City of Portland Emerald Ash Borer Management Plan 2021

Prepared by Project Canopy

Acknowledgements
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About Project Canopy
Project Canopy is Maine's urban and community forest program, a program of the Maine Forest Service under Maine's Department of Agriculture, Conservation and Forestry. It educates people about the benefits trees provide, and how trees make people's lives better. It connects people who have a particular expertise to people who need that expertise. It helps build bridges with town and city governments, and it knows how to communicate in a local, political environment. And just as important, Project Canopy helps people talk about success stories, so that they can find the motivation --- and inspiration --- that is crucial for developing creative, long-term community forestry programs.

The Maine Forest Service has an incredible reservoir of knowledge and expertise. The challenge for us is to get that knowledge to the people who can use it. Any long-term community forestry program needs commitment and understanding from many different corners. Project Canopy's role is to get people in different corners talking to each other, so that awareness about trees can grow by leaps and bounds. We do that by using down-to-earth strategies and deploying technical experts into the field to lend hands-on assistance.

For example:

- Helping recruit and organize volunteers;
- Providing model community tree ordinances;
- Assisting in fund-raising efforts;
- Training tree stewards;
- Providing street tree inventory software;
- Helping communities appoint/elect a community tree warden;
- Linking communities to other Maine communities with successful tree programs;
- Providing lists of local foresters and arborists;
- Building bridges to national community tree organizations;
- Assisting in development of a long-term community tree plan;

PROJECT CANOPY
Help trees help you.

And much more.

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Executive Summary

Figure 1. Emerald ash borer. USDA photo

The *Agrilus planipennis*, commonly known as the Emerald Ash Borer or EAB, is an exotic wood-boring beetle that was discovered in southeastern Michigan in 2002 and feeds exclusively on trees in the genus *Fraxinus* (there is evidence to support EAB also feeds on *Chionanthus virginicus* (white fringetree), which is also in the *Oleaceae* Family with ash.). Native to Asia and Eastern Russia, this tiny green beetle has killed hundreds of millions of ash trees in 35 states and 5 Canadian provinces, causing devastation rivaling that of Dutch Elm Disease and Chestnut Blight. This insect will inevitably destroy most ash trees left untreated by insecticides and will pose significant human health and safety risks.

Figure 2. Ash tree on the Western Prom tagged for Earth Day. Kim Ballard photo.

Here in Maine, EAB infestations have been confirmed in Aroostook, Cumberland and York Counties. Found in Portland in 2019, we can expect to lose the vast majority of the ash trees in the City within several years. While only 3% of publicly owned trees are ash, Portland, the most populated city in the state, is an area of particular risk as it is home to numerous parks, wooded trails, and neighborhoods nestled among streets hosting towering mature ash trees. Publicly owned trees include those on municipal properties (community parks, cemeteries, etc.), downtown sidewalks, as well as within the right-of-way (ROW) along city streets.

This pest management plan will describe the scope of the threat to public property and provide recommendations to slow the spread and minimize the economic, environmental, and social impacts of EAB on the City of Portland over the next 5 years. By implementing the provisions in this plan, the City is attempting to mitigate the disruption by EAB to its urban and community forest, and the numerous benefits it provides. Taking a proactive and aggressive approach to this invasion will enable the City to address public and private needs in an efficient and effective manner.

The goals of the Portland Emerald Ash Borer Management Plan are to:

- Ensure Public Safety and Minimize Liability
- Mitigate the Loss of Significant High Value Ash Trees
- Maintain the City's Tree Canopy
- Provide Public Education and Awareness

This plan is based on the most recent scientific studies and recommendations from key partners and multiple state and federal agencies. As this is a living document, updates to this plan should be made as new information and recommendations are released – ideally on an annual basis. A comprehensive update that includes achievements, lessons learned, and any additional goals, should be conducted at the end of 5 years.

State and local government, municipal boards and committees, conservation agencies, and private landowners all play an important role in monitoring and maintaining urban forests. **A healthy public tree population is contingent upon proper management, stewardship, and a municipality's commitment to understanding and maintaining its urban forest.**

Figure 3. Western Promenade. Kim Ballard photo.

Goals and Actions Summary

Ensure Public Safety and Minimize Liability

- Identify hazard trees in infested areas
- Remove dead or dying ash trees from roadways and public areas promptly (include private trees as funds allow)
- Detect spread of infestation into new neighborhoods as early as possible and suppress the pest pressure.

Mitigate the Loss of Significant High Value Ash Trees

- Define and identify high value ash trees
- Treat valuable ash trees
- Explore new treatment options and cost saving opportunities on an ongoing basis

Maintain the City's Tree Canopy

- Replant using non-host tree species at locations where ash trees were removed
- Plant two (2) trees for each ash tree removed
- Replant within one (1) year of removal
- Explore sources of funding for removal of trees on private property

Provide Public Education and Awareness

- Communicate with the public through a variety of media outlets, including newspaper, social media, and City blogs and websites
- Provide informational resources on EAB treatments, ash removal, and replanting (including cost-share planting program)
- Engage private land owners on EAB to prevent dying ash trees from becoming hazards to people and property
- Create County Firewood Bank

Introduction

Portland, Maine has earned its spot on numerous top ten lists in recent memory: most livable, happiest city, most learned, prettiest - the lists go on. A revitalized arts district, influx of James Beard Award winning chefs, and the increasing trend in telecommuting has helped to create a population boom in Maine's largest city. The International Jetport, Ocean Gateway and Thompsons' Point bring visitors and businesspeople into the city from all over the world, while multi-lane highways shuttle commuters, students and cargo through rural stretches and over tidal flats, bypassing neighborhoods of historic homes, industrial facilities and sprawling commercial strips.

Invasive pests utilize some of the very same modes of transportation to enter our state, and in the case of the emerald ash borer (EAB), its favorite ride is nestled just under the bark of firewood. While federal and state restrictions on the movement of firewood have been in place for decades, the ban on out-of-state firewood was initiated for Maine in 2010. Ultimately, not every carload of firewood can be intercepted. Statewide officials are left to manage this concern primarily through education to influence behavior change.

EAB was first found in Maine in 2018, and first found in Portland in the fall of 2019.

Project Canopy partnered with the City of Portland in 2020 in a three-year USDA Forest Health and Resilience grant to establish baseline protocols for ash treatment and removal, and subsequent planning and budgeting for treatment or removal of the city's 600+ ash street trees. This report is a key part of that grant.

Incorporating a forest pest management plan as a component of the larger urban forest management plan will establish a baseline and protocol to follow when invasive insects such as EAB and Asian longhorn beetle (ALB) threaten Portland's trees.

City Profile

The City of Portland, in Cumberland County, is located in Southern Maine, part of the Casco Bay Watershed. In 2020 the City's population reached nearly 69,000, making it the state's largest municipality. It is easily accessible from Interstate 95 and 295 and is less than a day's drive from Boston, New York, and parts of Canada. Portland hosts the University of Southern Maine as well as headquarters for Oakhurst Dairy, WEX and TD Bank, and its burgeoning arts, food, and tech scene, coupled with improvements to mass transit will ensure that its population will continue to rise.

Much of Portland lies along two high speed 2-4 lane interstates (95 and 295) and is a major thoroughfare for traffic headed north. Traffic can be very heavy and travel at speeds surpassing 80 mph. Land around these highways are controlled and maintained by Maine DOT and the Maine Turnpike Authority. US Rt 1, the Eastern Promenade and Baxter Blvd carry residents and tourists alike along the coast, while state routes 302, 22 and 25 allow commuters access to the downtown from the west. Small stands of mature eastern white pine and northern red oak dot the landscape along the outer reaches of the main roads, but much of the gateway streetscape is commercial or residential with limited tree canopy.

The "Forest City" boasts 721 acres of open space and public parks, which provide cooling respite from the surrounding hardscape as well as recreational opportunities. Thanks to a long lineage of City Arborists, much of Portland's historic downtown is host to shaded streets lined with mature oaks and maples, hardy ginkgos and crabapples, and fragrant honey locust and lindens. In 2012-2013, the city conducted a complete inventory of its 20,500 public trees which can be viewed at: http://portlandme.maps.arcgis.com/apps/webappviewer/index.html?id=8c1f329f45384c1080608df88501bcbe

Figure 5. Portland City Arborist, Jeff Tarling. Kim Ballard photo.

Portland has been recognized by the Arbor Day Foundation as a Tree City USA for over 40 years. The Tree City USA program is designed to recognize those communities that effectively manage their public resources, and to encourage the implementation of community tree management based on four standards. These four standards provide structure for a community forestry program, require that program to demonstrate success based on the judgment of the state forester's office, and provide for an awareness and appreciation of trees among the residents of the community.

Benefits of Urban Trees

Portland boasts a beautiful, bustling downtown, with great local shops and restaurants. Wide sunny sidewalks are a perfect spot to add substantial tree wells, planters and even rain gardens and stormwater catch basins.

A 2005 study determined shoppers in business districts with robust tree canopy will spend 9 to 12% more for products. They will travel greater distance to visit a district having high quality trees and spend more time there once they arrive[i].

Trees can calm traffic and reduce vehicle speeds by appearing to narrow the width of the roadway. In an area where streets were widened and trees were *not* present, accidents increased by almost 500% within an 8-year period[ii]. Tree lined streets and sidewalks encourage visitors and residents to walk and ride bikes, rather than drive personal vehicles due to the reduced urban heat island effect, ultimately reducing the need for increased parking.

The urban forest can help improve air quality by reducing air temperature, directly removing pollutants from the air, and reducing energy consumption in buildings, which consequently reduces air pollutant emissions from power sources. Numerous other studies repeatedly demonstrate the myriad benefits trees have on urban neighborhoods – from reduction in crime, to increased health, reduced energy costs and increase in property values.

Scope

This 5 year plan applies throughout the City of Portland on all public properties (including rights-of-way and sidewalk esplanades) where ash trees are currently growing, as well as on private properties where such trees may negatively impact public rights-of-way or other public properties if they fail. Additional funds may be utilized to assist homeowners in treatment or removal of infested private trees.

Figure 6. Ash # 54 on Spruce Street. Kim Ballard photo.

Administration

The City Arborist and Forestry Department, through the Parks and Recreation Department, will be responsible for implementing this plan and seeing that its provisions are carried out. The City Arborist will manage all contracted work.

State & Federal Quarantine

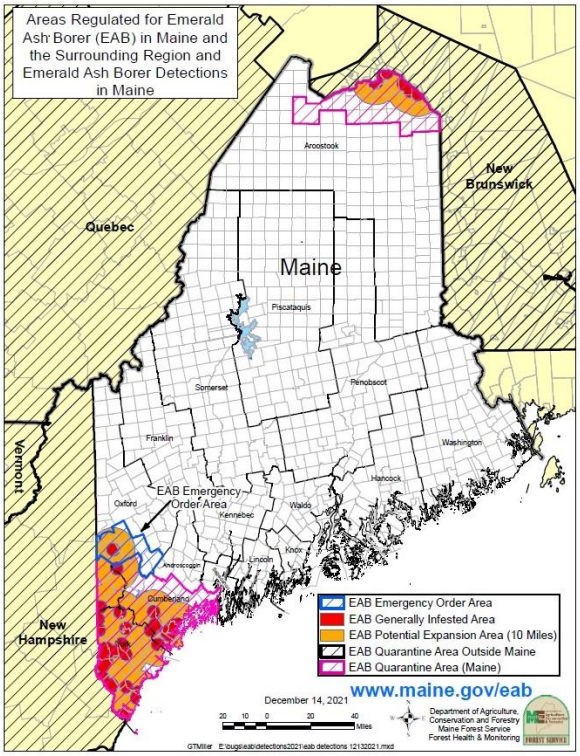


Figure 7. State quarantine for ash as of Dec 14, 2021.

In January 2021, the USDA removed the domestic quarantine regulations for the emerald ash borer. These Federal regulations, in place in one form or another since 2003, did not prevent the spread of EAB throughout its geographical range. Funding previously allocated to the implementation and enforcement of these domestic quarantine regulations will instead be directed to nonregulatory options to mitigate and control the pest.

While EAB still poses a significant threat to Maine's approximately 480 million ash trees, we are slowing its impact through continued state quarantines that limit the movement of ash out of infested areas and maintain prohibitions on importing ash into Maine. These quarantines currently include all of York County, all of Cumberland County, parts of Oxford County, and the northern portions of Aroostook County. Materials covered in this quarantine include nursery stock, green lumber, and other material living, dead, cut, or fallen, including logs, stumps, roots, and branches of the genus *Fraxinus*, as well as firewood of all hardwood species.

Ash Resources

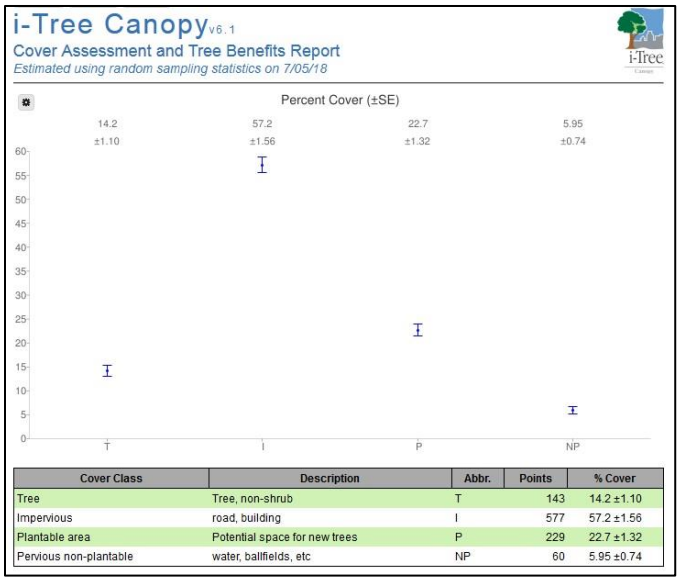
A comprehensive public tree inventory is an important piece of a vibrant community tree program, and provides a snapshot in time of the diversity, condition, and size of a city's urban forest. Portland directed two interns to conduct such an inventory in the summer of 2012. This data has served as the basis for the City Forestry Department's work plan and management strategy over the past near decade.

In the spring and summer of 2021, Project Canopy staff completed a random check/update of approximately 10% of the more than 600 ash trees identified in Portland's 2012 tree inventory. Data noted and updated for each tree potentially included street name/#, species, height, diameter at breast height (DBH), canopy size, condition, a recommendation for maintenance, wire and sidewalk conflicts, building interactions and any pest signs or symptoms. In general, the ash population of Portland is healthy and growing. Of the 87 trees sampled in 2021, 27 grew 3" or more in DBH than when first measured. 32 were found to be declining, and four (4) had been removed altogether. 13 ash trees had one or more symptoms consistent with

EAB infestation, but at the time of this report had not yet been confirmed by an entomologist.

Full Canopy Assessment

Project Canopy partnered with the City and Oakhurst Dairy in the Spring of 2018 to conduct an Urban Tree Canopy (UTC) assessment of the City.



Cover Class	Description	Abbr.	Points	% Cover
Tree	Tree, non-shrub	T	143	14.2 ±1.10
Impervious	road, building	I	577	57.2 ±1.56
Plantable area	Potential space for new trees	P	229	22.7 ±1.32
Pervious non-plantable	water, ballfields, etc	NP	60	5.95 ±0.74

Figure 8. Canopy Cover % for the Portland Peninsula.

This canopy assessment determined that approximately 23% of the land area is currently occupied by tree canopy. With 50% of the total area occupied by buildings and other non-plantable areas (parking lots, roads and bodies of water - however, some of this could be converted to tree canopy – such as tree islands and buffer strips in parking lots as well as green roofs.), **Portland's canopy cover could potentially increase by more than 27% on open lands of low-lying vegetation and re-engineering of some parking lots.**

Public trees provide a number of benefits to a community, including reducing stormwater runoff, reducing air pollution, reducing energy costs, and sequestering carbon dioxide (CO_2). Many tree benefits equate directly to the amount of healthy leaf surface in the canopy - the larger the tree canopy, the higher the benefit value provided by the tree. The City's canopy cover of 23% provides an estimated **$874,390 <u>annually</u> in air quality benefits alone as well as an estimated long-term stored CO_2 value of $15,610,923**[iii] to the residents and businesses of Portland. **<u>As canopy increases, these benefits and savings will only increase</u>.** It is also noteworthy that larger (mature) and long-lived trees provide substantially more benefits than small and young trees. As mature ash trees are removed, one-for-one replacements with smaller trees will <u>not</u> restore the UTC or benefits lost. **Regular maintenance and care are needed to provide for public tree health, longevity, and maximized urban forest benefits.**

Tree Benefit Estimates

Abbr.	Benefit Description	Value (USD)	±SE	Amount	±SE
CO	Carbon Monoxide removed annually	$145.20	±11.25	218.54 lb	±16.93
NO2	Nitrogen Dioxide removed annually	$259.53	±20.11	1.00 T	±0.08
O3	Ozone removed annually	$12,455.99	±964.99	6.14 T	±0.48
PM2.5	Particulate Matter less than 2.5 microns removed annually	$32,681.79	±2,531.93	725.70 lb	±56.22
SO2	Sulfur Dioxide removed annually	$34.39	±2.66	687.62 lb	±53.27
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	$13,086.95	±1,013.87	2.10 T	±0.16
CO2seq	Carbon Dioxide sequestered annually in trees	$31,215.85	±2,418.36	885.42 T	±68.60
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	$1,086,198.56	±84,150.09	30,809.44 T	±2,386.87

i-Tree Canopy Annual Tree Benefit Estimates based on these values in lbs/acre/yr and $/T/yr: CO 0.892 @ $1,333.50 | NO2 8.175 @ $259.97 | O3 50.093 @ $2,036.17 | PM2.5 2.961 @ $90,389.14 | SO2 2.805 @ $100.37 | PM10 17.096 @ $6,268.44 | CO2seq 7,224.756 @ $35.38 | CO2stor is a total biomass amount of 251,395.359 @ $35.38*

Note: Currency is in USD

Note: Standard errors of removal amounts and benefits were calculated based on standard errors of sampled and classified points.

About i-Tree Canopy

The concept and prototype of this program were developed by David J. Nowak, Jeffery T. Walton and Eric J. Greenfield (USDA Forest Service). The current version of this program was developed and adapted to i-Tree by David Ellingsworth, Mike Binkley, and Scott Maco (The Davey Tree Expert Company).

Limitations of i-Tree Canopy

The accuracy of the analysis depends upon the ability of the user to correctly classify each point into its correct class. As the number of points increase, the precision of the estimate will increase as the standard error of the estimate will decrease. If too few points are classified, the standard error will be too high to have any real certainty of the estimate.

A Cooperative Initiative Between:

Figure 9. Benefits provided by Portland's Peninsula Tree Canopy.

Figure 10. Ash tree on Western Promenade in Autumn. Kim Ballard photo.

Portland most recently updated its Comprehensive Plan in 2017. Included in that plan is a goal to "increase the urban tree canopy by 15% above current canopy coverage to benefit air quality, local climate, CO2 absorption, and aesthetics". As the ash population continues to decline over the next decade, **Portland will need to ensure adequate funding not only to increase and diversify canopy coverage, but to simply maintain a level of canopy as it loses large, mature trees and replants with much smaller, younger trees.**

Management Plan Elements

The City of Portland needs an aggressive yet effective, responsible, and financially viable approach to managing the spread of EAB. This plan incorporates the following Goals:

- Ensure Public Safety and Minimize Liability
- Mitigate the Loss of Significant High Value Ash Trees
- Maintain the City's Tree Canopy
- Provide Public Education and Awareness

This plan is structured to preserve and ultimately increase the City's urban tree canopy, slow down the spread of EAB where possible and allow for the preservation of high value trees in order to allow more time for improved and/or other control measures to be introduced in the future.

The Actions outlined within this plan are:

- Inventory, Monitoring and Assessment
- Treatment of Significant High Value Trees
- Tree and Stump Removal
- Tree Replacement (with a different species of tree)
- Wood Waste Disposal
- Public Education and Communication

To date, communities in North America have not successfully eradicated EAB once detected. Symptoms of EAB are slow to appear, making initial infestations hard to detect and once EAB is found, it is usually estimated that it has been present for 3-5 years. As the pest population builds, EAB eventually infests and kills all varieties of true ash (*Fraxinus* spp) trees in the area. Once ash trees are infested with EAB, they typically decline and die over a period of 2-3 years, at which point they become hazards to property, infrastructure, and to the public.

If not properly planned for, the burden of dealing with this number of trees in such a short period of time can leave a city without the proper finances or manpower to remove them, leaving the streets lined with hundreds of potentially dangerous trees. Cutting down already dead trees is more expensive due to the unpredictable nature of dead wood, the added strain on equipment, and added clean-up costs due to splintering.

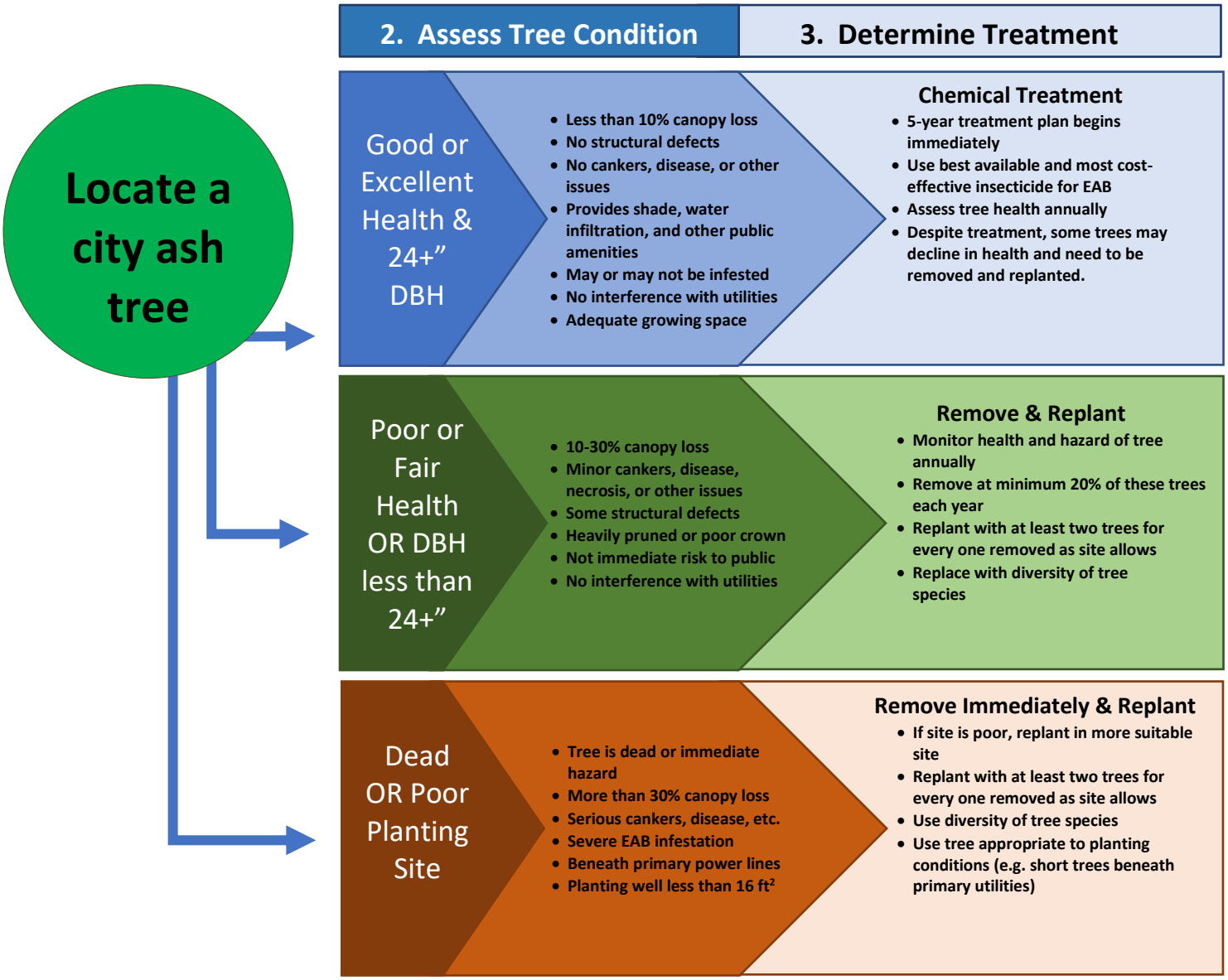


Figure 11. Selective Management Process for individual ash trees.

Inventory, Monitoring and Assessment
The City completed a thorough inventory of its public trees in 2012. Now that it is nearly a decade later, **all ash trees must be re-evaluated by a licensed arborist[iv] as soon as possible** to determine condition, size, and potential level of EAB infestation. Re-evaluation should begin in neighborhoods with current infestations and then expand radially outward, concentrating on streets and parks with the highest density of ash.

Ash trees in Good or Excellent health with a DBH over 24 inches are candidates for chemical treatment, and those deemed to be Fair, Poor or Dead need to be removed and replanted. Small ash trees less than ten (10) inches DBH cannot be treated with bark injections. Poor growing conditions should be taken into consideration as well.

Figure 12. Inspection of ash in a wooded stand. MFS photo.

If a tree exists in a natural space and it is not dangerous to property or passersby, then it should be left in place; dead trees provide habitat and improve soil, and they are an important part of ecosystems. **There is evidence that some white ash show inherent resistance to EAB, these trees need to exist as seed stock for future populations.**

An estimated budget and timeframe should be generated for the desired treatment and removal regime, based on the new inventory data.

Monitoring of non-infested areas must not be forgotten in the rush to remove hazard trees. **Regular and systematic inspections/surveys radiating from infested areas must be conducted in order to respond swiftly to expanding pest populations.** Determine sources of pest introduction such as campgrounds, nurseries, firewood dealers, and sawmills to include in inspection areas. Strategically located non-asset ash trees should be selected and prepared as girdled trap trees on an annual basis. All ash wood from pruning or removals must be inspected for EAB by looking for D-shaped exit holes and removing the bark to find larval galleries. Any new infestations discovered will then be noted on the inventory, and surrounding areas will then rise in priority for inspections.

Figure 13. TREE-age™ is injected into an ash in Concord, NH. Kim Ballard photo.

Treatment of Significant High Value Trees

High-value ash trees in the city will be treated with emamectin benzoate (TREE-äge™). This pesticide has been shown to provide 99% protection against EAB larvae for 2-3 years with a single application. Only trees in excellent and good conditions should be considered for this treatment since they are better positioned to survive the pest onslaught. Large diameter trees are favored over small diameter trees as they typically have higher value and provide greater benefits to the community. Other factors such as cost, location, logistics, and local support should be considered during the process. Be sure to follow all local ordinances and allow only licensed pesticide applicators to administer treatments.[v] On-going treatment will be necessary to protect trees for multiple years.

Biological control – release of parasitic wasps that prey on EAB – is an important component of EAB management, but must be used in conjunction with treatment and removal. It is not robust enough to control the pest on its own in urban settings or prior to high levels of EAB infestation.

Figure 14. Biocontrol - parasitic wasps that prey exclusively on EAB. From top to bottom: Spathius agrili, S. galinae, and Oobius agrili. USDA photo.

Tree and Stump Removal

Based on the degree of infestation and health, ash trees will need to be removed to limit hazardous conditions and minimize the safety risk associated with dead and declining trees. Ash wood infected by EAB decomposes rapidly requiring removals to be carried out within a short period of time after tree death. The removal of decaying and/or dead ash trees in public spaces needs to be done on a risk management basis. Priorities are given to trees in areas where heavy EAB infestations are located, trees posing high risk and trees with small diameters. Trees in areas that do not pose a danger should be left to fall naturally in place and decompose, providing habitat and conserving the ash component of the forests for as long as possible. In fact, it is recommended to release the canopy around female ash located in woodlots to allow young ash to mature and out-compete surrounding shade-loving species such as maple and beech. [vi]

Tree Replacement

Figure 15. Tree planting event at Portland Arts and Technology High School

As the budget permits, all removed public ash trees will be replaced on a 2:1 ratio, with non-host species that will enhance the planting site, are appropriate for the planting site, and add to the diversity and general health of the urban forest. Trees will be planted in accordance with ANSI A300 Tree Care Operations: planting, be in the 1 to 2 ½" caliper range and obtained from Maine licensed producers and dealers of nursery stock. Plantings will be prioritized by canopy cover goals. Those areas needing the most trees to reach their goal will be planted first, such as urban residential, central business districts and suburban residential. No plantings will be made that cannot be adequately maintained. All new plantings will conform to the "10-20-30" tree species diversity rule at minimum.[vii]

Wood Waste Disposal

The City must develop a plan to use the wood generated during the removal process. The plan must comply with the Maine Department of Agriculture, Conservation, and Forestry's (DACF) regulations for handling regulated materials. Wood that cannot be used for lumber, turning, firewood, chips, or mulch will be disposed of according to DACF specifications. Currently, Portland takes all wood waste to Riverside Recycling for chipping, but it is currently unknown if this facility will be able to handle the increase in material.

The City must also plan for the disposal of ash wood from private properties. Consider establishing neighborhood drop-off locations for stumps and branches. These must be regularly monitored and maintained. Be sure to provide public outreach to help property owners understand how to identify and deal with ash tree die-off. Coordinate with County Government and neighboring towns to establish Community Firewood banks where residents can procure firewood at no cost[viii].

Figure 16. Some of the many uses for urban wood. MFS photo.

For trees that are felled, but still in good condition, there is new hope for a second life as furniture, art, flooring, and numerous other wood products. The Urban Wood Network[ix] is a non-profit partnership that provides numerous resources for producers, makers and buyers.

Figure 17. Jeff Tarling talks with community members about urban trees. Kim Ballard photo.

Public Education and Communication

Keep your community informed as much as possible. Increasing communications and transparency regarding management of EAB and the city's urban forests will ensure that the community will help steward and care for this shared resource in the future. Below are a few ways to keep residents informed and engaged in the process of managing EAB and other invasive pests.

- Post information about the plan, including tree removals, treatment and plantings, to the city website.
- Place flyers about EAB, the pest management process, and upcoming meetings in public places.
- Personally contact abutters to properties where trees will be removed. Even door hangers can make a huge difference in attitudes.
- Write articles in the local newspaper and neighborhood newsletters.
- Post information to social media pages.
- Flag ash trees identified for removal or preservation with explanatory signage.
- Post signage on forest trailheads about EAB and proposed plans.
- Invite your District Forester to conduct ash and forest management walks in city forests or as a webinar.

A community that participates in planning, planting, and caring for their urban forest will respect and steward that forest much more than if it happens without their involvement.

Figure 18. Jeff Tarling and Maine Audubon's Sally Stockwell lead a Forest for Maine Birds talk in Evergreen Cemetery

Urban Forest Diversity

An important best management practice in urban forestry is to maintain a diverse range of species. It is recommended that communities work towards a goal of no more than 20% representation of a single genus (for example, *Acer*) in a tree population and no more than 10% of one species (for example, *Acer saccharum*). Resistance to disease and insect infestation is one of the many reasons that diversity of public trees is of particular concern. **A more diverse urban forest is more resistant to environmental stressors, and can therefore remain healthy and resilient in the face of change**. Furthermore, maintaining greater diversity can prevent a rapid loss of tree canopy due to insect and disease issues as well as natural end-of-life.

> As a general rule of thumb, street tree populations should consist of no more than 10% of any one species, 20% of any one genus, or 30% of any one family of trees. New tree plantings should continue to support the goal of diversification of the community tree population.

Ash trees (*Fraxinus*) comprise 3% of Portland's public trees. However, streets such as Danforth, Vaughan and Spring St are lined heavily with ash – the demise of all these trees at once would be devastating for those neighborhoods and the town as a whole. Maple trees count for a much higher percentage – likely close to 50%. Both ash and maple trees are currently threatened by invasive tree pests; EAB and ALB, respectively. While ALB has not been discovered to-date in Maine, a large ALB infestation is just to our south in Worcester, MA. Browntail moth and winter moth prefer to feed on oak foliage as well as that of fruit trees and have ravaged the area's trees over the last few years. While the wet cold spring of 2019 knocked the larval population down substantially, the hot dry spring in 2021 saw browntail moth numbers rebounding.

New plantings within Portland's city limits need to represent a diversity of species, and ones that will be able to withstand the harsher conditions expected with climate change: increased temperatures, flooding and more extreme winters. Species to consider are Kentucky coffeetree, shagbark hickory, tuliptree, black gum and London planetree.

Figure 19. Riverton Trolley Park. Kim Ballard photo.

Recommendations

Based on my observations in 2021, taking into account both conditions on the ground and extrapolated inventory data, it is my recommendation that 7% (50) of Portland's inventoried ash trees should be treated, and a minimum of 20% (110) should be removed within the 1st year. Removing 110 trees annually will of course eliminate the most hazardous trees first, but will also spread anticipated costs/labor across the next 5 years. At the end of 5 years, if this plan is followed, all inventoried ash that are not treated will have been removed. These figures are of course dependent on budget allotments, and continued inspections of the city's ash trees.

Conclusion

Trees in our downtowns and commercial landscapes contribute to a thriving economy, promote our sense of community, protect our natural resources, preserve our cultural heritage, and increase our overall well-being. Well-planned and planted trees calm traffic, boost retail sales, reduce stormwater fees, provide cooling shade for parking lots and buildings, and can create a visual gateway welcoming visitors to the destination of Portland. Larger shade trees can also provide heating and cooling savings to homes and businesses.

Figure 20. The state champion green ash in Deering Oaks Park

When a city's urban forest is threatened, such as Portland's is by the emerald ash borer, it must do all it can to mitigate the damage, both to its trees and its community. The burden of dealing with hundreds of dead and dying trees in a short period of time can place an enormous strain on a municipality's budget, personnel, and resources. Having a plan in place can allow for measured and predictable costs, reduced liability, and anticipated staffing levels. The ability to act swiftly and nimbly in an informed and responsible manner can truly make the difference in a community's bottom line – and its treeline. While we will not exterminate the pest, we can lessen its impact and keep Portland's canopy thriving and vibrant for years to come.

This report is one component of an effort by the City of Portland to understand, manage, and steward its public tree population. The recommendations outlined in this report are based on Project Canopy staff's observations and data analysis combined with their experience and evaluation; they should be considered by Portland's leadership based on long-term vision and capacity.

Best Management Practices for Handling Ash Wood

To Reduce the Risk of Spread of Emerald Ash Borer in Maine

***WITHIN* Regulated Areas**

Notice EAB tracks hidden under undamaged bark

You cannot always tell if a piece ash is infested with emerald ash borer (EAB) by looking at it.

Treat all ash as if it is infested.

Most ash trees within regulated areas are not yet infested. Following best management practices (BMPs) will slow the spread of EAB infestations and help protect Maine's ash woodlots, street trees, and forests.

EAB regulations prohibit all hardwood firewood and ash wood products from leaving EAB-regulated areas without a compliance agreement. These products can be moved freely within EAB-regulated areas.

However, follow the BMPs below to reduce the rate of EAB spread to uninfested areas.

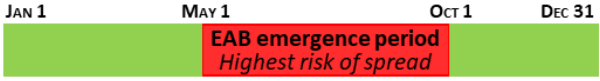
- **GRIND, CHIP, BURN OR COMPOST ASH TREE WASTE MATERIALS;**

OR

- **DELIVER ASH TREE MATERIAL WITHIN 5 MILES OF ITS ORIGIN;**

OR

- **TRANSPORT ASH WOOD AFTER OCTOBER 1. TO BE USED AT ITS DESTINATION BEFORE MAY 1 OF THE FOLLOWING SPRING;**



OR

- **CUT AND SEASON ASH WHERE IT IS CUT FOR 12 MONTHS OR AT LEAST OVER THE SUMMER BEFORE DISTRIBUTION;**

AND IN ALL CASES NOTIFY RECIPIENTS

- **THERE IS A RISK OF EAB INFESTATION FROM THE WOOD;**
- **IT CANNOT BE MOVED FROM THE REGULATED AREA WITHOUT AN AGREEMENT AND**
- **IT SHOULD BE PROCESSED AS SOON AS POSSIBLE.**

More information: maine.gov/eab
foresthealth@maine.gov
207.287.2431

maine DEPARTMENT OF Agriculture Conservation & Forestry

SAVING YOUR HIGH-VALUE ASH

A simple guide for homeowners and municipalities with true ash (*Fraxinus*) trees

Piera Siegert, NH State Entomologist, adapted for Maine.

Emerald ash borer adult
Photo credit: N.W. Siegert

The problem: Emerald ash borer is an introduced and destructive pest of all North American true ash (*Fraxinus*) such as white, green, and black/brown ash. Trees infested with emerald ash borer will die from the infestation within 3-5 years. Management strategies to slow the spread of ash mortality can reduce *overall* emerald ash borer populations, but they may not save the ash tree in front of ***your*** house or in ***your*** park. Potential costs associated with emerald ash borer for municipalities and homeowners include:

- Costs to remove/replace/treat infested trees
- Loss of landscaping and community character
- Increased heating/cooling costs
- Reduction in property value
- Potential property damage/personal injury suits

Ash-lined neighborhood in Lebanon, NH.
Photo credit: P.Y. Siegert

Emerald ash borer killed tree in Concord, NH.
Photo credit: P.Y. Siegert

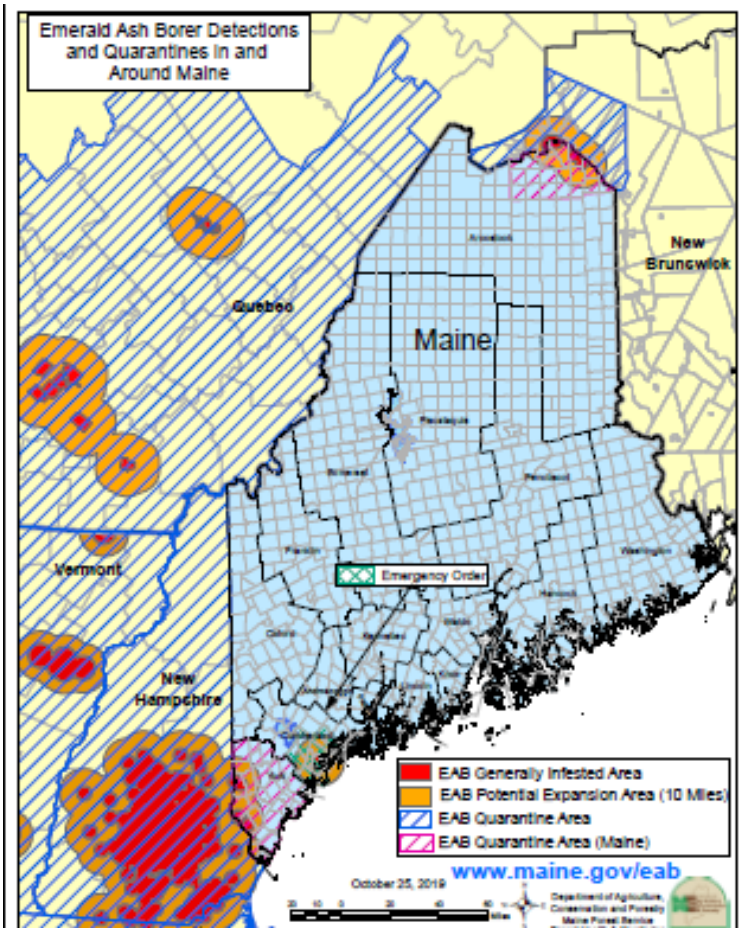
Although you cannot control the arrival of emerald ash borer on your property, you can decide what impact emerald ash borer will have by developing an emerald ash borer plan. This should be done regardless of proximity to known emerald ash borer populations. The first step is to stay informed about known emerald ash borer populations in the state (www.maine.gov/eab). Next, determine if you have ash trees, what size they are, where they are located, and if they add value to your property or community. Determine if your trees are on personal or public property. If public, contact your local municipal office to see if an EAB management plan is in effect. For private trees, use local foresters and arborists, on-line calculators (www.extension.entm.purdue.edu/treecomputer/ and other sites) or smart phone apps (ARBOR-mobile for iphone and ipad and others) to estimate the costs associated with tree removal, replacement or treatment. Once you have determined your investment in ash and considered your budget, you can develop a plan for which trees will be removed, replaced or treated with insecticides when emerald ash borer arrives. Having a plan empowers you to make informed decisions about your property or community. **Don't let the beetle decide what to do with your trees!**

Don't let the beetle decide what to do with your trees!

More information about using insecticides for emerald ash borer on the reverse
WARNING: *Insecticides can have health or environmental impacts. If you use insecticides always follow all label instructions or hire a licensed pesticide applicator.* **Pollinator impact note:** *Some studies have linked systemic insecticides to declines in honeybee populations. The body of evidence is inconclusive, but potential impacts to pollinators should be considered when initiating an insecticide regime. For information on insecticides used for EAB see* www.emeraldashborer.info/files/Potential_Side_Effects_of_EAB_Insecticides_FAQ.pdf.

Pesticides can be a useful tool for protecting valued ash trees. There are important considerations to keep in mind, however, when selecting an insecticide regime:

- Proximity to generally infested area—insecticide treatment is only recommended in the red and orange areas (see map left or visit www.maine.gov/eab for the most current information)
- Size of tree—measure the diameter (in inches) at 4.5 feet above the ground with a caliper or tape measure to get Diameter at Breast Height (DBH)
- Health of tree—systemic insecticides are less effective in trees that are already in decline
- Proximity to socially or environmentally sensitive habitats (like school properties, wells, or wetland areas)
- Mode of application of insecticide
- Effectiveness of treatment
- Cost of treatment
- Frequency of treatment



Not all emerald ash borer-approved insecticides are equally effective, nor are they all appropriate in every circumstance. Choosing an ineffective treatment for your conditions may result in product failure and is not cost-effective. Less effective treatments may prolong the life of an ash tree early in the invasion process but as neighboring untreated ash trees start showing signs of decline, indicating increasing local emerald ash borer populations, a more effective pesticide treatment may be necessary. There are resources available to help you assess the management options and products that are right for you. The table below shows the recommended active ingredients available for use. Most formulations are only available for use by a licensed pesticide applicator. For detailed information about products registered for use in Maine, visit: http://npirspublic.ceris.purdue.edu/state/state_menu.aspx?state=ME.

More resources are also available through www.maine.gov/eab, www.emeraldashborer.info/files/Multistate_EAB_Insecticide_Fact_Sheet.pdf and www.emeraldashborer.info, as well as by contacting an experienced Maine licensed pesticide applicator.

See map above to determine your management zone.		**Ash is less than 18" DBH**	**Ash is greater than 18" DBH**
Generally infested	Ash appear healthy	Imidacloprid, dinotefuran, or emamectin benzoate	Emamectin benzoate
	Ash are in decline	Emamectin benzoate	
	Ash are dead or with greater than 50% crown dieback	Tree removal. Insecticides unlikely to be effective.	
	Expansion management zone	Imidacloprid, dinotefuran, or emamectin benzoate	Emamectin benzoate
	Alert management zone	Treatment not yet warranted. Develop a plan.	

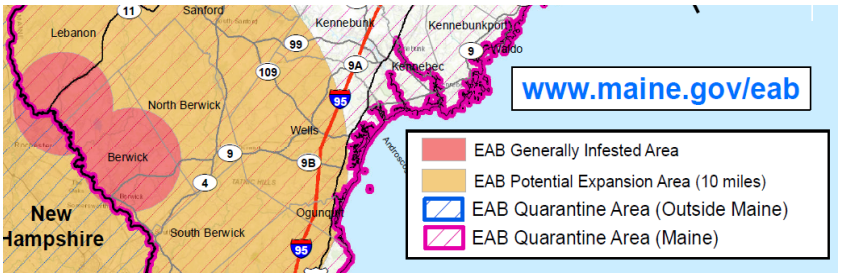
For assistance in developing a municipal emerald ash borer plan, and to find out how your management goals coincide with state management of emerald ash borer, please contact the Maine Forest Service.

Please help SLOW the SPREAD of Emerald Ash Borer: Guidance for Solid Waste Facilities in Maine

Human-assisted movement is the number one cause behind the spread of emerald ash borer (EAB) and frequently results in new infestations. Solid waste facilities that accept yard waste are at high risk of unknowingly accepting infested ash tree debris harboring EAB life stages. Follow these guidelines for handling infested or potentially infested ash material to slow the spread of EAB and help protect your municipality and surrounding forests. For information on what defines a quarantine or order area, please visit our Quarantine FAQ's at www.maine.gov/eab

Are you in the infested area?

Visit www.maine.gov/eab for a map of EAB-regulated areas (quarantine and emergency order) and generally infested areas and to sign up for map updates.



Example Infested Area (small, red shaded circles); and Quarantine Area (pink hatched). For a full map of the EAB regulated areas in Maine visit www.maine.gov/eab.

If Your Facility is INSIDE of the Infested Area

The easiest option is to keep all ash materials inside the EAB-regulated area. Ash material that remains within the regulated area does not require treatment.

Ash or mixed wood debris that may contain ash should be chipped or ground before moving it outside of any generally infested area within a regulated area. Chips must measure less than one inch in two dimensions and be able to pass through a 1.25" sieve to guarantee all life stages of EAB have been killed and the resulting material is safe for transport. If in doubt, Maine Forest Service officials can inspect chips to ensure the materials have been processed to this standard.

Materials larger than chips must undergo another certified treatment, such as heat treatment, to exit the regulated area. Since this is often impractical for solid waste facilities, chipping is often the best option. In some circumstances, coarse ground material can be shipped to facilities with a pre-existing compliance agreement outside of the regulated area during the non-flight season (October 1 through May 1) to be processed or disposed of properly.

If allowed, ash materials may be burned on site to destroy any EAB life stages. Please contact the Maine Department of Environmental Protection's Division of Solid Materials Management at 207-287-7688 to determine whether this is permitted at your facility and obtain a burn permit.

FIREWOOD THAT IS **NOT HEAT-TREATED** CAN SPREAD DAMAGING INSECTS AND DISEASES AND SHOULD NEVER BE MOVED OUTSIDE THE INFESTED AREA.

If Your Facility is OUTSIDE of the Regulated Area

EAB-regulated areas in Maine are subject to regular change. It is always best to know the relation of your facility to the currently regulated area. Ensure staff can identify ash materials and do not accept unchipped or unground ash material originating from within an infested area. Ask your customers where their wood waste originated, where it has been stored prior to disposal, and if they know whether their waste contains ash materials.

If they have ash material from the infested area, direct them to a facility in the infested area for disposal. Or, follow the treatment recommendations above to treat the material immediately and help slow the spread of EAB.

Contact Information

For questions involving proper handling of regulated ash materials at solid waste facilities, please contact Michael Parisio at the Maine Forest Service: michael.parisio@maine.gov or 207-287-7094

maine DEPARTMENT OF Agriculture Conservation & Forestry
FOREST SERVICE

PORTLAND PARKS, RECREATION & FACILITIES FORESTRY

City of Portland
Recommended Tree List

Helpful Info:

"The right tree in the right place" is a common refrain when it comes to tree planting. It is important to match the desired characteristics of the tree to the site where the tree is intended to grow. Important factors to consider when choosing a tree include mature height and canopy spread, shading/screening characteristics, flower and fruit production, as well as soil, sun, and moisture requirements.

Planting Site Guidelines:

- Planting space must be at least 3.5 ft x 4 ft and allow for any existing sidewalk to meet ADA standards (3 ft width)
- Minimum 10 ft from intersections, utility poles, hydrants, driveways, and traffic signs or signals
- Minimum 4 ft from underground utilities
- Setback (lawn) plantings must be visible to the public. Co-op trees will not be planted in side or back yards.

Tree Size Guidelines:

Shade/ornamental trees: 1.5 in – 2 in caliper (trunk diameter)
Coniferous trees: 4 ft - 6 ft height

Helpful Links:

International Society of Arboriculture (ISA) Tree Selections and Placement Guide
ISA Guide to Avoiding Tree & Utility Conflicts
Arbor Day Foundation "The Right Tree in the Right Place"
Cornell University Recommended Urban Trees
U.S. National Arboretum Tree Fact Sheets
USDA Plant Hardiness Zone Map

Co-op Nursery Information:

Skillins Greenhouses – Falmouth – 207-781-3860
O'Donal's Nursery – Gorham – 207-839-4262

Trees included in this list prove hardy to the local climate, display favorable characteristics, and are generally available in the nursery trade. The list is grouped into categories based on size and appropriate planting site.

Notation Guide:

ST	**Street Tree**: Planted along the edge of a street and in esplanades between the sidewalk and street. These are often "shade trees" and are chosen based on desired characteristics such as branching height, shape, and hardiness to grow in urban conditions.
LT	**Lawn Tree**: Set back away from the esplanade or street. These trees can be multi-stemmed, lower branched, and don't need to be as tolerant of urban conditions. This includes shade, ornamental, conifer, and fruit/nut trees.
*	Especially recommended and generally readily available

Small Trees (15 ft – 25 ft): Those labeled "ST" can be planted under wires

Hedge Maple (*Acer campestre)* **ST / LT**
Grows slowly to a height of 25 ft according to reference materials, however, we have several trees that are approaching 15 ft tall after 10 years.

Three-flowered Maple* (*Acer triflorum)* **ST / LT**
A unique small specimen tree with exfoliating bark and trifoliate leaves that turn yellowish-red in fall. See example at Longfellow Arboretum in Payson Park. Expensive due to slow grow rate.

Shadbush* (*Amelanchier, tree form*) **ST / LT**
Native tree with white or pink flowers in the spring. Prefers moist areas with light shade. Better suited for setback lawn planting and not dry compacted spaces like esplanades. 'Robin Hill' is single-stem variety with pink flowers. Good alternative to Callery Pear.

Hawthorn* *(Crataegus)* **ST / LT**
Flowers in June and is noted for its red berries in the winter. Our favorite variety, 'crus-galli', has glossy foliage and no thorns. 'Winter King' is better for setback lawn planting.

Flowering Crabapple (*Malus)* **ST / LT**
Many varieties with different shape, flower, foliage, and fruit. Varieties with larger fruit are not recommended as street trees.
For lawn planting: 'Adirondack', 'Spring Snow' (fruitless), 'Snowdrift', 'Donald Wyman', and 'Sargent'
For street/narrow planting: 'Pink Spire' and 'Sentinel'

Cherry* *(Prunus)* **ST / LT**
'Accolade' & 'Pink Flair' varieties produce clouds of pink flowers in early spring and can be planted as street or lawn trees. Upright forms should be used for narrow areas. 'Amur chokecherry' has pink/white flowers and interesting bark, and is only suitable for setback lawn planting.

Tree Lilac (*Syringa reticulata)* **ST / LT**
Tree form lilac with white flowers. Requires ample, non-compacted growing space. (Note: this tree is starting to be overplanted and we have some concerns about invasive tendencies).

Paperbark Maple (*Acer griseum)* **LT Only**
A beautiful small specimen tree with exfoliating bark and good fall color. Hard to find, may want to use a smaller size. Grows best in sheltered areas. See example at Longfellow Arboretum in Payson Park.

Korean Maple (*Acer sieboldianum)* **LT Only**
Small ornamental maple with good fall color, trees are often multi-stem & low branched. See examples in Longfellow Square.

Dogwood (*Cornus kousa)* **LT Only**
Kousa and the new Rutgers Hybrids, *C. kousa x C. florida*, are recommended specimen trees for lawn areas, white or pink flowers.

White Fringetree (*Chionanthus virginicus)* **LT Only**
Beautiful small tree/shrub with white flowers in June. Available only in multi-stem shrub form.

Magnolias *(Magnolia)* **LT Only**
Check with your co-op nursery for availability. Single stem types are more rare than multi-stem plants.

American Hophornbeam* (*Ostrya virginiana)* **LT Only**
Native understory tree that tolerates shade. Interesting bark.

Sourwood* (*Oxydendrum arboretum)* **LT Only**
Excellent small specimen tree with late summer bloom. Scarce, available in small sizes.

Stewartia (*Stewartia pseudocamellia* and *koreana)* **LT Only**
Flowers in July and has beautiful exfoliating bark. Longfellow Arboretum in Payson Park has a beautiful specimen planted in 1976.

Medium Trees (25 ft – 45 ft):

River Birch* (*Betula nigra)* **LT Only**
Fast growing tree with creamy white to brownish bark. Less insect & disease problems then Paper Birch. See grove of River Birch at the Longfellow Arboretum. Available in single & multi-stem. Yellow Birch are also a great option though hard to find.

Hornbeam, American or European* (*Carpinus caroliniana* and *betulus)* **ST / LT**
A nice small to medium sized, compact tree. The bark and leaves are similar to beech trees. Upright forms are useful for screening or hedges. Best planted in non-compacted lawn & esplanade areas. Avoid planting in tree wells.

Katsura* (*Cercidiphyllum japonicum)* **LT Only**
This is a unique tree with heart shaped leaves that open as reddish purple, turn green, with yellow-orange Fall color. This interesting tree can be seen at the Longfellow Arboretum in Payson Park.

American Yellowwood (*Cladrastis kentukea)* **ST / LT**
Compound leaves and white flowers blossoming bi-yearly in June. Locations Deering Oaks Park, State Street at Park Avenue on the left. Street planting only with ample room.

Turkish Filbert (*Corylus colurna*) **ST / LT**
Hardy with interesting bark. Should grow to 30'. We have been planting Filbert's for over 10 years with good results.

Honey Locust (*Gleditsia triacanthos)* **ST / LT**
Tough street tree able to grow in difficult sites. Small compound leaves cast a filtered shade. Branching habit can allow for planting closer to utility lines than most medium or large trees. 'Skyline' and 'Halka' are recommended varieties.

Tupelo* (*Nyssa sylvatica)* **ST / LT**
Native, rare shade tree that can tolerate damp sites and is slow growing. Fall foliage is bright red. Maine's largest is near O'Donal's Nurseries. Ferry Beach State Park in Saco has a beautiful stand of Tupelo as well. Not suitable for tree wells.

Korean Mountainash (*Sorbus alnifolia)* **ST / LT**
This is a beautiful tree which has a different appearance than the common European Mountainash. The Korean Mountainash has beech-like foliage and bark, white flowers in June, and pinkish-red berries in fall and winter.

Large Trees (45+ ft): should not be planted close to utility lines

Red Maple (*Acer rubrum)* **ST / LT**
Native maple with red leaves in the fall. Tolerates wet sites. More salt tolerant than sugar maples, so they are preferred for tree well and esplanade planting. We really like the upright shape cultivars.

‘Armstrong’ - upright cultivar can be seen in the Old Port area
‘Karpick’* - more open with an upright/oval form
‘Bowhall’* - more open with an upright/oval form
‘Redpointe’ - oval to round shape
‘Red Sunset’ - oval to round shape

Sugar Maple (*Acer saccharum)* **LT Only**
Native maple with yellow-orange fall foliage. Upright cultivars are available for narrow spaces. Not salt tolerant so avoid planting in tree wells and esplanades. ‘Green Mountain’ and ‘Majesty’ are recommended varieties.

Catalpa / Indian Bean Tree (*Catalpa)* **LT Only**
White flowers bloom in June and seedpods develop in the Fall. Interesting Winter form.

Beech, American or European (*Fagus grandifolia* and *sylvatica)* **LT Only**
Many leaf shapes with color ranging from green to purple. Standard beeches are best planted in lawn areas or behind sidewalks because they need plenty of room to grow. Interesting cultivars include *s. riversii* with purple leaves, and *s. asplenifolia* with fern-like leaves.

Ginkgo* (*Ginkgo biloba)* **ST / LT**
Unique with fan-shaped leaves and an interesting history. Slow growing after transplanting, but grow well in difficult sites. Cultivars: ‘Autumn Gold’* has broad, conical form with good fall color; ‘Magyar’ is an upright form. Plant non-fruiting.

Tulip Tree (*Liriodendron tulipifera)* **ST / LT**
Tulip shaped leaves with an interesting flower blooming at the top of the tree. Large, fast growing tree that needs room. Maine’s largest tulip tree is on Munjoy Hill. Upright cultivar available.

Cucumber Magnolia (*Magnolia acuminata)* **LT Only**
An interesting, large shade tree that does not have the showy spring flowers of other Magnolias. See a beautiful specimen at Brackett & Walker St.

Oak (*Quercus)* **ST / LT**
There are many varieties of native oak including the Red Oak, Pin Oak, Chestnut Oak, White Oak, and Swamp White Oak*. The Swamp White Oak has beautiful glossy foliage, exfoliating bark and transplants well. Consider upright varieties for small, narrow spaces. Only plant as street trees with ample space.

Elm, American or Chinese (*Ulmus americana* and *parvifolia)* **ST / LT**
Dutch Elm Disease (DED) has greatly impacted the population. New DED-resistant varieties have shown promise; ‘Patriot’, ‘Princeton’, ‘Pioneer’, and ‘Lacebark’. Limited availability. Different sizes and shapes. Fast growing.

Zelkova *(Zelkova)* **ST / LT**
Was promoted as an American Elm replacement. Vase-shaped but smaller than elms. Difficult branching angles can cause some problems later on if not pruned correctly. Many beautiful specimens exist in the West End near Danforth Street.

Conifers: planted as setback **Lawn Trees only**

Please note, many evergreens can quickly outgrow a small space. Review growth rates and mature sizes. Nurseries now offer many compact selections.

Pine (*Pinus)* **LT Only**

Swiss Stone Pine* (*P. cembra)*, small, 15-20', slow growing, with soft blue green needles. See nice specimen at the Shoreway Arboretum in South Portland.
'Vanderwolf's Pyramid' *Pine** *(P. flexilis)*, upright with soft blue-green needles.

Spruce (*Picea)* **LT Only**

Serbian Spruce* (narrow upright form), pendulous branching.
White Spruce is a good native option.
Blue Spruce are not recommended due to insect and disease problems.

Fir *(Abies)* **LT Only**

Moderate growth rate and large mature size. Firs have soft needles. Concolor Fir has blueish needles. Balsam and Fraser Fir are used as Christmas trees.

Deciduous Conifers LT Only

Evergreens that lose needles in fall. Offer the shape and screening of an evergreen while allowing sunlight in winter months. Great for lawn areas, naturalized damp sites, or as specimens. Great fall color and texture.

Dawn Redwood* (*Metasequoia)*
Eastern Larch *(Larix laricina)*
Japanese Larch *(Larix kaempferi)*

Fruit & Nut Trees: planted as setback **Lawn Trees only**

Maximum size 2" caliper / 6 ft. height / #7 Pot

There are many fruit and nut trees available at our Co-op nurseries. *Malus* 'Liberty' and 'Freedom' are two apple varieties with good pest resistance.

Citations

[i] K.L. Wolf, Business District Streetscapes, Trees and Consumer Response. *Journal of Forestry*
[ii] Swift et al, Residential Street Typology and Injury Accident Frequency. 2006
[iii] Figures 8 & 9 illustrate data only for the Portland Peninsula. Data totals for the entire city also include data from the NW region of Portland:

	Peninsula		***NW***		***Total***	
Benefit	value	amt (lb)	value	amt (lb)	**value**	**amt (lb)**
CO	$145.20	218.54	$1,941.75	2,920.00	**$2,086.95**	**3,138.54**
NO2	$259.53	2,000.00	$3,470.69	26,800.00	**$3,730.22**	**28,800.00**
O3	$12,455.99	12,280.00	$166,573.88	164,200.00	**$179,029.87**	**176,480.00**
PM2.5	$32,681.79	725.70	$437,053.32	9,700.00	**$469,735.11**	**10,425.70**
SO2	$34.39	687.52	$459.84	9,200.00	**$494.23**	**9,887.52**
PM10	$13,085.95	4,200.00	$175,011.64	56,040.00	**$188,097.59**	**60,240.00**
CO2Seq	$31,215.85	1,770,840.00	$417.449.29	23,681,460.00	**$31,215.85**	**25,452,300.00**
CO2Store*	$1,085,198.56	61,618,880.00	$14,525,724.45	824,028,900.00	**$15,610,923.01**	**885,647,780.00**
					$874,389.82	**25,741,271.76**

[iv] To find a licensed arborist, visit: https://www.maine.gov/dacf/php/arborist/ArboristList.shtml
[v] To find a licensed pesticide applicator, visit: https://www.maine.gov/dacf/php/pesticides/licensed-commericial-applicators.shtml
[vi] D'Amato, 2021
[vii] F. Santamour, Trees For Urban Planting: Diversity, Uniformity, And Common Sense. 1999
[viii] For more information on Community Wood Banks, visit: https://digitalcommons.library.umaine.edu/sfr_studentpub/1/
[ix] https://urbanwoodnetwork.org/