



Species Failure Profile for Trees Common to the Ohio River Valley

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Tree failures, especially in urban and recreational areas, can result in harm to human life and property. It is important, however, to recognize that the environmental and sociological benefits provided by trees significantly outweigh the limited risks presented by trees. Defects and species profiles that increase the potential for failure often can be observed or detected; many defects are associated with certain species, referred to as the species failure profile.

When trees fail, they fail in one of three general patterns: whole tree failure, failure at the trunk, or branch failure. Whole tree failure frequently occurs because of confined roots; cut roots resulting from activities such as trenching; decay or death of roots; or soil failure where healthy roots lose the ability to anchor the tree and pull out of the soil.

Trunk failures frequently occur at the point where decay organisms have weakened the trunk. Certain species are more prone to wood decay organisms than others. Wind hitting a tree's crown transfers force to the trunk. Without defects in the trunk, breakage will usually occur about half way between the soil and the bottom of the canopy.

Like trunk failures, branch failures occur at defects or half way between

where the branch is attached to the trunk or larger branch and where the foliage is attached. Branch failures often occur at the branch union (bifurcation, branch crotch) where the branch joins the trunk. Branches with a tight branch union (V-shaped branch union) frequently have included bark, making the branch union weak. Lateral branches that are vertical are called co-dominant leaders. These branches grow longer and increase in weight more rapidly than more horizontal branches, resulting in greater loads on the branch union.

Trees species are genetically variable in their ability to produce strong parts and remain structurally sound. These variabilities involve wood strength, susceptibility to fungal wood decay organisms, and the likelihood of a species to produce structurally branch unions.

The following table details species failure profiles associated with species common to the Ohio River Valley. Not all members of a species will have all of the defects associated with the species. Many only result when the tree is growing in a less than ideal location.

Property owners have a duty and obligation to inspect the trees on their property to ensure that they do not have obvious defects. If you are unsure

about your tree, the prudent thing to do is to have your tree(s) inspected by a qualified arborist. Arborists with the International Society of Arboriculture (ISA) Certified Arborist® credential or the Tree Risk Assessment Qualification® (TRAQ) are trained to detect and mitigate defects in trees.

Note: This guide is intended as an aid to identifying genetically influenced characteristics that may lead to failure of trees or parts of trees: site characteristics (i.e. soil volume, aspect, percent slope, etc.); environmental characteristics (i.e. wind speed, duration, loading; drought; temperature, moisture, etc.); and loss of strength caused by other factors (i.e. diseases, insect, animal damage). Failures can and will occur for reasons other than those listed. The time of failure cannot be predicted. Trees are biological organisms that accumulate defects throughout their lives. Not all of these defects can be observed or detected, even with the most advanced equipment available.

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Glossary

attachment—the point where a branch arises from the trunk (stem) or another branch, also known as branch attachment, bifurcation, or crotch.

borer—an insect that feeds in xylem tissue. Flatheaded borers (*Agrilus* spp., *Chrysobothris* spp.) are beetle larvae that usually feed in the most recent annual growth ring and can result in death of the branch; roundheaded borers (*Acanthocinus* spp., *Oberea* spp., *Saperda* spp., *Synanthedon* spp.) are moth or beetle larvae that usually feed throughout the xylem often resulting in branch failure.

butt rot—decay of the lower trunk, trunk flare, or buttress roots.

buttress root—roots at the trunk base that help support the tree and equalize mechanical stress.

canker—localized diseased area on stems, roots, or branches that is often shrunken and discolored.

CODIT—acronym for Compartmentalization of Decay in Trees.

codominant leader—forked branches that are nearly the same size in diameter arising from a common junction. These branch unions often have a V-shaped union (as opposed to a U-shaped union) and often have included bark.

compartmentalization—natural defense process in woody plants by which chemical and physical boundaries are created that act to limit the spread of diseases and decay organisms. Often referred to as CODIT.

dynamic loading—force that is created on a branch or other plant part that changes with time and motion (i.e. wind, climbers, rigging operations, etc.). Contrast with static loading.

girdling root—root that encircles all or part of a tree trunk or other roots, constricting vascular tissue and inhibiting secondary growth and the movement of water and photosynthates.

heartwood rot—any of several types of fungal decay of tree heartwood, often beginning with infected wounds in the living portions of wood tissue. Also called heart rot.

included bark—bark that has become imbedded in the branch union (bifurcation, crotch) between the branch and trunk or between codominant stems. Included bark is associated with failure of branches and codominant stems.

internal decay—wood (xylem) that is undergoing decomposition by fungi or bacteria.

load—see dynamic loading, static loading.

mechanical damage—injury by mowing equipment, construction equipment, animals, etc., with the potential for the introduction of pathogens (especially fungi) with the ability to colonize wounds, resulting in internal decay.

risk—the likelihood of an event occurring (tree or tree part falling and striking a target) compounded with the consequences of this event occurring.

risk assessment—the systematic process used to identify, analyze, and evaluate the likelihood of tree failure and associated consequences.

root failure—breaking of the roots, usually from internal decay resulting in whole tree failure. Contrast with soil failure.

sapwood rot—decay located in the sapwood. Bark and/or cambium may be damaged or dead. A common sign is the presence of numerous, small fruiting bodies on the bark.

soil failure—the inability of soil to provide sufficient resistance to prevent roots from sliding out of the soil resulting in whole tree failure. This occurs more frequently when soil is saturated. Contrast with root failure.

species failure profile—known types of failure associated with a species.

static loading—constant load exerted by a mass due to its weight (i.e. snow, ice, epiphytes, gravity, etc.). Contrast with dynamic loading.

sudden branch drop—unexpected failure of large branches, usually on hot, calm, days and evenings. Failures are generally at the union between a mature, over-extended, horizontal branch and trunk. This type of failure is rare but has been more closely associated with some genera (i.e. ash, beech, buckeye, chestnut, elm, Japanese pagodatree, maple, oak, pine, poplar, sycamore, sweetgum, tree of heaven, tulip poplar, willow) and inappropriate water relations. It is associated with extreme drought followed by the breaking of the drought. It is thought to occur as a result of wood drying and shrinking (cracking) during drought followed by rehydration and the resulting weight increase. It is often associated with other defects (wetwood, included bark, etc.). It is difficult to impossible to identify branches with the potential to fail.

target—people, property, or activities that could be injured, damaged, or disrupted by a tree failure.

whole tree failure—failure of an entire tree at or near the soil line resulting from uprooting (soil failure), root decay (root failure), or decay of the lower portion of the trunk.

Table 1. Species failure profiles for trees common to the Ohio River Valley

Species	Common Name	Observed Frequency of Failure	Defects
<i>Abies concolor</i>	white fir	Low	Codominant leaders, whole tree failure due to cankers, internal decay, butt & root rot
<i>Abies nordmanniana</i>	Nordmann fir	Low	Codominant leaders, whole tree failure due to cankers, internal decay, butt & root rot
<i>Acer</i> spp.	maples		Maples often have codominant leaders (due to opposite leaf arrangement) often with included bark, surface roots (potential for decay resulting from mechanical damage), girdling roots, sudden branch drop, cankers. Most species are poor compartmentalizers, verticillium wilt resulting in death and wood decay.
<i>Acer buergerianum</i>	trident maple	Low	Potential for codominant leaders with included bark. Smaller size reduces risk of harm.
<i>Acer campestre</i>	hedge maple	Low	Potential for codominant leaders with included bark. Smaller size reduces risk of harm.
<i>Acer griseum</i>	paperbark maple	Low	Potential for codominant leaders with included bark. Smaller size reduces risk of harm.
<i>Acer griseum x maximowicziana</i>	Girard maple	Low	Potential for codominant leaders with included bark. Smaller size reduces risk of harm.
<i>Acer miyabei</i>	miyabe maple	Low	Potential for codominant leaders with included bark. Smaller size reduces risk of harm.
<i>Acer negundo</i>	boxelder	High	Internal decay (poor compartmentalizer). Codominant leaders with included bark. Surface roots (damaged by lawn equipment) results in internal decay.
<i>Acer platanoides</i>	Norway maple	Moderate	Girdling roots, internal decay especially as a result of improper pruning and damage to surface roots

continued

Table 1. Species failure profiles for trees common to the Ohio River Valley (*continued*)

Species	Common Name	Observed Frequency of Failure	Defects
<i>Acer pseudoplatanus</i>	sycamore maple	Moderate	Girdling roots, internal decay especially as a result of improper pruning and damage to surface roots
<i>Acer rubrum</i>	red maple	Moderate	Sunscald, poor pruning, and equipment damage resulting in internal decay. Codominant leaders with included bark
<i>Acer saccharinum</i>	silver maple, water maple	Moderate-High	Sunscald, poor pruning, and equipment damage (trunk & surface roots) resulting in internal decay. Codominant leaders with included bark. High rate of failure for over-mature individuals
<i>Acer saccharum</i>	sugar maple	Low	Codominant branches with included bark, verticillium wilt resulting in death and wood decay. Usually declines before it fails.
<i>Acer saccharum nigrum</i>	black maple	Low	Codominant branches with included bark
<i>Aesculus xcarnea</i>	red horsechestnut	Moderate	Branch failure due to poor attachments, internal decay
<i>Aesculus flava</i>	yellow buckeye	Moderate	Branch failure due to poor attachments, internal decay, sudden branch drop
<i>Aesculus glabra</i>	Ohio buckeye	Moderate	Branch failure due to poor attachments, internal decay, sudden branch drop
<i>Aesculus hippocastanum</i>	common horsechestnut	Moderate	Branch failure due to poor attachments, internal decay, sudden branch drop
<i>Aesculus pavia</i>	red buckeye	Low	Branch failure due to poor attachments, internal decay, reduced risk because of smaller size
<i>Ailanthus altissima</i>	tree of heaven	High	Internal decay of trunk and roots, poor branch attachments with included bark, sudden branch drop
<i>Albizia julibrissin</i>	mimosa	High	Internal decay, soft wood (breakage at fulcrum), poor attachments, wilt diseases leading to death and wood decay. Often multi-trunked due to minimal winter hardiness
<i>Alnus glutinosa</i>	European black alder	Low	Rarely fails
<i>Amelanchier arborea</i>	downy serviceberry	Low	Rarely fails
<i>Amelanchier canadensis</i>	common serviceberry	Low	Rarely fails
<i>Amelanchier xgrandiflora</i>	apple serviceberry	Low	Rarely fails
<i>Amelanchier laevis</i>	Allegheny serviceberry	Low	Rarely fails
<i>Asimina triloba</i>	pawpaw	Low	Rarely fails. Reduced risk because of smaller size
<i>Betula lenta</i>	sweet birch	Moderate	Trunk failure due to internal decay, breakage when loaded by ice & snow, loss of small branches
<i>Betula lutea</i>	yellow birch	Moderate	Trunk failure due to internal decay, breakage when loaded by ice & snow, loss of small branches
<i>Betula maximowicziana</i>	monarch birch	Moderate	Trunk failure due to internal decay, breakage when loaded by ice & snow, loss of small branches
<i>Betula nigra</i>	river birch	Moderate	Trunk failure due to internal decay, breakage when loaded by ice & snow, loss of small branches; windthrow on wet sites
<i>Betula papyrifera</i>	paper birch	Moderate	Trunk failure due to internal decay, breakage when loaded by ice & snow, loss of small branches. Crown failure due to bronze birch borer
<i>Betula pendula</i>	European white birch	Moderate	Trunk failure due to internal decay, breakage when loaded by ice & snow, loss of small branches. Crown failure due to bronze birch borer
<i>Betula platyphylla</i>	Japanese white birch	Moderate	Trunk failure due to internal decay, breakage when loaded by ice & snow, loss of small branches. Crown failure due to bronze birch borer
<i>Betula populifolia</i>	gray birch	Moderate	Trunk failure due to internal decay, breakage when loaded by ice & snow, loss of small branches
<i>Carpinus betulus</i>	European hornbeam	Low	Rarely fails
<i>Carpinus caroliniana</i>	American hornbeam	Low	Rarely fails
<i>Carya illinoensis</i>	pecan	Moderate	Internal decay, branch failure from included bark
<i>Carya laciniosa</i>	shellbark hickory	Low	Rarely fails

continued

Table 1. Species failure profiles for trees common to the Ohio River Valley (*continued*)

Species	Common Name	Observed Frequency of Failure	Defects
<i>Carya ovata</i>	shagbark hickory	Low	Rarely fails
<i>Castanea mollissima</i>	Chinese chestnut	Low	Rarely fails, cankers, sudden branch drop
<i>Catalpa bignonioides</i>	common catalpa	Low	Trunk failure due to internal decay, verticillium wilt resulting in death and wood decay
<i>Catalpa speciosa</i>	northern catalpa	Low	Trunk failure due to internal decay, verticillium wilt resulting in death and wood decay
<i>Cedrus libani atlantica</i>	Atlas cedar	Moderate	Branch failure in wind, ice, snow
<i>Cedrus libani deodara</i>	deodar cedar	Moderate	Branch failure in wind, ice, snow
<i>Cedrus libani stenocoma</i>	hardy cedar of Lebanon	Moderate	Branch failure in wind, ice, snow
<i>Celtis laevigata</i>	sugar hackberry	Moderate	Poor branch attachments with included bark, poor compartmentalizer
<i>Celtis occidentalis</i>	common hackberry	High	Codominant leaders, poor branch attachments with included bark, poor compartmentalizer
<i>Cercidiphyllum japonicum</i>	katsuratree	Low	Numerous fine twigs but large branches rarely fail
<i>Cercis canadensis</i>	eastern redbud	Moderate	Codominant leaders with included bark, cankers, internal decay, verticillium wilt resulting in death and wood decay
<i>Chamaecyparis lawsoniana</i>	Lawson falsecypress	High	Codominant leaders, whole tree failure due to cankers, internal decay, butt & root rot
<i>Chionanthus virginicus</i>	white fringetree	Low	Rarely fails
<i>Cladrastis kentukea</i>	Kentucky yellowwood	High	Poor branch attachment, brittle wood
<i>Cornus florida</i>	flowering dogwood	Moderate	Branch and trunk failure due to cankers and borers
<i>Cornus kousa</i>	kousa dogwood	Low	Rarely fails
<i>Cornus mas</i>	cornelian cherry dogwood	Low	Rarely fails
<i>Cornus officinalis</i>	Japanese cornelian cherry dogwood	Low	Rarely fails
<i>Cornus racemosa</i>	gray dogwood	Low	Rarely fails
<i>Corylus americana</i>	American filbert	Low	Rarely fails, cankers
<i>Corylus colurna</i>	Turkish filbert	Low	Rarely fails
<i>Cotinus coggygria</i>	smoketree	Low	Declines and dies before it fails, verticillium wilt resulting in death and wood decay
<i>Cotinus obovatus</i>	American smoketree	Low	Declines and dies before it fails
<i>Crataegus crus-galli</i>	cockspur hawthorn	Low	Rarely fails
<i>Crataegus lavalleyi</i>	lavalley hawthorn	Low	Rarely fails
<i>Crataegus phaenopyrum</i>	Washington hawthorn	Low	Rarely fails
<i>Crataegus viridis</i> 'Winter King'	winter king hawthorn	Low	Poor branch attachment
<i>xCupressocyparis leylandii</i>	Leyland cypress	High	Codominant leaders, whole tree failure due to cankers, internal decay, butt & root rot, cankers
<i>Diospyros virginiana</i>	persimmon	Moderate	Poor compartmentalizer, poor branch attachments, brittle wood
<i>Eucommia ulmoides</i>	hardy rubber tree	Low	Branch failure due to horizontal branch arrangement
<i>Fagus grandifolia</i>	American beech	Low	Over-mature trees subject to internal decay of root and root flare (whole tree failure), internal decay from mechanical injury and poor pruning, sudden branch drop, cankers
<i>Fagus sylvatica</i>	European beech	Low	Over-mature trees subject to internal decay of root and root flare (whole tree failure), internal decay from mechanical injury and poor pruning, sudden branch drop
<i>Fraxinus americana</i>	white ash	Moderate	Over-mature trees subject to internal decay of roots and root flare from mechanical injury and poor pruning, emerald ash borer, sudden branch drop
<i>Fraxinus excelsior</i>	European ash	High	Over-mature trees subject to internal decay of roots and root flare from mechanical injury and poor pruning, emerald ash borer and other borers, sudden branch drop

continued

Table 1. Species failure profiles for trees common to the Ohio River Valley (*continued*)

Species	Common Name	Observed Frequency of Failure	Defects
<i>Fraxinus nigra</i>	black ash	High	Over-mature trees subject to internal decay of roots and root flare from mechanical injury and poor pruning, emerald ash borer and other borers, sudden branch drop
<i>Fraxinus pennsylvanica</i>	green ash	High	Over-mature trees subject to internal decay of roots and root flare from mechanical injury and poor pruning, emerald ash borer, sudden branch drop
<i>Fraxinus quadrangulata</i>	blue ash	Moderate	Over-mature trees subject to internal decay of roots and root flare from mechanical injury and poor pruning, possibly damage from emerald ash borer, sudden branch drop
<i>Ginkgo biloba</i>	ginkgo	Low	Rarely fails
<i>Gleditsia triacanthos inermis</i>	thornless honeylocust	Moderate	Cankers, borers, poor branch attachment
<i>Gymnocladus dioica</i>	Kentucky coffeetree	Low	Rarely fails
<i>Heptacodium miconioides</i>	seven-son flower	Moderate	Dead branches
<i>Ilex opaca</i>	American holly	Low	Rarely fails
<i>Juglans nigra</i>	black walnut	Low	Rarely fails
<i>Juniperus chinensis</i>	Chinese juniper	Moderate	Root rots, uprooting from saturated soils, ice & snow
<i>Juniperus communis</i>	common juniper	Moderate	Root rots, uprooting from saturated soils, ice & snow
<i>Juniperus scopulorum</i>	Rocky Mountain juniper	Moderate	Root rots, uprooting from saturated soils, ice/snow loading
<i>Juniperus virginiana</i>	eastern redcedar	Moderate	Root rots, uprooting from saturated soils, ice/snow loading
<i>Koelreuteria paniculata</i>	golden raintree	Low	Rarely fails
<i>Larix decidua</i>	European larch	Moderate	Internal decay
<i>Liquidambar styraciflua</i>	sweetgum	Low or Moderate	Branch failure from poor attachments and wind/snow/ice loading, whole tree failure from internal decay of buttress roots, sudden branch drop, low failure potential reported in more northern latitudes
<i>Liriodendron tulipifera</i>	tulip poplar	Moderate	Branch failure from poor attachments and wind/snow/ice loading, whole tree failure from internal decay of buttress roots, sudden branch drop
<i>Maackia amurensis</i>	Amur maackia	Low	Rarely fails
<i>Maclura pomifera</i>	Osage orange	Low	Rarely fails
<i>Magnolia acuminata</i>	cucumber magnolia	Moderate	Internal decay
<i>Magnolia fraseri</i>	Fraser magnolia	Moderate	Internal decay
<i>Magnolia grandiflora</i>	southern magnolia	Moderate	Internal decay, injury to surface roots leading to internal decay, snow/ice loading
<i>Magnolia xloebneri</i>	Loebner magnolia	Low	Included bark, soft wood (snow/ice)
<i>Magnolia macrophylla</i>	bigleaf magnolia	Moderate	Internal decay, soft wood (snow/ice/wind)
<i>Magnolia xsoulangiana</i>	saucer magnolia	Low	Internal decay
<i>Magnolia tripetala</i>	umbrella magnolia	Moderate	Internal decay
<i>Magnolia virginiana</i>	sweetbay magnolia	Moderate	Internal decay, snow/ice loading
<i>Malus</i> sp.	crabapple	Low	Rarely fails, cankers, fireblight
<i>Malus pumila</i>	apple	Low	Rarely fails, cankers, fireblight
<i>Metasequoia glyptostroboides</i>	dawn redwood	Low	Rarely fails
<i>Morus alba</i>	white mulberry	Moderate	Branch failure
<i>Morus rubra</i>	red mulberry	Low	Branch failure
<i>Nyssa sylvatica</i>	blackgum	Low	Rarely fails
<i>Ostrya virginiana</i>	hophornbeam	Low	Rarely fails
<i>Oxydendrum arboreum</i>	sourwood	Low	Rarely fails. Often declines and dies when cultural conditions are not appropriate.
<i>Parrotia persica</i>	Persian parrotia	Low	Rarely fails

continued

Table 1. Species failure profiles for trees common to the Ohio River Valley (*continued*)

Species	Common Name	Observed Frequency of Failure	Defects
<i>Paulownia tomentosa</i>	royal paulownia, princess tree	High	Small (12-18 inches) branches (terminal inflorescences), poor compartmentalization resulting in internal decay
<i>Phellodendron amurense</i>	Amur cork tree	Low	Rarely fails
<i>Picea abies</i>	Norway spruce	Low	Internal decay, basal decay, cankers
<i>Picea glauca</i>	white spruce	Moderate	Internal decay, basal decay, cankers
<i>Picea omorika</i>	Serbian spruce	Moderate	Internal decay, basal decay
<i>Picea orientalis</i>	oriental spruce	Moderate	Internal decay, basal decay, cankers
<i>Picea pungens</i>	Colorado spruce	Moderate	Internal decay, basal decay, cankers
<i>Pinus</i> spp.	pinus		Most species are prone to disease and insect pests resulting in higher likelihood of failure, sudden branch drop
<i>Pinus bungeana</i>	lacebark pine	Low	Snow/ice
<i>Pinus echinata</i>	shortleaf pine	Moderate	Branch failure from snow/ice loading, windthrow
<i>Pinus flexilis</i>	limber pine	Moderate	Branch failure from snow/ice loading
<i>Pinus nigra</i>	Austrian pine	Moderate	Trees decline and die from diplodia tip blight before failing.
<i>Pinus strobus</i>	eastern white pine	Moderate	Branch failure from snow/ice loading, root rots
<i>Pinus sylvestris</i>	Scots pine, scotch pine	Moderate	Branch failure from snow/ice loading, diplodia tip blight
<i>Pinus taeda</i>	loblolly pine	Moderate	Branch failure from snow/ice loading
<i>Pinus thunbergii</i>	Japanese black pine	Moderate	Branch failure from snow/ice loading. Bark beetle & pinewood nematode lead to death and wood decay.
<i>Pinus virginiana</i>	Virginia pine	Moderate	Branch failure from snow/ice loading, root rot, windthrow
<i>Pinus wallichiana</i>	Himalayan pine	Moderate	Branch failure from snow/ice loading
<i>Pistacia chinensis</i>	Chinese pistache	Low	No reports of failure
<i>Platanus xacerifolia</i>	London planetree	Low	Rarely fails, root and buttress decay resulting from mechanical damage, sudden branch drop
<i>Platanus occidentalis</i>	eastern sycamore	Low to moderate	Rarely fails, root and buttress decay resulting from mechanical damage, small to medium size branch drop resulting from anthracnose, sudden branch drop
<i>Platycladus orientalis</i>	Oriental arborvitae	High	Branch failure from snow/ice loading
<i>Populus</i> spp.	poplar		Canker diseases, all species are poor compartmentalizers, sudden branch drop
<i>Populus alba</i>	white poplar	High	Brittle branches, failure from snow/ice loading, internal decay
<i>Populus deltoides</i>	cottonwood	High	Brittle branches, failure from snow/ice loading, internal decay
<i>Populus nigra</i> 'Italica'	Lombardy poplar	High	Brittle branches, failure from snow/ice loading, internal decay, cankers
<i>Prunus</i> spp.	cherry, plum, peach, apricot		Numerous disease and insect pests predisposing these species to internal decay of branches, trunk, and roots, sapwood rots, heartwood rots, cankers; poor compartmentalizer
<i>Prunus cerasifera</i>	purpleleaf plum	High	Root and butt rot, branch failure from poor pruning
<i>Prunus sargentii</i>	Sargent cherry	Moderate	Internal decay
<i>Prunus serotina</i>	black cherry	Moderate	Internal decay
<i>Prunus serrulata</i>	Japanese flowering cherry	Low	Internal decay, cankers
<i>Prunus subhirtella</i>	Japanese weeping cherry	Low	Internal decay, cankers
<i>Prunus yedoensis</i>	Yoshino cherry	Low	Internal decay
<i>Pseudotsuga menziesii</i>	Douglas fir	Moderate	Codominant leaders, branch failure in storms
<i>Pyrus calleryana</i>	Callery pear	High	Codominant leaders with included bark, brittle branches, fire-light cankers
<i>Quercus</i> spp.	oak		Numerous disease and insect problems; Ganoderma, a root and buttress decay fungus, is especially serious on most species and can result in whole tree failure while in full canopy; inappropriate soil conditions can result in predisposition to other problems; sudden branch drop

continued

Table 1. Species failure profiles for trees common to the Ohio River Valley (*continued*)

Species	Common Name	Observed Frequency of Failure	Defects
<i>Quercus acutissima</i>	sawtooth oak	Low	Rarely fails
<i>Quercus alba</i>	white oak	Low	Rarely fails
<i>Quercus bicolor</i>	swamp white oak	Low	Rarely fails
<i>Quercus coccinea</i>	scarlet oak	Low	Poor branch attachments
<i>Quercus falcata</i>	southern red oak	Low	Poor branch attachments
<i>Quercus imbricaria</i>	shingle oak	Low	Rarely fails
<i>Quercus macrocarpa</i>	bur oak	Low	Rarely fails
<i>Quercus marilandica</i>	blackjack oak	Low	Poor branch attachments
<i>Quercus muehlenbergii</i>	chinkapin oak	Low	Rarely fails
<i>Quercus nigra</i>	water oak	Moderate-High	Internal decay in trunk and branches, poor branch attachment, poor branch taper
<i>Quercus pagodifolia</i>	cherrybark oak	Low	Rarely fails
<i>Quercus palustris</i>	pin oak	Moderate-High	Whole tree failure in over-mature trees with confined root system from Ganoderma, predisposed to decay due to bacterial leaf scorch
<i>Quercus phellos</i>	willow oak	Moderate	Poor branch attachment
<i>Quercus prinus</i>	chestnut oak	Low	Rarely fails
<i>Quercus robur</i>	English oak	Low	Poor branch attachment
<i>Quercus rubra</i>	red oak	Low	Poor branch attachment
<i>Quercus shumardii</i>	Shumard oak	Low	Rarely fails
<i>Quercus stellata</i>	post oak	Low	Rarely fails
<i>Quercus velutina</i>	black oak	Low	Rarely fails
<i>Robinia pseudoacacia</i>	black locust	High	Internal decay (artist conk [Ganoderma] and Phellinus) on this species indicate a high likelihood of failure, borers, poor branch attachment
<i>Salix xalba</i> 'Tristis'	weeping willow	High	Branch failure in wind, snow/ice due to internal decay and poor branch attachment, sudden branch drop
<i>Salix nigra</i>	black willow	High	Branch failure in wind, snow/ice due to internal decay and poor branch attachment, sudden branch drop
<i>Sassafras albidum</i>	sassafras	Moderate	Internal decay, brittle wood
<i>Sorbus alnifolia</i>	Korean mountainash	Moderate	Internal decay
<i>Sorbus aucuparia</i>	European mountain-ash	High	Internal decay, borers, usually declines and dies due to heat stress
<i>Styphnolobium japonicum</i>	Japanese pagodatree	Moderate	Small branch failure, poor branch attachment, sudden branch drop
<i>Taxodium ascendens</i>	pondcypress	Low	Rarely fails
<i>Taxodium distichum</i>	baldcypress	Low	Rarely fails
<i>Taxus baccata</i>	English yew	Low	Rarely fails, root rot
<i>Taxus cuspidata</i>	Japanese yew	Low	Rarely fails, root rot
<i>Tetradium daniellii</i>	Korean evodia	Moderate	Branch attachment, internal decay
<i>Thuja occidentalis</i>	American arborvitae	High	Branch failure from snow/ice loading
<i>Thuja plicata</i>	western arborvitae	Moderate to High	Branch failure from snow/ice loading
<i>Tilia americana</i>	American linden, basswood	High	Internal decay, poor branch attachment
<i>Tilia cordata</i>	European littleleaf linden	Moderate	Internal decay, poor branch attachment
<i>Tilia xeuchlora</i>	Crimean linden	Moderate	Internal decay, poor branch attachment
<i>Tilia tomentosa</i>	silver linden	Moderate	Internal decay, poor branch attachment
<i>Tsuga canadensis</i>	Canadian hemlock	Moderate	Branch failure from snow/ice loading, internal decay
<i>Ulmus</i> spp.	elms		All are prone to diseases and internal decay, branch failure from snow and ice loading, sudden branch drop

continued

Table 1. Species failure profiles for trees common to the Ohio River Valley (*continued*)

Species	Common Name	Observed Frequency of Failure	Defects
<i>Ulmus alata</i>	winged elm	Moderate	Poor branch attachment
<i>Ulmus americana</i>	American elm	Moderate	Poor branch attachment, Dutch elm disease
<i>Ulmus parvifolia</i>	Chinese elm, lacebark elm	High	Poor branch attachment, failure in wind, snow/ice
<i>Ulmus procera</i>	English elm	Moderate	Poor branch attachment
<i>Ulmus pumila</i>	Siberian elm	High	Very poor branch attachment, brittle wood, frequent failure in wind, snow/ice
<i>Ulmus rubra</i>	slippery elm	Moderate	Poor branch attachment
<i>Zelkova serrata</i>	Japanese zelkova	Low	Poor branch attachment

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