreach and Communications

In support of their regulatory and surveillance programmes, the USDA and its state co-operators have invested heavily in public education. This initiative comprises: websites, media blitzes and billboards emphasising the perils of EAB and imploring residents to not move firewood.

Current Status and Summary

In summary, despite numerous new finds well beyond the original epicentre in Michigan, and the recent addition of several states with very large ash populations (i.e., Minnesota, Iowa and New York with 937 and 900 million ash trees respectively, Kentucky and Iowa), the US continues to consider slowing the spread of EAB and protecting its ash resource a top priority. For this reason, Canada will be required to maintain its domestic and import regulations and to fund EAB research in order to maintain market access for hardwood forest products and avoid trade sanctions.

APPENDIX III

EAB STATUS AND RESPONSE STRATEGIES IN SELECT NORTH AMERICAN CITIES

Ontario

Brantford, Ontario

The Emerald Ash Borer (EAB) was first detected in the summer of 2010 using the CFS developed branch-sampling technique. In response to this, Brantford is currently developing management options for consideration by council.

Brantford had previously completed a full inventory of its street trees. Although the genus *Fraxinus* is well represented in Brantford area woodlands, it comprises only 6-7% of its street trees (3701 trees). Of note is that 22% of these are black ash (which are generally deemed to be undesirable for street tree planting due to root flaring and pest problems). Consequently, Brantford sees little merit in preserving these.

The Brantford Strategic Management Plan is still in its developmental stage and is confidential at this time. They are currently removing the infested trees and are but are not considering the proactive removal of ash trees en masse.

Branch sampling surveys continued in 2011 and several pockets of infestation were found. Infested trees will have been removed.

Brantford has considered using pest control products such as TreeAzin to preserve some high value street trees but have not treated any trees at this time.

Because they have an accurate and current inventory, they do not plan to use HSI in the foreseeable future as a potential tool to detect ash.

Burlington

EAB was first detected in Burlington in the spring of 2010; branch sampling confirmed that it was well established and had been present (but sub-detectable) in the community for many years. Although trap and branch-sampling surveys conducted in 2010 failed to detect any additional infestations elsewhere in the City, EAB has now been confirmed in the Royal Botanical Gardens in the southwest corner of the City.

Burlington has an estimated 7000 ash street trees and 9000 trees in its parks and managed woodlands; this comprises about 9.5% of its total urban canopy.

Burlington drafted a Management Plan in 2009, which outlined four options for dealing with its urban ash trees. While initial recommendations called for no treatment of its ash and the proactive removal of all street ash trees over a 10 year period, this position was modified in 2010 with published data to support the use of TreeAzin to save some high value urban trees. To that end, over 500 trees were successfully treated in 2010, and, a similar number in 2011.

On May 25, 2011, Burlington City Council approved an aggressive action plan to preserve the ash component of its urban canopy with a gradual transition to non-ash species over the next 20 years. \$11million has been budgeted over a 10 year period for this initiative. It is interesting to note that treated street and park ash will only amount to 0.3% of their overall urban canopy.

Burlington plans to defer the removal of confirmed infested trees until visible decline is in evidence; they feel this approach will help with public acceptance of their plan and is manageable.

There are no plans to use HSI at this time as the city already has good inventory data, and they feel the HSI technology is not cost effective to their purposes.

Hamilton, Ontario

EAB was first detected in Hamilton in 2009, but surveys indicate that it had been established there for several years prior to this. EAB induced mortality and decline were in evidence in several areas of the City in 2010. Hamilton has an estimated 11,078 ash street trees (representing seven percent of all species); and 12,000 ash park trees and cemetery trees. There are also numerous ash trees in city-owned woodland and natural areas within the City for which there are no estimates. With removal, disposal and replacement costs estimated at \$1250 per tree, it could cost the City of Hamilton a minimum of \$35,829,875 to treat, remove, replace and dispose of street and park and cemetery trees killed by EAB assuming that most untreated trees would die over the next 10 years. Ash is also widely planted on private properties throughout the City and homeowners could expect to shoulder similar costs for removal of their dead trees. While the City does not assume responsibility for trees on private property, it can order their removal under its property standards bylaw where they are deemed to be hazardous. Costs for this would continue to be assumed by the property owner.

A Strategic Management Plan was prepared by a private consultant for the City Hamilton in the fall of 2010 and presented to City Council. Four options were developed for consideration:

1. **Minimal Management:** Ash trees would only be removed if they die or become hazardous;
2. **Active Management:** The Municipality would conduct annual surveys to determine which trees were infested. All known infested ash trees on Municipal property would be removed;
3. **Pre-emptive Management:** The Municipality would conduct annual surveys to detect publicly owned infested trees and any “hot” spots where infestation was more prevalent. All publicly owned ash trees would be removed as cost-efficiently as possible over a defined period (10 years) irrespective of their infestation status. Priority would be given to the staged removal of ash trees in areas where their numbers are high to preserve the canopy as long as possible and maximize opportunities for replanting. The Municipality could elect, at its discretion, to treat high value publicly owned trees with registered pest control products. The objective of this option is to manage and distribute the costs associated with EAB infestation over an extended period rather than manage the pest *per se*;
4. **Aggressive Management:** The objective of this option is to save as many trees as possible and slow the spread of EAB locally. The municipality would undertake to conduct annual surveys of its street and park trees to detect those infested with EAB. These would either be removed or treated depending on their condition. Additionally, all ash trees within a defined radius of these would either be treated with registered pest control products, or removed. There is no expectation that EAB can be eradicated but this option is likely to prolong the life of some high value trees which would otherwise die and preserve the urban canopy.

All options would entail replacement of removed trees with caliper trees.

In consultation with the City of Hamilton, Option 3 (Pre-emptive Management) was recommended as EAB was likely already well established at numerous locations throughout the City. The total estimated cost of deploying this option was estimated to be \$36,367,242 over a 10 year period. There was a further recommendation that priority be given to areas of the City with high concentrations/populations of ash trees in order to maximize tree replacement initiatives and preserve the urban forest canopy.

There are no plans to use HSI to detect ash trees or EAB.

TreeAzin may be used to treat some high value trees although this has yet to be approved. Despite the recommendation for pre-emptive removal of its ash trees, Hamilton has yet to remove any non-infested/asymptomatic trees. As of August, 2011, EAB induced mortality is in evidence at several locations in the City and numerous removals have been required over the summer.

Along with many other Ontario municipalities, Hamilton is seeking financial assistance from the federal and provincial levels of government and is lobbying, along with other municipalities for increased funding for EAB related research.

Kitchener, Ontario

The City of Kitchener has been preparing for the arrival of EAB for several years. A memo to council in May of 2010 recommended that monies be set aside for the development of a strategic management plan, that the tree inventory approved for 2014 be moved forward to 2011, and that a 10 year Capital and Operating budget plan be developed to actively manage EAB. A budget request to Council for additional funding has been deferred to 2012. With the discovery of EAB in Waterloo Region in the fall of 2010, these recommendations became even more imperative. EAB is now known to exist in at least 2 locations in Kitchener.

An inventory completed in 2009 indicated that 10.4% of Kitchener's street trees (4,522 trees) are ash. It is estimated that the removal and replacement of these will cost \$4.75 million over a ten year period. This does not include the loss of ash from the City's extensive park and woodland areas (1550 ha) for which no firm estimate is available.

City Forestry staff has recommended a pro-active response to the EAB issue. The key elements of this are: conducting an inventory ash on public and private lands, detection and delimitation surveys using prism traps and the CFS branch-sampling protocol, and the possible use of pesticides (TreeAzin) as well as proactive tree removal to protect part of the existing ash population. In support of this, a communications strategy is being developed as well as a policy to deal with ash on private land. A management plan was developed in 2010 by a private consultant and the City has engaged an additional consultant to assist with training its staff and evolving some practical management options.

In collaboration with the CFS, Kitchener implemented a branch sampling survey within 4km of the known infested site which resulted in several new areas being detected. During the summer of 2011, 30 green prism traps were deployed, several of which detected beetles in already suspect areas.

Kitchener has established an EAB working group that includes the Region of Waterloo *per se*, all municipalities within the Region, and as well, the City of Guelph in nearby Wellington County. A joint website has been established and is maintained by the Region.

London

As an outcome of UFORE surveys, London estimates that it has 440,000 ash trees (which comprise around six percent of street trees and ten percent of its parks and woodlands). This has been confirmed by an actually physical inventory and GPS based counts.

EAB was first found in the City of London during the fall of 2006 and spring of 2007 at three disparate sites. An investigation concluded that it had been established at these for several years prior its initial detection and that there were likely other sites to, or from which it had spread. The initial response by London was to attempt to limit the spread of EAB within the City. To this end, the CFIA removed three infested trees in the fall of 2006 and several infested trees in a public park were cut and chipped in 2007. In order to comply with CFIA quarantine requirements and slow the spread of EAB within London, the City provided several areas where residents and tree service companies could drop off ash logs and debris. Material taken to these sites was tub-ground prior to it being removed to a recycling facility north of London. A major complication for the City and the CFIA was that the privately owned recycling facility to which London took its yard waste was outside of the three 5km nested quarantine zones which had been established by the CFIA. This seriously affected the collection of yard waste materials as the City could not guarantee that these would not contain potentially infested ash materials. As a result, yard waste materials had to be processed prior to transfer to the recycling facility and the City was forced to incur significant additional costs (estimated at \$500,000) to comply with the federal quarantine. In 2007, several heavily infested areas were found on numerous private properties (including a college and a large hospital) and it was evident that EAB was well established in London. To date, many of these trees remain standing but have now become a major hazard and will have to be removed soon.

With additional finds of EAB in 2008 at several locations in Middlesex County, a decision was made by the CFIA to discontinue the nested quarantine zones within the City and to permit the movement of untreated yard wastes to London's recycling facility. This has resulted in a considerable cost savings to the City with probably little increased risk of EAB being spread in these materials.

Several areas within the City which were thought to be EAB free were surveyed by the Canadian Forest Service in 2009 and were determined to be heavily infested. Some trees in these areas were in serious decline by the end of the summer of 2009, demonstrating how rapidly populations can build up to tree-killing levels in apparently healthy trees. 37 trees were treated with TreeAzin on an experimental basis.

As of August, 2011, EAB induced mortality is now evident at many locations throughout the city with many areas severely impacted.

The City of London is currently developing a strategic management plan and has hired a consultant to assist them with this process (due, summer of 2011). Many areas of London have high numbers of large ash trees along their streets and there is considerable interest in conserving these through the use of TreeAzin™ in 2011 although there is no plan at present to treat city owned trees. Notwithstanding, London encourages its citizens to treat privately owned trees and has developed a webpage to address citizen concerns. While there are no proactive plans to remove ash within the City to control EAB, infested street or park trees which become hazardous will have to be removed. Without treatment, it is acknowledged that most of the City's estimated 30,000 street, park and backyard ash trees are likely to die in the near future and will have to be removed.

Oakville, Ontario

Oakville developed an emergency response plan for EAB in 2008 and will have a strategic management plan ready for the end of 2011. Oakville is aggressively trying to save its ash trees and retain its urban canopy. It estimates that it has 177,000 ash trees in its urban woodlands and along its streets.

Oakville's premise is that it is cheaper to treat trees over a given period than to proactively remove them, and has data to support this position. To this end, Oakville successfully treated 500 trees in 2008 and 2009 and 1600 trees in 2010 (25% of the treatable municipal ash canopy) with TreeAzin. Indications¹ are that this product has given excellent control over a 2 year period.

In addition to prism trap and branch sampling surveys, Oakville contracted AMEC Earth and Environmental Inc., a remote sensing company, in 2010 to conduct research into the possible use of Hyperspectral Imagery HSI to detect ash in the urban canopy and possibly, EAB infested trees. A statement posted on Oakville's website (August, 2011) maintains that their HSI trial was 80% effective in discerning ash from other tree species and met its stated objectives. A major tenet of Oakville's programme is to engage private property owners in preserving ash and HSI can be linked to GPS based property data and assist in indentifying ash on private property.

In addition to plotting ash, Oakville is also hopeful that HSI can be used to detect EAB infested trees. To date, there is no data to show that this component of the trial was successful.

¹ Based on gallery dissection in treated trees and data provided by the patent holder

In support of its research and management activities, Oakville has placed considerable emphasis on the development of public education and outreach materials, which are posted on its site.

Oakville, along with many other EAB affected communities has attempted to secure financial assistance from the federal and provincial governments... without success to this point.

Ottawa

The City of Ottawa could soon be the most heavily EAB impacted urban area in North America. EAB was found in east-end Ottawa in the summer of 2008 and is likely to have dispersed to other areas of the City prior to this. Based on how the beetle has behaved in the US and Canada to this point, the City has discounted any possibility of eradicating it and has decided to mitigate the damage through a comprehensive action plan. A recent review conducted by City staff indicates that ash trees make up 25 percent of the total urban forest cover of the City or an estimated 75,000 trees with a further 150,000 ash trees along the edges of municipal natural areas and private homes. In all, Ottawa has around 1000 km² of woodland. Ash is estimated to comprise 25 percent of forests and woodlands in the greater Ottawa area and the City expects that within a period of 10 to 15 years, they could lose 18,000 hectares of forest in the adjacent rural area and a further 2,600 hectares of tree cover from the urban area as a result of EAB. The City has recently approved a comprehensive action plan which includes slowing the spread of the insect through selective control actions along with a proactive planting program, to mitigate the impact. Elements of their action plan are:

- **Tree removal** both to slow the spread of EAB and to remove dead or dying trees
- **Pesticide injections** for high value trees (using TreeAzin™)
- **Proactive tree planting and replacement tree planting** on both City-owned and private property; Ottawa has received funding from City Council to plant replacement trees on private property.
- **A Public Consultation/Outreach Programme** to include an extensive public awareness campaign to reduce the movement of wood, provide management solutions for homeowners and landowners with ash trees, and provide options for tree replacement

In support of this action plan a tree inventory using GPS is being carried out to map all City of Ottawa trees with the emphasis at present on ash trees. City council has allocated an additional \$1,400,000 in their 2009 budget to combat EAB:

- \$300,000 to cover costs related to EAB's initial operational impacts and the further development of the EAB Management Strategy
- \$600,000 to increase tree planting and the tree distribution program to residents and

- \$500,000 to implement a modified handling and processing procedure for ash wood and leaf and yard waste collected as part of the City's leaf and yard waste program

TreeAzin was used to treat 500 urban street trees in 2010 and an additional 1000 trees in 2011; there are no plans to treat woodland trees. Ottawa planted 2000 trees in 2011 to replace those affected by EAB.

An additional challenge for Ottawa is the protection of a collection of rare ash trees at the Central Experimental Farm arboretum. This arboretum contains what is probably the largest and oldest collection of trees in Canada and a decision was recently made to protect many of the more valuable ash tree specimens there through the use of TreeAzin™.

Addition information detailing how Ottawa is managing EAB at the Regional Municipal level is included in Appendix IV.

St. Catharines

With EAB being found at high levels in and around the City in 2010, St. Catharines has given up on trying to save its 4000 ash street trees. The City had previously conducted both branch and traps surveys and treated around 40 trees with TreeAzin in 2010. There are no plans (or money) to treat any more trees or to continue surveying in 2011. No pre-emptive removals are planned and trees will just be removed as they die. Some areas of the City are extensively planted to ash and will be heavily impacted. The City has no official response plan.

A recent report (August, 2011) states that there are over 500 million ash trees in the Niagara Region of Ontario, and that areas outside of St. Catharines will be heavily impacted by EAB over the next few years.

Toronto

The City of Toronto has an estimated 860,000² ash trees (8.4% of its total trees) in its urban canopy of which 32,400 are street trees. Of these, an estimated 1,350 have been killed thus far by EAB and 150 have been removed for research purposes. Around 900 are scheduled for removal in 2011.

With the detection of EAB at one site in the fall of 2007, federal quarantines were placed on Toronto by the CFIA. While it was hoped that this find was a one-off outlier, numerous other well-established infestations were found throughout 2008 and 2009 in the City and adjacent municipalities. Prior to the initial detection of EAB, the Toronto Urban Forestry Department

² Many of Toronto's 860,000 ash trees are < 15 cm dbh and only those which present a hazard will be removed.

prepared a detailed report to council outlining the potential impact of EAB. A report published by the City in 2010 states that 98% of Toronto's ash trees could be infested within the next six years.

Toronto has cooperated extensively with the CFS and other researchers on the development of the branch sampling protocol and on the treatment of trees with TreeAzin™. Data from trials conducted there in 2008 and 2009 indicate that the pest control product was quite effective in killing all stages of larvae and could be used to preserve high-value trees. Toronto's management plan (still under development) calls for the gradual replacement of most ash trees with non-host species and the preservation of high value trees with TreeAzin™. Prior to 2011, 444 trees on municipally owned golf courses and in parks were successfully treated and there are plans to treat more in 2011. Their plan will call for an emphasis on public consultation and engagement, and continued liaison with the research community.

Toronto has been surveying for EAB since 2003 and employs traps, visual inspections and branch sampling to detect EAB. Toronto has no plans to use HSI in their surveys as they feel other tools give them the data they need to manage their program at a lower cost.

Toronto estimates that removing all 82,000 city owned ash trees and replacing them with non-host caliper trees would cost \$60-80 million over a five year period (this figure does not include ash trees in parks and woodland areas).

Windsor

By the time EAB was found in Windsor in July of 2002, it had been there for several years and ash mortality was already in evidence. No control measures were undertaken, other than to remove dead and dying trees and to provide a public ash drop-off/disposal site. The City of Windsor estimates that it had to remove, stump and replace 6000 hazard ash trees on public property at a cost of \$4 million. This represented nine percent of its canopy at that time. No attempt was made to remove the thousands of dead ash in woodland areas, which quickly died and have long since fallen. Nor did the City assume responsibility for the removal of trees on private properties other than to order the removal of hazard trees under its Property Standards By-law. This proved a hardship for some property owners with large ash trees which had to be removed. As the entire western portion of Essex County (including Windsor) had been placed under quarantine in 2002, there were no restrictions on the movement of ash tree materials to the City's recycling facility east of Windsor. To date, most ash trees in the Windsor area (with the exception of blue ash) have died and have now been removed. An estimated five percent of the original ash population is still living but is generally infested. To quote the City Forester "EAB is no longer an issue". In all, it is estimated that over one million ash trees died in

Windsor and surrounding Essex County, including most of the pumpkin ash (*Fraxinus profunda*) in the area (an endangered tree species now threatened with extirpation in Canada as the direct result of EAB).

On a positive note, there are unconfirmed reports that ash seedlings have survived in Essex and in neighbouring Michigan and these may allow the genus to rebound at some time in the future in some woodlands.

US Cities Affected by EAB

As part of the analysis of the EAB situation in Canada, four US cities affected by EAB were chosen for comparison purposes: Buffalo and Rochester New York; Toledo, Ohio; and Milwaukee, Wisconsin.

Buffalo, New York

The USDA-FS estimates that there are over 900 million ash trees in upstate New York. However, despite ash being a very common tree in urban woodlands and on private properties in the greater Buffalo area, the City's Parks and Recreation Division estimates that ash comprises only 1% of its public street and park trees (they concede that this is very low percentage compared to other cities and they are fortunate in this regard). Consequently, they are not overly concerned with EAB at this time despite it being found in areas to the south and west of the City. They have no data for private or commercial properties in the area.

Surveys have been conducted by New York State officials using baited purple prism traps and have been continuing in 2011. There are no plans to use HSI at this time for any purpose. As of June, 2011, surveys have detected numerous new infestations in the Buffalo area, as well as other areas of upper New York State.

Buffalo does not have an EAB response plan, but local media report considerable concern at the municipal level. Other than the protection of trees in their historic Olmstead Parks system, they have no plans to use pesticides to save trees. Infested trees would only be cut as they die and become hazardous. The treatment or removal of trees on private property would be at the discretion of the property owner.

Numerous infested sites in and around the greater Buffalo area have been detected as of August, 2011.

Milwaukee, Wisconsin

Milwaukee was selected for this study because it is a large city (population 628,088) roughly equivalent in size to Hamilton, Ontario, with a significant ash population. As well, Milwaukee is at the same latitude as Burlington, Ontario. EAB is estimated to have been present at some locations in the state for at least seven years. While EAB was initially detected in Wisconsin in August 2008, and now infests 11 counties which are under State Quarantine, it has yet to be detected in Milwaukee *per se*. Wisconsin has an estimated ash population of 765 million trees, with ash comprising 20 percent of its urban trees. A UFORE project completed by Milwaukee estimated that 17% of their canopy was ash.

Milwaukee has been preparing for the imminent arrival of EAB for several years and has implemented an ambitious scheme to mitigate the impact on their urban canopy. The City of Milwaukee's urban forester emphasizes that their overall long-term strategy is NOT to save ash, but rather to maintain the relative percentage of their urban canopy. He feels trying to save ash long term is a lost cause and eventually they will all have to be replaced. Milwaukee has a response plan but it has yet to be put on paper. In 2009, they pre-emptively treated all 27,000 of their eligible ash trees with TREE-äge™ (Emamectin Benzoate) at \$60(US)/tree (a total of \$800,000 was allocated for this project). This is cost effective when compared to the \$25 million that has been estimated to remove and replace their publicly owned ash trees. Ultimately, the city plans to remove and replace all 33,000 ash trees at a rate of 5% per year (although at the present time they are just culling trees with structural defects or in poor health).

Milwaukee has experimented extensively with Hyperspectral Imagery (HSI) in an attempt to determine the percentage of ash in their canopy. In the opinion of the City Forester, it is reasonably accurate at identifying ash in the canopy but some ground truthing is required to confirm aerial data. Some understory ash trees were missed in the aerial survey and as well there were some false positives (specifically sliver maple and honey locust). The City Forester feels it is a potentially useful tool for private property owners to identify ash. HSI data can be merged with their GIS parcel layer which will allow the city to determine the ownership of private ash trees. Milwaukee plans to use this information for community outreach so that people who have at-risk ash trees are aware of the threat posed by EAB, and can prepare accordingly prior to EAB becoming established in the city.

While it was hoped that HSI would improve the probability of early EAB detection, provide critical information for hazard tree management, and enable the city to predict EAB movement this has not come to fruition. The City Forester does not feel HSI can be cost effectively used for detecting EAB positive trees as there are too many variables and there are cheaper alternatives.

In his opinion, costs for HSI are high and fixed and are not likely to get much cheaper even if it does become more widely used. He feels that HSI and other spectral analysis tools (including visual photography) could be useful in tracking the leading edge of EAB at some point in the future.

Rochester, New York

Rochester does not have a strategic management plan for EAB but is developing one. The City plans to treat 4700 urban trees (94% of its ash eligible trees) in 2011 with TREE-äge. Their long-term plan is to pro-actively remove the ash component of their canopy over a period of time and they have already removed 300 trees (representing 6% of the ash component of their canopy) in support of this.

They rely on traps to gather their survey data and have no plans to use HSI at any time in the future. 2011 surveys have detected numerous infestations in the Rochester area.

Toledo, Ohio

In 2004, Toledo, with a population of 300,000, had an estimated 9100 street and park ash trees (representing eight percent of its overall canopy). While there is no estimate available for the number of ash trees on private property or in woodlands, the City Forestry Manager described Toledo as being a “very treed city”. No attempt was ever made to GPS street trees due to a lack of funding but the City has used a tree-management system called ACRT since 1985 to keep track of its inventory and trees are linked to street addresses in its database.

When EAB was first detected in the city in 2004, it was believed the overall level of infestation was very low. As Ohio was officially in an eradication mode at that time, 1,100 trees in a buffer zone on its east end were removed using federal funding. By late 2005, considerably more EAB infested trees had been found in the area and other parts of the State and eradication was officially abandoned as a realistic goal. By 2007, the level of infestation in the City’s ash population was approaching 100 percent with considerable mortality being observed. As of May, 2009, an estimated 2600 ash street trees were still standing but most of these were heavily infested and either dead or dying and will have to be removed. Recent media reports (July 2009) state that there is a considerable backlog in removing dead ash (and other species) due to a significant budget shortfall and that there is a risk of trees falling.

Other than for research purposes, Toledo has never officially treated trees with pesticides. EAB was detected far too late to save many trees, and the City was concerned that annually treating trees for the foreseeable future was not a sustainable or fiscally responsibly strategy. While some private property owners did initially elect to treat their trees, most, including golf courses did not, mainly because of the cost. The City Forester reports that even those trees which were

professionally treated with pesticides (primarily formulations of Imidacloprid such as Merit) became heavily infested and many have died.

Toledo estimates that it costs \$800-\$1000 (\$US) to remove an ash tree and replace it using city crews. They elected to remove small trees first due to the ease of replanting. Some of the larger trees which could not be immediately removed soon became hazards. Trees taken down in 2004 and 2005 by the State were tub-ground with most of the material going to playground mulch. Mulch remains the bi-product of choice as they are able to recoup \$15/yd³. There is no plan to use dead ash trees for bio-fuel; the nearest plant is in Akron, 2.5 hours away and it is simply not a cost-effective option for them.

The City Forester advised that affected cities should have a strategic plan in place with respect to ash removal and replacement. Their retrospective recommendation was to process whole streets or areas at one time (rather than the piece-meal/*ad hoc* removal of infested trees) and to leave the stumps, especially if the tree is large, to rot for a couple of years. This, he claimed would have reduced their overall costs of removal and replacement significantly.

APPENDIX IV

A SUMMARY OF EMERALD ASH BORER MANAGEMENT ACTIVITIES AT THE COUNTY AND REGIONAL MUNICIPALITY LEVELS (ONTARIO)

Purpose:

The purpose of this study is to provide a comparison between York Region and other, similar municipalities with respect to selecting the most appropriate strategy for managing The Emerald Ash Borer (EAB) in Regionally/County owned woodlands. It is intended to accompany the document: “York Region Emerald Ash Borer Management Plan”, August 17, 2011.

Scope and Terms of Reference

In February of 2011, The Regional Municipality of York (York Region) undertook to develop a Management Plan to mitigate the impact of the Emerald Ash Borer (EAB) on its ash resources and woodland areas, and as well, to provide guidance to its lower tier municipalities on how best to manage this serious invasive pest. This document is intended to provide a summary of EAB management actions being undertaken in a cross-section of southern Ontario. Eight Counties¹ and Regional Municipalities (RMs) in southern Ontario with similar woodland profiles and relative levels of EAB infestation (vis-à-vis York Region) were selected for study and comparison purposes. This report deals only with woodland areas managed under the authority of the RM or County and excludes data for detached urban areas (unless otherwise indicated). Unfortunately, due to the intensive urbanization of much of southern Ontario, and the different approaches taken by RMs with respect to managing their woodlands, a direct comparison is very difficult in most instances.

Within a given area, the relative percentages of ash in the overstorey as well as age-class distribution profiles vary widely and have been greatly influenced by past and current land use, forestry practices, settlement and development patterns, and geophysical features (such as soil type and drainage). Climate is also a factor, but to a lesser extent. Ash² (genus *Fraxinus*) is an early successional hardwood which is tolerant of various soil types and sites. It grows relatively quickly and produces large and easily dispersed seed crops at a relatively early age. These features lend it to colonizing disturbed areas and old fields, common throughout the study areas. It has also been planted extensively both in both rural and urban settings and frequently spreads from these. For these reasons, it is commonly found in most woodlands (albeit, sometimes at low overstorey composition) and is over-represented in many areas. This has exacerbated the overall impact of EAB.

¹ The term “County”, as used in this report can also refer to single and multi-tiered Regional Municipalities (RMs)

² There are 3 native species of ash commonly found in southern Ontario forests within the area of study

This accuracy of this report has been compromised in some cases by a paucity of up-to-date information on the amount of forest cover within the various counties contacted and the percentage of this that is ash. This is because:

- Few Counties/RMs employ foresters
- Several RMs have multi-tiered government with little apparent coordination of forestry related activities
- Other agencies such as Conservation Authorities play a major role in managing regional forests (these are not part of the study group unless otherwise indicated) but do not appear to be always integrated into the decision making with respect to management of Regional forests
- No inventory of southern Ontario forests has been conducted by the Ontario Ministry of Natural Resources (OMNR) or its co-operators since the 1990s and most data is seriously out of date
- Past surveys conducted on behalf of the OMNR clump ash with other hardwoods and there is no stand-alone ash statistic. For that reason, the percentages of woodland ash listed below for each RM are composites of educated guesses and opinions provided by the respondents.

Methodology

Counties and RMs in southern Ontario with similar woodland profiles and relative levels of EAB infestation (to that of York Region) were selected for study and comparison purposes. A detailed questionnaire requesting the following information was sent to officials responsible for managing woodlands and urban forests within their respective areas:

- The percentage of the landmass which is forest or woodland
- The relative percentage of ash in their woodlands
- Anticipated impacts of EAB
- A synopsis of EAB related management or control activities currently in place or contemplated by their RM.

Responses were collated and analyzed and appear, with relevant comments below.

Durham:

General Comments

The Regional Municipality of Durham is composed of eight municipalities including the urbanized areas of Ajax, Oshawa, Pickering, Whitby, and Clarington. The Region has very strict woodland conservation by-laws in place and contracts out for professional forestry services and enforcement of its Forest Conservation By-law.

The Lake Simcoe Region Conservation Authority (LSRCA) takes the lead role in managing forests owned by Durham Region. Harvesting on privately owned woodlands greater than 1 hectare is regulated under Regional By-laws and a forestry consultant is employed as the Region's By-law Enforcement Officer. In

addition to enforcement, considerable emphasis is placed on promotion and education of woodland owners. The management of individual trees, as well as woodlands less than 1 hectare in size are the responsibility of the individual landowner and the eight lower tier municipalities which comprise Durham and is not included for discussion here.

EAB has been confirmed in the Region and it is included in the Greater Toronto EAB Quarantine Zone, as defined by the CFIA.

Woodland Composition

Approximately 25 percent (or 65,920 ha) of the Region is in forest cover. The Regional Project Planner estimates that the percent of ash in the overstorey ranges from 10-20 percent on private woodlands. There is no data on age/class distribution.

Recent forest inventories conducted by the LSRCA indicate that white ash represents less than 10 percent of the species composition in these mixed wood forest compartments throughout the Durham Regional Forest.

The LSRCA manages six forest tracts that make up the Durham Regional Forest. The total area of forested land on these tracts is 596 hectares with most of this being conifer plantations established between 1926 and 1947 to reduce the ongoing soil erosion of open blow sand areas along the Oak Ridges Moraine. As with most aging red pine plantations, there is an aggressive hardwood understorey developing, much of which would be composed of red and white ash. No statistics are available for this.

EAB Management Initiatives

Although EAB is recognized as a threat to the Region's woodlands, there has been no formal analysis done on the potential impact EAB will have on Durham forests and no strategic plan for EAB has been developed to this point. To date, there have been no decisions made by the LSRCA with respect to salvage logging, pre-emptive ash removal or the use of pest control products. On privately owned woodland greater than 1 hectare, permits are required to cut trees under the Region's By-law. The Region's forestry consultant provides education and expert advice to private landowners as well as forestry professionals who are considering forest management and harvest (which would include EAB affected woodlands). Durham relies on the OMNR and CFIA for advice, guidance and consultation with respect to EAB and refers public enquiries to these agencies.

Discussion

Although Durham has a relatively high percentage of ash in its private woodlands, the percentage of ash in regionally owned woodlands managed by the LSRCA is considerably less. Durham has some of Ontario's strictest by-laws with respect to the management of private woodlands greater than 1 hectare and permits are required to harvest these. Notwithstanding, it is the prerogative of the individual woodlot owner as to how the ash component is managed.

Ottawa

General Comments:

“Ottawa” is a single tier municipality and encompasses numerous local municipalities which were amalgamated in 2001, including the former Carleton County. Several foresters are on staff. The Ottawa-Gatineau Region is currently under federal quarantine and was combined with parts of Gatineau, Québec as well as the entire united county of Leeds and Grenville into a single quarantine zone in March of 2011.

Woodland Composition

The City Forester estimates that 28 percent or approximately 1000 km² is in forest cover with 20-25 percent of this being ash. Much of the woodland ash would be classified as young to semi-mature and is the result of old fields being colonized from adjacent wild areas. The remainder would be primary forest where ash has survived as an understorey and is now emerging.

EAB Management Initiatives

EAB is seen as a serious threat to Ottawa woodlands and it is predicted that it will have a considerable impact on ash trees in the area. Ottawa is currently developing site specific prescriptions for its various classes of woodlots and hopes to have these available soon. Ottawa has conducted an extensive EAB trap survey throughout the City and is developing a branch sampling protocol in conjunction with the CFS. Additionally, it is looking at updating its inventory for public lands using remote sensing and ground-truthing.

While they have treated over 500 urban trees with TreeAzin in 2010 and an additional 1000 trees in 2011, there are no plans to treat or otherwise manage EAB in woodland trees. Additionally, they do not plan to pre-emptively remove woodland ash trees but are currently investigating options to convert urban and rural ash trees affected by EAB into usable forest products and have run two trials with a portable sawmill and tub grinder. Working with the Regional Forest Health Network they have developed a fact sheet for use by private woodlot owners and have a 311 public enquiry line to deal with EAB related calls.

Discussion

Ottawa likely has the highest woodland and urban ash population of any municipality in North America and will be heavily impacted by EAB. Their emphasis is on preserving some high value urban trees; they concede that there is little that can be done to save woodland ash. 18,000 hectares of forest could be heavily damaged as a result of EAB.

A detailed discussion on how Ottawa is managing EAB at the urban level is included in section III.

Oxford

General Comments

Oxford County is a multi-tiered RM and comprises the City of Woodstock and seven other Towns and Townships. EAB was discovered in the County in the fall of 2010. While no heavy infestations have been found thus far, it has likely been introduced to other areas of the County with the movement of firewood or other forest products. As of March, 2011 Oxford is included in a federally quarantined area.

There is no current tree inventory for Oxford County and no full-time forester (although they do have a Woodlands Conservation By-law Officer). The City of Woodstock (the County Seat) has a municipal arborist on staff. At a recently held EAB workshop at which the new CFS-developed branch sampling protocol was demonstrated, EAB larvae were found in most of the branches collected (from within and around the City) and it is believed that EAB may be pervasive throughout many areas of the County. It is reported by the CFIA that signs and symptoms of EAB infestation are now prevalent across the City of Woodstock.

Woodland Composition

At the time of the last inventory Oxford had 26,703 hectares of woodland or 13 percent of its area. The Municipal Law Enforcement Officer estimates that the amount of forest cover for the County is now closer to 10 percent and that ash would range on average from 30-50 percent of most woodlots.

EAB Management Initiatives

Despite the potential to be a very damaging pest in Oxford, there are no plans to treat urban or woodland trees or to pre-emptively cut, or salvage woodland trees killed by EAB.

Discussion

Oxford has a multi-tiered structure and there is little interest at some levels to undertake any initiatives to manage EAB. Once EAB enters into its epidemic phase and mortality becomes more evident, this position may change.

Peel

General Comments

The Region of Peel has two-tiered government and comprises the Cities of Brampton, and Mississauga, and the Town of Caledon, each with proportional representation on Regional Council. While there is no Regional Forester, both Brampton and Mississauga employ urban foresters and Caledon has a Parks Supervisor who looks after forestry related issues. Peel is included in the southern Ontario Quarantine zone modified by the CFIA in March, 2011.

Woodland Composition

The latest inventory for Peel indicates that it has 22,750 hectares or 18 percent of its total area in forest. Mississauga and Brampton each have 6 percent woodland, and Caledon has 28 percent (19,335 ha.).

The City Forester for Mississauga estimates that they have 15 percent canopy cover (street trees and woodlands combined) with 16 percent of this being ash. Their inventory indicates that they have 25,000 ash street trees representing 10 percent of their urban street trees.

The City Forester for Brampton estimates they have 12 percent canopy cover and that 15 percent of this is ash. The majority of their ash street trees would be less than 30 years old.

There is no data available for Caledon at this time but several areas have a considerable ash component depending on the site.

EAB Management Initiatives

Mississauga sees EAB as a very serious problem that will have a significant impact on its ash street trees and woodlands. They are currently working on developing a strategic plan which they hope to complete in 2011. Surveys for EAB are on-going.

Mississauga has an accurate street tree inventory and UFORE data will be available by the end of 2011. EAB surveys were conducted in 2009 and 2010 using both visual and the CFS branch-sampling protocols. Data is expected to be analysed by the end of 2011.

Mississauga is considering using pest control products such as TreeAzin to preserve both urban and woodland ash trees. To this end, there has been considerable discussion on what criteria need to be considered for selecting trees for treatment; once all the data currently being collected has been collated, they will develop a strategic plan with the assistance of a consultant. Mississauga has no plans to pre-emptively remove woodland ash but they would consider salvage actions.

Mississauga has placed EAB related information on its web. Additionally, it provides information to the public via Councillor mail-outs, presentations and media interviews. All EAB related calls received by its 311 Call Centre are directed to Forestry staff for response, even where these apply to private lands.

Mississauga has conducted workshops and training sessions for its staff and has worked closely with neighbouring municipalities on developing survey protocols.

Brampton is currently reviewing its ash inventory and determining the extent of its infestation. While plans have been developed to replace and possibly treat urban ash trees, approval has yet to be received from City Council. There are no plans per se to treat or otherwise manage woodland ash unless these are of special significance. No pre-emptive removal or salvage logging operations are planned. While some work has been done with respect to public education they expect to increase their communication activities once ash mortality is more evident.

Discussion

Peel is a highly urbanized, multi-tiered Regional Municipality without a Regional Forester. Most of the authority to undertake woodland and urban tree management initiatives lies with the Municipalities rather than Peel Region itself and for that reason the priority appears to be to protect its urban street trees. There is no indication that the Region has any interest in undertaking any actions to protect its woodland ash trees.

Perth

General Comments

EAB was discovered in the southern part of the County in the fall of 2010. While no heavy infestations have been found thus far, it has likely been introduced to other areas of the County with the movement of firewood or other infested forest products. As of March, 2011, Perth is included in a federally quarantined area with other southern Ontario counties and RMs.

Perth County is made up of four Municipalities and Townships. The Cities of Stratford and St. Marys are separate entities and not part of the County (and were not contacted). While Perth County does not have a County Forester, it contracts a Regional Tree Inspector to enforce county By-laws and also relies on the Guelph District OMNR Forster as well as other contacts at the Upper Thames Region Conservation Authority & local OMNR stewardship coordinator for advice.

Woodland Composition

Perth has an estimated 19,000 ha in woodland, or approximately seven percent of its total area. The relatively low percentage of canopy cover is the result of its high, flat topography with few significant river valleys and high percentage of arable land. The ash content of its woodland overstorey is estimated to be around 35 percent. Ash is a major component of all age classes and is particularly abundant and even dominant in the seedling and sapling stage in many forests. Most of the woodlands are privately owned and managed with the remainder being managed by Conservation Authorities. There is no County-owned woodland.

EAB Management Initiatives

While there is considerable interest by some parties to enact bylaws to restrict the movement of firewood within the County and thereby slow the spread of EAB, County officials consider EAB to be a federal or provincial issue and there are no plans at present to conduct EAB surveys or undertake any control or management initiatives other than to cut hazard trees along roadways and in urban areas. Notwithstanding, land owners have been encouraged by the local stewardship coordinator to self-survey their properties and to not cut ash pre-emptively. While EAB is referenced on their County website, this has been heavily borrowed from the CFIA website and does not offer much information on how to manage EAB in woodlot.

Discussion

The Regional Tree Inspector considers EAB to be a major problem that will seriously damage Perth's forests and may lead to more forest being converted to farmland by private woodland owners. Because of its relatively small amount of remaining forest cover, all woodlots greater than 0.2 ha are protected under the Forest Conservation By-law, considered one of the most stringent in southern Ontario.

Waterloo Region

General Comments

The Regional Municipality of Waterloo consists of the Cities of Cambridge, Kitchener, Waterloo and the Townships of North Dumfries, Wellesley, Wilmot and Woolwich. Unlike many other RMs in southern Ontario it has a full time Regional Forester, in addition to foresters in Kitchener, Cambridge and Waterloo. The Grand River Conservation Authority (GRCA) is also a major partner.

EAB was confirmed in the southern part of the Region in the fall of 2010; as of March 2011, Waterloo Region is included in a federally quarantined area with other southern Ontario counties and RMs.

Woodland Composition

A total of 18,171 ha are in forest equating to 13% of the Region's land mass. The ash content in the overstorey is estimated by the OMNR at around 12 percent, but some woodlots are as high as 70 percent ash. In addition to Waterloo Region per se, the Cities of Kitchener, Cambridge and Waterloo have woodland areas with a significant percentage of ash but no firm numbers.

EAB Management Initiatives

While EAB has not been found elsewhere in the Region to this point, it is likely present at other locations at sub-detectable levels. The Region of Waterloo has established a joint working group to coordinate forestry issues such as EAB. There are no strategic plans in place at the Regional level to treat or salvage woodlands and the Region has not had any real dialogue with its woodlot owners to this point (although other agencies such as the OMNR, Wellington Waterloo Woodlot Owners Associations and forestry consultants are well aware of the impact EAB will have on the Region's woodlands).

Notwithstanding, Kitchener is currently working on its own strategy and is attempting to obtain funding from its Council. Kitchener estimates that it will cost \$4.75 million to remove and replace its 4,522 urban street ash trees. While Kitchener has over 1000 ha of natural areas within its boundaries, no data is available for these areas, although ash is likely to be a major component of these.

Waterloo Region conducted visual EAB surveys of its woodlands early in 2011. Results are not available at this time. Branch sampling surveys were also conducted in Kitchener.

While some of its cities are developing response plans and may elect to preserve urban ash trees with pest control products such as TreeAzin, there are no plans at the Regional level to treat or otherwise protect woodland trees.

Likewise, there are no plans to pre-emptively remove woodland ash and the Region's By-laws will not permit overcutting in woodlands. However, it has been policy for several years to remove ash trees along Regional Roads which are a hazard to power lines (rather than trim them).

Waterloo Region has EAB referenced on its website, news releases in place and is developing flyers and management notes for woodland owners. Their website has several telephone numbers and email contacts listed for members of the public needing information.

Discussion

EAB, while present has yet to build to epidemic levels in Waterloo. While ash only comprises around 12 percent of Waterloo's woodlots, EAB is likely to have a profound effect on the Region over the next 10 years.

Wellington

General Comments

Wellington is a multi-tiered entity consisting of seven municipalities; the City of Guelph is not part of the County but has some shared areas of responsibility. Unless otherwise indicated, Guelph is not included in this discussion. Despite having a fairly high percentage of forest cover, Wellington County does not have a forester on staff. This is partly compensated for by the presence of the OMNR District Office in Guelph, which provides advice to Wellington County land owners.

EAB was confirmed in the southern part of the County in the fall of 2010: as of March, 2011, Wellington is included in a federally quarantined area. While no heavy infestations have been found thus far, EAB has likely been introduced to other areas of the County with the movement of infested firewood (or other forest products) and new sites will be found in 2011.

Woodland Composition

At the time of its last forest inventory, Wellington County had 44,875 ha of woodland, amounting to 17-18 percent of its land mass. Ash is prevalent in the County, especially those low-lying sites to the north of Guelph in which the ash content can be 90 percent or more. On average, woodlands contain 20-30 percent ash in their overstorey. The County owns around 460 ha of woodland that it manages. The Grand River Conservation Authority also owns and manages large tracts of land but was not consulted. The City of Guelph estimates that it has a 7 percent ash component in its woodlands, although ash comprises 24 percent of its urban canopy. In addition to the numerous native and exotic species of ash in its collections, the University of Guelph also has mature forests in its arboretum with around 10 percent ash; many of these are very large, mature specimen trees.

EAB Management Initiatives

Neither the County nor its municipalities have plans in place to deal with EAB. Other than those conducted by the CFIA in support of its slow-the-spread strategy, no surveys have been done for EAB by the County and there are no plans to do so, despite the high percentage of ash in its woodlands. Additionally, there are no plans to treat or salvage woodlands and the County has not consulted with its woodlot owners to this point (although the CFIA, OMNR and Wellington Waterloo Woodlot Owners Associations and other organizations are well aware of the impact EAB will have on County woodlands and have held numerous workshops in recent years).

The City of Guelph plans to conduct branch sampling of its urban ash trees in the near future. A plan which contains recommendations to treat some high value urban street and woodland trees is being

prepared for City Council and funding being sought. Criteria for selecting candidate trees have not been developed thus far.

EAB is referenced on the County's website with links to the CFIA website. The City of Guelph has information on its website and also refers people to the CFIA website for more information.

Discussion

Wellington County has a high percentage of ash in its woodlands and in its urban areas and EAB is likely to have a devastating impact on this area over the next 10 years. While EAB has been confirmed in the County, it is apparently confined to the extreme southwest corner of the county and no EAB induced mortality or decline have been reported thus far.

Halton

General Comments

The Regional Municipality of Halton (Halton Region) is a multi-tiered entity consisting of four municipalities: Halton Hills, and Milton, Oakville and Burlington.

As of March, 2011, Halton is included in the newly established EAB quarantine zone for southern Ontario. Under the terms of Ministerial Order in place for this area, the movement of ash forest products and firewood is permitted throughout this region. While only confirmed in Oakville, and Burlington, research suggests EAB populations are building and spreading in the southern part of the Region and widespread mortality in its woodlands and urban areas will likely be observed within the next five years. For instance, EAB was confirmed at the Royal Botanical Garden in July of 2011 and appears to have been present there for several years.

Halton Region works closely with Conservation Halton (formerly the Halton Region Conservation Authority) to manage its woodland areas.

Woodland Composition

The estimated forest cover for Halton is 23% with ash comprising less than 10% of its woodlands. In some upland woodland areas, this percentage is considerably higher and EAB is likely to have a profound impact.

In addition to its woodlands, the Region also has an estimated 1500 roadside trees which are looked after by its municipalities.

EAB Management Initiatives

In 2009, Halton contracted with a consultant to analyse its situation vis-à-vis EAB and to provide it with some possible management options. Four options were developed for consideration by Halton, ranging

from: minimal activity to mitigate EAB induced damage, to a concerted attempt to slow the spread of EAB in the Region and protect and preserve the ash component of its woodlands.

After consultation with its municipalities and other stakeholders, Halton has elected to not attempt to save its woodland ash trees from EAB. While this will result in most of the ash becoming infested and dying out over the next 10 years, it is consistent with what is being done in other Ontario Regions with similar ash and woodland profiles and is consistent with the science around this. There is no practical or cost effective method at present to treat woodland ash trees.

Notwithstanding, Oakville and Burlington have elected to save some high value urban street and park trees through the use of surveys and treatment with TreeAzin. Oakville developed an emergency response plan for EAB in 2008 and will have a strategic management plan ready for the end of 2011. Oakville is aggressively trying to save its ash trees and retain its urban canopy. It estimates that it has 177,000 ash trees in its urban woodlands and along its streets.

Oakville's premise is that it is cheaper to treat trees over a given period than to proactively remove them, and has data to support this position. To this end, Oakville successfully treated 500 trees in 2008 and 2009 and 1600 trees in 2010 (25% of the treatable municipal ash canopy) with TreeAzin. Indications³ are that this product has given excellent control over a 2 year period.

In addition to prism trap and branch sampling surveys, Oakville contracted AMEC Earth and Environmental Inc., a remote sensing company, in 2010 to conduct research into the possible use of Hyperspectral Imagery HSI to detect ash in the urban canopy and possibly, EAB infested trees. A statement posted on Oakville's website (August, 2011) maintains that their HSI trial was 80% effective in discerning ash from other tree species and met its stated objectives. A major tenet of Oakville's programme is to engage private property owners in preserving ash and HSI can be linked to GPS based property data and assist in identifying ash on private property.

In support of its research and management activities, Oakville has placed considerable emphasis on the development of public education and outreach materials, which are posted on its site.

Burlington is currently seeking approval of its EAB management plan which will see both trap and branch sampling surveys conducted throughout the city and high value (those greater than 30cm dbh and in good health) urban trees preserved through injection with TreeAzin. While it is expected that in excess of 99% of its urban ash trees will perish over the next ten year, the city feels there is merit in maintaining mature tree canopy and neighbourhood character, especially on streets planted to ash monocultures. In 2010, 526 street trees were successfully treated with a similar number of trees being treated in 2011. In all, 3100 urban ash have been targeted for treatment and preservation over the next 10 years.

³ Based on gallery dissection in treated trees and data provided by the patent holder

Both Burlington and Oakville are actively engaging their citizens through public meetings and interactive websites. To this point, the public is onside with planned activities to preserve the ash component of their urban forests.

Discussion

While little is being done at the RM level to preserve woodland ash, ash is considered to be a major component of the urban canopy and Oakville and Burlington are amongst the leaders in Canada in trying to preserve this.

Discussion and Conclusion:

- Forests and woodlands are not managed on a consistent basis from Region to Region and it is very difficult to make a direct comparison between York Region and other RMs and Counties in the study group
- Many RMs and counties (especially those without a Regional Forester) leave it up to their constituent municipalities to manage woodlands, especially where these are located in or near urban areas (Mississauga and Brampton for example)
- Some areas have no regionally managed forests and virtually 100% percent of woodland is in private ownership (Perth)
- Despite managing sizeable tracts of woodlands in some instances, conservation authorities are not always integrated into the decision making matrix in some areas; in any event they were not extensively consulted in this study
- Of the RMs contacted, none is actively attempting to manage EAB in its woodlands; there are no plans to use pest control products or, in most cases to even survey for the pest in woodlands
- Most of the RMs and counties contacted do not have a plan to mitigate environmental and economic damages caused by EAB or to salvage ash in their woodlands
- The position taken by York Region that it should not try to manage EAB in its woodlands is reasonable and consistent with what is being done elsewhere in Canada

APPENDIX V

CFIA EMERALD ASH BORER SURVEY PROTOCOL -2011

1.0 Background and Objectives

The emerald ash borer (EAB) is an invasive alien wood boring beetle native to China, Japan, North Korea, South Korea, Mongolia, and Taiwan. In North America, EAB has resulted in significant mortality of ash, *Fraxinus* spp. EAB was first confirmed in Canada in August of 2002 in Windsor, Ontario. Since the initial detection, EAB has been found in Quebec and in numerous locations throughout Ontario. Regulated areas have been designated under Ministerial Orders in all known infested areas of Ontario and Quebec.

2.0 Target Pests or Life Stages

Emerald ash borer adults, larvae, pupae and associated signs and symptoms are targeted in this survey. Emergence and flight period of EAB is affected in part by latitude, altitude and weather. Within Canada, adults emerge between the end of May and late July through distinct D-shaped exit holes. After emergence, adults feed on the edges of ash leaves creating a notched appearance. Adults may be observed on or near host trees from early June into August. Eggs approximately 0.6 by 1.0 mm are laid in bark crevices or under bark scales and are very difficult to detect in the field. Larvae hatch in a few weeks and burrow under the bark where they feed on the vascular tissue and form distinct S-shaped galleries. Some larvae may be present year round, however the majority of the population will overwinter as prepupae in pupal chambers in the sapwood or bark. Pupation begins within the pupal chambers in the bark or sapwood in spring and pupae are present from late April until mid-June.

3.0 Target Hosts

All species of ash: *Fraxinus* spp.

4.0 Timing

4.1 Trapping Surveys

Baited traps will be deployed in the field by June 1st and taken down by August 31st.

4.2 Visual Surveys

Ground surveys at trap sites should be conducted at the time of trap collection (late August) when the signs and symptoms of EAB are most **evident**.

4.3 Branch Sampling

Branch sampling is an effective method of detecting EAB-infested trees and also provides information on the infestation status of individual trees. For details regarding this sampling technique, refer to *Detection of Emerald Ash Borer in Urban Environments Using Branch Sampling*, Ryall et al (Technical Note No. 111)

5.0 Target Areas and Site Selection

Detection surveys for EAB will focus on all areas where the pest could have been introduced through human activities. Target sites include but are not limited to:

- Urban centres
- Holiday destinations: Provincial parks, seasonal campgrounds
- Rest stops along major transportation corridors
- Areas identified by the public and reported during public inquiries/call-outs as suspects
- Areas with ash decline

6.0 Survey Methodology

6.1 Trapping Surveys

6.1.1 Traps

Green Prism Traps with Tanglefoot purchased from Synergy Semiochemicals Corp. (Catalogue # P385-GTF).

6.1.2 Lure Types

A higher load (12 ml), (Z)-3-hexenol lure will be affixed to the green prism traps. Lures must be purchased from Synergy Semiochemicals Corp. (Catalogue #W245).

Please see Appendix 2 (of this document) for instructions on trap and lure assembly.

6.1.3 Storage and Handling of Lures

Store lures in sealed packages at temperatures below 0° C, with any opened lure packages being placed in sealed containers after use. During transportation to the field, ensure that lures are kept cool (within a cooler) and out of direct sunlight. Disposable gloves must be worn at all times when handling the lures.

6.1.5 Trap Placement and Density

- Traps will only be deployed in ash trees (*Fraxinus* spp.) 20 cm or greater in diameter with preference given to larger ash trees
- The host tree should be located along a forest edge, in an open area, or in an open stand of trees such as in parks
- If no ash is present within 250 m of a grid point or selected survey site, inspectors should note “no ash present” and move onto to the next grid point.
- When few traps have been deployed in a given urban centre due to lack of ash, the survey should be augmented by targeting high risk sites in that area or nearby areas with a greater abundance of ash (traps can be placed at a higher density in such cases to a maximum of 3 traps per 3 km²)
- One trap should be placed per site using a telescopic extension pole with a modified hook. Traps will be placed as high as possible within the canopy, but no lower than 5 metres above the ground. Traps should be placed in the middle of a branch stable enough to support the weight of the trap and suspended at least 0.6 metres from the bole on the south or southwest side of the tree.
- Contact must be made with the landowner prior to conducting survey activities. The longitude/latitude coordinates in decimal degrees (NAD 83 datum) are to be recorded at each trap location.
- A sign is to be affixed to each tree containing a trap
- Please contact your local CFIA office to co-ordinate trapping and visual survey locations as this will minimize overlap in surveillance efforts.

6.1.6 Trap Servicing:

Traps will be serviced by July 15th to collect specimens for laboratory submission and ensure that there is no brush or debris obstructing the traps. Lures will dispense for the entire duration of the trapping period and do not need to be replaced.

If trap surfaces contain twigs, leaves or other debris, this should be removed from the trap surface and putty knife can be used to renew the sticky surface of the glue.

Final sample collection should be completed by August 31st at which time the traps will be removed from the site and disposed. The trap spreaders and limb hooks can be re-used.

6.2 Visual Surveys

6.2.2 Pedestrian

Ground surveys are based on the visual detection of EAB life stages as well as the signs and symptoms associated with an infestation. Visual surveys should be conducted at all trapping locations at the time of trap collection.

- 20 ash trees within a 100 m radius of the trap location should be inspected for signs and symptoms of EAB.
- Emphasis should be placed on declining ash in the area.
- If EAB is not detected during a visual survey and the location is highly suspect, the site should be prioritized for a trapping survey in 2012.

7.0 Biosecurity Precautions

When visiting areas that are or could be infested with pests of significance, staff must take the necessary precautions to ensure that the risk of spread is mitigated.

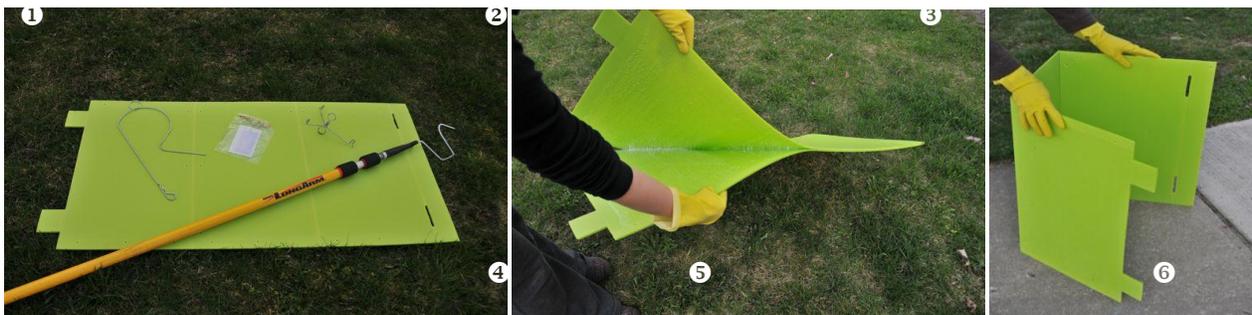
8.0 Supplies

Green EAB sticky prism traps from Synergy Semiochemical Corp.
Higher load (Z)-3-hexenol lure (i.e. 12 ml pouch from Synergy Semiochemical Corp.
Trap spreader assemblies from Midwest Wire Products LLC

Tree limb hooks from Midwest Wire Products LLC
 Zip/Cable ties (minimum of 4 inch)
 Mr Long Arm© Heavy Duty 23' telescopic extension pole
 Hook attachment for extension pole (Heavy duty paint roller available at any Home Depot, modified for hanging traps)
 Trap Signs
 Personal health and safety equipment and supplies
 Waterless cleaning lotion such as Phoenix 5700
 Drawknife
 Knife and hatchet
 Pruning shears
 Forms
 Pencils and markers
 Maps
 GPS unit
 Flagging Tape
 Rubber Gloves
 Hand lens
 Binoculars
 Putty knife
 Kimwipes
 Vials with 70% ethanol
 Thermos of boiling water
 Labels
 Diameter measuring tape
 Digital camera

Appendix 1

Trap and Lure Assembly





1. Please see section 9.0 of the survey protocol for a complete listing of supplies needed.
2. Traps come in multiples of two, with the sticky side of each trap facing inward. To separate, slowly peel trap panels apart, being careful not to bend panels and set aside unused trap. Gloves must always be worn when handling the traps and lures.
3. Bend the trap along the scored sections to create a triangular prism. The sticky side of the trap should be facing outward.
4. Feed the tabs located at the edge of the trap inward through the perforated slots located on the opposite edge of the trap.
5. A twist tie or zip tie should be threaded through the perforated holes closest to the tab fold at both the top and bottom of the trap in order to secure the panel edges together.
6. Each of the three hooks located on the trap spreader should be inserted through the perforated holes located at the top of the trap. The hooks should be placed in a downward position as indicated in the above photo.
7. Using a zip tie or twist tie, affix the lure to the bottom rung of the trap spreader so that the lure is hanging downward inside of the trap.
8. Attach the wire limb hook to the top rung of the trap spreader by feeding the lower loop of the lure hanger through the top rung of the trap spreader.
9. Once assembled, place two CFIA 1335 (yellow trap stickers) back to back and affix to the lower right hand corner of any trap panel, avoiding the sticky surface of the panel. Feed the modified hook attachment of the Mr. Long Arms through the hole on the top of the wire limb hook to raise the trap into the host tree.



Frontline

Forestry Research Applications

Canadian Forest Service - Sault Ste. Marie

Technical Note No. 111

Detection of Emerald Ash Borer in Urban Environments Using Branch Sampling

K. L. Ryall, J. G. Fidgen, J.J. Turgeon

The emerald ash borer (EAB), *Agrilus planipennis* Fairmaire (Fig. 1), a non-native insect pest of Asian origin, presently infests large numbers of ash (*Fraxinus* spp.) trees in Ontario and Québec and could soon spread to other provinces.



Fig. 1. Adult emerald ash borer

One of the many requirements for effective management of EAB is early detection of infestations, when densities are still low and before signs and symptoms are obvious. *Visual surveys* rely on external signs and symptoms (e.g., exit holes, larval tunnels seen through cracks in the bark, feeding by woodpeckers or squirrels) that may not be noticeable for 2 to 3 or more years after the arrival of the population, particularly if the infestation begins in the upper part of the tree. *Sticky traps* baited with an attractant have the potential to detect EAB adults in an area before signs or symptoms become visible, but may not necessarily provide information on the infestation status of individual trees.



Fig. 2. Healthy-looking ash trees with no visible sign or symptom, but determined to be infested with EAB using branch sampling.

Ryall et al. (2010) sampled many ash trees with **no** obvious sign or symptom of EAB attack (Fig. 2) and showed that *branch sampling* was an effective method of detecting EAB-infested trees; indeed, 74% of the infested trees would have been discovered if the method described below had been used. The purpose of this note is to describe this basic sampling technique.

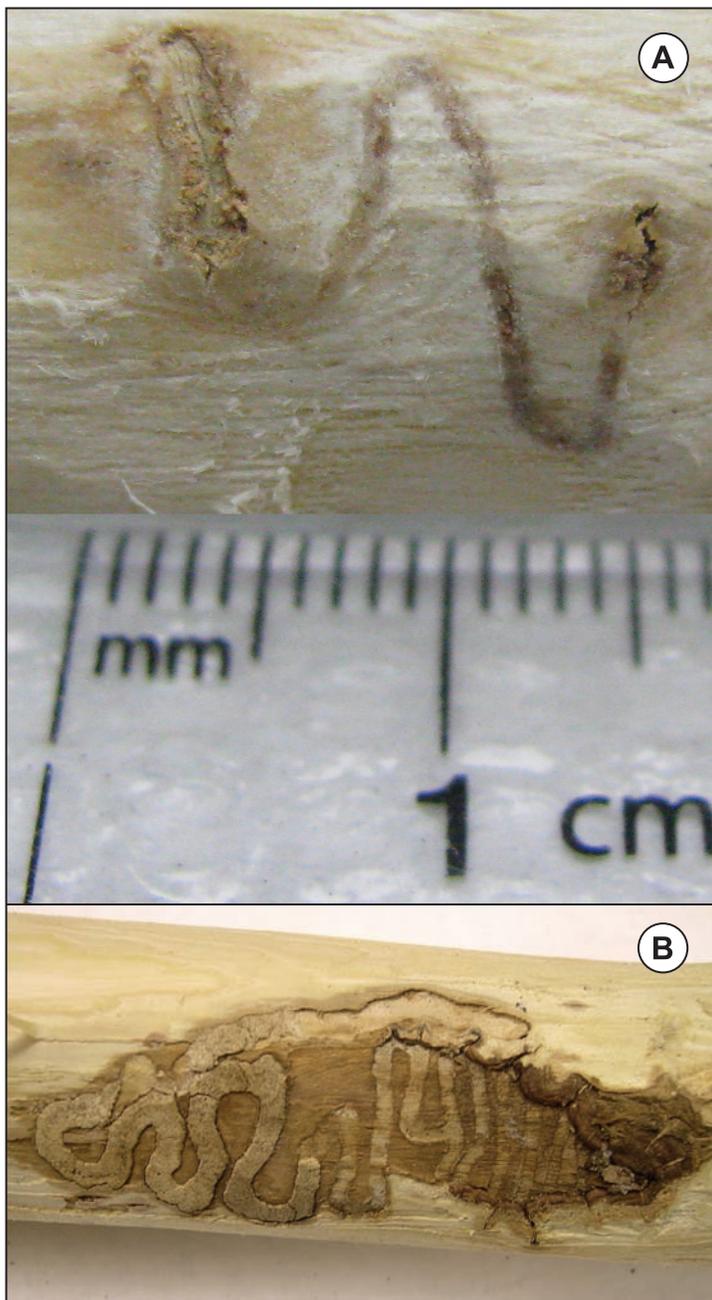


Fig. 3 Early (a) and late (b) stage serpentine galleries made by EAB larvae, found by branch sampling.

Description of the Branch Sampling Method

This method is suitable for sampling open-grown ash in any landscape, but it is of particular value in urban areas with high-value ash trees (Fig. 2). Branch sampling can be performed at any time between September and May; however, because larvae continue to feed and grow in size in early fall, their galleries are easiest to see if branches are sampled after October. This technique can be performed using the following steps:

1. Select an open grown black, red, green, European or white ash, 6-18 m tall and 15-50 cm DBH with large open crown;
2. Identify **two** live branches in the mid-crown preferably 5-7 cm in diameter at the base (minimum 3 cm; maximum 10 cm) ideally from the south side of the tree; **NOTE:** Be sure to follow appropriate safety procedures and to cut branches using proper tree pruning methods.

3. Cut each branch at its base using a pole, chain or pruning saw (see Fig. 4a);
4. Measure off 75 cm from the base and cut the branch again at this point. Remove any lateral branches from this piece (Fig. 4b);
5. Secure the 75 cm piece in a vise (Fig. 4c);
6. Peel (whittle) the bark in thin strips (1-2 mm thickness) from the basal 50 cm of the branch using a good quality draw- or paring-knife (Fig. 4d);
7. Examine the branch carefully, looking for EAB galleries and/ or larvae (Fig. 3). Remember that gallery length varies from a few millimetres to several centimetres.

If the objective is only to detect EAB, then sampling can stop when the first gallery is found. If the objective is to assess densities, then it is important to count all EAB galleries and living larvae on the sample. Counts take 2-3 times longer to carry out than presence/ absence sampling.

The branch sampling technique can be done concurrently with other tree management activities, such as pruning. Samples from ash trees could be rerouted to a centre where whittling is performed. Because ash tree material can contain live EAB, **it must not be moved outside of regulated areas established by the Canadian Food Inspection Agency (CFIA). In non-regulated areas, discovery of EAB galleries or of a live specimen must be reported to the CFIA.** Procedures for **movement and disposal** of ash wood are available at: <http://www.inspection.gc.ca/english/plaveg/pestrava/agrpla/regrestrice.shtml>.

Caveats

This technique was developed using open-grown urban trees. Its efficacy for use in woodlots has not been tested. Similarly, sampling of much larger or smaller branches and trees than those recommended herein may result in lower detectability of EAB infestations

Conclusions

Branch sampling is a highly effective tool for detection of incipient EAB populations, before outwardly signs or symptoms become apparent. Early detection of EAB populations can provide managers with additional time to identify and implement management options before unacceptable ash mortality occurs. This technique can be used for early detection of incipient EAB populations; to provide estimates of EAB density on infested trees and to delimit the extent of outbreaks. Ongoing research is developing area-wide detection and delimitation survey protocols, is relating EAB density to severity of visual signs and symptoms, and is calibrating effectiveness of baited traps as another early detection tool.

For further information, contact Dr. K. L. Ryall, Canadian Forest Service, Great Lakes Forestry Centre, Sault Ste Marie, ON. krista.ryall@nrcan-rncan.gc.ca.

Developed by Natural Resources Canada, Canadian Forest Service, in collaboration with Canadian Food Inspection Agency and Ontario Ministry of Natural Resources. We are grateful to the cities of Toronto, Pickering and Sault Ste Marie for permission to sample trees.



Fig. 4. Cutting (a), measuring and trimming (b) ash branches. Branches, cut to a length of 75 cm, are placed in a vise and bark is whittled off the basal 50 cm (c) (1.5 m piece shown here). Whittling removes bark in thin 1-2 mm strips (d).

ADDITIONAL READING

de Groot, P., Biggs, W.D., Lyons, D.B., Scarr, T., Czerwinski, E., Evans, H.J., Ingram, W. and Marchant, K. 2006. A visual guide to detecting emerald ash borer damage. Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Centre. 16 pages.

Lyons, D.B., Caister, C., de Groot, P., Hamilton, B., Marchant, K., Scarr, T., and Turgeon, J.J. 2007. Survey guide for detection of emerald ash borer. Natural Resources Canada – Canadian Forest Service and Canadian Food Inspection Agency, Sault Ste. Marie, Ontario, Canada.

Ryall, K.L., Fidgen, J.G., and Turgeon, J.J. 2010. Development of a sampling unit for early detection of the emerald ash borer, *Agilus planipennis*, in individual urban trees. Unpublished.

IDENTIFYING ASH TREES

Take this guide to each tree on your property to identify ash



Ridged Bark:

On mature trees (left), bark is tight and displays patterns of diamond shaped ridges. On young trees (right), bark is relatively smooth.



Compound 'Opposite' Leaves:

Leaves contain 5 to 11 leaflets with smooth or toothed margins (tips). Leaflets are positioned opposite with one at the top.



Seeds:

When present, seeds usually hang in clusters and are dry and oar-shaped.



'Opposite' Branches:

Branches and buds are directly across from each other rather than staggered. However, due to the death and grooming of individual branches, it is possible that not every branch will be opposite.



WHAT IS THE EMERALD ASH BORER?

The Emerald Ash Borer is a metallic green wood-boring beetle of about 1 to 1.5 cm in length that attacks all native species of ash trees, typically killing them in 2 to 3 years. Its larva bore tunnels inside the tree, feeding off the inner bark until the tree dies.

Native to northeastern Asia, the pest was first discovered in Ontario in the Windsor area in 2002. Since then, infested ash trees have been discovered in Essex, Lambton, Elgin and Middlesex Counties, and in the Municipality of Chatham-Kent.

RECOGNIZING INFESTED ASH TREES

Infested ash trees often exhibit the following symptoms



Crown Dieback:

Severely attacked trees may exhibit crown dieback as the canopy dies from the top down. Leaves may wilt or turn yellow during the growing season.



Bark Cracks:

Vertical splits of 7 - 10 cm are often present over larval galleries. These are often more noticeable on young trees that do not already have splits from growth-related expansion.



Woodpeckers:

Woodpeckers feed on the larvae under the bark. Look for increased Woodpecker feedings or signs of their probing in the bark.



Exit Holes:

Once fully mature, the adult beetles emerge through exit holes they chew through the bark. These holes are distinctly D-shaped and are 3.5 to 4 mm across.



Tunnels:

Winding S-shaped larval tunnels snake under the bark where larvae bore channels. Removing the bark exposes larvae and sawdust-filled galleries.