Ash Tree Inventory, Condition Assessment, & Management Plan

Final Report

CNUC

Prepared for the

City of River Falls, Wisconsin

City of River Falls

July 2023

Acknowledgements

We thank several staff associated with the City of River Falls for their assistance with completing the project. Mike Noreen provided technical oversight and assistance with forestry questions. Jamie Neils was vital for support with the Geographical Information System and development of an ash tree specific data system for field work. Finally, we appreciate the City of River Falls Tree Advisory Committee for their questions and suggestions for implementation of this work.

Project Staff

Paola Nansel | Inventory Specialist

Sarah Lilley | Project Manager

Richard Hauer, Ph.D. | Subject Matter Expert

Paola Nansel
Tree Inventory

Sarah Lilley
Project Management

Richard Hauer
Subject Matter Expert

City of River Falls Urban Forestry Mission Statement

The mission of the City's Urban Forestry Program is to preserve and perpetuate one of the community's most valuable natural resources and assets, its municipal forest of trees on public property. This includes trees on boulevards, parks, and other City properties.

Executive Summary

Emerald ash borer (EAB) is a beetle pest introduced from Asia with the ability to cause nearly 100% mortality of American ash trees. Ash species are commonly used as street trees due to their appealing form and deciduous nature, and make up approximately 25% of the tree population in the City of River Falls. EAB was first identified in River Falls in 2019, and the City has been awarded a grant from the Wisconsin Department of Natural Resources to identify, treat, and retain approximately half of the public ash trees, and remove those ash which are unlikely to flourish even if treated.

CNUC was contracted to complete an assessment of the City's ash trees, evaluating their level of EAB infestation, overall health condition, and characterization of their growing sites. Following data collection, CNUC analyzed the information to prioritize ash trees for removal or retention and treatment.

A total 1,451 public ash trees were assessed, and a three-tiered approach identified ash trees to retain or remove based on field observations. In the first evaluation, 151 ash trees not likely to survive as evidenced by advanced EAB infestation, a condition rating of <50%, and exhibiting a structural risk were recommended for removal. In the second evaluation of the data, a point-based model was employed which considered EAB infestation levels, overall tree conditions, and site ratings, resulting in an additional 479 recommended removals. A tertiary evaluation primarily used site conditions to select 100 trees for removal which would be unable to thrive in their planted location. In total, 730 trees were identified as being recommended for removal, with 721 recommended for retention and treatment.

Treated (above) versus untreated (below) ash (*Fraxinus*) trees, summer 2023.

The City of River Falls urban forest is at a transition point with the ash tree population. A substantial number of high value ash trees exist with retention recommended. Ash tree treatments in the N. Wasson Lane and Hoffman Park area is proposed as a starting point due to preserve tree canopy. Details on trees to retain and remove were collected and presented through the existing GIS tree inventory along with an Excel file database. An initial two-year EAB treatment cycle is recommended, after which transitioning to a three-year treatment cycle is proposed.

Introduction

Vibrant communities include many elements that provide a sense of place for people to live. Trees within a community deliver one such important reason that makes a healthier community today and in the future. Trees also provide the long-term connection between generations of people that visit and live within a community. To sustain this important tree infrastructure, the City of River Falls has an active Urban Forestry program that maintains an approximate 8000 public tree population. These trees occur within public boulevards, in parks, and other public green space areas. Perpetuating the community tree population is a vital principle that guides the forestry program.

The community forestry program has a long-term commitment to fostering a healthy and maintained tree population. This effort is recognized as a Tree City USA for over 20 years. Emerald ash borer (*Agrilus planipennis*), however, is a challenge currently facing the community tree population. The City of River Falls is entering year four after the insect was first identified on July 1st, 2019 (City of River Falls, 2019). Emerald ash borer (EAB) left to its own course results in a near 100% tree mortality within approximately one to two decades after introduction. Approximately 5 to 7 years after being identified in a location, tree mortality becomes exponential with ever-increasing tree decline and mortality.

In reaction to the likely outcome due to EAB, a response plan was developed and posed three elements as solutions to the insect infestation and eminent loss of a significant portion of the tree population (City of River Falls, 2019). These elements provided a means to attack the pest early on. The response plan proposed a means to confront EAB on the community's terms, rather than doing nothing and letting the insect gain the advantage (Herms and McCullough 2014, Hauer and Peterson 2017, Hauer et al. 2020).

Element One addressed updating a tree inventory. This task was completed in 2019. One significant finding was approximately 2000 public ash trees exist, comprising 25% of the total 8000 public trees. The 2023 response that is a basis for this plan will build upon and update the past inventory.

Element Two designated a survey and detection strategy which resulted in the July 2019 discovery of EAB near Dick's Fresh Market. This was the first positive identification in Pierce County, Wisconsin. The surveying for EAB has continued to the present. Findings in this report further provide the current status of the insect within River Falls.

Element Three introduced an Ash Management Policy which provided ten issues to address. In brief, the policy addressed trees on public and private lands, trees in maintained and natural areas, tree removal and replacement options, communication and resources, and EAB treatment options. This EAB response and management plan specified assessing ash trees for potential retention and identifying trees for which removal is likely the better option. This involved collecting tree and site information and developing a method to identify high quality ash trees for proactive treatment against EAB, and also identify low quality ash trees for which removal is likely a better option.

Ash Management Policy

1) Proactive Removal
2) Disposal
3) Historic/Significant trees
4) EAB Treatment Options
5) Woodlot Management
6) Private Property Trees
7) Tree Replacement
8) Regulations
9) Communications
10) Resources

Four objectives were developed to complete the overall goal to determine tree suitability for protective treatment against EAB. These objectives included:

1) Implement project with kickoff meetings with the community tree board and city staff in the field to explain project and calibrate the inventory methods.
2) Conduct a field assessment of approximately 1,400 ash trees to determine the EAB infestation level and overall condition rating as customized to the needs of the City and recorded in the City's ArcGIS software.
3) Develop and submit a final report with recommendations on how to manage the City's ash tree population.
4) Create an Excel spreadsheet with individual ash tree maintenance recommendations.

This report first describes the methods developed to assess the ash tree population. Next, a summary of findings gives the current state of the ash tree population and suitability to retain ash trees through proactive treatment. Finally, management recommendations are provided to assist the city with implementing their EAB response.

Methods

A systematic approach to rate ash trees for management action used an existing tree inventory that was supplemented with a field-based tree inventory. An overall project goal was to identify ~ 700 trees as high value ash trees for retention and treatment. An equal number of trees were identified as lower quality trees for proactive removal. A preliminary assessment found this approach to balance retention of high value ash trees

and associated tree canopy, against trees in a lower state where tree removal is the better option. The total number of trees to retain was also based on available resources to maintain the tree population.

A leaf-off field assessment of trees occurred between April 27 and May 10, 2023. While a leaf-on assessment would allow for identification of tree thinning, the leaf-off assessment was vital to complete the assessment prior to an early June start of tree treatments. A 60-tree leaf-on sample occurred on July 11, 2023 with findings validating the leaf-off recommendations. Collected data was integrated into the existing GIS tree inventory (Table 1).

Table 1. Data collected to assess the ash tree population and associated site conditions.

Data Variable	Data Unit
Stem Diameter (DBH @ 4.5')	Inch
EAB Infestation Rating[1]	Category
Canopy dieback	Yes/No
Epicormic sprouting	Yes/No
D-shaped exit holes	Yes/No
Bark splitting	Yes/No
Woodpecker damage	Yes/No
Tree Condition Rating[2]	Category
Cankers	Yes/No
Cavities	Yes/No
Codominant stems	Yes/No
Fungal fruiting bodies	Yes/No
Stem girdling roots	Yes/No
Hangers (branches)	Yes/No
Hardscape damage	Yes/No
Improper pruning	Yes/No
Leaning	Yes/No
Mechanical damage	Yes/No
Poor root structure	Yes/No
Poor structure	Yes/No
Rating comments	Text
Site Conditions[3]	Category
Comments (as needed)	Text
Photos (as needed)	Image

Notes: [1]Infestation ranking – None, Minor, Moderate, Major, Advanced | [2]Tree condition – Evaluated from 0 to 100% taken in 5% increments | [3]Site conditions – Poor, Fair, Good, Excellent

Emerald Ash Borer Assessment

Identifying if a tree currently is infested with EAB and the severity level was vital to ranking trees. The EAB infestation rating used visual observation for signs and symptoms (Table 2, Appendix A). Evidence of D-shaped exit holes and/or serpentinite galleries were considered a sign of EAB activity (Table 3). A sign is defined as physical evidence of the insect. In contrast, a symptom is defined as a tree's response to an insect or disease. In the case of EAB, woodpecker activity results in the symptoms of bark flecking or blonding. This symptom is visually easy to see with the contrast of a lighter color inner bark, resulting from bird pecking and the outer bark layer falling off the tree. Bark splitting is another symptom. This results from bark drying as a response to damage to the wood surface from EAB

Table 2. Survey and detection through emerald ash borer signs and symptoms.

1. Delayed leaf-out in spring (symptom)
2. Thinning canopy or crown (symptom)
3. Branch die back from top of tree (symptom)
4. S-shaped galleries from larval tunneling under the bark (sign)
5. Woodpecker bark flecking damage (symptom)
6. Epicormic shoots from base of tree or water sprouts on branches (symptoms)
7. Bark splits (symptom)
8. D-shaped exit holes first spotted in upper branches (sign)

larva, resulting in the bark to crack. Canopy dieback can result from a variety of causes, with EAB being one and damage to the water transporting tissue. This results in a lack of water moving into the canopy and leaf and twig death. Finally, epicormic sprouting is a tree's response to damaged tissue and an attempt to resprout twigs and leaves in response to wood and bark tissue damage and the loss of existing branches, twigs, and associated foliage. Collectively, these signs and symptoms were used to rate trees for their level of EAB infestation.

Trees were ranked into one of five states of EAB infestation. These were None, Minor, Moderate, Major, and Advanced. None is self-evident with no signs or symptoms of EAB observed. That does not mean EAB is not present in a tree, rather, no physical evidence or outward tree response or bird activity was observed. If a tree did have EAB, at this stage the activity is limited.

Ranking ash trees from minor to advanced took into consideration how much of the tree was infested (Table 3). For example, a minor infestation was limited to the upper canopy with less than one-third of the tree exhibiting symptoms. In contrast, an advanced EAB infestation level was considered for ash trees with at least two-thirds of the canopy showing symptoms and/or a tree visually showing signs (e.g., D-shaped exit holes or serpentine galleries within eye level from the ground).

Tree Retention & Removal Model

Each tree was ranked for potential inclusion into either a retention or removal category. The method to identify trees for potential removal used three iterative approaches (Appendix B). The initial *Primary Approach* used an advanced state of EAB infestation, trees in fair or lower condition, or a structural stability risk to determine trees likely to die or be removed within five to ten years whether treated or not. Next, the *Secondary Approac*h used a weighted point system to empirically rank trees from 0 to 100. This point-based approach weighted state of EAB infestation at 60%, tree condition at 20%, and site condition at 20%. Trees with the highest point total (≥ 60, 0 to 100 scale) were further considered for retention. The final *Tertiary Approach* identified site limitations such as overhead utility lines, a growing space site limitation, small tree size, root structural issues, or hardscape damage as reasons to potentially remove ash trees. Finally, the combined methodology that was used for each of the three approaches are further detailed in Appendix B.

Table 3. Procedural definitions used to rank the state of infestation of emerald ash borer.

Ranking Criteria	Definition
Minor	One or more symptoms observed in the upper canopy limited to less than one-third of branches of the main stem
Moderate	One or more symptoms observed in the upper canopy limited to one-third to less than one-half of branches of the main stem
Major	One or more symptoms observed in the upper canopy limited to one-half to less than two-thirds of branches of the main stem
Advanced	One or more symptoms observed in the upper canopy with two-thirds or more of branches of the main stem and/or a tree visually showing signs (e.g., D-shaped exit holes or serpentine galleries within eye level from the ground)

Ash Tree Population Assessment

Managing a tree population considers several factors to support decision making. These factors include but are not limited to the tree's size, health, structural stability, and location. Site factors such as limited growing space, overhead utilities, restricting visibility at an intersection, and damage to other infrastructure also helps to inform management. The cost of management relative to tree benefits is an additional important consideration. And certainly, any evidence of EAB and the severity would inform management. Within this section we report on evidence of EAB symptoms, the size and condition of ash trees, condition of the planting site, and structural issues.

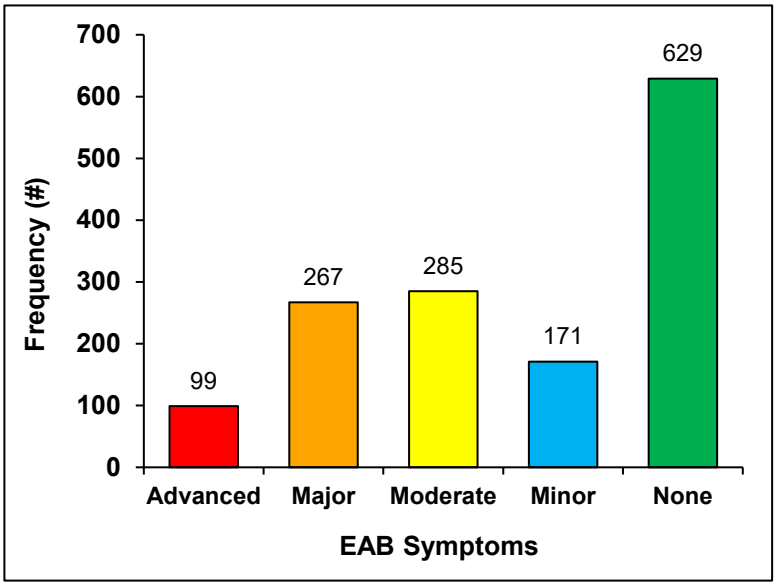

Figure 1. State of emerald ash borer identified on ash trees (*Fraxinus* spp.) in River Falls, WI, in May 2023. (n=1451)

Evidence of EAB

Ash trees in River Falls exhibited signs and symptoms of EAB ranging from advanced symptoms (99 trees, 7%) to none observed (629 trees, 43.3%) in May 2023 (Figure 1). Minor to major symptoms were observed in 50% (723 trees) of the population. Thus, 822 (56.7%) trees were identified with symptoms consistent with EAB infestation ranging from a minor to advanced condition (Figure 1). Few trees (38, 2.6%) were exhibiting the D-shaped exist hole sign at the ground level. The use of binoculars to observe a D-shaped exit hole was not done, rather, other canopy level symptoms were used to determine EAB presence. Canopy dieback (31 trees, 2.1%) was an uncommon symptom. Bark flecking, bark splitting, and/or epicormic sprouting were commonly observed on slightly more than half of the trees (Figure 2).

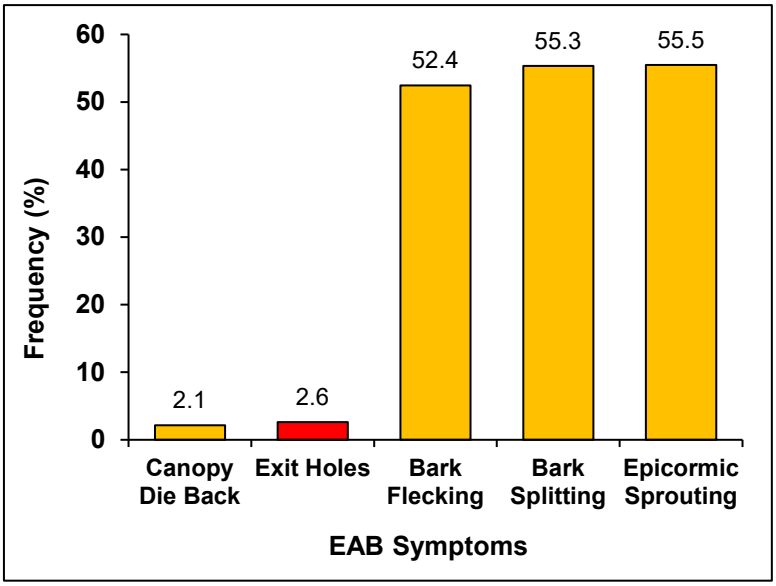

Figure 2. Emerald ash borer symptoms identified on ash trees (*Fraxinus* spp.) in River Falls, WI, in May 2023. Rankings were based on the percentage of trees exhibiting off-leaf symptoms (e.g., exit hole, flecking from woodpeckers, bark cracking) and percent of trees exhibiting symptoms ranging from advanced (~2/3+), major (~1/2), moderate (~1/3), minor (~<1/3) and none (none observed). (n=1451)

Overall, a 94% accuracy comparison occurred between the spring 2023 and pre-2023 assessments for EAB. A total 332 (22.9%) trees were identified as infested with EAB pre-spring 2023 (Table 4). Of these, 245 (73.8%) were identified as infested and verified in 2023.

Table 4. Comparison of emerald ash borer observations in 2023 and pre-2023 records.

EAB State	Results 2023	No EAB Pre-2023	Yes EAB Pre-2023
Advanced	99	66	33
Major	267	167	100
Moderate	285	209	76
Minor	171	135	36
None	629	542	87
Totals	**1451**	**1119**	**332**

Another 87 (26.2%) ash trees were reported as EAB infested in 2021 and 2022, but were not field verified in 2023 as evaluated with leaf-off field signs/symptoms. Of these 87 trees, 31 were listed as treated in 2021 or 2022. Thus, it is possible that these treated trees have recovered and are no longer exhibiting signs or symptoms of infestation.

In 2023, 822 (56.7%) trees were identified as have symptoms ranging from advanced to minor (Figure 1, Table 4). In contrast, 629 (43.3%) trees had no visible signs/symptoms of a potential EAB infestation in 2023.

Tree and Site Condition

The health of ash trees was inferred through visual evaluation to estimate tree condition based on the external condition of the tree on parts from the root system to twigs and buds (Figure 3). Overall, a 64.6% tree condition was observed which is lower than a benchmark 75% rating for a typical managed tree population without limiting factors such as EAB. The tree condition rating suggests an early-stage reduction due to effects of EAB. This is consistent with a year four post-EAB positive identification and a 60.4% condition rating in Stevens Point WI (Hauer 2022). The majority (85%) of ash trees were still in a good (81.3%) or excellent (4.6%) condition.

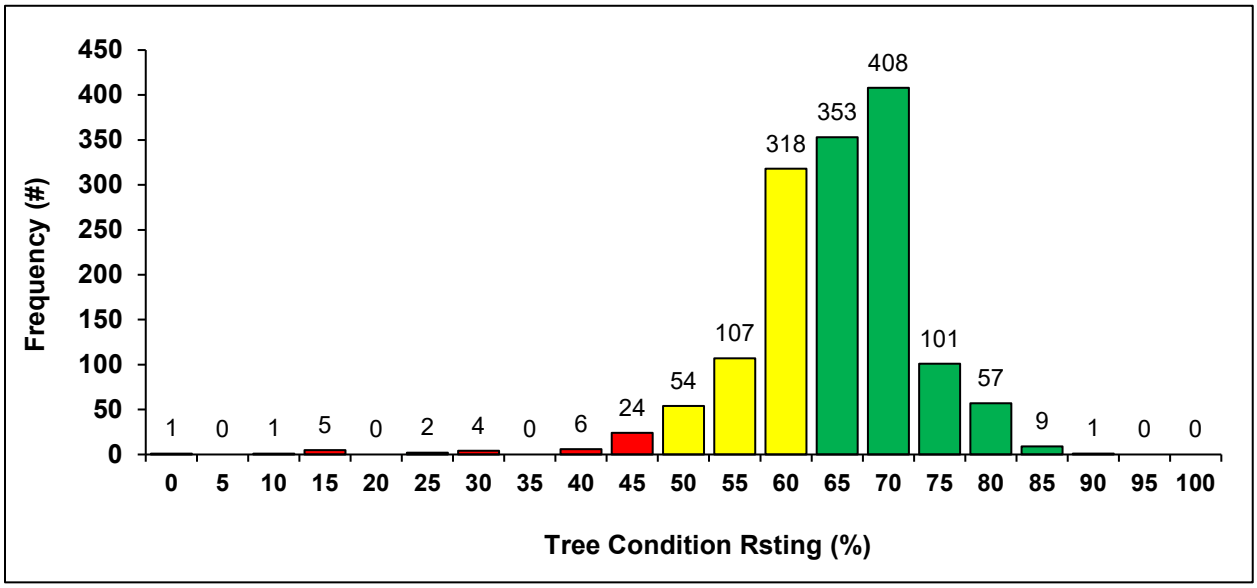

Figure 3. Tree condition rating which depicts the overall health of ash trees (*Fraxinus* spp.) in River Falls, WI, in May 2023. Ratings based on the Council of Tree and Landscape Appraisers methods. (n=1451)

Ash trees ranged in a trunk diameter size from small (<7 inches, 40 trees) to large (>33 inches, 36 trees). Over 2/3rds of the trees exceeded 12 inches in diameter. Site conditions were assessed to depict the growing conditions of ash trees (Figure 4a). Mean diameter was estimated at 16.7 inches based on frequency in a diameter category.

Over 60% of trees were growing in either a good (37.6%) or excellent (25.4%) site (Figure 4b). Only 3.1% of trees were in a poor growing location. The good and excellent planting locations provide a suitable distance to allow structural root development to occur, contrasted to poor and fair sites that would limit root development and potentially result in damage to curbs and sidewalks.

Tree structural conditions were recorded as factors that could affect tree longevity (Table 5). In addition, tree maintenance issues such as pruning, hanging branches (result of recent ice storm) and hardscape damage were recorded. Overall, 404 trees (27.8%) were recorded as having one or

Table 5. Tree structural factors identified on the ash tree (*Fraxinus* spp.) population in River Falls, WI, in May 2023. (n=1451)

Structural Factors	Frequency (#)	Frequency (%)
Cankers	127	8.8
Cavities	109	7.5
Codominant Stems	130	9.0
Fungal Fruiting Bodies	1	0.1
Stem Girdling Roots	20	1.4
Hangers	32	2.2
Hardscape Damage	3	0.2
Improper Pruning	22	1.5
Leaning	71	4.9
Mechanical Damage	21	1.4
Poor Root Structure	5	0.3
Poor Structure	46	3.2

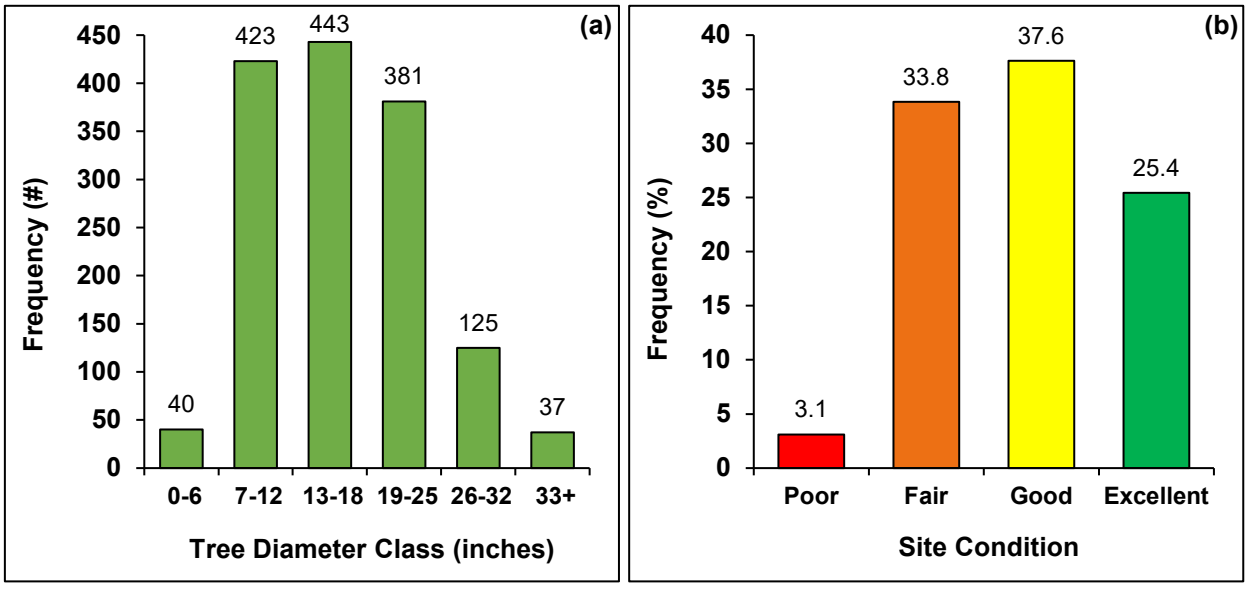

Figure 4. Tree trunk diameter classes (a) and tree planting site condition (b) of ash trees (*Fraxinus* spp.) in River Falls, WI, in May 2023. Tree Diameter measured at 4.5 feet above ground and Site Condition rankings range from poor to excellent relative for restrictions for root development. (n=1451)

more tree structural issues. Thus, over 70% were observed to lack a significant factor that would affect the potential to live for several decades. A caveat is each tree likely has some minor factors (e.g., small dead twigs, compartmentalized former wounds, small wounds), but these were not recorded due to their insignificance for tree longevity. As an example, stem girdling roots were only noted if the stem circumference had 30% or more with a root causing compression (Hauer and Johnson 2021). Below this threshold, long-term health impacts would be minimal during normal growing conditions.

Recommendations

The outcome from a field assessment of ash trees was successfully completed. A total 721 trees were identified as high value ash trees with a recommendation to retain for treatment. These trees have a high condition rating, minor or no evidence of EAB was found, and the trees have a projected long-term survival if treated (Figure 5). An analysis with the EAB-Plans MKE software found the treated ash tree population would return an approximate 7 to 1 benefit to cost (Hauer et al. 2012, Vannatta et al. 2012). The benefits that a tree provides result from ecosystem benefits and the contribution to property values of adjoining landowners (Vannatta et al., 2012a, Vannatta et al., 2012b, Hauer et al 2012, Hauer et al. 2020).

A similar 730 ash trees were identified as candidates for preemptive removal. These trees were identified to have moderate to advanced stages of EAB symptoms, were rated lower in condition, or had site issues. In addition, some of these trees had structural issues with tree failure at the trunk likely within the next 5 to 10 years if significant loading from wind, snow, or ice occurs (Figure 6).

Figure 6. Example crack at the trunk union with the defect continuing to the ground.

An excel computer file was developed to model tree retention and removal recommendations. Trees are listed as recommended for removal within all three

Figure 5. Treating ash trees with greater than 40-50 percent or more canopy dieback is not recommended. (photos adapted from Michigan State University and the USDA Forest Service)

model runs through the primary, secondary, and tertiary methods explained earlier. Potential issues were also identified. These include trees recorded for removal that were recorded as treated in the database. It is recommended to communicate with the property owner prior to tree removal to explain the situation. Based on the field assessment in spring 2023, trees treated in the past had some factor that suggest removal is a better option. In addition, as mentioned earlier, there were a few cases of trees identified as having EAB that were not verified in the spring 2023 assessment.

It is advised to complete a follow-up assessment to verify the condition of these trees. Another potential issue is it is likely that some ash trees exist on public property, but were not assessed in spring 2023. During the spring 2023 assessment, a few trees recorded as ash trees were identified as a non-ash tree species. In addition, a few additional ash trees were found during the field assessment and added to the tree assessment database. However, based on the field assessment, these errors would be expected and did not appear to exceed published standards for tree inventory precision and accuracy.

Prior to treating a tree, it is recommended to complete a visual assessment of the tree canopy. If the tree shows more than 30 to 40% canopy decline, treatment is less likely to be successful (Figure 5). Appendix C provides further guidance for evaluating canopy thinning within the ash tree canopy (Smitley et al., 2008). Treatment of ash trees should follow label rates for chemicals used and also follow manufacture recommendations for the equipment used to treat ash trees against EAB (Herms et al. 2019, Hauer et al. 2022).

A proposed treatment with emamectin benzoate is the ideal treatment for the ash tree population. A two-year treatment cycle is an effective treatment (Herms et al. 2019). However, recent data found a three-year cycle is also effective. The caveat for the three-year cycle is treated trees should be treated in the month of June of year three. An initial two-year treatment cycle is recommended with shifting to a three-year cycle proposed. Ideally, treatment as early as possible in the growing season for most effective for chemical uptake and distribution in the tree. In addition, adult EAB emerge from ash trees in mid-May to early June (Figure 7). Treated trees will also have the effect with killing adult EAB that feed on foliage during the summer. However, treatment that occurs later in summer and early fall prior to leaf drop is also effective.

Figure 7. Emergence of emerald ash borer occurs in late May to early June between 450 and 500 growing degree days. This happens around the same time black locust trees are in bloom. (Debbie Miller, USDA Forest Service, Bugwood.org).

References

City of River Falls. (2019). City of River Falls Emerald Ash Borer Community Preparedness Plan Updated 2019. Accessed May20, 2023. https://www.rfcity.org/DocumentCenter/View/3761/City-of-River-Falls--Emerald-Ash-Borer-Plan

City of River Falls. (Undated). Urban Forestry. Accessed May 20, 2023 https://www.rfcity.org/243/Urban-Forestry

Hauer, R.J. (2012). Emerald Ash Borer Economics, Management Approaches, and Decision Making. Tree Care Industry. August 2012. 23(8): 14–17

Hauer, R.J., J.J. Ball, and E. North. (2022). Observation of External Wounding on Green Ash (Fraxinus pennsylvanica Marshall) Trees Associated with Tree Injection Systems. Forests 13(11): 1802. https://doi.org/10.3390/f13111802

Hauer, R.J., I.S. Hanou, D. Sivyer. (2020a). Planning for active management of future invasive pests affecting urban forests: the ecological and economic effects of varying Dutch elm disease management practices for street trees in Milwaukee, WI USA. Urban Ecosystems. 23:1005 – 1022. https://doi.org/10.1007/s11252-020-00976-6

Hauer, R.J. and G.R. Johnson. (2021). Effects of Structural Root Depth on The Formation of Stem Encircling Roots and Stem Girdling Roots: Implications on Tree Condition. Urban Forestry & Urban Greening. 60 (2021) 127031. https://doi.org/10.1016/j.ufug.2021.127031

Hauer, R.J. and W. Peterson. (2017). Effects of emerald ash borer on municipal forestry budgets. landscape and urban planning. 157: 98–105. DOI 10.1016/j.landurbplan.2016.05.023

Herms, D.A., and D.G. McCullough. (2014). Emerald ash borer invasion of North America: history, biology, ecology, impacts, and management. Annual Review of Entomology, 59(1), 13–30

Herms D.A., D.G. McCullough C.S. Clifford, D.R. Smitley, F.D. Miller, W. Cranshaw. (2019). Insecticide options for protecting ash trees from emerald ash borer. North Central IPM Center Bulletin. 3rd Edition. 16 pp.

Smitley D. T. Davis, and F. Rebek. (2008). Progression of ash canopy thinning and dieback outward from the initial infestation of emerald ash borer (Coleoptera: Buprestidae) in southeastern Michigan. Journal of Economic Entomology. https://doi.org/10.1093/jee/101.5.1643

VanNatta, A. and R. Hauer. (2012a). Money and Ash Tree Management: Prioritizing Decisions in the Face of EAB. Arborist News. 21(4):42–44

VanNatta, A.R., R.H. Hauer, N.M. Schuettpelz. (2012b). Economic Analysis of Emerald Ash Borer (Coleoptera: Buprestidae) Management Options. Journal of Economic Entomology. 105(1):196–206

Appendix A – Signs and Symptoms Used to Identify Emerald Ash Borer

Signs of Emerald Ash Borer

Signs of emerald ash borer (EAB) are physical evidence of the insect. The adult beetles (Figure A-1) emerge in late May to early June, between 450 and 500 growing degree days. Emergence of EAB also coincides with the flowering of black locust trees. It is more likely and easier to observe the signs of EAB exit holes which are approximately 1/8 inch in width. The serpentine galleries are also a sign of the insect and observed after bark falls of the tree or by removing the bark (Figure A-3). Bird flecking is another potential sign resulting in a "blonding" bark appearance (Figure A-4 and Figure A-5)

Figure A-1. Adult emerald ash borer (Agrilus planipennis) feeding on a leaf. (Photo credit, Leah Bauer, USDA Forest Service Northern Research Station, Bugwood.org)

Figure A-2. Green ash tree (*Fraxinus pennsylvanica*) showing D-shaped exit hole. (Photo credit, Richard Hauer)

Figure A-3. Green ash tree (*Fraxinus pennsylvanica*) showing serpentine larval galleries. (Photo credit, Richard Hauer)

Figure A-4. Another potential sign occurs from birds pecking at ash trees (*Fraxinus spp.*) resulting in the exterior and darker bark to be pecked off and exposing lighter inner bark. (Photo credits, Left image Bill McNee WIDNR https://forestrynews.blogs.govdelivery.com/2019/04/01/treat-your-valuable-ash-trees-against-eab/ and Right image Steven Katovich, USDA- Forest Service, Bugwood.org

Figure A-5. Woodpeckers may also leave a sign of EAB top image. Example of bark flecking on ash tree Spring 2023 in River Falls right image (Photo credits, Right Image Richard Hauer and Top image, Bill McNee WIDNR, https://dnr.wisconsin.gov/newsroom/release/70191)

Symptoms of Emerald Ash Borer

Symptoms of emerald ash borer (EAB) are the trees response to the insect. In addition, a symptom of EAB often occurs through the activity of birds in search of larva. While many insects and diseases may result in an trees expression to the issue, the field symptoms are an important means to detect the presence of the insect. Figure A-6 shows an example of epicormic sprouting on the tree trunk. Epicormic sprouting may also occur on branches. This is the tree's attempt to recovery by growing new twigs and foliage. Unfortunately, this is a short-lived attempt for survival. Bark cracking occurs because of cambial damage by EAB larva. The resulting damage results in the loss of vascular tissue transporting water and the resulting desiccation and eventual cracking of bark (Figure A-7). An eventual outcome of EAB is the dieback of branches and associated loss of leaves. This double outcome is the start of the decline and eventual death in 3 to 5 years (Figure A-8). While this outcome is imminent for untreated ash, ash treated following label rates is very effective in preventing the death of ash trees and the preservation of tree canopy.

Figure A-6. Epicormic sprouting on an ash tree stem. (Photo credit, Left image, Joseph OBrien, USDA Forest Service, Bugwood.org and Top image James W. Smith, USDA APHIS PPQ, Bugwood.org James W. Smith, USDA APHIS PPQ, Bugwood.org

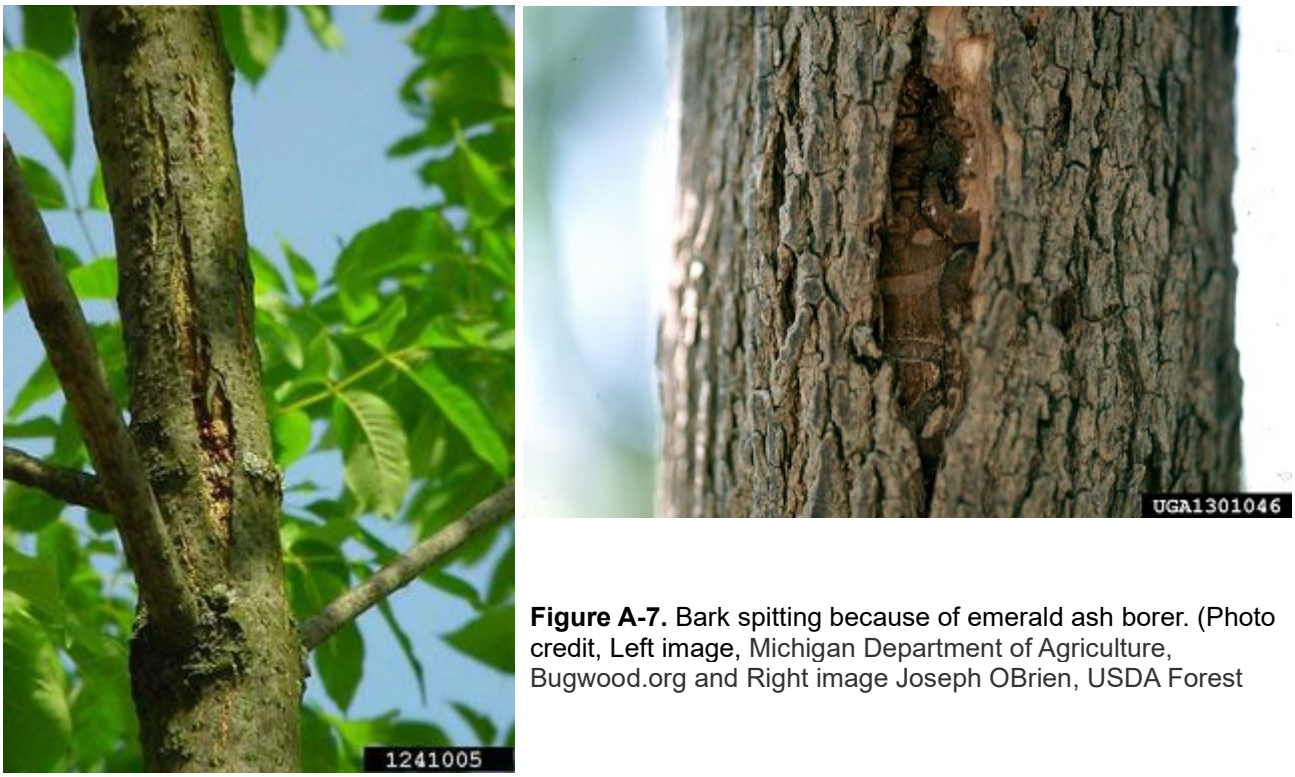

Figure A-7. Bark spitting because of emerald ash borer. (Photo credit, Left image, Michigan Department of Agriculture, Bugwood.org and Right image Joseph OBrien, USDA Forest

Figure A-8. Treated versus untreated ash tree. Tree on the left is showing an example of canopy dieback, compared to the treated tree with a healthy appearing canopy. Photo credit Ryan Armbrust, Kansas Forest Service, Bugwood.org, Photo accession # 5549968

Appendix B – River Falls Ash Tree Retention and Removal Model

Table B-1 displays the method to select ash trees for retention and removal. The three-tiered approach resulted in 730 trees proposed for removal.

Table B-1. Criteria used to select potential ash trees for removal based lower value interpreted as likely to be removed within five to ten years regardless of emerald ash borer.

Primary Approach Criteria (EAB Advanced or Low Condition) = 151 Trees Removed

Remove if Trees Not Likely to Survive or be Removed Within Five Years

EAB = Advanced (Trees likely not to survive if treated)

Tree Condition < 50% (Trees likely to be removed within five years)

Structural Risk (Vertical crack at codominant branch attachment to base of tree)

Secondary Approach Criteria (Point Based Model) = 479 Trees Removed

Remove if Point Score ≤ 60

Point Score = EAB Infestation Rating + Tree Condition Rating + Site Condition Rating

EAB Infestation Rating (Weight = 60%)

Categories: None = 60, Minor = 45 | Moderate = 30 | Major =15 | Advanced = 0

Tree Condition Rating (Weight=20%)

Condition: 80 to 100 = 20 | 60 to 79 = 15 | 40 to 59 = 10 | 20 to 39 = 5 | 0 to 19 = 0

Site Conditions Rating (Weight = 20%)

Categories: Excellent = 20 | Good = 14 | Fair = 7 | Poor = 0

Tertiary Approach Criteria (Utilities, Site, and Tree Size) = 100 Trees Removed

Remove if Limiting Sites Factors, Tree Health, or Hardscape Damage

Under Utility Lines = Yes

Site Condition = Poor

Small Tree < 7-inch Trunk Diameter

Structural Factors = Yes (Poor root structure, stem girdling roots)

Hardscape Damage = Yes (Sidewalk lifting or curb damage likely near-term repairs)

Appendix C – Tree Canopy Thinning Assessment Method (Adapted from Smitley et al., 2008)

0 %

10 %

20 %

30 %

40 %

50 %

60 %

70 %

80 %

90 %

100 %