Surveying Oregon Ash Habitat in Preparation for the Emerald Ash Borer:

By the Oregon Ash Team, Following City of Eugene Protocol

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ABSTRACT

Since the first detection of Emerald Ash Borer (*Agrilus planipennis*) (EAB) in Michigan in 2002, the beetle has caused widespread ash tree (*Fraxinus spp.*) mortality by feeding on the trees' circulatory tissue, ultimately killing the tree from the ground up. Endemic to the West Coast, Oregon ash trees (*Fraxinus latifolia*) are an important contributor to streambanks and aquatic ecosystems. These trees filter nutrients and pollutants, while providing shade that regulates water temperatures in the bottomland habitat. After EAB was detected in Forest Grove, Oregon, in 2022, the City of Eugene is concerned that a quick spread, often aided by anthropogenic means, may decimate populations of Oregon ash within city parks and natural areas. This project aims to document and establish baseline data on vegetation conditions within Oregon ash stands in Eugene, Oregon, while helping standardize proper protocol for future efforts. The data will help inform management decisions aimed at mitigating environmental damage and slowing the spread of the Emerald Ash Borer beetle.

INTRODUCTION

The Oregon ash tree (*Fraxinus latifolia*) is native to the Pacific Northwest region and is abundant in riparian and seasonally flooded bottomland ecosystems. It is commonly found in poorly drained soils, thrives in wetlands and floodplains, and is frequently planted near wetland trail systems (Frenkel & Heinitz, 1987; Sun et al., 2024). No other native tree species possesses the same resilience towards significant exposure to standing water and the ability to thrive in clay soil like Oregon ash. Oregon ash coexists with bigleaf maple (*Acer macrophyllum)*, red alder (*Alnus rubra*), and black cottonwood (*Populus trichocarpa*) in moist environments. In these communities, the canopy of Oregon ash is the most abundant, comprising a significant proportion of canopy coverage over the western portion of the Columbia watershed systems. The shade they provide, as well as their role in stabilizing stream banks and filtering pollutants and excess nutrients, makes Oregon ash a crucial component of stream ecosystems (Maze et al., 2024). These ecological services help create habitats for native plant and fish species and maintain healthy water conditions along the Columbia River. Additionally, Oregon ash maintains hydrologic conditions of its habitat by filtering out pollutants and excess nutrients in the water as well as providing shade that cools water temperature. Both clear-cutting and girdling ash trees have been proven to raise the water table of an area, further showing their importance to their ecosystems (Diamond et al., 2018). Today, this vital Pacific Northwest species is facing potential eradication from an invasive pest sweeping across the United States, with potentially devastating effects to the Willamette Valley wetlands.

That beetle, the emerald ash borer (*Agrilus planipennis*) (EAB), is a small metallic green wood-borer native to Asia that feeds primarily on ash trees (*Fraxinus spp.*). Native Asian ash trees have evolved alongside the EAB and only succumb to its effects if they're in distress, while North American ash trees aren't and can be infected in any condition. When it was originally discovered in the United States in 2002, very little was known about its biology, and experts struggled to effectively eradicate the pest (Herms & McCullough, 2014). As of 2024, EAB has spread to 36 states and 5 Canadian provinces despite current mitigation strategies, killing hundreds of millions of native ash trees across North America and becoming one of the most destructive invasive forestry pests on the continent (Poland et al., 2015; Sun et al., 2024).

The beetle spends much of its life cycle as larvae beneath the bark of ash trees, making them difficult to detect until the advanced stages of infestation. These larvae feed on the circulatory tissue which is composed of both phloem and xylem, with a preference for the phloem, in the sapwood region of a tree, eventually stopping the flow of nutrients and killing it (Wang et al., 2010). Concerns are being raised in the Pacific Northwest due to EAB's ability to readily infest Oregon ash and the disastrous consequences it poses for the region. Fortunately, in the last two decades, researchers have developed a stronger understanding of EAB's biology and how it spreads, lending to more effective monitoring and detection methods.

EAB primarily spreads through natural dispersal and human-assisted movement. In the case of the former, EAB can fly but frequently reinfest the tree they hatched out of, compounding the infestation until the tree perishes and the beetles are forced to seek out new ash for egg laying (Poland & McCullough, 2006). In the latter, EAB can be transported in wood products made from infested trees. Trees killed by EAB infestation are frequently turned into firewood and transported long distances, in one instance spreading them much further than they would otherwise be capable of during a yearly breeding cycle.

Regardless of the dispersal method, characteristic signs of EAB infestation usually aren't visible until several years post-infection. This leads to a lag effect in which EAB is already well established by the time state forestry services become aware of its presence (Ward et al., 2020; Poland & McCullough, 2006). Due to the rapidly destructive effects of EAB, the continual development of detection and monitoring processes is critical. There are different techniques for detection and monitoring, and each has strengths in how it works to further detect EAB. To address this, modeling methods predicting future EAB spread may help develop preventative management strategies. Existing modeling methods utilize spatial modeling but have been criticized for relying on insufficient data. Alternative methods have included cell-based models that treat counties as individual units to track spread, which have helped showcase concerning irregularity in EAB jump distance via human-assisted travel. However, other factors such as quarantine dynamics need further study to fully understand modeling systems and their results (Prasad et al., 2009; Ward et al., 2020).

Branch sampling is the process of randomly selecting tree stems to examine (Silk et al., 2019). Early surveys suggest that EAB infestations begin in the lower bole of the tree, but recent sampling indicates that EAB infestations begin in the small-diameter stems, most commonly in the middle crown of the tree (Silk et al., 2019). This is why branch sampling proved to be more successful in early detection because it targets the branches.

Visual surveying is another key tool of detection. However, it is limited by the infestation window. Bark splits, woodpecker damage, D-shaped exit holes, epicormic shoots, and canopy loss are all signs of EAB, although some are more uniquely characteristic of the beetle than others (Silk et al., 2019). D-shaped exit holes, for example, are formed by the distinctive physiology of new adult beetles leaving the tree after pupation. EAB larvae also leave serpentine galleries within the tree from eating the tissue, but this is only seen when the bark is removed (Zhou et al., 2024). The advantage of visual surveying is its simplicity, allowing for easy public dissemination and the potential for citizen-assisted large-scale monitoring (Bliss-Ketchum et al., 2021). While data reliability remains a challenge, structured training and data validation protocols can enhance the accuracy of citizen-collected observations.

An alternative method of EAB management that's been considered and tested is trapping, whether that's trap trees or baited traps. Creating trap trees is the most effective detection method (Sun et al., 2024). This is when a ring of bark is removed from the tree to girdle it and attract

EAB. It is a valuable technique because it focuses just on EAB and ensures detection (Bliss-Ketchum et al., 2021). On the other hand, it requires excess ash trees, and that can be a very limiting factor. Finally, baited traps are most commonly seen in the form of purple sticky prism traps. The traps are coated with a thick sticky oil and a compound that mimics the chemical signal that ash trees emit when in distress, attracting EAB and causing it to get stuck when it lands (Sun et al., 2024). However, this method is costly due to the human labor it requires, and not very effective, prone to capturing non-target insects. Trapping methods play a crucial role in the early detection of EAB, enabling more effective management interventions. Perkovich et al. (2023) emphasize the importance of trap design, color, and placement in maximizing capture rates of *Agrilus* species. Their work demonstrated that purple-colored traps with high infrared reflectance significantly improved EAB capture efficiency. Additionally, variations in trap height and adhesive composition affected beetle attraction rates, underscoring the need for continued refinement of trapping protocols.

To effectively prevent the spread of EAB, it is important to examine their travel pathways and behavioral processes (Bliss-Ketchum et al., 2021). Understanding the pest biology and our opportunities for intervention is important in responding accordingly. Integrated Pest Management (IPM) is a six-step process for the monitoring and management of pests. The process includes identifying the pest and its stressors, monitoring the seriousness of the condition, evaluating management strategies, applying strategies, determining the efficiency of applied strategies, and monitoring/follow-up. Zhou et al. (2024) found that, due to the unpredictability of EAB, the timing of monitoring is crucial. July through September is the ideal time to detect and monitor these pests. The female larvae lay eggs starting in May, and larval feeding can begin as early as June and July. From this, damage caused by EAB is commonly prevalent starting in July and carrying through September. Detection and monitoring techniques are found to be most accurate at this time, peaking at greatest accuracy in August. It is important to note that the hatching of eggs can extend through September, pushing the feeding timing through March. It is simply most common in the mentioned time frame (Zhou et al., 2024). The pest's continuous spread and infestation provide evidence that our monitoring techniques need to be improved upon (Sun et al., 2024).

Seeing the destruction that Emerald Ash Borer has caused in Forest Grove and Salem, other suburban and urban areas in the Pacific Northwest must plan and monitor their ash populations to mitigate damage in the wake of EAB's eventual arrival. The City of Eugene is concerned about the loss of biodiversity and degradation of healthy riparian areas following the destruction of ash stands. They also lack quantifiable data regarding ash stands in Eugene to inform future management decisions. This monitoring project has generated baseline data on the vegetation present in the understory of ash stands and the detection of EAB.

STUDY AREAS

5/30/25, 11:33 AM site map updated - Google Earth

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Figure 1. Map of 8 project sites in the broader Eugene area.

Throughout this project, we worked at eight sites owned or co-owned by the City of Eugene. The Coyote Prairie site is 240 acres of wetland prairie land located about 1.5 miles West of Eugene. They are part of the City of Eugene's Wetland Mitigation Bank program with the end goal of restoring and improving wetland functions to improve native plants, air, water, flooding, and biodiversity. The Amazon Park site is 100 acres of land, and this area includes both community centers and natural areas in the South Eugene region. These natural areas include Amazon Creek, ash stands, and wetland prairies. This park is also a part of a creek restoration program in the Wetland Mitigation Bank program in the hopes of restoring the natural area. The Oak Patch West site is a park located off of Amazon Creek and is about 4 miles west of the Amazon Park sites, with a significant ash stand by the Fern Ridge trail. The Bethel Community Park site is owned and managed by the City of Eugene, and is a 33-acre park in Northwest Eugene that has many recreational areas within it. This site is within the West Eugene wetlands area and has similar habitats and vegetation, even though it is not considered a wetland by itself. Gudu-kut natural area is adjacent to the Amazon Creek channel and is composed of seasonal ponds, wet prairie, and forested wetlands. This site is 6.4 acres and is located in the West Eugene area, and is managed for wetland preservation and enhancement. The Frank Kinney Park site is an 8.97-acre neighborhood park in South Eugene located alongside a riparian area. The Bertelsen Nature Park site is a 35-acre park in the West Eugene area. This site contains many types of natural habitats, including wetlands, wet prairie, oak savanna, and riparian areas. The Amazon Prairie site is a 329-acre space located close to the Eugene airport. It is currently undergoing phase one of its restoration project, with 148 acres of the prairie being designated for restoration into wetlands, upland prairie, and riparian habitat to support more of the native plants and animals.

METHODS

Equipment

Each field team (3-4 members) was equipped with essential tools for data collection. These included aerial maps with GIS-mapped plot locations, data sheets on write-in-the-rain paper, pencils, diameter tape (d-tape) for measuring DBH (diameter at breast height), measuring tapes for establishing plot boundaries, clickers for counting, digital devices with GIS and the

EAB survey tool, compass, digital camera or phone, pin flags, mallet, center stakes, plant identification aids, and clippers for dense vegetation.

Plot Establishment and Data Collection

Stand Walk-Through

Before setting up plots, all field teams conducted a stand walk-through to familiarize themselves with vegetation types, ash tree density, and understory composition. We also looked out for any site-specific hazards, like human encampments, aggressive wildlife, hazardous debris, and unstable trees. Notes on potential EAB presence, canopy health, and human impact were recorded.

Establishing Ash Stand Plots

Each standard plot was set up circular with a 400 m^2 (11.28m radius) boundary, marked with a center stake and pin flags. Locations were predetermined by the City of Eugene partner, using GIS mapping; minor adjustments were made to avoid impassable vegetation, human encampments, or other obstructions. Additionally, some lower-priority plots were substituted for inaccessible plots. Within these newly established plots, our first form of data entry was two representative photos taken from the center stake, facing north and east, including a data collector as a size reference.

If any obstructions were present, we relocated to lower priority plots to substitute for data and maintain plot integrity. Trees were identified sequentially in a clockwise direction from the northernmost tree. The starter tree was marked with a metal tag at both breast height and at the base, with the plot number and “EAB start tree”. We assigned each tree a unique number, such as

“Tree 4, Plot 2,” recorded in the EAB Survey Tool, on iPads provided by the department or smartphones. The DBH was measured at 1.37m and recorded in inches. For multi-trunked trees, each trunk’s DBH was recorded. Signs of EAB, including serpentine galleries (Figure 2), D-shaped exit holes (Figure 3a), woodpecker activity (Figure 3b), bark splits (Figure 4), and epicormic shoots (Figure 5), were noted. We flagged and reported any concerning trees. Photos were taken of trees showing possible EAB symptoms. Data for non-ash trees within the plot was recorded on paper data forms.

We used 8m radius subplots within the main plots to document tree saplings (>1.37m tall, <4 inches DBH) and shrubs. Saplings and shrubs were identified by species, DBH measured, and heights estimated to the nearest meter. Shrubs taller than 1.37m were included, with their width and height recorded. Multi-trunked willows were classified as shrubs. Herbaceous species, including grasses, blackberry bushes, and ivy, were recorded using the herbaceous data form. Cover percentages (Figure 6) were estimated and put into six categorical classes ranging from 0% to 100% (Figure 7).

Class	**Cover Level**
1	0-5%
2	6-25%
3	26-50%
4	51-75%
5	76-95%
6	96-100%

Table 1: Table of herbaceous layer coverage classes 1-6 in percentage (Figure 7).

Protocol Deviations

Acknowledging protocol deviations, two plots had slight changes to our protocol due to plot conditions. Firstly, Bertelsen North Slough Plot 2 had a large density of saplings. Seventy-three were surveyed before time constraints required stopping, but it's estimated that approximately one hundred saplings were present. To compensate for this, the data of surveyed saplings and the plot's ratio of ash, native, and non-native saplings was extrapolated to the full one hundred saplings, which was later used in data analysis. Similarly, at Coyote Prairie Main 1, the difficult-to-navigate nature of the plot and a great number of saplings led us to measure half the plot's saplings and double them. Fifty-three saplings total were measured from one half of the plot, deemed representative of the entire space, and then doubled for data analysis. As the plot had dramatically fewer shrubs, only eight, all shrub data was collected in full with no doubling or other extrapolation.

Reference Images

<u>Figure 2:</u>
Example of S-shaped larval galleries under bark showing signs of EAB larval activity.
(Steeck, 2024)

Figure 3a:
Example of D-shaped exit holes showing signs of adult EAB presence.
(Steeck, 2024)

Figure 3b:
Example of woodpecker activity to help differentiate from Figure 2a D-shaped exit holes.
(Steeck, 2024)

Figure 4:
Example of a bark split that would show signs of larval EAB activity and potentially expose Methods 1 S-shaped galleries.
(Steeck, 2024)

Figure 5:
Example of Epicormic shoots that show signs of larval EAB activity.
(Steeck, 2024)

Figure 6:
Example of USDA ash canopy ratings as they correlate to percent canopy.
(Steeck, 2024)

RESULTS

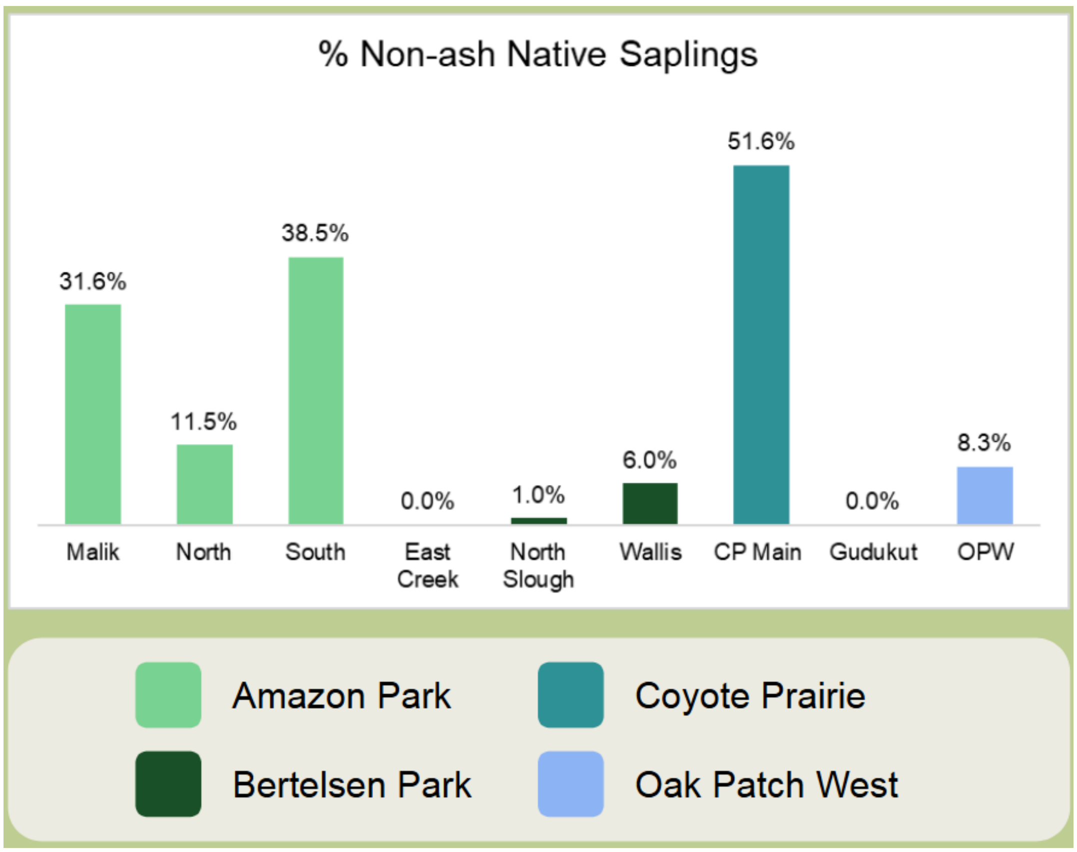
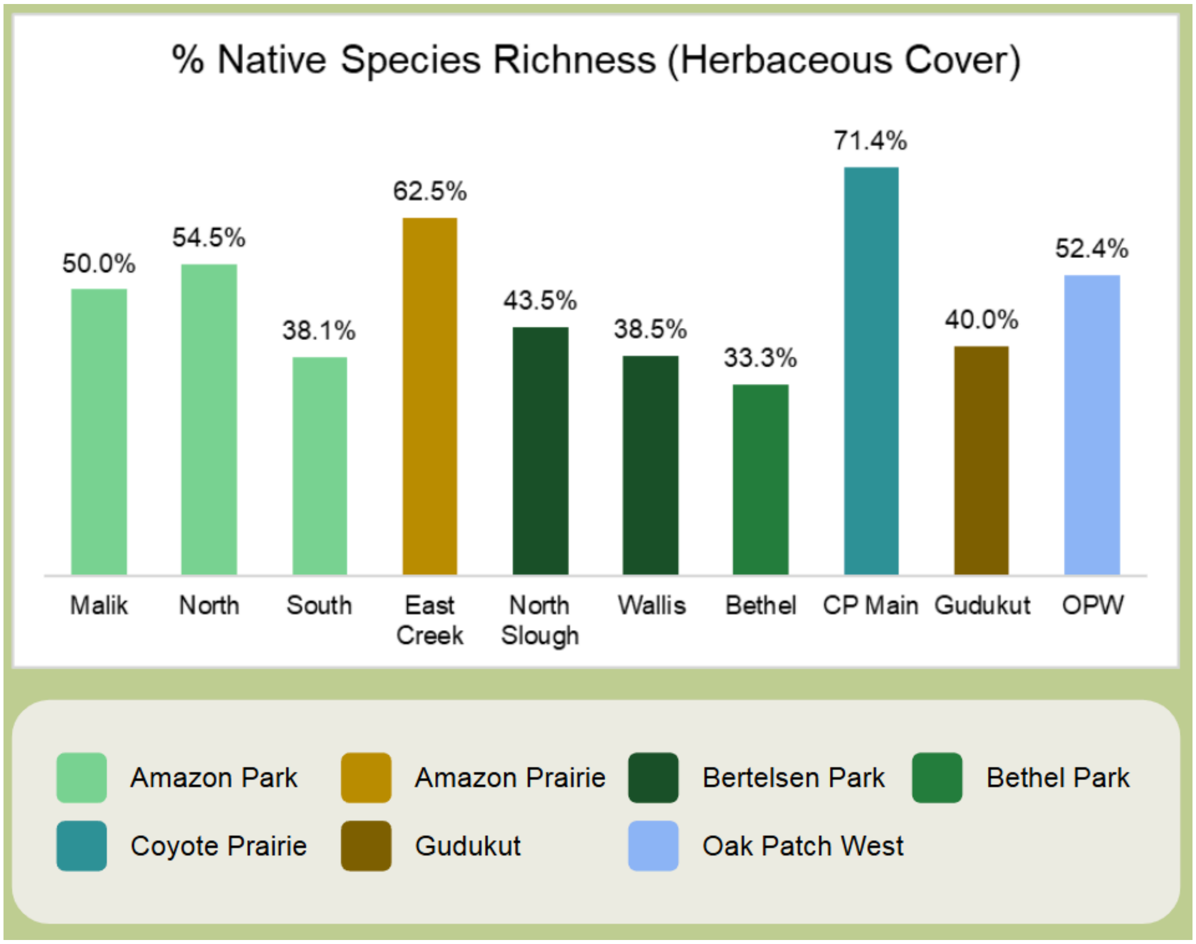


Figure 7: This graph represents the percentage of non-ash saplings that are native. The highest percentage of native non-ash saplings is within the Main stand of Coyote Prairie and the Malik and South stands within Amazon Park. Bethel Community Park was excluded from the analysis because the single plot sampled did not have any saplings. Gudukut and East Creek had no native saplings that were not Oregon ash, however, they also had very low sample sizes (Malik

n=5, North n=1, South n=2, East Creek n=1, North Slough n=2, Wallis n=2, CP Main n=3, Gudukut n=1, OPW n=4).



<u>Figure 8:</u> This graph shows the percentage of native species richness among herbaceous species within each stand. The Coyote Prairie Main and East Creek stands have the highest percentages. The variation is within the general range of 30-70% native. Amazon and Bertelsen are the only parks with more than one stand sampled, but there are similarities between the stands within each respective park. The number of instances of a unique native and non-native species was counted for each plot and the percentage of native species was averaged for each stand (Malik n=5, North n=1, South n=2, East Creek n=1, North Slough n=2, Wallis n=2, Bethel n=1, CP Main n=3, Gudukut n=1, OPW n=4).

	% Ash Trees	% Ash Saplings	% Native Shrubs	% Non-ash Native Trees	% Non-ash Native Saplings	Tree Density per m^2
Wetland Forest	96.87%	69.70%	95.08%	32.50%	15.71%	0.0712
Riparian	71.25%	46.64%	86.67%	95.83%	17.21%	0.032

Table 2: A comparison of the averages between the data for all wetland forest plots (n=22) and all riparian plots (n=10). The percentage of grown trees with a DBH greater than 4 inches and the percentage of saplings that are ash are significantly higher in wetland forests than in riparian areas. There are similarly more native shrubs in wetland forest sites. The percentage of non-ash native trees and saplings, however, is higher in riparian plots, significantly so for the grown trees. We also see a greater density of ash trees per square meter in wetland forests.

DISCUSSION

Our research goal was to create a baseline monitoring of ash stands and understory vegetation in anticipation of Emerald Ash Borer (EAB) infestation. The outcomes of this research have provided helpful distinctions on which sites and stands should be prioritized for restoration and management. Our team has developed several restoration and management recommendations to efficiently and effectively protect our native riparian and forested areas from the Emerald Ash Borer. Over our eight weeks of field work, we evaluated 32 ash forest stands, examining their tree, sapling, and herbaceous qualities. Based on the species richness, social factors, and community composition of saplings and shrubs, our team arranged the priority of stands into high and low priority. From this, we organized our recommendations according to the priority of the stand.

In addition to our standard plots, we collected data in riparian areas with unique rectangular plot types that measured 100 square meters in size. We sampled 10 total riparian plots, 5 at Amazon Prairie and 5 at Frank Kinney. We choose to focus our analysis primarily on the wetland forest sites, as the riparian plots comprise a smaller portion of our data, and several of these plots lacked ash trees. Riparian areas are more varied in their species composition, however, Oregon ash remains an important species to the habitat. 71.25% of the trees we sampled in riparian plots were Oregon ash, and without them, there will be massive impacts on the stream banks as well as shade cover that affects stream temperatures. The other trees growing in these areas were almost entirely native, which is encouraging, knowing the ash canopy will be replaced by native species. The amount of native saplings, however, was much lower, at 17%. Riparian sites will have to be managed carefully to ensure that the ash canopy is not replaced by invasive species. We recommend planting species such as big leaf maple, white oak, white and red alder, and black cottonwood to replace Oregon ash in these areas (Withrow-Robinson 2024).

For our high-priority plots, we focused on Amazon, which includes the Malik, South, and North stands within it. We identify Amazon as the highest priority site for reasons such as species richness and social factors. The Malik stand in Amazon has the greatest species richness, while the North and South stands lack species richness comparatively. We have included these stands as a high priority in acknowledgement that Amazon Park has significance to a large portion of the Eugene community. We will be giving recommendations in the context of the Amazon stands, but the same recommendations apply to our other high-priority stands as well. For this recommendation, we propose treating a total of 200 trees within Amazon. Malik, our highest priority and largest stand within Amazon, will have 100 trees treated. The north and south stands will each have 50 trees treated within those stands. Next, we propose cutting down a total of 400 ash trees within Amazon. In Malik, 200 ash trees should be cut, while in North and South stands 100 ash trees should be cut from each. The majority of these trees should be pruned and removed, while some will be left on the ground or toppled for wildlife or bird nesting. The purpose of cutting these trees is in preparation for planting other native trees to replace the benefits of ash trees in the ecosystem. The ash trees should be replaced with native trees such as Oregon white oak (*Quercus garryana*) or black hawthorn (*Crataegus douglasii*). Clearings should also be left within the stand to transition the vegetative community, create habitat heterogeneity, and restore patches of wet prairie.

For low-priority stands, we advise the management teams to take several precautions. First, our team recommends the low-priority areas to be gated off with warning signs, advising individuals to steer clear of the area due to the risk of dead and decaying trees falling. Since we will not be working to restore the tree population, many of the trees will die off relatively quickly after the introduction of EAB, at which point they can be removed and burned or chipped. In addition, we recommend that the sites be proactively girdled as trap trees to draw the EAB away from the high-priority sites to the low-priority sites. With enough funding, there is the option of creating lethal trap trees with trees treated with insecticide before being girdled (McCullough et al. 2016). Finally, depending on the situation, most notably how it affects the surrounding area, we recommend that trees be trimmed to limit other risks of damage. These sites have the potential to be converted to wetland prairie habitat if restoration begins before aggressive invasive species like Himalayan blackberry (*Rubus bifrons*) have a chance to establish themselves.

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LITERATURE CITED

Bliss-Ketchum, L., Draheim, R., Hepner, M., & Guethling, O. (2021). Emerald Ash Borer: Readiness and Response Plan for Oregon. Unpublished Report. Oregon Department of Forestry, Oregon Department of Agriculture. Salem, Oregon.

Diamond, J. S., McLaughlin, D. L., Slesak, R. A., D'Amato, A. W., & Palik, B. J. (2018). Forested Versus Herbaceous Wetlands: Can Management Mitigate Ecohydrologic Regime Shifts from Invasive Emerald Ash Borer? Journal of Environmental Management, 222. Pub-Med Central. https://doi.org/10.1016/j.jenvman.2018.05.082

Frenkel, R. E., & Heinitz, E. F. (1987). Composition and Structure of Oregon ash (*Fraxinus latifolia*) in National Wildlife Refuges of Oregon. Northwest Science.

Herms, D. A., & McCullough, D. G. (2014). Emerald Ash Borer Invasion of North America: History, Biology, Ecology, Impacts, and Management. Annual Review of Entomology, *59*(1). Annual Reviews. https://doi.org/10.1146/annurev-ento-011613-162051

Kral, G., & Shaw, D. (2023). *Alternatives to Ash in Western Oregon With a Critical Tree Under Threat, These Options Can Help Fill Habitat Niche*. https://www.oregon.gov/odf/forestbenefits/Documents/alternatives-to-ash-western-oregon-march-2023.pdf

Maze, D., Bond, J., & Mattsson, M. (2024). Modelling Impacts to Water Quality in Salmonid-bearing Waterways Following the Introduction of Emerald Ash Borer in the Pacific Northwest, USA. Biological Invasions, *26*(8). https://doi.org/10.1007/s10530-024-03340-3

McCullough, D. G., Poland, T. M., & Lewis, P. A. (2016). Lethal trap trees: A potential option for emerald ash borer (Agrilus planipennis Fairmaire) management. *Pest Management Science*, *72*(5), 1023–1030. https://doi.org/10.1002/ps.4083

Oregon Public Broadcasting (Director). (2025, May 1). *Oregon's ash trees are dying — Can anything stop the Emerald ash borer beetle? | Oregon Field Guide* [Video recording]. https://www.youtube.com/watch?app=desktop&si=kpqxQjzqL_NS90Qr&v=sYJ44_vh8iw&feature=youtu.be&ab_channel=OregonPublicBroadcasting

Perkovich, C. L., Oliver, J. B., Addesso, K. M., Basham, J. P., & Youssef, N. N. (2023). Effects of Trap Shape, Size, and Color Variations on Capture Rates of *Chrysobothris* (*Coleoptera: Buprestidae*) and Related Buprestids. Florida Entomologist. https://doi.org/10.1653/024.106.0111

Poland, T. M., Chen, Y., Koch, J., & Pureswaran, D. (2015). Review of the Emerald Ash Borer (*Coleoptera: Buprestidae*), Life History, Mating Behaviours, Host Plant Selection, and Host Resistance. The Canadian Entomologist, 147(3). https://doi.org/10.4039/tce.2015.4

Poland, T. M., & McCullough, D. G. (2006). Emerald Ash Borer: Invasion of the Urban Forest and the Threat to North America's Ash Resource. Journal of Forestry: 2006. https://research.fs.usda.gov/treesearch/15034

Prasad, A. M., Iverson, L. R., Peters, M. P., Bossenbroek, J. M., Matthews, S. N., Davis Sydnor, T., & Schwartz, M. W. (2009). Modeling the Invasive Emerald Ash Borer Risk of Spread Using a Spatially Explicit Cellular Model. Landscape Ecology, 25(3). https://doi.org/10.1007/s10980-009-9434-9

Silk, P. J., Ryall, K., & Roscoe, L. (2019). Emerald Ash Borer, *Agrilus planipennis* (Coleoptera: Buprestidae), Detection and Monitoring in Canada. Forestry: An International Journal of Forest Research. https://doi.org/10.1093/forestry/cpz036

Steeck, D. (2024). Emerald Ash Borer (EAB) Inspection Guidance. https://canvas.uoregon.edu/courses/255154/files/20693430?wrap=1

Steeck, D. (2025). Protocol for Collecting Ash Forest Characterization Data; ELP Project 2025. In P. Boulay (Ed.), Canvas. https://canvas.uoregon.edu/courses/255154/files/20858012?wrap=1

Sun, J., Koski, T.-M., Wickham, J. D., Baranchikov, Y. N., & Bushley, K. E. (2023). Emerald Ash Borer Management and Research: Decades of Damage and Still Expanding. Annual Review of Entomology. https://doi.org/10.1146/annurev-ento-012323-032231

Wang, X.-Y., Yang, Z.-Q., Gould, J. R., Zhang, Y.-N., Liu, G.-J., & Liu, E. (2010). The Biology and Ecology of the Emerald Ash Borer, *Agrilus planipennis*, in China. Journal of Insect Science, 10(128). https://doi.org/10.1673/031.010.12801

Ward, S. F., Fei, S., & Liebhold, A. M. (2020). Temporal Dynamics and Drivers of Landscape‐level Spread by Emerald Ash Borer. Journal of Applied Ecology, 57. British Ecological Society Journals. https://doi.org/10.1111/1365-2664.13613

Withrow-Robinson, B. (2014, December 18). *A guide to riparian tree and shrub planting in the Willamette Valley: Steps to success* [Extension Catalog publication]. Extension Communications; Oregon State University Extension Service. https://extension.oregonstate.edu/catalog/pub/em-9040-guide-riparian-tree-shrub-planting-willamette-valley-steps-success

Zhou, Q., Zhang, X., Yu, L., Qi, R., & Luo, Y. (2024). Determining the Optimal Time Window to Detect Emerald Ash Borer Damage for Effective Management. Pest Management Science, 81(3). https://doi.org/10.1002/ps.8533