# Project Title: Enhancing Stand Level Management Tools to Maintain Riparian Forest Cover to Benefit Water Quality in *Fraxinus latifolia* Dominated Riparian Forests Threatened by Emerald Ash Borer

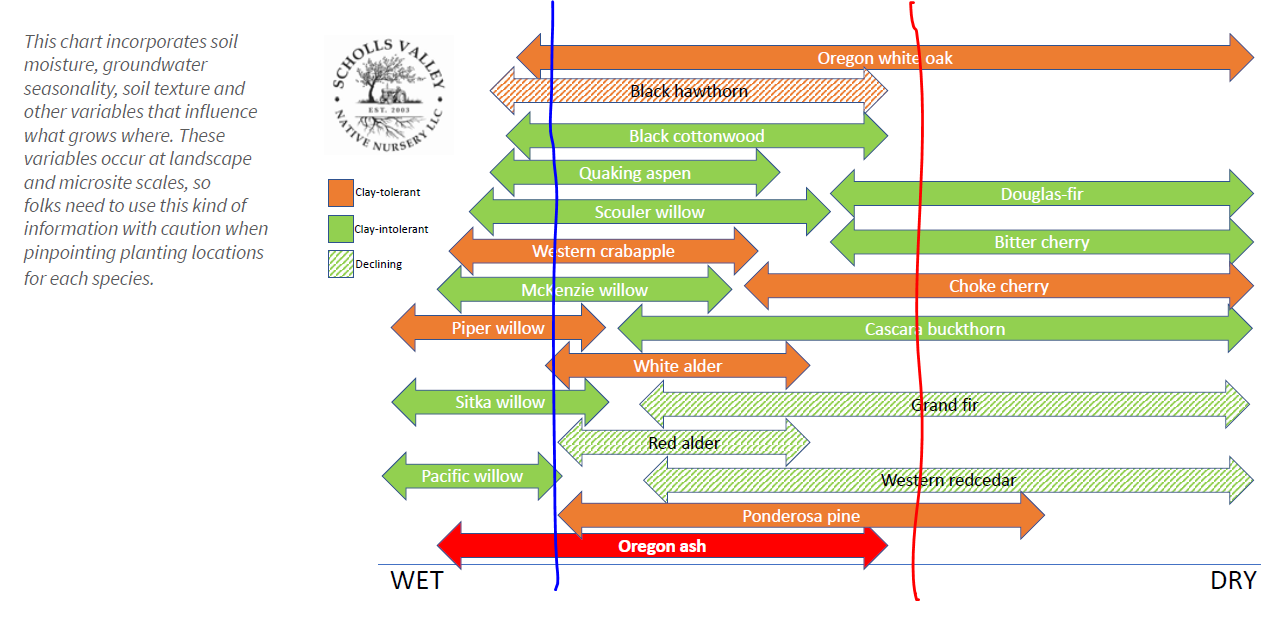
*Faxinus latifolia* stand management tools to maintain riparian forest cover and water quality against emerald ash borer

# Project Concept:

Establish trials to expand and refine practitioner knowledge of factors that define Oregon ash’s environmental niche and alternative species that can fulfill the niche and the most effective strategies to manage stands to maintain riparian forest cover.

## Statement of Need

Emerald Ash Borer will have wide ranging impacts on forest cover throughout the lower elevations of the Tualatin Valley and the entire range of Oregon ash in the PNW. Greater than 95% mortality of Oregon ash is expected. Oregon ash is the most dominant overstory component along perennial streams in the Tualatin River valley and negative impacts on water quality temperature from loss of shade are anticipated. While impacts on ash forested wetlands will be detrimental and likely lead to a future altered successional state or reversion to historical savannah conditions, the impacts to the loss of Oregon ash in riparian forests will have a greater impact on water quality as riparian forests are more commonly found along perennial streams and provide shade during the summer months of elevated temperatures. Fortunately, riparian forests can support a wider diversity of native species as compared to forested wetlands for multiple reasons but likely most strongly driven by a more mesic soil moisture regime than forested wetlands. The graphic developed by George Kral and shown below shows how Oregon ash compares to other trees and shrubs that can help maintain forest cover. I inserted a blue line to the graphic to distinguish the transition from forested wetland to riparian forest, and a red line to delineate wet from mesic riparian forests.



Forest Wetland l Wet Riparian forest l Mesic Riparian Forest

Figure 1. Edited Environmental Gradient Depicting Ash and potential replacement species (G. Kral)

The exact location of where that blue and red line should be is debatable and would vary by local site conditions. However, the environmental conditions that are most prevalent in the Tualatin river valley and which covers the most acreage in near proximity to perennial streams is the wet riparian forest. This is largely due to landscape position as it relates to local soil moisture conditions. Figure 2 below depicts a typical riparian and floodplain landform along a higher order and low gradient Tualatin river tributary. The mesic riparian forest is found along the banks of Dairy creek and as you move away from the top of bank by creek elevation is lost and plant communities are wetter, soils finer in texture. Not depicted here is the steep transition from top of bank towards Dairy creek where the plant community is dominated by shrubs that can tolerate inundation such as red osier dogwood (*Cornus stolonifera*).

Table

Description automatically generatedGraphical user interface

Description automatically generated with medium confidence

Figure 2. Map showing a potential riparian planting project and how the soil moisture gradient influences potential plant communities.

Oregon ash has a complex history in the Tualatin valley. Burning from the Kalapuyans restricted the encroachment of ash into prairies for thousands of years. European settlement led to an increase in Oregon ash due to the cessation of burning as ash seeds itself vigorously in to open and partially shaded environments. Eventually hydrological manipulation of rivers for flood control greatly diminished the extent of large riparian cottonwood and ash dominated forests. Drainage to facilitate conversion to agriculture of what were previously prairies and then more ash dominated forests ensued in the latter half of the 1900’s. The overall percent cover of ash was likely greatly reduced but of the remaining low elevation forests and woodlands ash likely comprised a larger slice of the pie as it seeded readily into less dynamic landscapes devoid of scouring floods that favored cottonwood and fires that favored oak. As forest cover retreated once flood control and agriculture accelerated ash was likely favored comparatively and made up a larger proportion of the woodlands and forests, we see today throughout the Tualatin River valley.

With the arrival of Emerald Ash Borer, we find ourselves in a highly industrialized and environmentally regulated Tualatin basin dependent on a sliver of a remnant riparian forest to maintain shade over perennial waters to comply with regulatory benchmarks and provide rudimentary ecological function in a rapidly warming climate. The conditions that led us here are complex and the degree to which ash provides shade in riparian zones is outsized. Fortunately, most of the riparian zone of the Tualatin basin can support a wide diversity of species, and reliance on ash isn’t a necessity but will require active management to convert these forests to more diverse and resilient forested communities. Many near channel riparian stands are lacking in non-ash tree diversity and the likelihood of conversion to a diverse and adapted forest overstory is often unlikely. Many stands lack a local source of viable non-ash tree replacements due to the dominance of ash, and high cover of competitive native and non-native shrubs and herbaceous species means natural regeneration of non-ash trees is unlikely for many stands. The scope of the threat in the Tualatin valley is daunting, but by focusing efforts to convert ash dominated riparian forest stands we believe we can best address the anticipated impacts to water quality in the Tualatin valley.

There are many potential effects from the spread of EAB in Oregon ash’s range, and there are several uncertainties (table 1) as to how quickly it will spread. While these uncertainties exist, based on experiences in 35 other states it is important for individual land managers to start preparing forest stands to be resilient to a likely catastrophic outcome for mature ash over the next ten years. Given the proximity and urgency of EAB to the Tualatin valley there is a need to rapidly strengthen the toolbox for natural resource managers to begin conversion of ash dominated riparian forests. Many natural resource managers in the Tualatin valley have over a decade of experience in large scale riparian forest establishment and management, including access to a high diversity and quantity of planting stock and budgets that allow for management beyond initial establishment. While there is much to build upon there is a need to learn and adopt new best management practices quickly.

|  |
| --- |
| Is current extent of EAB really confined to Forest Grove? |
| How fast will EAB spread throughout Oregon ash's range? |
| If an approach to slow the spread of EAB (SLAM) is attempted, to what extent and effect might it have? |
| Since the biological control is being comparatively early in the establishment of EAB will this greatly affect dynamics of invasion? |
| How much ash is there in the Willamette Valley and how will its distribution affect invasion dynamics? |
| Of the ash in the Willamette Valley how much is growing on sites suitable for replacement species? |

Table 1. Uncertainties Regarding EAB Invasion December 2022

Two areas of need to inform riparian forest management are 1) refinement of methods to identify environmental gradients suitable for various replacement species and 2) implementing trials to convert ash dominated riparian forests in the most successful and cost-effective manner.

1. Refining methods to identify an environmental gradient focused on replacement species for ash

When planning out restoration projects natural resource managers utilize multiple sources of information to inform their thinking, including soil maps and observations of onsite vegetation. Plants are often the best indicator of environmental gradients because they are generally readily identified year-round in the mild climate of the PNW. To identify suitability more precisely on a narrow environmental gradient where less than 1 foot in elevation change can mean a site is suitable for non-ash tree species it is important to identify the indicators more precisely for these thresholds. Efforts should be focused on identifying common species that are easily identifiable year-round and help delineate the narrow band in floodplain and riparian communities where replacement species are being considered. Appendix A contains an expanded discussion of alternative methods to locate thresholds in the environmental gradient as it relates to ash and potential replacement species. I think research should focus on the 3rd option detailed in the appendix to utilize botanical indicators.

1. Implementing management trials to convert ash dominated riparian forests cost effectively

The impact of EAB on the PNW will be different than the majority of North America, especially the mid-latitude eastern deciduous forests which possess a greater diversity of non-ash tree species capable of filling in the vacancy left by ash. However, the black ash (*Fraxinus nigra*) forested wetlands of the northern latitudes provide the best analog to conditions in the PNW. In these forests black ash provides most of the cover and site conditions preclude the colonization of other species adapted to the more upland adjacent forest. Several field trials have been conducted to evaluate silvicultural and replanting management options in black ash stands, notably the work from Northern Minnesota discussed in several articles stands out as a potential template to adapt for PNW ash dominated riparian forests (Palik et al 2021, Looney et al 2015, D’Amato et al 2018). These trials evaluate multiple replacement species and silvicultural strategies for 1-2- and 8-year success, and the environmental impacts from different methods. Adapting these or similar methods with local practitioner knowledge of species tolerances shown below in figure 3 seems an essential step. Of special interest is evaluating more closely the ability of planted species to tolerate shade given that the arrival of EAB to a given site is unknown. By evaluating species in or ex situ for shade tolerance it would inform land managers of varying degrees of proximity to the current known infestation. Like the Northern MN trials, we would like to evaluate the tolerances to shade and soil moisture for potential assisted migration candidates also. This effort could draw from ongoing work of Tualatin SWCD and CWS to identify species present in riparian and wetland communities in predicted future climate analogs for testing in a common garden setting. Figure 4 highlights the species, stock types and establishment methods that are potential candidates to test and further inform a local body of knowledge to sit along other species listed in figure 3.



Figure 3. Pocket reference for tree and shrub tolerances for species present in Tualatin riparian zones. Suitability to future climates should be added to this table.

|  |  |  |
| --- | --- | --- |
| **Species** | **Stock Types** | **Establishment Methods** |
| Acer macrophyllum | Bareroot | No site prep |
| Alnus rhombifolia | Live stake | Release spray around plantings |
| Alnus rubra | 1 gallon | Patch cut winter competing shrub veg/Release spray spring |
| Calocedrus decurrens |  | Cut only |
| Malus fusca |  | Clear cut of overstory |
| Pinus ponderosa |  | Patch cut of overstory |
| Populus tremuloides |  | Soil disturbance and rhizome spread |
| Populus trichocarpa |  | Open canopy, extremely light intolerant |
| Prunus virginiana |  |  |
| Quercus garryana |  | Most often greenhouse cultivated or MASS acorn planting, cleared overstory |
| [Rhamnus purshiana](https://www.fs.usda.gov/database/feis/plants/tree/pruvir/all.html) |  | Rhizome sprouting is fastest, fire adapted species |
| [Salix lasiandra](https://www.fs.usda.gov/database/feis/plants/tree/salsco/all.html) |  | Stake planting, anywhere |
| Salix scoulerii |  | Seed and vegetative regeneration, somewhat drier habitat than most willows |
| [Umbellularia californica](https://owic.oregonstate.edu/california-laurel-umbellularia-californica) | | Seedlings can establish at low light levels on moist bottomslands/deep soil—rapid initial growth |

Figure 4. Species, Stock Types, and Establishment Methods of multiple combinations to consider for trials

The interest of Clean Water Services and Tualatin SWCD is centered around establishing replacement trials for riparian forests, but a similar experimental design could be applied to ash in wetland conditions for people interested in maintaining forest cover, or in situations where objectives are more centered around economic return for private landowners. Currently ash has a low economic value in Oregon and is not a huge component on private non-industrial or industrial forest ownership distributed along the foothills of the Tualatin valley and above. However, ash is a common species found in the margins of agricultural lands, generally in places that were difficult to convert to agriculture. These stands come with regulatory protections for farmers participating in USDA programs and it is unclear how much these stands will be regulated by ODF’s Forest Practices Act. These landowners are also not commonly reached by OSU Forest extension or Oregon Small Woodlands so awareness of EAB and options for management are likely not well understood yet. Given this assumed gap in awareness and likelihood to try and recoup economic return it will be necessary to clarify regulations, but also good to get ahead on preliminary results of management trials that will benefit these ag woodland owners.

## Project Outcome

Clean Water Services and Tualatin SWCD will have greater knowledge to identify site conditions that correlate to environmental gradients essential to guiding management in the conversion of ash dominated riparian forests. Field trials will further develop best practices to cost effectively transition ash dominated riparian forests to diverse and resilient riparian forests that continue to provide shade to perennial streams of the Tualatin basin. The results of these trials could inform the development of stand level assessments that would guide management similar to the “Emerald Ash Borer Silviculture Guidelines” by [Wisconsin DNR](https://cf-store.widencdn.net/widnr/b/5/c/b5c7d7de-9e58-492f-896f-4027a9d3b32c.pdf?response-content-disposition=inline%3B%20filename%3D%22EABWIManagementGuidelines.pdf%22&response-content-type=application%2Fpdf&Expires=1671171720&Signature=AYG~SGgxAsiyuGoGzntxEjuujqCdmLOBGgZ~Nd01OnWEVEY0oD93Y1Jziyx~SeOHYKjTrwYY9Mb1eM5IwrXr2~Lw3zNRwCEHuLbeym0Z3oUBZbLpud8B336w-B45pwQ5bK5xRQ20R~BMURlqTxPRKMJ6DfOGWrmh4-BtPs5srFYWKAqvdMUCwejI~kftnIx2GzJuS~HCCSf5uSb1EmbuW4HxlcrljDGhIGH-rOhrQVohmf0P3UcZ8tcVDX3MZttVcZeYexaR98OSwJOuIT5YHsDkfny1qTGpfk~nzOqzwueDywo9gpBgNgcDcdoe7GGeweBfTeJVee37SQ2Bni6W7A__&Key-Pair-Id=APKAJD5XONOBVWWOA65A) but tailored to the needs of the Tualatin and PNW. *See appendix B for a draft of management guidelines in the form of a decision key that could be adapted to a less threshold driven flow chart similar to one found in WDNR report.*

**Appendix A**

4 techniques to identify thresholds along an environmental gradient for replacement species suitability for Oregon ash

1. Landscape Scale/Low Effort/Coarse Output- Utilizing information from NRCS soil series like method referenced in Prive 2016.

Sean Prive’s 2016 MS thesis completed an extensive survey of ash dominated forested wetland communities, sampling across 11 forested wetlands between Lane and Washington county. At each of these plots he correlated the soil series from NRCS web soil survey and the plots fell across 7 soil series identified in Table 2.4 (p37). He then totaled the extent of these soil series to be approximately 150,000 hectares as the potential niche for Oregon ash in the Willamette Valley. This is roughly equal to 11% of the entire Willamette Valley (Prive p95). Prive’s work while extensive likely didn’t capture all of the wetland soil series where ash is present and surely didn’t cover the more mesic soils where ash is also present. His survey work was focused on ash dominated forested wetlands and he recognizes that more mesic conditions were underrepresented (Prive p29). Chehalis silty clay loam is a common local to the Tualatin basin example of a soil series where ash is often found and co-dominant with other riparian species. Surely there are other mesic soil series where ash makes up a major component but weren’t included in Prive’s 150,000 hectares estimate. However, it might be possible to work with NRCS or someone familiar with the soils data to parse wetland soils where other tree species can’t grow from the ones where they can. This would help estimate the # of acres that would be almost assured of converting to a non-forested wetland dominated by willows or herbaceous veg from the acreage that if already diverse or through artificial regeneration could be maintained in a forested state. This information could guide management decisions at a broad scale and potentially be useful to individual landowners who could reference their soil series to inform replacement species options.

We could look at the potential to utilize CWS veg monitoring data and NRCS soil series to try and identify all soil series where ash is found. Potentially clip monitoring data for ash presence to soils data?

1. Site Scale/Medium Effort/Fine Output - Onsite soil sampling to identify suitability for replacement species

Another component of Prive’s work that could help guide management decisions on suitable replacement species was the soil sampling he did at each of the plots he surveyed. He was very interested in determining how environmental conditions were driving the presence/absence of oak in the ash dominated forest, so he used a 4-inch soil auger to extract 25 cm deep soil cores. He was looking for the depth to significant mottling in the soil as evidence of how high the average annual high-water table was. (Prive p16). He was able to show a relationship where the deeper he saw soil mottling the more likely oaks were present (fig 2.15 p49). Based on his results you wouldn’t expect oaks to be present if soil mottling was less than 10 cm deep. Sites with soil mottling less than 10 cm deep would likely be unsuitable to be managed for other tree species besides ash. This tool would require some skill and specific equipment but could be utilized on a site scale to identify management zones for non-ash tree species. This approach could be useful especially when working in afforestation where ag land is being converted back to riparian forest and a manager lacks the vegetative indicators discussed in method 3.

1. Stand Scale/Low Effort/Fine Output – Observing existing vegetation to indicate site suitability

Probably the most used and reliable way to identify environmental gradients and target plant communities is by observing vegetation that is already present onsite. If the site has multiple tree species already present, then you can rely on the presence of the non-ash tree species to guide management and potentially lead you to enhancing with species non currently present but tolerant of suitable conditions. For example, if there is a stand dominated by ash, but oak is also present I might consider also planting species like WV Ponderosa pine and Scouler Willow. However sometimes tree indicators aren’t present or don’t provide enough detail. If oak were present but the understory was dominated by slough sedge (*Carex obnupta*) or reed canary grass (*Phalaris arundinacea*) one could assume this stand might not support much non-ash diversity besides maybe oak and some of the willow species. If species like *Carex pachstachya* and *Juncus patens* were present one might plant alder, WV Ponderosa pine, Scouler willow, aspen etc. etc. If *Rubus ursinus* and oceanspray were present one might assume they could plant big leaf maple and Douglas fir. If it were possible to correlate common indicator tree and non-tree species that occur within Oregon ash’s wide range then it would assist land managers in making decision about replacement species.

Again, this might be possible by drawing from Prive 2016. I don’t fully grasp the methods for surveying plant communities in the 3rd chapter, but it seems there is the possibility to draw guidance from the data to identify vegetative indicators. I think the higher the CTWI score the more it associates with oak/ more mesic conditions (p60). On page 59 it seems as though his work focused on classifying plant communities along a stand structural and/or successional gradient but it might also be possible to pull from the raw data how species correlated to site characteristics notably using soil to identify soil moisture regimes. Again, one potential weakness if relying only on Prive’s data would be that his sampling focused on ash dominated stands, and won’t address some of the more mesic, ash dominated and prevalent sites. Prive does provide several examples of associated species that help delineate wet from dry, notably two exotics reed canary grass = ash but likely no oak, Rubus sp = ash and oak.

Additional data sources that might help identify vegetative corollaries are Clean Water Service’s quantitative veg monitoring data from restoration projects. This is an extensive dataset that will show presence/absence and % cover for tree and herbaceous species across thousands of acres of restoration sites. The data could probably be utilized to focus on remnant plant communities or maybe less informative it could focus on older planted sites assuming that some of the planted species will have been selected for site suitability if they persist after 5+ years.

Descriptions of riparian plant communities could also be explored to identify appropriate indicator species although these descriptions might focus more on native species, when exotic species are likely more present and identifiable by a larger proportion of land managers. Heinitz and Frenkel 1987, “Composition and structure of Oregon ash forest in WFNWR” is one resource and a more extensive one Titus et al 2006, “Native wetland, riparian, and upland plant communities and their biota in the Willamette Valley”.

This method is probably the most conducive to informing site management as vegetation indicators are generally easily seen year-round. Choosing indicator species that effectively delineate along ash’s soil moisture gradient that are both easy to identify and identifiable year-round would make the most sense.

1. Landscape Scale/High Effort/Fine Output Controlled flood simulation experiments like Kabrick et al 2012

The experiment described in “Quantifying flooding effects on hardwood seedling survival and growth for bottomland restoration” (Kabrick et al 2012) is an example of a controlled experiment in Missouri to evaluate multiple species for their tolerance and suitability to varying intensity and duration of flood and soil moisture regimes. Researchers constructed swales where they could control hydrology to perform the experiment to inform bottomland restoration in the central hardwood region by exploring flood tolerances. It is an impressive experiment, but likely unnecessary given there is about 20 years of practitioner experience with restoring riparian forests in the Pacific Northwest. This method might be well suited for testing non-local species identified as potential assisted migration candidates, specifically if resource managers want to focus on replacement of ash cover in forested wetlands and are open to considering non-local species.

**Appendix B**

**Decision Key based on scenarios to inform budgeting at basin scale**

This guidance applies to forests being managed for function and biodiversity with an emphasis on the unique role ash plays in contributing a high proportion of canopy over perennial waters in the Tualatin basin. This information is presented as a dichotomous key, but would be better represented by a flow chart once details are worked out. This information is for generating broad stroke budget estimates only and shouldn’t be seen as a substitute for on site assessments by land managers

\*Hazard trees should be mapped and budgeted at $1500 each

1 Are you on a site that is unlikely to support tree alternatives to ash due to prolonged inundation in spring?

1a If yes then consider what functions are critical to support and how well they can be provided for using tall shrubs or if important functions can persist regardless of canopy structure or beneficial to convert to prairie or other habitat type

In an ash forested wetland that is truly mucky would you plan pacific willow for a bit of the height, shade, structure or convert to lower stature scrub shrub or allow natural succession to take place which might include more weeds or opportunistic native scrub expansion such as rose, spiraea. Documentation of these historical reference communities ahead of anticipated shifts might be prudent.

Example: TH Nature Park, Churchill Forest, Quamash Prairie, EdenAcres

Cost per acre above normal:

Range - $500 - $5000 (Varies widely based on goals of landowner, and might require more in depth analysis before leading to management decision)

Average - $3000

1b No the site can accommodate non-ash tree species but is remnant forest >40 ft tall - 2

1c No the site can accommodate non-ash trees species but is part of a revegetation effort - 5

2b Remnant forest and non-ash tree cover > 50% go to 3

2c Remnant forest and non-ash tree cover < 50% go to 4

3a Remnant forest with non-ash tree cover > 50% and more than 3 non-ash tree species/ac

Evaluate for targeted release of group C trees if canopy closure from ash is expected to diminish non-ash canopy before ash die back from EAB symptoms. Vary timing prescription based on geographical proximity to Forest Grove (5 years within 3 miles, 10 years within 10 miles, 15 years anywhere in basin). The further from Forest Grove the more time for ash to continue to grow and exclude other species so thinning potentially more important further from ground zero in these stands. Consider light to moderate shade tolerant underplantings (incense cedar, cascara, big leaf maple) in ash dominated areas.

Example:

Cost per acre above normal:

Range -

Average -

3b Remnant forest with non-ash tree cover > 50% and less than 3 non-ash tree species/ac

Evaluate for targeted release of group C trees if canopy closure from ash is expected to diminish non-ash canopy before ash die back from EAB symptoms. Vary timing prescription based on geographical proximity to Forest Grove (5 years within 3 miles, 10 years within 10 miles, 15 years anywhere in basin). The further from Forest Grove the more time for ash to continue to grow and exclude other species so thinning potentially more important further from ground zero in these stands. Consider light to moderate shade tolerant underplantings (incense cedar, cascara, big leaf maple) in gaps of ash dominate areas. In addition to release of non-ash trees create patch cuts within ash stands > 40 ft diameter to plant with sun dependent tree species (oak, cottonwood, white alder, pine, Scouler willow, chokecherry).

Example:

Cost per acre above normal:

Range -

Average -

4 Remnant forest with non-ash tree cover < 50%

Prioritize for targeted release of group C trees if canopy closure from ash is expected to diminish non-ash canopy before ash die back from EAB symptoms. Vary timing prescription based on geographical proximity to Forest Grove (5 years within 3 miles, 10 years within 10 miles, 15 years anywhere in basin). The further from Forest Grove the more time for ash to continue to grow and exclude other species so thinning potentially more important further from ground zero in these stands. Consider light to moderate shade tolerant underplantings (incense cedar, cascara, big leaf maple) in gaps of ash dominated areas. In addition to release of non-ash trees create patch cuts within ash stands > 40 ft diameter to plant with sun dependent tree species (oak, cottonwood, white alder, pine, Scouler willow, chokecherry). This scenario will require a greater amount of patch cuts and replanting effort, then scenarios 3a and 3b so costs are increased.

Example:

Cost per acre above normal:

Range - $1,500-$3,000

Average - $2,250

5a Planted forest less than 8 years old

Treat ash as a broadleaf weed in young stands. Use foliar sprays and/or cut stump treatments as needed. To diversify the tree canopy consider interplanting with all suitable tree-like replacement species regardless of shade tolerance. Consider using large stock sizes for slower growing species such as oak to hopefully outcompete surrounding shrubs. Might require additional mowing or reduction of adjacent shrub layer to allow for tree establishment. Vary tree interplanting densities based on non-ash tree distribution and cover. Implement these prescriptions ASAP in order to achieve cost efficiencies of treating small ash, and of having more light available to establish alternative sources of shade. Cover of non-ash tree species can also be incorporated to help prioritize decisions, basically is enough non-ash cover exists then less urgency or need for interplanting.

Example: Lee ECREP

Cost above normal: $1000 per acre

5b Planted forest more than 8 years old with non-ash tree cover <50% or less than 3 species from tree group C per acre

Cut release all group C trees to 20 foot distance on all sides. Create cut/stump patch cuts proportional to cover and distribution of group C trees on site. The less group C trees the more patch cuts needed. Interplant patch cuts with sun dependent species from group C and D. Underplant with shade tolerant species from groups C and D where space allows.

Example: Gales/Forest Grove

Cost above normal: $2000 per acre.

5c Planted forest more than 8 years old with non-ash tree cover >50% and more than 3 species from tree group C per acre

Cut release all group C trees to 20 foot distance on all sides. No herbicide treatments for ash should be necessary except where dense ash groves might shade out trees or shrubs in next 5 years. Ash can be cut or cut/sprayed in dense pockets where it is shading out desirable vegetation.

Example: Nick Duyck ECREP

Cost above normal: $1500 per acre

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