ID-241

University of Kentucky
College of Agriculture,
Food and Environment
Cooperative Extension Service

After Your Ash Has Died

Making an Informed Decision on what to Replant

William M. Fountain, Horticulture, Ellen V. Crocker, Forestry, Lee Townsend, Entomology, Nicole Ward Gauthier, Plant Pathology

As a homeowner, even under the best of circumstances it can be challenging to know how to provide the best care for your trees. The arrival of the emerald ash borer to Kentucky has presented extra challenges. As the emerald ash borer rapidly kills young and old, healthy and struggling ash trees, homeowners must decide whether to save their trees with insecticides. Untreated trees will die and should be removed if there is a chance that their failure could result in harm to people or property. The question then arises: What should be planted to replace it?

Unfortunately the emerald ash borer is only the latest in a series of invasive pests that have recently decimated our trees. Here, we provide basic information on the death of our ash trees and what types of species are less likely to be impacted by invasive insects and diseases in the future.

The Loss of Two Giants

The year was about 1904. A fungus that became known as chestnut blight (*Cryphonectria parasitica*) was unintentionally introduced into the US on nursery stock imported from Japan. Within the coming decades it caused the death of 4 billion American chestnuts (*Castanea dentata*) growing throughout the Appalachian woodlands and eastern North American forests. American chestnuts were massive; clearly the largest species in eastern North America. They routinely reaching heights of 100 feet with trunks 14 feet in diameter. Their branches made up an estimated 25 percent of the canopy cover in parts of the east. The death of these trees had dire consequences for the ecology of the woodlands and wildlife that depended on their nuts for food. However, there was minimal impact to the urban landscape since this species was rarely found in cities.

A disease of elms was found in Europe and later brought to North America later in the same decade. Throughout the 20th century, millions of urban elms would die across North America and Europe. This disease became known as Dutch elm disease (DED), not because it came from the Netherlands but for the person who discovered it. It was actually three different but closely related diseases (*Ophiostoma ulmi*, *O. himalulmi*, and *O. novoulmi*). Like chestnut blight, DED was also introduced from Asia. This time the affected trees were the dominant species in the urban landscape.

The American elm (*Ulmus americana*) and related elms were planted extensively in cities during and after the Industrial Revolution. Elms were easy to grow and had high branching that allowed traffic to pass below a canopy that spread, providing cooling shade in the days before air conditioning. These trees were tolerant of urban pollution and compacted soils. They could live in wet or dry sites and in soils that were acid or alkaline. In effect, they were the perfect tree. This majestic tree lined entire streets, exceeding 50 percent of the total urban tree canopy in some cities. With the demise of the elms, people began looking for the best replacement. This is when the ash and red maple (*Acer rubrum*) became popular as urban trees.

Green ash (*Fraxinus pennsylvanica*), black ash (*F. nigra*), white ash (*F. americana*), and a few other species of ash replaced the American elm. The form of these trees was not as attractive but they were easy to propagate and grew rapidly in nurseries. In addition they tolerated the harsh urban conditions that prevented many other tree species from growing in our industrialized cities.

Mark Twain is often credited with the statement, "*History doesn't repeat itself but it often rhymes.*" The emerald ash borer (*Agrilus planipennis*) was unintentionally introduced into greater Detroit in the late 1990s. By 2016, hundreds of millions of ash trees native to North America and Europe were dead or dying and many millions more were threatened. Like chestnut blight and Dutch elm disease, this insect borer was an unintentional introduction from Asia. Three different problems were attacking three unrelated groups of plants. Our ability to see the connections and understand the problems can allow us to avoid making the same mistake as we replace our dying ash trees.

Continental Drift and Species Diversification

We need to look back about 200 million years ago to the breakup of large super continents. Laurasia formed North America, Europe, and Asia; Gondwana separated into India, Africa, South America, Australia, and Antarctica. Plant and animal life on both

was already very advanced. However, as the new continents drifted apart, different selection pressures sent evolution along very different survival paths. Consequently the chestnuts of North America and Europe were not exposed to the same diseases and plant feeders as the Asian species. The same is true for elms, ash and many other species. Accidental or intentional transcontinental movement of organisms can have devastating effects on native species that lack effective survival traits. We generally remain unaware of this worldwide problem unless we travel to these other areas and study their environmental challenges.

Offsetting the Negative Impact of World Trade

One strategy for preventing the next big insect or disease catastrophe is to avoid excess use of a species. Ideally, any one genus of plants should not exceed 5 percent or 10 percent of our landscape. If, or more likely when, a new pest is introduced into North America we do not want to see a rhyming of history as occurred with the chestnut, elm and ash. Developing a diverse landscape can prevent the staggering losses that occurred with the American chestnut, elm, and now our ash trees and the resulting loss in percent canopy cover. This practice also slows the spread of problems that inevitably develop. It gives green industry professionals time to develop pest management strategies. In addition it produces a more interesting landscape throughout the year.

Second, we should avoid the overuse of species that are found on all three former Laurasian continents: North America, Asia, and Europe. This includes some of the most common trees in our landscapes (Table 1).

Table 1. Common Kentucky landscape plants native to North America, Europe, and Asia with life-threatening disease/insect problems.

Genus (common name)	Number of species in genus (Genera in family/ total species in family)[1]
Abies (fir)	48 (11/255)
Acer (maple)	154 (137/1,751)
Amelanchier (serviceberry)	28 (104/4,828)
Betula (birch)	119 (6/234)
Carpinus (hornbeam)	42 (6/234)
Carya (pecan & hickory)[a]	27 (12/89)
Castanea (chestnut)	9 (9/1,101)
Cornus (dogwood)	45 (12/124)
Crataegus (hawthorn)	380 (104/4,828)
Fagus (beech)	11 (9/1,101)
Fraxinus (ash)	63 (25/688)
Juglans (walnut)	21 (12/89)
Juniperus (juniper)	75(32/166)
Larix (larch)	14 (11/255)
Liriodendron (tulip poplar)[a]	2 (6/250)
Magnolia (magnolia)[a]	242 (6/250)
Malus (apple/crabapple)	62 (104/4,828)
Picea (spruce)	40 (11/255)
Pinus (pine)	130 (11/255)
Platanus (sycamore)	9 (1/9)
Populus (poplar)	98 (54/1,269)
Prunus (plum, cherry)	254 (104/4,828)
Pyrus (pear)[b]	69 (104/4,828)
Quercus (oak)	597 (9/1,101)
Salix (willow)	552 (54/1,269)
Tilia (linden)	46 (245/4,465)
Tsuga (hemlock)[a]	10 (11/255)
Ulmus (elm)	40 (8/64)

[1] Nomenclature from: *The Plant List: A Working List of All Plant Species* (http://www.theplantlist.org/) accessed 18 July 2016.

[a] Native to North America and Asia, but not Europe

[b] Native to Europe and Asia, but not North America

Basic Principles of Pathogenicity

Some basic principals of pathology and entomology strongly influence the potential for a disease or insect to attack a host plant. Insects such as the Japanese beetle that feed on hundreds of different types of plants are rare. These lessons are:

- The larger the number of species in a genus, the larger the number of diseases and insects that are likely to attack these plants. (See Table 2.)
- Plants without close relatives are referred to as monotypic plants. They tend to have fewer disease and insect pests. (See Table 2.)
- A disease or insect pest is more likely to attack a plant species in the same genus than one belonging to a different genus. Likewise, a plant from a different genus in the same family is more likely to be attacked than a plant from a different family. Plants with close relatives on different continents are called disjunct species.
- The larger the number of species in a genus, the larger the number of diseases and insects that are likely to attack these plants. (See Table 1)
- Genera with few or no relatives that are native to other continents are less likely to have life-threatening problems. (See Table 2.)

Plums and cherries (*Prunus*), oaks (*Quercus*), and maples (*Acer*) are examples of genera with hundreds of species across all three Laurasian continents. These and similar groups of plants are widely used in landscapes in spite of having serious disease and insect problems.

Not all of these are large trees or aesthetic replacements for American elm and ash. Some have traits, including the potential to be invasive, that may make them unsuitable for use in specific landscapes. Evaluate and match the cultural conditions of the site with the cultural requirements of the plant.

There is no such thing as a perfect plant. Species listed in Table 3 are acceptable for use in urban landscapes but should not exceed 5-10 percent of existing species in the region. Species in Table 4 are already greatly over-planted and should not be used except in extenuating circumstances.

The Value of Preservation

You may have mature trees in your landscape that are on the "do-not-plant list" (tables 1 and 4). This publication does not encourage the removal of healthy trees that are already serving an important role in making our homes and cities desirable places to live, work, and play. When these trees are either no longer safe or do not serve their intended purpose, replace them with a species that is less prone to a catastrophic disease or insect.

Table 2. Monotypic or limited number of species

Species (common name)	Size[3]	Provenance of genus, number of species in this genus[2] (number of genera in family/total species in family)	Cultural and aesthetic characteristics: (The following species are considered relatively disease and insect free in their native habitat & North America)
Ailanthus altissima (tree of heaven)	LT	Asia 7 (19/121)	This species is highly invasive by suckering and seed. The use of this species is not advised for home landscapes and open parks. If it is used it should only be used where physical confinement is possible. This species is dioecious (male plants and female plants). Only male selections should ever be considered and only where the roots are physically confined by pavement to the base of the trunk. This species has extremely rapid growth and is very urban tolerant.
Asimina triloba (pawpaw)	MT	North America 11 (128/2,106)	This is the only member of this family in North America. Can spread by suckering. Produces edible fruit but is self-incompatible (needs cross-pollination from multiple plants for good fruit set).
Cercidiphyllum japonicum (katsuratree)	LT	Asia 2 (1/2)	Interesting leaf shape, good fall color, upright habit, must be watered during droughts.
Citrus trifoliata (was: *Poncirus t.*) (trifoliate orange)	LST	Asia 33 (158/1,730)	Considered by many taxonomists to be monotypic in its own genus (*Poncirus*), others put it into *Citrus*. Large thorns are produced on stems. Cultivar 'Dragon's Claw' makes an interesting container specimen.
Cladrastis kentukea (yellowwood)	MT	North America, Asia 8 (946/24,505)	Kentucky native; considered the most attractive native flowering tree. Often flowers in alternate years
Cunninghamia lanceolata (Chinafir)	MT	Asia 2 (32/166)	Evergreen conifer. Needles have sharp points.
Davidia involucrata (dovetree)	LST	Asia 1 (12/124)	Needs excellent soil, water during drought, flowers have a unique appearance but are sporadic.
Eucommia ulmoides (hardy rubbertree)	LT	Asia 1 (1/1)	Monotypic; drought tolerant, very dark green foliage, minimal or no fall color.
Franklinia alatamaha (Franklin tree)	LST	North America 1 (15/370)	Requires acidic, moist soils high in organic matter, not drought tolerant. Excellent fall color.
Ginkgo biloba (ginkgo)	LT	Asia 1 (1/1)	Monotypic; dioecious (only male selections should be used to avoid the offensive odor of fruit); excellent yellow fall color, leaves drop at same time, very tolerant of heat and drought once established. Coarse and open when young.
Gymnocladus dioica (Kentucky coffeetree)	LT	North America (Asia) 5 (946/24,505)	Dioecious (use of male selections is encouraged to avoid litter from fruit); very tolerant of heat, reflected light (parking lots), and drought once established.
Kalopanax septemlobus (castor-aralia)	LT	Asia 2 (40/1,533)	Small thorns on trunk and branches. Very tolerant of alkaline soils and heat, reflected light (parking lots), and drought once established.
Koelreuteria paniculata (golden raintree)	MT	Asia 3 (138/1,751)	Very tolerant of heat, reflected light (parking lots), and drought once established. Often listed as an invasive species (seedlings are almost always limited to immediately under the tree).
Maackia amurensis (Amur maackia)	MT	Asia 9 (946/24,505)	Attractive flowers and reddish bark; tolerant of heat and drought once established.
Maclura pomifera (Osage orange)	LT	North America (Asia, Africa) 12 (40/1,217)	Dioecious (male selections are highly encouraged to avoid the excessively large fruit). Very tolerant of alkaline soils, heat, reflected light (parking lots), and drought once established.
Metasequoia glyptostroboides (dawn redwood)	LT	Asia 2 (32/166)	Deciduous conifer; tolerant of wet sites; requires acidic soils.
Nyssa sylvatica (blackgum)	LT	North America (Asia) 9 (12/124)	Outstanding ornamental tree (dark green foliage, scarlet fall color) but rapidly becoming over-planted.
Oxydendrum arboreum (sourwood)	MT	North America 1 (151/3,554)	Outstanding ornamental tree (interesting flowers, bright red fall color) but requires acidic, well-drained soils high in organic matter.
Parrotia persica (parrotia, Persian ironwood)	MT	Asia 1 (22/99)	Interesting bark, tolerant of heat and drought once established.
Phellodendron amurensis (Amur corktree) LT	LT	Asia 5 (158/1,730)	Dioecious (fruit has an odor like varnish), reported to be slightly invasive; very tolerant of heat, drought, and reflected light (parking lots) once established.
Poncirus trifoliata (hardy orange)		Asia 1 (159/1,730)	see: *Citrus trifoliata*
Ptelea trifoliata (wafer-ash, common hop-tree)	LST	North America 5 (159/1,730)	Interesting fruit, sun or shade, requires well-drained soils.
Sciadopitys verticillata (umbrella pine)	LST	Asia 1 (1/1)	Evergreen conifer; monotypic. Very slow growth.
Styphnolobium japonicum (Japanese pagodatree)	LT	Asia 8 (946/24,505)	Attractive and prolific yellow flowers and fruit; fruit can be a litter problem.
Taxodium distichum (baldcypress)	LT	North America 2 (32/166)	Deciduous conifer; tolerates well-drained to flooded sites; requires acidic soil.
Tetradium daniellii (was *Evodia* d.) (Korean evodia)	MT	Asia 8 (158/1,730)	Tolerant of acidic or alkaline soils, wet or dry sites. Reported to be slightly invasive on wet sites.
Xanthoceras sorbifolium (yellowhorn)	LST	Asia 1 (138/1,751)	Striking large shrub or small tree (depending on prujing); rare in commerce, less heat tolerant; not considered by APHIS to have a high potential to become invasive.
Zelkova serrata (Japanese zelkova)	LT	Asia 6 (8/64)	V-shaped branching; tolerant of heat and drought once established, circling roots are a common problem.
Ziziphus jujube (jujube)	MT	Europe, Asia 53 (53/839)	Edible fruit; very tolerant of heat and drought once established.

[2] Many of the number of species may appear to be inflated because of the splitting of species by taxonomists into multiple groups to account for seemingly minor differences.
[3] LT (large tree - 50 feet or larger at maturity)
MT (medium tree - 25 to 50 feet tall at maturity)
LST (large shrub - 10 to 25 feet tall at maturity) [pruning is often used to determine habit]

Table 3. Trees that are currently over-planted and should only be used with caution

Species (common name)	Size	Provenance:	Cultural notes:
Acer campestre (hedge maple)	MT	Europe	Tolerant of alkaline and dry soils once established
Acer griseum (paperbark maple)	LST	Asia	Attractive bark; produces large number of seeds but they are rarely viable (alive)
Acer miyabei (miyabei maple)	MT	Asia	Good as street tree
Acer saccharum (sugar maple)	LT	Eastern North America	Prefers good soils; excellent fall color; the subspecies *A.s. nigrum* is more drought tolerant
Acer tataricum ginnala (Amur maple)	LST	Asia	Reported to be invasive; excellent fall color and interesting leaf shape; tolerant of hot, dry and compacted soils once established
Aralia spinosa (Hercules' club)	LST	Eastern North America	One of the best plants for hot, dry shade; prominent thorns on trunk
Carpinus caroliniana (American hornbeam)	MT	Eastern North America	No serious disease or insect problems but common to Europe and Asia; tolerant of wet sites; interesting bark
Castanea sp. (Hybrid chestnut)	LT	Hybrid of Asian and North American species	Resistant (but not immune) to chestnut blight; flowers are odoriferous
Castanea pumila (chinquapin)	LST	Eastern North America	Some resistance to chestnut blight; shrubby tree
Fraxinus quadrangulata (blue ash)	LT	Eastern North America	Some resistance to emerald ash borer
Nyssa sylvatica (blackgum)	LT	Eastern North America	Outstanding dark green foliage and red fall color; becoming over-planted
Ulmus sp. (Hybrid elms)	LT	Hybrid of Asian and North American species	Resistant (but not immune) to Dutch elm disease

Table 4. Species that should not be planted (already significantly over-used)

Species (common name)	Size	Provenance:	Cultural notes:
Acer rubrum (red maple)	LT	Eastern North America	The most commonly planted species in North America; not tolerant of dry sites or alkaline soils
Betula nigra (river birch)	MT	Eastern North America	Not tolerant of alkaline soils; surface roots, especially on compacted soils; tolerates wet sites
Cornus florida (flowering dogwood)	MT	Eastern North America	Prefers to be in a shaded site with excellent soils; numerous of disease and insect pests related to being planted on less than optimum sites
Gleditsia triacanthos inermis (thornless honeylocust)	LT	Eastern North America	Numerous disease and insect problems related to cultural stresses
Platanus xacerifolia (London planetree)	LT	Hybrid of Asian and North American species	Tolerant of urban stresses and poor sites; surface roots especially on compacted soils
Quercus palustris (pin oak)	LT	Eastern North America	Prefers wet sites but often planted on dry, compacted soils; not tolerant of alkaline soils; numerous disease and insect problems
Quercus phellos (willow oak)	LT	eastern North America	Prefers wet sites but often planted on dry, compacted soils; not tolerant of alkaline soils

Finding New and Different Types of Plants

Consumer demand ultimately drives the availability of tree species and cultivars. However, this is tempered by what the wholesale nursery industry grows. Nurseries must try to predict demand 4 to 7 years into the future and develop efficient production systems to meet it. Wholesale nurseries cannot afford to get ahead of the curve and grow a large numbers of new plants before there is a market for them. Education of consumers and tree producers must go hand-in-hand. In time, recommended trees will become more common in the marketplace.

The market requires plants that are attractive and look like a tree at a relatively small size. Some species that make great trees in the residential and commercial landscape do not have these characteristics. Consumers must buy and plant these trees based on what it will look like in a few years. For example, the Kentucky coffeetree (*Gymnocladus dioica*) is essentially disease and insect free and tolerates the disturbed and alkaline soils that are all too common in cities. This North American native is very tolerant of reflected light and heat making it especially well-adapted to parking lots and along streets. Because it often does not produce branches until it is 8 or 10 feet tall, it looks like a stick in a large pot when consumers see it in the retail nursery. It takes a skilled salesperson to convince the customer that this ugly duckling will grow into a beautiful swan. This is true of many other underutilized trees and shrubs.

It is human nature for us to make decisions based on the familiar with or what we already see in abundance. We trust the decisions of others more than our own judgement. This caused trouble when previous generations planted too many elms and ash turning our cities into monocultures. Planting a diversity of species is the best strategy to keep our urban forests healthy and able to provide environmental benefits for generations to come.

When it is time to replace the dead ash on your property, begin by looking at the list of suggested trees in Table 2. Consider all of the cultural limitations of the proposed site and the aesthetic traits that you want. Your local county Cooperative Extension Service, green industry professional (nursery, garden center, or landscape management professional) or landscape architect can assist you. If your local retail nursery or garden center does not have a particular plant, ask if they can find it for you. Kentucky wholesale producers can be

searched at: http://www.kyagr.com/marketing/plant/plant-guide.html. If you are unsuccessful in finding an in-state source consult a mail-order nursery.

Mail-order nurseries often carry unusual or specialty plants. However, the limitations on the size of materials that can be shipped means they are often smaller than those available from a local nursery. A plant search web site such as the one operated by the Andersen Horticultural Library (Minnesota Landscape Arboretum) called Plant Information Online can help you. You can find it at: http://plantinfo.umn.edu. You can search for cultural information about a plant you are not familiar with and find a retail source for it.

Taking a little extra time to make an informed decision will help to ensure that future generations do not have the heartache and expense associated with losing a large elm or ash.

Society grows great when old men plant trees whose shade they know they shall never sit in. (Greek proverb)

Glossary of Terms

Acid: Soil pH is measured on a scale from 1 to 14. Values below 7.0 are referred to as being acid or acidic. Soils that are too acidic may have mineral elements that become so available that they become toxic. Others may become unavailable. Very acidic soils can also kill beneficial soil microorganisms.

Alkaline: Soil pH is measured on a scale from 1 to 14. Values above 7.0 are referred to as being alkaline or basic. Soils that are too alkaline may have mineral elements that become so available that they become toxic or become unavailable. Very alkaline soils can also kill beneficial microorganisms.

Compacted soil: Soils that are compressed have reduced pore space and increased density. Roots grow poorly in compacted soil. Water does not infiltrate into or percolate through compacted soils.

Cultivar: A cultivated variety of a species. Cultivars are selected and grown for their aesthetic qualities or tolerance for diseases, insects or cultural challenges.

DED: Dutch elm disease; one of three fungi that originated in Asia that is lethal to many elm species (*Ulmus*).

Dioecious: A species that has male and female flowers on separate plants. Opposite of monoecious.

Disjunct: species that are geographically separated in their native range but very closely related as a result of having evolved from a common ancestor.

Family: A subdivision of an order that contains closely related genera.

Genus (plural genera): a subdivision of a family; a group of species with fundamental traits in common but differing in the lesser characteristics.

Gondwana: The super continent that broke apart approximately 200 million years ago to form Africa, South America, Australia, India, and Antarctica.

Laurasia (Laurasian): The super continent that broke apart approximately 200 million years ago to form Asia, North America, and Europe.

Monoecious: A species that has male and female flowers or these flower parts on the same plant. Opposite of dioecious.

Monotypic: A genus that has only one living species.

Provenance: the geographic location where a species evolved.

Species: (abbreviated as sp. or spp. [plural]) taxonomic group of organisms composed of individuals of the same genus that can reproduce among themselves and have similar offspring. Species is both singular and plural.

References

Dirr, Michael A. *Dirr's Encyclopedia of Trees and Shrubs*. Portland OR: Timber Press, 2011.

Dirr, Michael A. *Manual of Woody Landscape Plants, Their Identification , Ornamental Characteristics, Culture, Propagation, and Uses,* 5th ed. Champaign, IL: Stipes Publishing, LLC. 2009.

Jones, Ronald L. *Plant Life of Kentucky: An Illustrated Guide to the Vascular Flora*. Lexington KY: University of Kentucky Press, 2005.

Warton, Mary E and Roger W. Barbour. *Trees and Shrubs of Kentucky*. Lexington, KY: University of Kentucky Press, 1973.

The Plant List: A Working List of All Plant Species. Accessed 18 July 2016 at http://www.theplantlist.org.

Issued 12-2016