# Maintaining Hardwood Forest Profitability Without Ash Species

MISSISSIPPI STATE UNIVERSITY™ EXTENSION

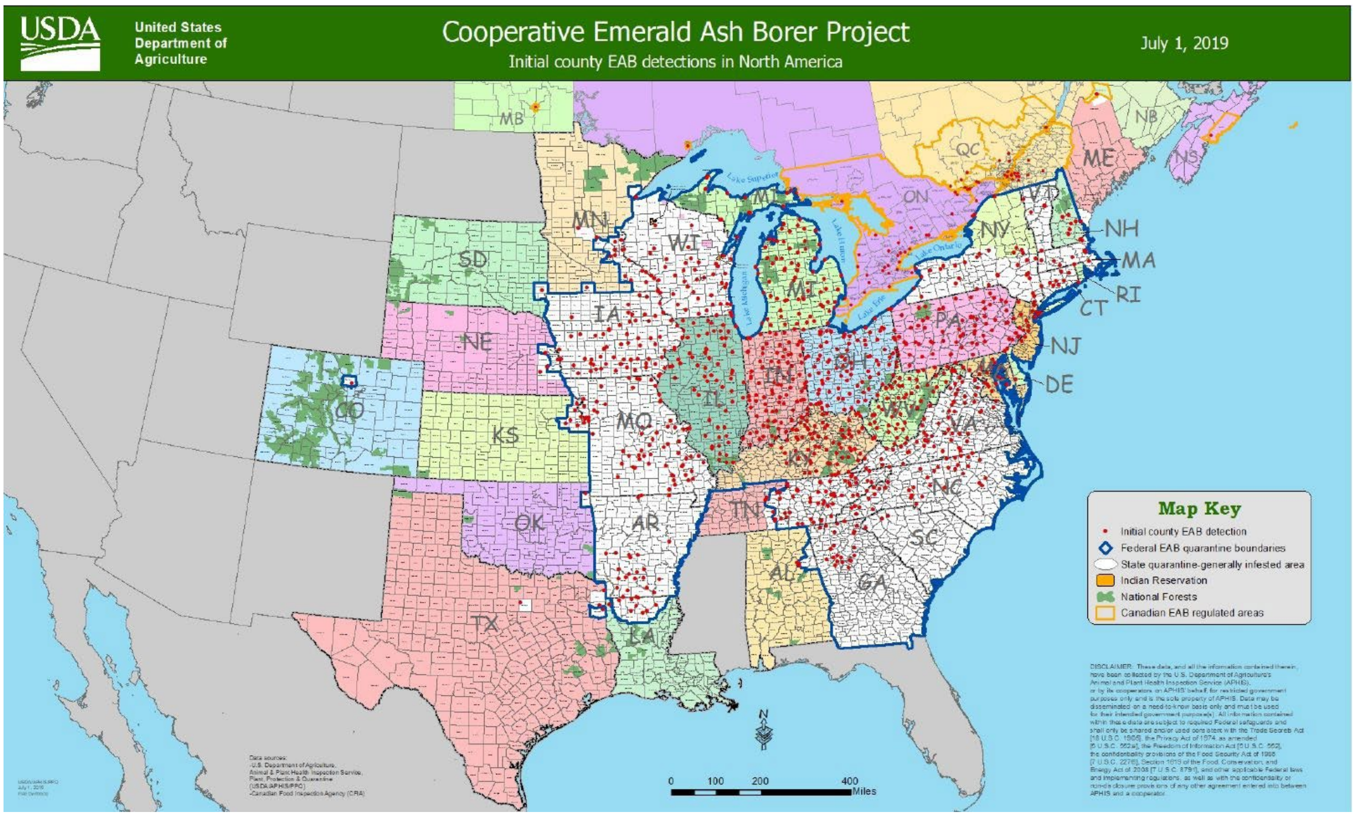


Figure 1. Emerald ash borer distribution as of July 1, 2019. Highlighted states have EAB infestations. Areas outlined in blue are federal quarantine areas, while red dots represent counties where EAB has been detected.

Mississippi is currently surrounded on all sides by states with established emerald ash borer (*Agrilus planipennis*) (EAB) infestations (**Figure 1**). For hardwood landowners, this is an unfortunate development, as EAB has killed hundreds of millions of ash trees (*Fraxinus* spp.) on its way to becoming the most economically damaging insect ever introduced to North America (Herms and McCullough 2014) (**Figure 2**). While it is impossible to predict if or when EAB will reach Mississippi, there is no reason to believe it will not invade the state. Consequently, it is time to focus on what this means to landowners and steps that may lessen the impacts of EAB in Mississippi.

Figure 2. An adult emerald ash borer emerges from an infected ash tree.

Understanding the biological background of EAB is critical for making prudent management decisions. EAB is considered an exotic invasive species because it is not native to North America and, as a result, ash has not developed a natural defense to stop its attack. Fortunately, EAB has relied almost exclusively on ash species as a food source. However, in 2014, EAB was detected in white fringe tree (*Agrilus planipennis*). Outside of this additional species, EAB has not been found in any other North American species, suggesting that other commercially valuable tree species, such as oaks (*Quercus* spp.) and pines (*Pinus* spp.), are not at risk. Although individual species of ash differ in their attractiveness to EAB, all species are eventually attacked and killed. Tree size does not seem to be a mortality factor, as trees across a range of diameter sizes have been attacked. For these reasons, we encourage landowners to consider removing ash from their future management plans.

Some landowners may be tempted to immediately harvest their ash. If mature ash sawtimber represents a large component of your stand (more than 25 percent), harvesting should probably be considered. However, in most situations, ash is not the predominant species within stands, making the harvesting decision more difficult. In these far more common situations, several factors should be considered before deciding to harvest.

One important consideration is the regeneration potential of your stand. For landowners whose primary management objective is generating income, replacing ash with another economically valuable species is important for maintaining forest value. Ideally, desirable seed sources, stump sprouts, and advance regeneration will be available to naturally regenerate the stand. In stands where this is true, removing ash can provide income that could be used to shape an economically desirable future stand through natural regeneration and timber stand improvement (TSI). Unfortunately, due to decades of high-grading (cutting the best trees and leaving those of lower quality and less desirable species) and low shade tolerance of many preferred economic species, desirable natural regeneration potential is often lacking. In addition to these factors, ash is a prolific sprouter and frequently produces large seed crops, making it difficult to economically eradicate from a stand for management purposes. Cumulatively, these factors result in a situation where many landowners will be forced to rely on herbicides and artificial regeneration (planting or seeding) of alternative species in order to preserve future value of their stands.

It is important to consider species site relationships whenever regeneration is attempted. Hardwood seedlings are more sensitive to site conditions than pines. For this reason, landowners planting alternative species for replacement of ash should familiarize themselves with specific requirements of individual species. This is especially true for bottomland sites, where soil fertility and hydrology can vary greatly over relatively short distances. Below, we identify some economically valuable species that can be planted to compensate for loss of ash from hardwood forests. In addition, we will discuss important site requirements for these species and some common issues encountered in artificial regeneration.

## Upland Planting Considerations

The oak group contains several options for replacing ash in upland hardwood stands. Planting in the correct light environment is critical for oak establishment. Oak seedlings are capable of surviving at light levels as low as 20–30 percent sunlight. Think of this amount of light as what one would see on a shady, but not overly dark, hardwood forest floor. Research has shown, however, that oaks grow best on sites recieving between 30 and 50 percent sunlight. This relates back to the growth strategy of oak, which prioritizes root growth over height growth early in life. Planting oaks in intermediate light environments, such as described above, provides oak seedlings with enough light to build root systems, but not enough to facilitate rapid growth of competing herbaceous and/or early succession woody species, which prioritize early height growth above all else. Providing oaks with favorable light condtions is only part of the planting equation. It is equally important to plant seedlings on a well suited site. Landowners should be aware that planting a seedling on a high quality growing site does not necessarily increase its odds of survival. This is because survival ultimately depends on a seedling's ability to compete under ambient conditions, in addition to its stress tolerance. **Table 1** lists information on site characteristics for ash and some suggested alternative species.

**Table 1. Preferred physiographic positions and site conditions for ash and financially valued alternative species.**

| Species | Common Upland Site Characteristics | Soil Texture | pH Range |
|---|---|---|---|
| white ash | rich, moist, well-drained upland soils | fine–coarse | 5.0–7.5 |
| green ash | moist upland soils | medium–coarse | 5.0–8.0 |
| northern red oak | north slopes with deep soils | fine–medium | 4.3–6.5 |
| shumard oak | terraces or deep upland soils, especially loess hills | medium–coarse | 5.8–7.6 |
| black oak | dry upland sites; best on lower slopes | fine–coarse | 4.5–6.0 |
| southern red oak | dry upland sites and broad ridges | medium–coarse | 4.2–6.0 |
| scarlett oak | poor, dry soils and upland ridges | medium–coarse | 4.5–6.9 |
| white oak | all upland sites except extremely dry, shallow soil ridges | medium–coarse | 4.5–6.8 |
| loblolly pine | all but the driest soils | fine–coarse | 4.5–7.0 |
| shortleaf pine | dry, rocky upland soils | fine–coarse | 4.0–6.0 |

Source: Burns and Honkala 1990.

White ash (*F. americana*) and green ash (*F. pennsylvanica*) are the most common upland hardwood ash species in Mississippi. Both species prefer moist upland soils. However, both can also occupy drier upland sites. Thus, landowners should recognize that multiple oak and pine species may be needed to fill the niche left behind by ash. Landowners should also understand that stands often contain several different types of growing sites. As such, a one-size-fits-all approach is often not appropriate. Below are planting suggestions for different types of growing sites.

## *Upland Sites*

*Xeric (Dry) Sites*

Xeric sites are defined by low moisture and nutrient availability. Physiographic locations typically considered xeric include ridges and south- or west-facing slopes. Sites that have a thin A-horizon (topsoil) or sandy texture are also considered xeric. Replanting on xeric sites will probably be unnecessary because ash is fairly uncommon on such sites. If you happen to have ash on xeric sites, planting containerized seedlings may be a better option than bare-root seedlings. Although they are typically at least twice the cost of bare-root seedlings, containerized seedlings often survive drier planting sites better because they have more developed and undisturbed root systems. For xeric sites, we recommend planting southern red oak (*Q. falcata*), white oak (*Q. alba*), or scarlett oak (Q. coccinea). Alternatively, if you prefer a mixed-pine hardwood stand, loblolly pine (*P. taeda*), shortleaf pine (*P. echinata*), or a combination of oak and pine can be planted. If site conditions are excessively dry, shortleaf is a better option than loblolly. Regardless of species planted, landowners should be aware that trees will grow slower on xeric sites because of their relative lack of resources (lower site index).

*Mesic (Moist) Sites*

In contrast to xeric sites, mesic sites feature higher moisture content and nutrient availability. Physiographic locations typically considered mesic include north- and east-facing slopes and mid-slope to lower-slope locations. Sites with deep, well-drained soils, like the loess hills, are also thought of as being more mesic than xeric. Ash is generally most prevalent on mesic sites. Consequently, mesic sites are where the greatest amount of ash replacement will occur. Given greater moisture and nutrients available on mesic sites, bare-root seedlings typically survive well. Extra costs associated with containerized seedlings are not necessary unless late-season planting is necessary. Commercial species best suited for planting on mesic sites include northern red oak (*Q. rubra*), white oak, black oak (*Q. velutina*), Shumard oak (*Q. shumardii*), and loblolly pine.

## Bottomland Planting Considerations

There are some unique factors that must be considered when attempting to artificially regenerate bottomland sites. First, species-site relationships are very important and will be discussed thoroughly in the next section. After carefully choosing species based on soil information, you should consider other site variables.

As with upland sites, light is necessary when establishing new stands. Depending on which alternate species is selected, appropriate light levels will range between 20 percent and full sunlight. Many individuals will opt to plant oak species if forced to convert former ash stands. As previously mentioned, oak natural regeneration is maximized at 50 percent full sunlight. Planted oak seedlings will actually grow best at light intensities greater than 50 percent light, but herbaceous vegetation inherent to bottomland sites often overtakes planted seedlings if shade is not present. Seedlings need a period of time to establish competitive root systems before overshadowing canopy trees are removed.

Green ash is by far the most common bottomland ash species; however, pumpkin ash (*F. profunda*) may be encountered occasionally growing on sites too wet for green ash. Bottomland forests have a range of unique sites. Consequently, each of these sites warrants a different planting mixture as it is encountered. As with uplands, bottomland sites should not be planted using a blanket planting mixture. A variety of species will be appropriate or inappropriate depending on the individual planting site. Below are suggested species to plant on bottomland sites.

### *Bottomland Sites*

Site variation within bottomland systems is driven primarily by topography, which influences a multitude of other site variables, including drainage class, soil moisture, texture, structure, pH, and vegetation. Differences in elevation and parent material change as soil particles suspended in flowing water are deposited across the floodplain. Research has shown elevation differences as small as 6 inches can completely change a site's ability to sustain a given species. There are some differences between major and minor bottoms. Major bottoms (i.e., river bottoms) will typically possess greater soil variability, and minor bottoms (i.e., creek bottoms) will typically be more uniform with less soil variability. In addition, the physical distance among topographic positions can be compressed in minor bottoms with some topographic features being completely absent. Both can be highly productive when species are matched to site capability, and both are capable of growing similar species on proper topographic positions. **Figure 3** below shows the typical topographic positions and their placement within a major floodplain.

While some hardwood species are capable of surviving and growing on a wide range of sites, others can survive only on very narrow ranges of site conditions. **Table 2** describes individual topographic positions and lists potential hardwood species to replace ash. All alternate species presented are not commercially desirable, but they are capable of surviving on these sites. Depending on goals, commercially undesirable species may or may not be considered as viable options for planting.

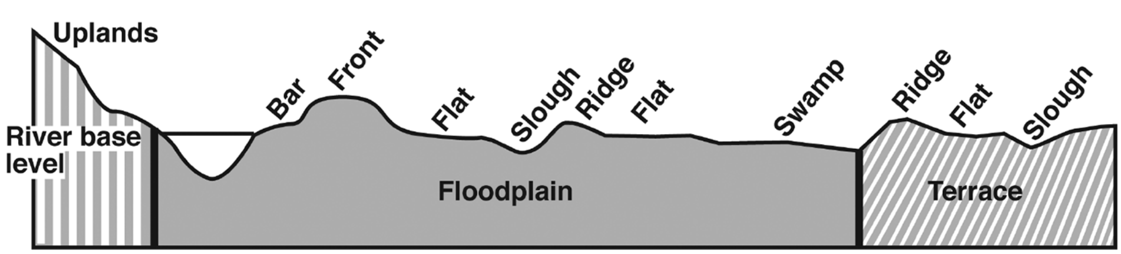


Figure 3. A typical floodplain. Source: Mississippi State University Extension Service Publication 2004 Bottomland Hardwood Management Species/Site Relationships.

**Table 2. Site suitability by topographic position of major and minor bottoms.**

| Topographic Position | Desirable/Suitable Species | |
|---|---|---|
| | **Major Bottoms** | **Minor Bottoms** |
| bars | eastern cottonwood, black willow | river birch, black willow |
| fronts | eastern cottonwood, American sycamore, sweetgum, pecan, green ash, water oak, cherrybark oak, swamp chestnut oak | cherrybark oak, Shumard oak, American sycamore, sweetgum, yellow poplar |
| ridges | willow oak, water oak, sweetgum, American sycamore, green ash, cherrybark oak, swamp chestnut oak | cherrybark oak, Shumard oak, swamp chestnut oak |
| high flats | Nuttall oak, green ash, sugarberry, willow oak | cherrybark oak, water oak, willow oak, Shumard oak, swamp chestnut oak |
| low flats | overcup oak, water hickory, green ash, common persimmon, sugarberry | willow oak, overcup oak, common persimmon, green ash |
| sloughs | overcup oak, black willow, water hickory | overcup oak, common persimmon |
| swamps | baldcypress, water tupelo | baldcypress, swamp tupelo, water tupelo |

Source: Mississippi State University Extension Service Publication 2004 Bottomland Hardwood Management Species/Site Relationships.

*Bars, Sloughs, and Swamps*

Bars are the first topographic position encountered when moving outward from a watercourse. They are typically very wet and flood regularly. Sloughs and swamps are both old stream channels that were left as the course of the creek or river moved. Drainage is inherently poor on these sites, and, because of their heavy clay soils and lower elevations, standing surface water will be encountered for much of the year. Bars, sloughs, and swamps are not considered ash-capable sites. Thus, further discussion of ash replacement is not warranted for these sites.

*Fronts*

Fronts are generally considered the best sites in the floodplain for tree growth. Fronts are formed when streams overflow, water velocity decreases, and immediate deposition of sediment starts to occur. These are the highest sites, have the best drainage, and stay flooded only in extreme flood events. Most hardwood species will grow on front sites. However, eastern cottonwood (*Populus deltoides*) is typically the primary species found on these sites. This is because cottonwood grows fast and has a vertical leaf orientation, which allows plenty of light for other species to regenerate in the understory. Ash is not typically considered a front species, but, in some cases, it can comprise a significant portion of the overstory. In situations where ash is 25 percent or more of the stand, suitable replacement species include sweetgum (*Liquidambar styraciflua*), pecan (*Carya illinoinensis*), water oak (*Q. nigra*), cherrybark oak (*Q. pagoda*), Shumard oak, and swamp chestnut oak (*Q. michauxii*).

*Flats*

Flats are flat expanses between the front and a ridge or between ridges. Soils are typically clays with somewhat poor to poor drainage. However, an important aspect of flats is the absence of standing water for most of the growing season. Depending on elevation in relation to the drainage capability of the soils, flats may be classified as high or low. These sites are not as productive and are of lower quality than the front or ridges. Subsequently, the most desirable species (for timber management) are not suited for these sites. However, there are suitable replacement species for ash. On high flats, landowners should consider Nuttall oak (*Q. texana*) and willow oak (*Q. phellos*). If the flat is dry enough (i.e., minor bottoms), cherrybark oak, water oak, Shumard oak, and swamp chestnut oak might be viable alternatives. When considering ash replacement on low flat sites, water oak, Nuttall oak, overcup oak (*Q. lyrata*), and common persimmon (*Diospyros virginiana*) are all capable of surviving increased soil moisture typically found on these sites.

*Ridges*

Ridges are simply old fronts and are excellent sites. Ridges typically rise 2 to 3 feet above the flats and have coarser soils than flats. Consequently, drainage is better, and these sites are capable of sustaining more commercially attractive species. These sites are capable of growing the same oak species as discussed in the fronts section above.

## Potential Problems

### *Shade-Tolerant Midstory*

A unifying characteristic of all the discussed alternative species is their relative intolerance of shade. Oak seedlings perform best between 30 and 50 percent light, while pine species require higher light environments. This is why planting in a relatively open environment is important.

One factor that often causes problems for light-seeking species is that of a shade-tolerant midstory species. As a result of decades of fire exclusion and high grading, shade-tolerant species often dominate the midstory. This is important to financially driven landowners, as most shade-tolerant species have little economic value. Harvesting ash in the presence of an established midstory will do little to create the preferred light environment for your desired alternative species. Instead, in most cases, harvesting will simply release undesirable midstory stems, setting the stage for lower timber revenues. For this reason, treating the midstory before harvesting is a good management practice.

Midstory injection is the easiest, most effective, and cheapest tool for eliminating large, undesirable stems due to the prohibitive expense and risk of non-target stem damage if using mechanical removal. Moreover, midstory injection will prevent residual sprouting, which can also be problematic when competing with shade-intolerant seedlings. For more information on midstory injection, see MSU Extension Publication 2942 *Tree Injection for Timber Stand Improvement*.

### *Herbaceous Vegetation*

Outside of properly matching species to the site, competing vegetation is possibly the most influential factor in hardwood planting failures. Both herbaceous and woody competition may pose a threat to survival of planted seedlings, with herbaceous competition posing the greatest threat during the first years of establishment. While woody competition from resprouts, new germinants/advanced regeneration, and midstory stems may pose substantial competitive problems on some sites, significant levels of herbaceous competition will be encountered nearly every time planting is to occur on hardwood sites. Chemical site preparation can provide excellent short-term control of competing vegetation. This is especially true if control of competing woody species is needed; however, chemical site preparation should be used only to control species that cannot be eliminated through growing-season herbaceous weed control efforts. It is these herbaceous applications that typically provide longer-term control of competition if the proper herbicide is used. Chemical site preparation is of limited value if it does not control vegetation throughout the majority of the first growing season. Thus, when chemical control is deemed necessary to control existing on-site vegetation, it should be part of a herbicide regime that includes the seedlings' first growing season.

Increased growth and survival of hardwood seedlings planted in areas treated with broad-spectrum pre-emergent herbicides is well documented. Increases in survival average 25 to 30 percent greater than in untreated areas. Multiple herbicidal treatments have been tested, and specific herbicide recommendations can be found in MSU Extension Publication 2873 *Herbicide Options for Hardwood Management*.

### *Invasive Species*

Another potentially serious problem with replacement of ash is the possibility of invasive plant species encroachment. Harvesting operations provide prime opportunities for establishment of invasives, as they expose bare mineral soil and increase resource availability. Harvesting and logging equipment can also transport seeds and rhizomes between sites, further increasing odds of an invasive spread. While not all invasive species are strong competitors on harvested sites, several already established in Mississippi prefer such conditions. Once established, species such as cogongrass (*Imperata cylindrica*), Chinese tallow (*Triadica sebifera*), and privet (*Ligustrum* spp.) will aggressively occupy growing space. This can be very problematic for competition with oaks and pines.

Close monitoring and decisive action are key for minimizing invasive species impacts. It is a sound management practice to search for existing invasive species before and after any kind of harvesting. Treating invasive species prior to harvest is strongly encouraged, as most invasives are harder to control in full sunlight conditions. Another advantage of treating early is that a greater selection of herbicides will be at your disposal compared to post-planting treatments. After planting, it is still a good idea to check your property for invasive establishment, as invasives are typically easier to treat while young. Control recommendations for some of the more commonly encountered invasive plant species can be found in MSU Extension Publication 2873 *Herbicide Options for Hardwood Management*.

## Summary

The impending arrival of the emerald ash borer is an important development for hardwood management in Mississippi. Due to EAB's host preference, stands with high concentrations of ash are in the greatest danger. While it is impossible to predict when and where EAB will arrive, stands with ash constituting more than 25 percent of merchantable sawtimber carry the greatest immediate financial risk. Preemptive harvesting is one way to generate income and mitigate risk. However, there are several factors to consider before taking this step, including future regeneration potential, herbaceous vegetation, midstory competition, and invasive species. In most situations, maintaining future value through natural regeneration will not be an option. Planting or seeding can be used to overcome existing regeneration deficiencies. However, landowners need to remember that hardwoods are more sensitive to site conditions than pines. Consequently, site variables should be considered when selecting alternative species.

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