# Allegheny National Forest

## Silviculture Prescription Guidance for addressing Beech Bark Disease, Emerald Ash Borer and Hemlock Woolly Adelgid

**April 2014 revision**

The following discussion provides some guidance for managing forested stands on the Allegheny National Forest (ANF) given numerous forest health threats and limited resource availability.

For all species threatened by a serious forest pest or disease (pathogen), ANF silviculturists need to reduce (but not eliminating) host abundance as part of their silvicultural prescriptions. This is true for ash in the face of EAB, hemlock in the face of HWA (though there is less emphasis here due to much lower economic value- but same concepts apply), and for American beech given the beech bark disease complex.

Given the number of serious forest health concerns on the ANF, the overall age of the forest and age class imbalance, silvicultural emphasis should be on balancing age class distribution and sustaining forest health. Thinning should only be prescribed in rare situations where small-diameter (< 12 inches average merchantable stand diameter) stands that are overstocked.

**Hazard tree management and fuel loading needs to be monitored and addressed as these species and other trees on the ANF die.** Hazards trees along public roads and campgrounds will need to be monitored and removed as necessary. Fuel loading will be of particular concern for denser hemlock stands once eastern hemlocks die from hemlock woolly adelgid infestations. It may be necessary to reduce fuel loads in some area, particularly those near structures and other improvements.

## American Beech and Beech Bark Disease:

The beech bark disease (BBD) complex has been present on the ANF since the early 1980s, steadily progressing south and west from the northeastern corner of the ANF, and now covers the entire forest (see Figure 1).

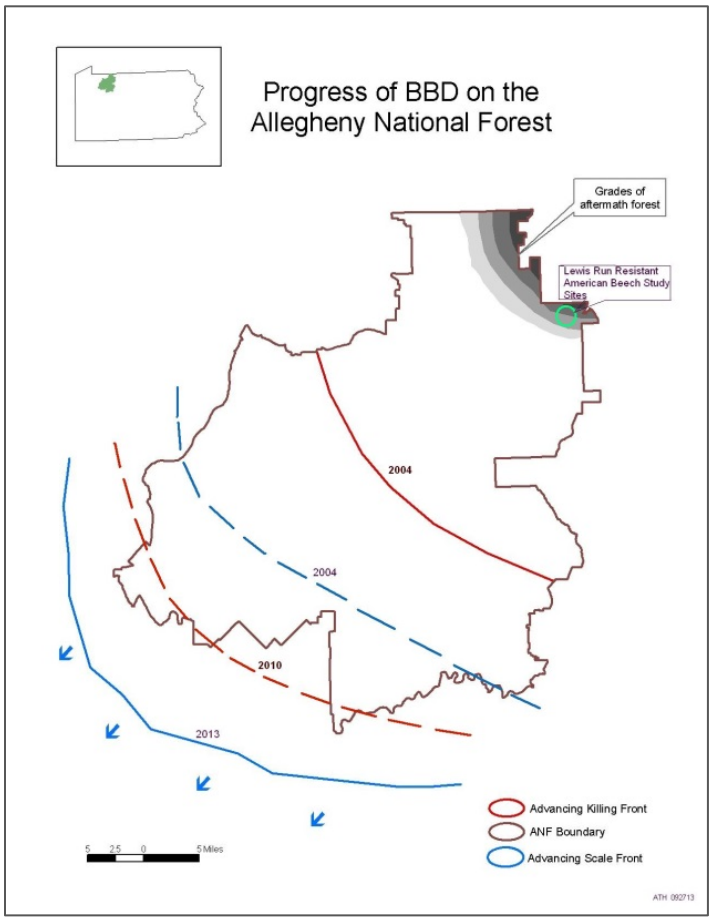


**Figure 1: Spread of Beech Bark Disease across the Allegheny National Forest**

There are some key points to bear in mind when considering management of American beech on the landscape and as part of a silvicultural prescription.

- The disease complex tends to attack the largest beech trees first.
- During the first wave of the infestation (1991-2003) in the northeastern portion of the ANF, over 2/3 of the beech basal area died, predominantly in the largest size classes.
- Subsequent waves of scale populations will infest smaller diameter trees over time, down to the sapling size class.
- Prolific root suckers develop following mortality of mature trees, and these root suckers are genetically identical to their “parent” trees, and likewise susceptible to the disease complex.
- We estimate 1-5 percent of American beech on the ANF will be resistant to the disease complex in the long term (Koch, personal communication 2013).

## Project Level Recommendations:

Similar to species at risk from other pests, we need to evaluate, monitor and address American beech stocking and health across the ANF. As part of this, prioritize areas for treatment in order to direct species composition, maintain forest health, and achieve LRMP desired goals, objectives and conditions.

Prioritize stands for treatment, first addressing those stands where commercial value of beech can be recovered, where other species are present in sufficient quantity and distribution to regenerate the stand. Lowest priority stands should be heavily impacted aftermath stands that will require substantial investment with low to moderate potential for desired outcomes (e.g. stand trajectory is too difficult to alter given lack of seed trees and abundance of beech brush in understory).

In all cases, efforts should be directed to reducing susceptible American beech abundance either through harvest or reforestation activities (in stand regeneration treatments), while featuring and promoting a diversity of other hardwood tree species in both the overstory and understory.

## Stand Level Recommendations:

The ANF strategy for addressing the beech bark disease complex focuses on reducing the abundance of American beech that is susceptible to BBD, both in the overstory and understory, in order to sustain a diversity of tree species and improve overall health of forests on the ANF.

The following is an excerpt from page 94 of the Forest Plan, with clarification/notes added in italics:

- Recognize the difference between the advancing (scale) and killing (nectria fungus) fronts of the beech bark disease complex. During management activities, the most current science and methods should be applied with the overall intent of increasing the component of beech that is resistant to the disease complex. ***We feel 1-5% may be resistant, so this will be a very small increase overall.***
- **Advancing Front**: In stands prescribed for harvest activity in the advancing front, identify susceptible American beech trees and designate them for removal during harvest activity. Favor leaving those beech trees that have characteristics indicating that they may be resistant to beech bark disease. ***In reality, potentially resistant trees are anticipated to be a very small percentage of the total beech- 1-5%. Silvicultural prescriptions in the advancing front should reduce host tree (beech) abundance and favor other species not threatened by such immediate forest health threats.***
- **Killing front (well established):** Retain healthy, scale-free, or lightly infested beech to provide mast and retain potential disease-resistant trees. Healthy trees should have full, healthy crowns, tight smooth bark, and no rot or cavities. They should not exhibit any scale (or only have light scale present), fungus, crown dieback, tarry spots, or puckered bark. ***The reference to having only light scale is specific to areas where the killing front is well established, not the advancing front.***

## Potentially healthy American Beech:

Potentially healthy American beech should have full, healthy crowns and tight, smooth bark, and only very light scale present, if at all (Mielke et al 1986). The best of these beech trees should be considered for retention in the advancing front. In the killing front, where all other beech have died, these trees have a high likelihood of being resistant and should be retained.

Bob White, USDA Forest Service (retired) stands by a healthy American Beech

## Susceptible American Beech:

Susceptible American beech may have any of the following: more than trace scale population, tarry spots, nectria fruiting bodies, puckered and cracked bark, yellowing crowns, and loss of fine branches. Silvicultural prescriptions on the ANF should specify that these beech trees be identified and removed.

***Tarry Spots from BBD.***
Photo by Joseph O'Brien, USFS

**Nectria Fruiting Bodies.**
Photo by Joseph O'Brien, USFS

**Beech scale**
Photo by Ontario's Invading Species Awareness Program

## Green and White Ash and Emerald Ash Borer:

Similar to beech, we need to be reducing ash basal area in all of our silvicultural prescriptions, while favoring other species less immediately threatened by forest pests and diseases. Emerald ash borer (EAB) was confirmed on the ANF in 2013, and was likely established several years before the 2013 detection.

EAB is a very efficient killer of ash trees; it will likely kill the vast majority of ash in our forest regardless of how many ash trees are present. This will happen very quickly once EAB arrives. Once EAB shows up in a stand, we can expect the first dead trees to begin to show in about 4 years. After about 6 years, mortality will approach 100%.

Overall, ash species comprise around 2.5% of the basal area on the ANF. However, it occurs in higher concentrations in some areas on the ANF, such as near the Allegheny Reservoir, Allegheny and Clarion Rivers, and in the Greater Stickney and Queen Creek areas. We anticipate near 100% of the ash resource to die, beginning this decade. We need to evaluate the ash resource across the ANF and prioritize areas for treatment to reduce ash abundance, recoup economic value, and feature other tree species. This may or may not result in a separate project proposal and analysis.


**Emerald Ash Borer**. Photo by Leah Bauer


**Woodpecker damage and emerald ash borer larvael galleries**. Photo by Kenneth Law

## Slow the Spread

Silvicultural treatments that are designed to enhance the growth of non-ash species or regenerate non-ash species can decrease the impacts of EAB. Evidence of EAB has been present in the ANF region since 2010. Treatments designed to decrease the amount of ash will be most effective if these treatments are applied well before EAB infestations are present. These treatments can be done during normal timber sale treatments where ash exists. Removal of the largest ash in the stand has the most benefit as the largest ash provide the greatest amount of phloem (EAB feeding area) while maintaining the ash genetics within the stand by reserving some of the smaller ash.

## Recommendations

The following recommendations are derived from the Eastern Region Ash Management Strategy (USDA-FS 2009) and a presentation on ash management by Ned Karger of the Collins Pine Company (Karger, 2011). In addition to these silvicultural recommendations, the ANF will identify high value ash (e.g. in campgrounds) and develop integrated pest management strategies that include cultural, biological, and pesticide measures to maintain high value ash health and address hazard trees. Ensure hazard tree assessments in developed recreation areas and high use areas monitor ash health and promptly remove dead and dying ash trees. Ash trees will not stand long following mortality. Some of these trees may be removed through small salvage or stewardship sales, to recover economic value of ash.

**In all harvest areas**

- Reduce stand vulnerability to EAB by removing ash phloem
- Create a more diverse forest resource that is resistant to catastrophic changes affecting a single species or genera.
- Do not eliminate ash, but keep future hazard trees in mind when marking first entry sales.

**Where ash comprises 10% or less of stand stocking (most cases)**

- Use standard silvicultural treatments such as thinning, shelterwood seed cuts and/or single/group tree selection harvests to reduce stand stocking to prescribed levels. Focus marking on the largest ash trees in the stand, treating them as risk trees. Do not eliminate ash from the stand but focus on leaving the smaller diameter ash. Species diversity and retention of some ash genetic material are still important to the future stand.

- When creation of snags is prescribed, only consider ash as a future snag (do not girdle to kill ash). It should be assumed that all the ash will become snags in the future, so plan accordingly. If there is a component of ash in the stand there is likely no need to create snags for the short term. Note, however, that ash trees decay and fall within a few years of mortality.

- When creation of large woody debris is prescribed, use ash as the resource.

When ash comprises 10%-30% of the stand stocking, or when ash, beech, and hemlock in combination comprise more than 30% of overall stand stocking, and diameter is less than 12 inches, thin stand, removing ash, beech and hemlock.

When ash comprises 10%-30% of the stand stocking, or when ash, beech, and hemlock in combination comprise 10-30% of overall stand stocking, and diameter is greater than 12 inches, consider an integrated thinning, to remove ash, beech and hemlock.

When ash comprises more than 30% of stand stocking, or when ash, beech, and hemlock comprise more than 30% of stand stocking, consider regenerating the stand. When preparing marking guidelines and implementing the shelterwood seed cut, emphasize removal of most ash, all susceptible American beech, and most hemlock, in order to feature seed trees of other species in order to regenerate the stand to a diversity of hardwood species. Encourage regeneration of a diversity of species such as black cherry, red maple, oaks, basswood, aspen, sugar maple, cucumber tree, white pine, etc. Allow ash regeneration to develop but do not make investments in promoting ash regeneration.

In all of these treatments, do not eliminate ash from the stand but focus on leaving the smaller diameter ash. Species diversity and retention of some ash genetic material are still important to the future stand.

# Disposing of ash products

Due to quarantines and movement restrictions associated with ash, it is important that timber sale prospectus packages reflect this and that all ANF sale administrators are aware of quarantines.

# Monitor stands for “lingering ash”

Recent research suggests that a very small percentage of the ash in a stand will remain healthy for at least a few years after most of the ash is infested or dead. There is a possibility that some of these

"lingering ash" may have some natural resistance or tolerance to EAB. This is being investigated by Jennifer Koch and Therese Poland of the NRS. Look for lingering ash and record their locations. If they produce seed, collect it and submit it for preservation following the instructions in the 2009, version of the Eastern Region Ash Seed Collection Guidelines.

# Do not plant ash

Native ash species should not be planted. Situations that are appropriate to plant ash species will be determined in the future. Ash may be planted as part of research projects related to EAB or genetics work related to EAB.

## Eastern Hemlock and Hemlock Woolly Adelgid:

Consider and address hemlock health and abundance when prescribing treatments on the ANF. Hemlock woolly adelgid (HWA) was confirmed in 4 separate locations on the ANF during calendar year 2013. HWA is much slower spreading than emerald ash borer, but is expected to similarly result in high mortality levels for eastern hemlock on the ANF, beginning in the coming decade.


**Hemlock Woolly Adelgid.** Photo by Michael Montgomery


**Hemlock woolly adelgid-caused Crown dieback.** Photo by James Johnson

Increased hemlock mortality (in HWA infested stands) may follow a mild winter that is followed by a dry summer, as research has shown these factors to be highly linked (Estruth et al. 2013). In general, there is a higher likelihood of hemlock dying within a year if crown dieback exceeds 30% or if foliar transparency exceeds 35%. Research is also being conducted on whether preemptive thinning of un-infested hemlock stands may boost tree vigor (Fajvan 2007).

# Recommendations

In addition to the silvicultural recommendations below, the ANF has worked with partners to identify high value hemlock conservation areas across the landscape and will develop integrated pest management strategies that include cultural, biological, and pesticide measures to maintain hemlock health in priority conservation areas. These recommendations are consistent with, and in part derived from, direction provided in the draft Pennsylvania Conservation Strategy (Faulkenberry et al. 2013).

Outside of hemlock conservation areas, in areas heavily stocked with hemlock that are operable for harvest and skidding equipment, prescribe thinning and stand regeneration treatments as appropriate.

Thinning treatments should be applied where a well distributed overstory of hardwoods with at least 70% healthy stocking is present. In these stands, reduce the abundance of hemlock, retaining some hemlocks that are in a codominant crown position with at least 30% live crown ratio. Hemlocks with higher live crown ratios (i.e., tree vigor) have been shown to better survive hemlock woolly adelgid infestations (Fajvan and Wood 2009). Hemlock health/vigor does not predict susceptibility to hemlock woolly attack, but may enable the trees to survive longer once infested. Trees with live crown ratios of 30% and less should be targeted for removal. For more information on live crown ratio and how to measure it see Schomaker, et al.

Stands heavily stocked with hemlock that contain less than 60% stocking in healthy, well distributed hardwoods should be considered for regeneration. When preparing marking guidelines and

implementing shelterwood seed cuts, emphasize removal of most hemlock and all susceptible American beech. Feature seed trees of other species to regenerate the stand to a diversity of hardwood species. Do not eliminate hemlock from the stand but focus on leaving some hemlock (e.g. 5 feet of basal area/acre) in codominant or intermediate crown positions with live crown ratios greater than 30%. Species diversity and retention of some hemlock genetic material are still important to the future stand.

## Monitor stands for "lingering hemlock"

Recent research suggests that a very small percentage of hemlock may survive hemlock woolly adelgid infestation for decades. There is a possibility that some of these "lingering hemlock" may have some natural resistance or tolerance to EAB. This is being investigated by scientists with the NRS. Look for these lingering hemlock trees and record their locations. If they produce seed, collect it and submit it for preservation following the instructions developed by Camcore (Jetton et al. 2013).

## Do not plant eastern hemlock- plant replacement conifer

Eastern hemlock should not be planted at all, as hemlock woolly adelgid infests hemlocks of all size and age classes. Efforts should be made to plant replacement conifer in high value hemlock areas. See Appendix A for a comparison of potential hemlock replacement species.

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# Appendix A
# Species Considerations for Conifer Planting

### FSM 2070, Vegetation Ecology, definition of native plant species:

**Native plant species:** A plant species which occurs naturally in a particular region, state, ecosystem and habitat without direct or indirect human actions.

### R9 Supplement to FSH 2409.17, Silvicultural Practices Handbook, Chapter 2, Reforestation:

"Planting of nonnative species to fill the function and structure of native species that have been devastated is not desirable and must be approached with great caution. An example where this might be tempting is when hemlock trees have been killed by woolly adelgid. Such practices need careful NEPA analysis and Regional Silviculturist involvement."

### Species Considerations for Conifer Planting on the ANFi

| Species | Habitat Characteristics | Present Distribution* | Site Requirements | Shade Tolerance/ Growth | Deer Palatability/ Browse Tolerance | Pest / Disease/ Pollution Considerations | Other Considerations/ Climate Change Projections |
|---|---|---|---|---|---|---|---|
| Red Spruce *Picea rubens* | Lacking lower limb structure and thermal characteristics of hemlock. Best replacement species for northern flying squirrel, as it supports lichens (bryoria fremontii) required by northern flying squirrel for food and nesting material. | North of PA, and higher elevations in northern Appalachian mountains. Specimens in McKean County | Higher elevation, good moisture regime. Grows well on poor sites, acidic and shallow soils preferred. | Tolerant- Very Tolerant. Long-lived (350-400 years), slow growing. | Browsing occurs, but not preferred browse. | Spruce budworm, eastern spruce beetle, eastern dwarf mistletoe. Potentially sensitive to pollution (sulphur dioxide, nitrogen oxides and ozone). | Suitable habitat projected to occur north of ANF region in climate change models. |
| White Spruce *Picea glauca* | Retains lower limbs. | North of PA with specimens in a few counties south of the ANF. Planted on the ANF in the past. | Tolerant of wide range of sites in northern North America, from moist to dry, alkaline and acidic. | Intermediate shade tolerance. Long lived (250-300 years) | Not preferred as browse. | Can be susceptible to frost heaving. Seedlings can be damaged by rodents. Spruce budworm. European spruce needleminer. Tomentosus root disease. Various bark and wood boring beetles. | Considered a hardy tree. Strong affinity to local environments. Suitable habitat projected to occur in northern New York state and New England in climate change models. |

| Species | Habitat Characteristics | Present Distribution* | Site Requirements | Shade Tolerance/ Growth | Deer Palatability/ Browse Tolerance | Pest / Disease/ Pollution Considerations | Other Considerations/ Climate Change Projections |
|---|---|---|---|---|---|---|---|
| Black Spruce *Picea mariana* | Small dbh at maturity, retains lower limbs, shallow rooting. | North of PA with specimens in Tioga County | Moisture regime important, prefers dark brown peat, boggy areas and wet organic soils. Common in swamps or bogs. Pioneer species. | Tolerant. 200 year lifespan typical. | Not preferred as browse. | Eastern dwarf mistletoe, spruce budworm, bud and needle rusts. | Not a large tree, usually planted in pure stands. Suitable habitat projected to occur north of Canadian border in climate change models. |
| Balsam Fir *Abies balsamea* | Retains Lower Limbs, Fairly small crown area. Provides food and cover for wildlife. Second best species for northern flying squirrel. | Generally north of PA, and higher elevations in Appalachian mountains. Specimens in Warren County | Abundant moisture required, slightly acidic sites. | Very Tolerant. Slow growing, 80 year lifespan typical. | Browsing occurs, but not preferred browse. | Balsam wooly adelgid. Intermediate sensitivity to sulphur dioxide and tolerant of ozone. | Suitable habitat projected to occur north of ANF region in climate change models. |
| Pitch Pine *Pinus rigida* | Lacking lower limb structure and thermal characteristics of hemlock. | Native to ANF and surrounding counties. | Dry, low quality sites- poor sandy soils. Mineral soil seedbed essential for regeneration. Pioneer species. | Intolerant. 200 year lifespan typical. | Limited to seedlings and sprouts. | Syrix wood wasp and various wood boring bark beetles. | Very good at surviving injury, has the ability to "green up" after fire or pests. Suited habitat not projected to migrate northward as much as other species in climate change models. |
| Virginia Pine *Pinus virginiana* | Lacking lower limb structure and thermal characteristics of hemlock. | Generally south of ANF and northern PA. Specimens in Potter County. | Requires well drained sites, prefers poor sandy soils. Mineral soil seedbed essential for regeneration. | Intolerant. 100 year lifespan typical. | Not preferred as browse. | Syrix wood wasp and various wood boring bark beetles. Sensitive to air pollution (ozone). Meadow mouse girdling. | Grows well in old fields, pioneer species, successful competitor. Suitable habitat projected to migrate northward into ANF region in climate change models. |

| Species | Habitat Characteristics | Present Distribution* | Site Requirements | Shade Tolerance/ Growth | Deer Palatability/ Browse Tolerance | Pest / Disease/ Pollution Considerations | Other Considerations/ Climate Change Projections |
|---|---|---|---|---|---|---|---|
| Eastern Redcedar *Juniperus virginiana* | General Bush-like appearance, may lose lower limbs in forest grown areas. | Widely distributed through eastern and Midwestern U.S. Specimens in Forest County, but separate from ANF. | Can grow on a wide variety of conditions, prefers deep, moist, well drained sites. Prefers calacareous soils. | Intolerant-Very Intolerant. 150 year lifespan typical. | Intermediate preference/ Tolerant | Cedar gall. Tolerant of air pollution (sulphur dioxide and hydrogen fluoride). | Pioneer species. Can tolerate drought and temperature extremes. Suitable habitat projected to migrate northward into ANF region in climate change models. |
| Red Pine *Pinus resinosa* | Lacking lower limb structure and thermal characteristics of hemlock. | Planted already on ANF, McKean County population. Generally native to counties east of ANF. | Dry sites but will grow on wetter sites. | Intolerant to very-intolerant. 200 year lifespan typical. | Not preferred/ Tolerant | Syrix wood wasp and various wood boring bark beetles. Sensitive to sulphur dioxide but tolerant of ozone. | Pioneer. Usually planted in pure stands. Suitable habitat projected to occur north of ANF region in climate change models. |
| Northern white-cedar *Thuja occidentalis* | General Bush-like appearance, may lose lower limbs in forest grown areas. Provides an abundance of food in cover for wildlife, especially in winter. | North of PA, mostly into Canada and Northern New England area. | Moist, nutrient rich sites, such as those along streams. Prefers calacareous soils. | Tolerant. Slow-growing, persistent. 300 year lifespan typical. | Preferred/ \ Not Tolerant | Carpenter ants/ Leafminers. Tolerant of sulphur dioxide and ozone. | Can withstand suppression for long time periods. Suitable habitat projected to occur north of Canadian border in climate change models. |
| Eastern White Pine *Pinus strobus* | Lacking lower limb structure and thermal characteristics of hemlock. | Native to ANF and surrounding states. | Well drained, drier sites, with coarse textured soils. | Intermediate. 200 year lifespan typical, but can be long-lived (450 years). | Preferred/ Not tolerant. | White pine weevil, syrix wood wasp, white pine blister rust. Sensitive to ozone and sulphur dioxide. | Grows rapidly and is considered an excellent tree for reforestation projects. Suitable habitat projected to migrate northward but still remain ANF region in climate change models (could consider more southerly genotypes). |

| Species | Habitat Characteristics | Present Distribution* | Site Requirements | Shade Tolerance/ Growth | Deer Palatability/ Browse Tolerance | Pest / Disease/ Pollution Considerations | Other Considerations/ Climate Change Projections |
|---|---|---|---|---|---|---|---|
| Shortleaf pine *Pinus echinata* | Lacking lower limb structure and thermal characteristics of hemlock. | South of ANF. Native to ridge and valley region of southeastern PA. | Wide range of sites from dry sites to deep well-drained soils. | Intolerant. 200 year lifespan typical. | Limited to seedlings and sprouts | Syrix wood wasp and various wood boring bark beetles. Intermediate air pollution sensitivity. | Pioneer- competes better on dry sites. Suitable habitat projected to migrate northward into ANF region in climate change models. |

*Note: Distribution column requires further work to separate indigenous from naturalized species.

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[1] References include:

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