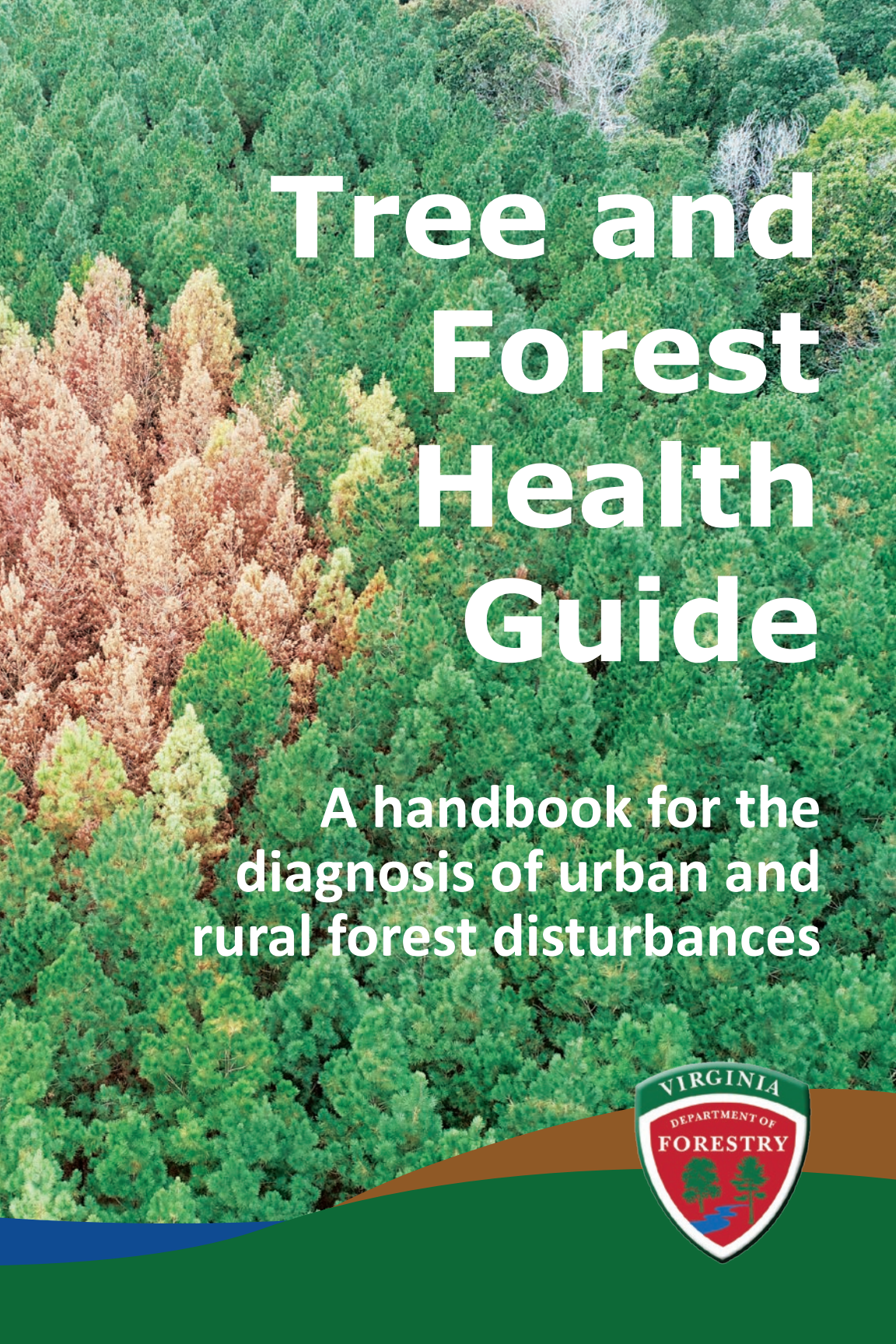

Tree and Forest Health Guide

A handbook for the diagnosis of urban and rural forest disturbances

VIRGINIA DEPARTMENT OF FORESTRY

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INTRODUCTION

Information in this publication is intended to help Virginia foresters provide good advice about tree and forest health to landowners. Conditions that are common or important enough in Virginia to gain frequent attention are covered. General guidelines are given for the diagnosis and treatment of biotic (living) and abiotic (non-living) disturbances of forests and individual trees. Trees in an urban setting are often exposed to different stress factors than trees growing in a natural forest, and this guide is intended to assist both traditional forest health professionals as well as urban and community foresters. Many excellent resources exist to help identify and treat specific pest problems. This publication should not be used as a final reference, but rather a quick field guide and training tool.

Mechanical, cultural, biological, and chemical control options are discussed in this guide. Management information is intended to provide landowners with treatment options. Use of registered pesticides should be considered only when unacceptable damage can be prevented through pesticide application, and the landowner is aware of the alternatives, costs, and benefits of chemical control. Chemicals listed in this guide are registered and regulated by the U.S. Environmental Protection Agency and the Virginia Department of Agriculture and Consumer Services. Pesticide users must follow label directions with regard to application site(s), rates of application, number of applications, and minimum time interval between application and harvest. The label is always the law!

The following guidelines should be considered when making forest management decisions:

1. Tree species compete best within their natural ranges. When competition is not a factor, most species tend to grow best on deep, moist, well-drained, fertile soils.
2. If management objectives do not require pure stands, encourage a mixture of species. Mixed stands tend to be less susceptible to attack and less vulnerable to damage from pest organisms.
3. Trees usually respond quite slowly to environmental changes. They may decline over a period of several years before succumbing to prolonged stress, and it may take many years of favorable conditions before they recover fully from a weakened state.
4. Vigor decreases with advanced age; trees can live longer than people, but they don’t live forever.
5. Most tree problems result from a combination of factors. Often abiotic influences make trees more susceptible to biotic agents, and the combination of stressors ultimately leads to a tree’s decline.

For specific recommendations beyond the scope of this guide, please contact the Forest Health or Urban and Community Forestry staff at the Virginia Department of Forestry, or consult the Virginia Cooperative Extension Pest Management Guide.

BIOTIC IMPACTS – INSECTS

SAPSUCKERS

Leafhopper

Hosts

Leafhoppers belong to a very large and diverse family of plant-feeding insects with a varied host list. In Virginia forests, leafhopper pests attack hardwood species like basswood, beech, dogwood, elm, maple, and oak.

Signs/Symptoms

Leafhopper appearance is variable depending on species though they generally have an elongated body shape and range in size from ⅛ inch to ½ inch long. Some species are brightly-colored and others blend in with their host plant. As their name implies, they jump readily when startled. Damage appears as stippling, curling, and discoloration on leaves, though most of the damage they cause is a result of the variety of diseases leafhoppers can transmit during feeding with their piercing, sucking mouthparts.

Timing

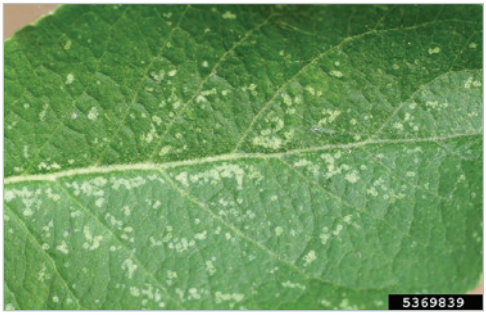
The life cycle varies depending on species. Females lay eggs in host-plant tissue and hatched nymphs pierce the leaf and feed on sap. Most species only produce one generation per year.

Management

Control is generally not warranted for leafhoppers since natural enemies exist and usually keep populations below damaging levels. In nurseries, leafhoppers can be excluded with covers and screens. There are insecticides labeled for leafhoppers, but applications can be difficult considering how mobile the insects are. Apply when leafhoppers are first seen and thoroughly spray the undersides of leaves.

Notes

These insects can transmit bacterial leaf scorch.



Leaf stippling. Photo: Whitney Cranshaw, Colorado State University, Bugwood.org

Adult leafhopper insect. Photo: David Cappaert, Bugwood.org

Aphid

– SAPSUCKERS –

Hosts

Many species of hardwoods and conifers. Aphids tend to be host-specific.

Signs/Symptoms

Aphids feed on plant sap in clusters and prefer young, soft plant tissue. Feeding by aphids may cause spotting, yellowing, wilting, or curling of leaves, as well as distorted growth, dieback, and decline. They produce large amounts of a sticky sugary substance called honeydew. A fungus called sooty mold will often grow on this substance, which causes leaves and branches to turn black. Aphids are usually only minor or aesthetic pests; however, large infestations may cause serious damage, especially to landscape and ornamental trees.

Timing

Life cycles vary according to species, but most aphids overwinter in the egg stage and hatch in the spring.

Management

Natural enemies, such as lacewings, lady beetles, and certain parasitic wasps, usually keep aphid populations in check. Horticultural oils can be sprayed during aphid dormancy to kill overwintering eggs. If applied in the early spring when the eggs hatch, horticultural oils will also smother any aphids present at the time of application. Dilute with water and spray to coat the top and underside of leaves. Chemical control options with contact and systemic insecticides are available for severe infestations, but pesticides should be used with caution as they may also kill natural enemies.

Leaves with aphid damage. Photo: University of Georgia Plant Pathology, University of Georgia, Bugwood.org

Adult aphid with immature aphids. Photo: Frank Peairs, Colorado State University, Bugwood.org

Notes

Aphids are small, soft-bodied insects that have two small protrusions called cornicles on the back end of their abdomen.

Scale

– SAPSUCKERS –

There are two types of scales: armored and soft. Armored scales live beneath a hard, protective covering that is not attached to their body. They do not produce honeydew. Soft scales excrete honeydew and produce a waxy protective layer that is attached to their body. Common armored scales in Virginia include gloomy, tea, San Jose, oystershell, and white peach scale. White wax, crape myrtle bark, magnolia, and lecanium are common soft scales.

Hosts

Many species of hardwoods and conifers.

Signs/Symptoms

Most are an aesthetic pest, as their feeding and excretion of honeydew can leave a sticky coating on anything underneath. Sooty mold often grows on honeydew-coated plant parts. Foliage spotting, speckling, chlorosis, curling, wilting, galls, distorted growth, bark swelling, twig and branch dieback, and eventual mortality can occur if infestations are heavy.

Timing

Varies according to species, but, in general, scales have a mobile crawler stage right after hatching in the spring and fall. The crawler then settles down permanently, inserts its mouthparts into the plant, and begins feeding on plant sap.

Management

Adults are difficult to treat once they develop a protective covering, so close monitoring is necessary to determine when crawlers are active. Horticultural oils and insecticidal soaps are effective on crawlers, although repeated applications may be necessary. For high-value trees with heavy scale infestations, systemic insecticides may be applied. Natural enemies often help manage populations.

Notes

Scales are highly variable in appearance, but all are relatively small (i.e., <5 mm in diameter or length).

Mature armored tuliptree scale. Photo: Gerald J. Lenhard, Louisiana State University, Bugwood.org

Magnolia tree scale. Photo: William Fountain, University of Kentucky, Bugwood.org

Pine Spittlebug

– SAPSUCKERS –

Hosts

All pine, particularly Scotch and eastern white pine.

Signs/Symptoms

Identified by a frothy spit-like mass in the twigs and needles of pines. Immature spittlebugs feed on new growth and excrete excess water and sugar, which forms a bubbly substance around their bodies. Adults feed on the same plant, but do not produce a spittle mass. Heavy infestations may cause flagging, branch dieback, and tree mortality. Pine spittlebug feeding sites may also enable the infection of fungal diseases, such as diplodia tip blight.

Timing

Overwinters in the egg stage. Eggs hatch in spring and spittle masses are present in May and June. Adults without spittle masses will be present from mid-June.

Management

In light infestations, nymphs can be controlled by manually removing insects – spraying small trees with water at high velocity to dislodge nymphs. Contact insecticides may be needed to protect trees in heavy infestations. Registered insecticides should be applied in mid-July when adults are active.

Pine spittlebug insect. Photo: Lacy L. Hyche, Auburn University, Bugwood.org

Spittle masses on pine branch. Photo: Steven Katovich, Bugwood.org

Hemlock Woolly Adelgid

– SAPSUCKERS –

Hosts

All hemlock species.

Signs/Symptoms

The hemlock woolly adelgid feeds on nutrient-rich tree sap. Immature crawlers settle at the base of hemlock needles and secrete a white woolly covering (ovisac) around their bodies that resembles small white cotton balls on the underside of a hemlock branch. Feeding by the adelgid causes needle loss, canopy thinning, branch dieback, and tree mortality over four to 10 years.

Timing

The life cycle of the hemlock woolly adelgid is complicated and has two generations in North America. Nymphs hatch from late March through early May and are mobile for several weeks before settling at the base of needles where they feed, develop into adults, and lay eggs. A second generation hatches in midsummer and these adelgids remain attached to hemlock needles throughout the fall and winter. White woolly ovisacs are most noticeable from late fall through spring.

Management

Horticultural oil provides short-term control when applied during the crawler stage, but systemic insecticides should be applied for long-term control. Neonicotinoid systemic insecticides can be applied to the soil or the trunk and may provide up to seven years of protection. Several biological control agents are also being evaluated.

Notes

The hemlock woolly adelgid is native to Asia and western North America, but invasive in eastern North America. The adelgid does not cause mortality to hemlocks in its native range, only eastern and Carolina hemlocks in the east are susceptible.

Magnified view of a hemlock woolly adelgid.
Photo: Kelly Oten, North Carolina Forest Service, Bugwood.org

White woolly ovisacs of the hemlock woolly adelgid. *Photo: VDOF*

Pine Bark Adelgid

– SAPSUCKERS –

Hosts

Eastern white pine.

Signs/Symptoms

Like other adelgids, this insect inserts long piercing, sucking mouthparts into the bark and feeds on tree sap. Mature adelgids produce a white woolly coating; heavily infested trees will have white woolly material along trunks and branches. The pine bark adelgid is generally considered a minor pest and causes little damage to healthy trees. In plantations and Christmas tree farms, populations may induce excessive branching and reduce growth.

Timing

After overwintering as an immature nymph, the pine bark adelgid matures and produces its white woolly ovisac in the spring. Eggs are deposited within the ovisac from which mobile crawlers emerge. Crawlers find new sites on the tree to feed and develop.

Management

Control is not warranted for light or moderate infestations. Natural predators usually keep pine bark adelgid populations low. In heavy infestations, horticultural oil and insecticidal soaps may be applied in the early spring before crawlers mature and lay eggs. If this does not provide adequate control, registered contact and systemic insecticides are available.

White woolly coating of the pine bark adelgid on a branch. Photo: Petr Kapitola, Central Institute for Supervising and Testing in Agriculture, Bugwood.org

Eastern white pine infested with pine bark adelgid. Photo: VDOF

Balsam Woolly Adelgid

– SAPSUCKERS –

Hosts

All true firs (balsam and Fraser fir in eastern U.S.).

Signs/Symptoms

Adults cause damage by feeding and injecting their saliva into the tree, causing swelling (i.e., gouting) at the nodes. These deformities disrupt movement of water and reduce tree growth and value. Needle loss and thinning of the canopy eventually lead to tree mortality within two to three years.

Timing

There are multiple generations per year, but adult populations generally peak in the spring and again in early fall. After overwintering as adults, balsam woolly adelgids mature in the spring, produce a white woolly ovisac, and lay eggs. When the eggs hatch, crawlers disperse and select a feeding site. This cycle of maturing, egg laying, hatching, and crawler dispersal repeats.

Management

Contact insecticides are most effective against the crawler stage in May-June or September-October. Insecticidal soaps and horticultural oils can be applied when adult adelgids are present, but application should be timed to avoid burning tree foliage. Limited success has been found with biological control.

Notes

This invasive insect is native to central Europe. It can cause significant economic damage to Christmas tree farms and nurseries.

Trees killed by balsam woolly adelgid. Photo: David Beckman, Idaho Department of Lands, Bugwood.org

Tree mortality caused by balsam woolly adelgid. Photo: Elizabeth Willhite, USDA Forest Service, Bugwood.org

Trunk infested with balsam woolly adelgid. Photo: USDA Forest Service - Region 8 - Southern, Bugwood.org

Mite

– SAPSUCKERS –

Technically not insects, mites are more closely related to spiders and ticks. Spider mites are common urban pests of trees, shrubs, and flowers, and can produce silk. Eriophyid mites are smaller, less common, and are often identified by the type of damage (i.e., galls, blisters, or rust).

Hosts

Many woody plant species, both deciduous and evergreen.

Signs/Symptoms

Mites feed on the undersides of leaves and needles. This injury produces tiny white or yellow spots called "stippling" on leaves and needles. This stippling causes the plant to look bronzed and have a yellowed discoloration. When a heavy spider mite infestation occurs, webbing will also be present. Eriophyid mites may cause the formation of galls, blisters, or a rusty color on infested leaves.

Timing

Mites live through the winter as eggs on vegetation. In the spring, nymphs hatch and complete development in one to two weeks depending on the temperature. After hatching, mites build colonies on the undersides of leaves and spider mites produce webbing over infested leaf surfaces. Infestations are particularly common during hot, dry summer weather.

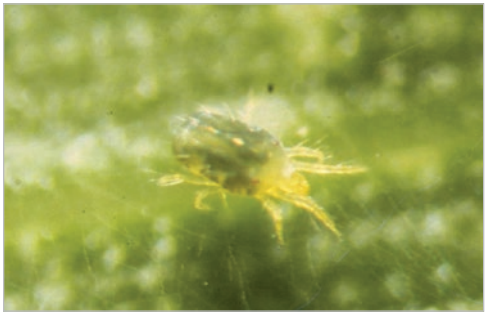
Management

Inspect your plants regularly, looking for stippling and webbing, and check the underside of leaves and needles with a hand lens for mites. Mites thrive on plants under stress, so preventative management is key. Keep plants well-watered to reduce the chances of mite attacks. Insecticidal soap and horticultural oil can be used and will not affect natural enemies that keep mite populations under control. When infestations are particularly high, contact pesticides may be warranted and applied in the spring.

Notes

Spider mites are common pests in greenhouse environments.

Magnified view of mites and leaf damage. Photo: Whitney Cranshaw, Colorado State University, Bugwood.org



Adult mite. Photo: F.C. Schweissing, Bugwood.org

Mealybug

– SAPSUCKERS –

Hosts

Fruit trees and pine species including loblolly, slash, Virginia, shortleaf, and longleaf.

Signs/Symptoms

Mealybugs usually feed in colonies in protected areas, such as between branches and touching leaves, in branch crotches, or on the trunk near the soil. Mealybugs will appear white because of the waxy coating they produce as they develop. Mealybugs suck sap from the tree and excrete honeydew, which can cause black sooty mold to develop, reducing plant vigor and fruit quality.

Timing

Mealybugs are very prolific. Adult females lay 200 or more eggs in cottony egg sacs over a 10- to 20-day period. Egg sacs may be attached to crowns, leaves, bark, fruit, or twigs. Newly-hatched nymphs are mobile and not yet covered in wax. As nymphs develop, they settle to feed and begin developing wax. Nymphs have several developmental stages before becoming adults.

Management

Mealybugs are difficult to manage with insecticides, since they are continually producing new generations in high numbers. Fortunately, most species are controlled by natural enemies. It's best to avoid using broad-spectrum insecticides to preserve these natural enemy populations. If infestations are particularly bad, insecticidal soaps, horticultural oil, or neem oil insecticides applied directly on mealybugs can provide some suppression, especially against younger nymphs that have less wax accumulation.

Mealybugs clustered on pine. Photo: William M. Ciesla, Forest Health Management International, Bugwood.org

Woolly masses from adult mealybugs. Photo: John C. French Sr., Retired, Universities: Auburn, GA, Clemson and U of MO, Bugwood.org

Mealybug crawlers. Photo: John A. Davidson, University of Maryland, College Park, Bugwood.org

Spotted Lanternfly

– SAPSUCKERS –

Hosts

Associated with more than 70 different plant species, including fruit trees, ornamental trees, herbs, vines, agricultural crops, and various hardwoods, especially the invasive tree species "tree-of-heaven" (*Ailanthus altissima*).

Signs/Symptoms

The spotted lanternfly feeds by sucking sap from the stems, branches, and trunks of trees, which creates weeping wounds. The insect then excretes honeydew, which promotes the growth of sooty mold. Sooty mold is dark in color and can damage the plant by blocking sunlight and preventing photosynthesis. Feeding by the spotted lanternfly can cause foliage wilting, branch dieback, and reduced fruit yield.

Timing

Spotted lanternflies have one generation per year. They lay eggs in the fall, and the eggs overwinter. Eggs are laid in masses covered with a gray, putty-like substance. The eggs hatch around May, and nymphs begin feeding immediately. Adults appear in July, often in large groups.

Management

The most important management strategy is to take measures to stop the spread of this insect. Always inspect vehicles, goods, and your clothes before leaving an infested area. This is required if you are exiting a quarantine zone. Early nymphs crawl up and down the tree trunk and can be controlled with sticky bands in the late spring/early summer. Egg masses should be scraped into alcohol or destroyed by smashing or burning. This pest prefers tree-of-heaven, and host removal can also be beneficial. Finally, contact or systemic chemical control may be used when spotted lanternfly is abundant.

Notes

This is a serious invasive pest that is currently under quarantine, and sightings should be reported. If you think you've identified spotted lanternfly in your area, contact your local extension agent and VDOF Forest Health staff.

Spotted lanternfly adults. Photo: VDOF

Spotted Lanternfly, continued

Spotted lanternfly nymphs.
Photo: VDOF

Spotted lanternfly egg masses.
Photo: VDOF

Sooty mold. Photo: VDOF

Lace Bug

– SAPSUCKERS –

Hosts

A variety of evergreen and deciduous trees and shrubs. Common species include hawthorn, American elm, apple, sycamore, oak, cherry, azalea, and rhododendron.

Signs/Symptoms

Populations often go undetected until infestations are severe. Although lace bugs feed on the underside of leaves, damage appears on the leaf surfaces. Feeding causes tiny chlorotic spots on the upper leaf surface called stippling. Heavy feeding may cause leaves to turn gray or yellow and then fall. Brown to black droplets of frass and old "skins" of the nymphs can be found on the underside of damaged leaves.

Lace bug damage. Photo: Whitney Cranshaw, Colorado State University, Bugwood.org

Timing

Development varies between species. Species that occur on evergreens overwinter as eggs on the underside of leaves. Eggs hatch in the early spring, and nymphs develop to adults in about one month. There are four generations per year. Other species in the genus *Corythuca* (hawthorn and grass lace bugs) overwinter as adults on or near hosts in bark crevices or protected areas on the ground surface. Eggs are laid on the undersides of leaves in spring. Development takes one to two months and there are three to four generations per year.

Adult lace bug. Photo: Whitney Cranshaw, Colorado State University, Bugwood.org

Management

Inspect trees in the early spring for adults, eggs, and nymphs. Control measures should be applied in the early spring, during the development of the first generation of lace bugs. If populations are low, simply wash them off with water. Repeated applications of insecticidal soaps or horticultural oils are effective in controlling moderate lace bug populations. If the infestation is heavy, chemical sprays may be necessary, but should be limited to protect natural enemies.

Adult lace bug with nymphs. Photo: Whitney Cranshaw, Colorado State University, Bugwood.org

Periodical Cicada

– SAPSUCKERS –

Hosts

Many deciduous trees including oak, hickory, ash, maple, hawthorn, apple, black locust, birch, and dogwood, and other woody plants.

Signs/Symptoms

Damage to trees occurs when adult cicadas cut slits into small branches and twigs in which they lay eggs. These twigs frequently wilt and die, and this flagging can cause growth loss, partial defoliation, and reduced production in fruit-bearing trees.

Timing

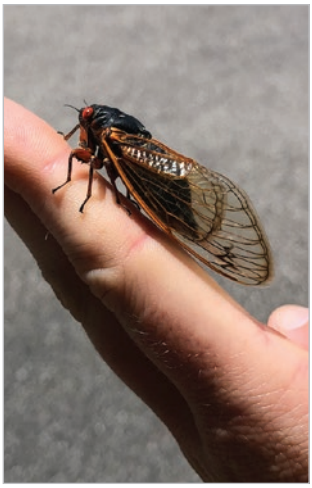
Broods of periodical cicadas emerge every 13 or 17 years. Nymphs spend up to 17 years underground feeding on plant roots, and then emerge in synchrony in the late spring months. They molt into the winged adult stage and leave their outer immature "skin" attached to tree trunks and twigs.

Management

Small trees can be covered with fine netting to prevent damage during years of periodical cicada outbreaks, but chemical control is generally not recommended. Growers may choose to delay planting new trees until after brood emergence.

Notes

Periodical cicadas are often called "17-year locusts", but this is a misnomer since locusts are actually grasshoppers. There are also annual cicadas that emerge in July and August every year in much lower numbers. Annual cicadas are dark green and black, while periodical cicadas are black with red eyes.



Adult periodical cicada. Photo: VDOF

Slits on branches in which cicada eggs are laid.
Photo: Tim Tigner, Virginia Department of Forestry, Bugwood.org

Flagging caused by cicadas.
Photo: Daniel Herms, The Ohio State University, Bugwood.org

Boxelder Bug (Seed Sucker)

Hosts

Box elder, maple, and ash trees.

Signs/Symptoms

This pest does little damage to its host trees. Adults and nymphs periodically migrate in large groups, and can be seen covering tree trunks, houses, and the ground in large numbers. If these groups move indoors, they can be a household nuisance, and frass may stain.

Timing

Boxelder bugs have two generations per year. Adult females overwinter and lay eggs in the cracks of the host tree's bark. Nymphs hatch in 11 to 14 days and develop into adults in the early summer months. Adults lay eggs which hatch into the second-generation nymphs. These nymphs develop into adults by August and September. In the fall, adults overwinter in dry, protected areas in both man-made and natural settings.

Management

Because boxelder bugs generally do not cause serious damage to trees in the landscape, management is only necessary to prevent them from moving into homes. This can be a difficult task because masses aggregate in such large numbers. Cultural methods, including sealing entry points and vacuuming swarms, are recommended; insecticide is not advised.

Adult boxelder bug. Photo: William M. Ciesla, Forest Health Management International, Bugwood.org

Adult boxelder bugs with nymphs. Photo: Steven Katovich, Bugwood.org

Cluster of adult boxelder bugs. Photo: Whitney Cranshaw, Colorado State University, Bugwood.org

Brown Marmorated Stink Bug

– SAPSUCKERS –

Hosts

Large host list with several hundred species. Preferred ornamental and forest trees include maple, ash, princess tree, pecans, catalpa, redbud, and magnolia. Fruit trees, such as apple, pear, and peach, are common hosts.

Signs/Symptoms

This insect feeds with piercing, sucking mouthparts. Most noticeable damage occurs on fruiting structures of plants, but stink bugs can also feed on branches and limbs by piercing through thin bark. Feeding causes discoloration, chlorosis, or necrosis in spotty areas on fruit tissue or can lead to corky spots in the tissue below feeding sites. If feeding occurs while fruit is still growing, the fruit will be deformed. Feeding on tree seedpods will result in seed death.

Brown marmorated stink bug adult. Photo: Susan Ellis, Bugwood.org

Timing

Adults emerge from a winter diapause in the late spring and immediately seek out host plants. Mating occurs a few weeks later and eggs are deposited in rows on the underside of leaves. Immature brown marmorated stink bugs develop through five instars before becoming adults. There can be multiple generations per year.

Brown marmorated stink bug nymphs. Photo: David R. Lance, USDA APHIS PPQ, Bugwood.org

Management

In Virginia, the most severely damaged plants are fruit trees. Light infestations are usually tolerable. For large populations, spot spray when and where they are causing damage, usually late July and August. Use an insecticide labeled for the host plant and agricultural use. There are some parasitoid wasps being evaluated for biological control.

Adult brown marmorated stink bugs feeding on fruit. Photo: Gary Bernon, USDA APHIS, Bugwood.org

Notes

Some species of stink bugs are native to Virginia. The brown marmorated stink bug, however, is an introduced species from Eastern Asia, first discovered in the United States in the early 2000s.

DEFOLIATORS

Bagworm

Hosts

Feed on more than 100 species but prefer conifers.

Signs/Symptoms

Bagworms defoliate trees and create tough, cocoon-like bags from silk and host foliage. Larvae feed on buds and foliage causing browning and branch dieback. They produce silk to create and anchor their bags, and these anchors may girdle and kill tree twigs. Defoliation can be severe and may ruin yard trees.

Timing

Mating takes place in late summer and early fall. Eggs are laid inside bags and hatch in the spring. Small larvae use silken threads like balloons to float to nearby trees where they settle, feed, and begin new bag construction. Larvae carry their bags with them until they mature and anchor to twigs in late summer.

Management

Mechanical control may be achieved on small landscape trees by removing and destroying bags by hand in the fall and winter. Insecticides are effective only against small bagworm larvae in the spring or early summer. Spraying with *Bacillus thuringienses* in early to mid-June should give satisfactory control.

Bagworm pupa. *Photo: Gerald J. Lenhard, Louisiana State University, Bugwood.org*

Tree damaged by bagworms.
Photo: Pennsylvania Department of Conservation and Natural Resources - Forestry, Bugwood.org

Bagworm bag created with silk and host foliage.
Photo: William Fountain, University of Kentucky, Bugwood.org

Pine Webworm

– DEFOLIATORS –

Hosts

Pine species including loblolly, pitch, shortleaf, slash, Virginia, longleaf, and eastern white pine.

Signs/Symptoms

Defoliation of young seedlings is the primary symptom. Young webworm larvae mine the needles whereas older larvae consume the entire needle. As larvae mature, they construct nests made of silk, frass, and old needles. Feeding may cause foliage to brown and reduce growth of young seedlings. Typically, by the time damage is observed, the larvae are done feeding and have left the host.

Pine webworm frass and webbing. Photo: VDOF

Timing

Adults are active in late spring through the summer. After mating, females lay eggs in rows on pine needles. As larvae mature, they form colonies within a single frass nest on a branch and then drop to the ground to pupate in soil.

Management

The pine webworm is not a serious pest and management is typically not required. Populations are generally controlled by natural enemies. If populations are high and seedling stocking is marginal, you can treat larvae in July to August with a full-coverage spray of insecticide, such as *Bacillus thuringiensis*.

Pine webworm larva. Photo: Connecticut Agricultural Experiment Station, Bugwood.org

Pine webworm frass and webbing. Photo: VDOF

Pine Sawfly

– DEFOLIATORS –

Hosts

All pines are susceptible.

Signs/Symptoms

Defoliation of pines is the primary symptom. Young larvae only feed on the outer edges of needles leaving brown straw-like remains. Older larvae consume the entire needle, often leading to complete defoliation of the host.

Timing

Adults emerge in spring and females can lay eggs with or without mating. Eggs are laid in slits sawed into pine needles. After a month, eggs hatch and larvae immediately begin feeding in groups. Feeding continues for three to five weeks before insects create cocoons and pupate (either on the tree or in the soil).

Management

Management is generally not required since pine sawfly populations are controlled by natural predators. If the infestation has persisted two to three years without a natural population crash, contact insecticides can be used on both young and old larvae. It is best to treat when larvae first appear, before extensive feeding occurs.

Notes

There are many species of pine sawflies in Virginia including the redheaded, introduced, European, and Virginia pine sawfly. While sawflies look like caterpillars, they are actually the larvae of a stingless wasp.

Redheaded pine sawfly damage. Photo: Steven Katovich, Bugwood.org

Redheaded pine sawfly larvae. Photo: Gerald J. Lenhard, Louisiana State University, Bugwood.org

Sawfly eggs laid on pine needles. Photo: Andrea Battisti, Universita di Padova, Bugwood.org

Broadleaf Sawfly

– DEFOLIATORS –

Hosts

Many deciduous trees and shrubs.

Signs/Symptoms

Sawflies are defoliators, but the specific type of damage varies by species. Some sawflies are leaf miners, others skeletonize or chew holes causing leaves to turn brown. Sawflies often stay together and feed in groups, which enables them to quickly defoliate entire plants. Slug sawflies secrete a slimy substance over their bodies that makes them resemble a slug.

Slug sawfly larvae. Photo: Eric Rebek, Oklahoma State University, Bugwood.org

Timing

Adult sawflies are inconspicuous and short-lived. Females lay eggs in slits sawed into leaves or stems. Larvae are usually present in early summer when they feed in groups for approximately a month before pupating. The number of generations per year varies by species.

Management

Though damage from sawflies can be quite alarming, they typically cause little to no long-term damage unless there are multiple consecutive years of defoliation. Populations are typically controlled by natural enemies. Insecticidal soaps may protect high-value landscape trees while maintaining natural enemy populations. Insecticides may be applied when larvae are present, but make sure to read the label. Since sawflies are not caterpillars, some insecticides such as *Bacillus thuringiensis* (Bt) will not be effective.

Pear sawfly larvae. Photo: Jerry A. Payne, USDA Agricultural Research Service, Bugwood.org

Notes

There are many species of sawflies that attack deciduous trees and shrubs in Virginia including the oak, pear, dogwood, and rose slug sawfly.

Sawfly damage on oak. Photo: William A. Carothers, USDA Forest Service, Bugwood.org

Eastern Tent Caterpillar

– DEFOLIATORS –

Hosts

Cherries, apples, crabapple and numerous other hardwood species.

Signs/Symptoms

The most obvious sign of this pest is silken "tents" formed in branch crotches. As caterpillars feed and mature, the tents grow as well. Caterpillars cluster together in their tents for protection, emerging to feed on leaves in the morning or evening. Heavy infestations can completely defoliate a tree.

Timing

Tent caterpillars emerge in early spring about the same time as buds begin to open on host trees. They feed through the spring and spin cocoons in early summer. Adults then emerge in mid to late summer to mate and lay eggs.

Management

Typically, management is not necessary. Trees will produce a new flush of foliage after initial defoliation. Chemical control options are available for high-value trees and should be applied in early spring when first leaves are fully expanded. Egg masses, which appear as dark, raised rings on small branches, can be manually removed.

Notes

The eastern tent caterpillar is often confused with the forest tent caterpillar. Eastern tent caterpillars have blue, black, and orange markings and a solid white line running down their back.

Eastern tent caterpillar silken tents. Photo: Steven Katovich, Bugwood.org

Eastern tent caterpillars. Photo: VDOF

Forest Tent Caterpillar

– DEFOLIATORS –

Hosts

Many hardwood species, especially bottomland hardwoods including sweetgum, birch, silver maple, oak, elm, cherry, basswood, water tupelo, and oak.

Signs/Symptoms

Caterpillars defoliate trees in early spring as they leaf out. Unlike the eastern tent caterpillar, no true tent is created. Instead, they group together on leaves and on silken mats on the main stem of host trees but do not construct tents.

Timing

Forest tent caterpillars hatch when leaves are beginning to unfold in early spring. They feed through the spring and then disperse to spin cocoons and pupate. Adults emerge in mid to late summer, mate, and lay eggs.

Management

Outbreaks cause heavy defoliation, but usually not long-term damage. Trees will produce a new flush of foliage after initial defoliation. Chemical control options are available for high-value trees and are most effective if applied when caterpillars are small in early spring.

Notes

The forest tent caterpillar is often confused with the eastern tent caterpillar. Forest tent caterpillars have a brownish body with pale blue lines along the sides and white keyhole- or footprint-shaped spots running down their back.

Forest tent caterpillar. Photo: Steven Katovich, Bugwood.org

Defoliation caused by the forest tent caterpillar.
Photo: Steven Katovich, Bugwood.org

Fall Cankerworm

– DEFOLIATORS –

Hosts

Many hardwood species, especially oaks.

Signs/Symptoms

Cankerworms are loopers, or inchworms, that "inch" along as they crawl. Larvae feed on opening buds and new leaves in the spring, and move from tree to tree via silk strands. Young larvae create small holes in leaves as they feed, but older larvae consume the entire leaf except the midrib. Since cankerworms are an early season defoliator, trees often deplete stored reserves when they refoliate following a cankerworm attack. Healthy trees can withstand a season of defoliation, but multiple consecutive years of defoliation can cause long-term damage.

Fall cankerworm caterpillar. Photo: VDOF

Timing

Adults are active in the fall and females lay eggs on tree branches. Eggs hatch in April to May and larvae begin feeding on new leaves. Larvae drop to the ground in June where they pupate in the soil.

Management

Sticky bands can be placed around the trunks of host trees in November and December to monitor populations and catch adult females as they crawl up the trunk. Insecticides, such as *Bacillus thurgingiensis*, can be applied early in the season when larvae have just emerged.

Feeding damage by fall cankerworm. Photo: VDOF

Notes

The fall cankerworm is often a nuisance pest in urban areas since defoliation can be unsightly, and the dropping of frass and silken strands can be alarming.

Adult fall cankerworm on a mass of eggs. Photo: USDA Forest Service - Region 8 - Southern, Bugwood.org

Fall Webworm

– DEFOLIATORS –

Hosts

Fall webworms feed on a wide variety of hardwoods, but commonly attack hickory, walnut, birch, and cherry.

Signs/Symptoms

Larvae are gregarious and can be found feeding in groups inside large webs. As they feed on foliage, they spin a silken web around the leaves and branches on the outer portion of trees. Larvae are yellow with white hairs and have either a black or red head depending on the specific form. They may defoliate trees, but rarely cause long-term tree damage. The fall webworm is not considered a major forest pest, but the webs do detract from the aesthetic quality of landscape trees.

Timing

Adults emerge in the summer and females lay eggs on the underside of leaves. When eggs hatch, larvae immediately begin to spin a silken web over the foliage on which they feed. The fall webworm is a late-season pest and feeds late summer through early fall.

Management

Control is usually not necessary but removing and destroying webs may help reduce the population. Physically breaking webs open with a stick will allow predators (e.g., birds, wasps) to access and feed on the larvae. Insecticides can be applied when caterpillars are young, but are not practical on a large scale.

Fall webworm caterpillars within webbing. Photo: Steven Katovich, Bugwood.org

Fall webworm infestation. Photo: David Coyle, Clemson University

Gypsy Moth

– DEFOLIATORS –

Hosts

Gypsy moth caterpillars feed on hundreds of tree species but tend to prefer oaks, especially white and chestnut oak on ridgetops.

Signs/Symptoms

Young caterpillars create small "shot-holes" in soft leaf tissue, but older larvae will consume the entire leaf. Gypsy moth caterpillars can defoliate entire trees, and during outbreak years, they are capable of defoliating hundreds of thousands of acres of forestland. Healthy trees can usually survive one or two years of defoliation, but multiple consecutive years of attack may lead to tree death, especially in stressed trees.

Timing

Caterpillars feed in the spring, pupate in early summer and adults emerge approximately two weeks later. Eggs are laid in tan-colored masses that contain several hundred eggs. These egg masses overwinter and are found on tree trunks, the underside of branches, or nearby rocks.

Management

Foliar insecticides or growth regulators can be applied on a large scale to suppress gypsy moth populations. *Bacillus thuringiensis* can be applied as a foliar spray in early spring when the larvae first emerge. To protect individual trees, homeowners can destroy egg masses or put up barriers on the trunk to control the crawling caterpillars. Even though the gypsy moth is not native, there are several natural predators present, such as ground beetles and small mammals. *Entomophaga maimaiga* is a fungus that attacks gypsy moth caterpillars. This fungus proliferates during periods of rain, so a wet spring is favorable for gypsy moth control.

Notes

The gypsy moth is invasive in North America. It was introduced from Europe in the mid-1800s and has defoliated hardwoods in Virginia since the 1980s.

Gypsy moth-defoliated ridgetops. Photo: VDOF

Gypsy Moth, continued

Gypsy moth caterpillar. Photo: VDOF

Gypsy moth male (left) and female (right) adults.
Photo: USDA APHIS PPQ, Bugwood.org

Gypsy moth egg masses and pupal casings. Photo: VDOF

Elm Leaf Beetle

– DEFOLIATORS –

Hosts
Elm trees.

Signs/Symptoms
Adult beetles chew irregular round holes in elm leaves, and larvae skeletonize the leaf surface. Leaves turn brown and may fall prematurely. Heavily-infested trees are weakened and repeated attacks can lead to tree mortality. Damage is most obvious on landscape trees.

Timing
Adults overwinter in protected areas, such as structures or houses, and emerge in the spring to lay eggs on elm trees. Larvae feed on leaves and then move to the base of the tree to pupate. There are two generations per year.

Management
Elm leaf beetle feeding is usually not a threat to the tree, but heavy infestations may warrant control. Spray all foliage with a contact insecticide in the spring when leaves are first fully expanded, and then again in July. Another strategy is to apply the insecticide in a foot-wide band around the trunk to kill larvae as they crawl down to pupate.

Notes
There are many leaf beetles in the family *Chrysomelidae*. The elm leaf beetle and the larger elm leaf beetle are common Chrysomelid pests of elm in Virginia.

Adult elm leaf beetle and damage. Photo: Jan Liska, Forestry and Game Management Research Institute, Bugwood.org

Larger elm leaf beetle larva.
Photo: VDOF

Leafminer

– DEFOLIATORS –

Hosts

These insects impact many hardwood species. In Virginia, common species impacted are birch, basswood, holly, and magnolia.

Signs/Symptoms

Leafminer larvae feed between the upper and lower leaf surfaces. This form of feeding is used by many types of insects so leafminers can be moths, beetles, flies, or sawflies. The pattern created by feeding helps to classify which type of leafminer is present. Mines may be serpentine or blotch, or a combination of the two depending on the number of insects feeding and extent of damage.

Timing

Specific timing varies with species but typically there are overlapping generations within a year. Adults generally emerge in spring and lay eggs in leaf tissue where the larvae feed and develop. Pupation occurs within the mined areas or in the ground.

Management

Most damage is cosmetic with no significant harm to the tree. Control is usually not warranted as natural enemies control leafminer populations. Insecticide options are available but require correct timing and precise identification of the leafminer species.

Leafminer damage on oaks.
Photo: VDOF

Holly leafminer damage. *Photo: John C. French Sr., Retired, Universities: Auburn, GA, Clemson and U of MO, Bugwood.org*

Locust Leafminer

– DEFOLIATORS –

Hosts

Black locust trees.

Signs/Symptoms

Adult beetles have a black head and orange wings with a black stripe down their back and are about 6 mm long. They feed on the lower surface of leaves, skeletonizing and chewing small holes. Larvae also cause damage by cluster feeding on inner leaf tissue and creating mines that disperse in many directions. Leaves turn brown due to feeding damage, and heavily-infested trees may suffer growth and vigor reduction.

Timing

There are two generations per year. Adults emerge in the spring and larvae are present later in the season. Larvae begin feeding together, then disperse and feed within individual mines. Larvae prefer to feed in the terminal part of the foliage and pupate within the mines. The second generation of adults emerge later and feed before finding a suitable site to overwinter. Annual browning is most noticeable in late summer along major highways in Virginia.

Management

The appearance of the damaged black locust trees is often alarming and worrisome, but the locust leafminer rarely causes serious long-term damage. Natural predators help control populations of locust leafminers and therefore other control methods are generally not warranted.

Locust leafminer damage on foliage. Photo: Steven Katovich, Bugwood.org

Adult locust leafminer. Photo: Lacy L. Hyche, Auburn University, Bugwood.org

Locust leafminer damage in a stand. Photo: Chris Evans, University of Illinois, Bugwood.org

Late Season Defoliators

– DEFOLIATORS –

There are countless Lepidopteran (butterfly and moth) insect pests that defoliate trees in late summer to early fall. These pests are usually native and only cause minor short-term damage. Examples of common late-season defoliators in Virginia include the variable oakleaf caterpillar, orange-striped oakworm, catalpa caterpillar, walnut caterpillar, and yellownecked caterpillar.

Variable oakleaf caterpillar damage. Photo: VDOF

Hosts

Many deciduous trees, varies by specific insect.

Signs/Symptoms

Late-season defoliators can defoliate branches or even entire trees. Defoliation is mostly aesthetic, but repeated infestation can impact tree health. Heavy populations can be a nuisance on urban or landscape trees and shrubs due to frass that drops to the ground.

Timing

Life cycles vary with species, but adults usually emerge midsummer and lay eggs on leaves. Larvae are active in late summer and fall. Pupation generally occurs in winter.

Management

Management is seldom warranted, though contact and systemic insecticides are effective against young larvae. If infestations are low, hand-removal can be successful. Natural enemies usually control populations.

Notes

Late-season defoliators generally cause less damage to trees because the trees do not use stored reserves to refoliate so close to autumn leaf drop. In contrast, trees will put out a new flush of leaves after early season defoliation, thus using up stored carbon reserves and weakening the tree.

Orange-striped oakworm. Photo: USDA Forest Service - Region 8 - Southern, Bugwood.org

Yellownecked caterpillar. Photo: Gerald J. Lenhard, Louisiana State University, Bugwood.org

Japanese Beetle

– DEFOLIATORS –

Hosts

More than 250 different ornamentals, vegetables, trees, and shrubs.

Signs/Symptoms

Adults feed on a variety of plant species during the summer months, leaving only a lacy network of leaf veins. Damaged plants release volatiles that attract more Japanese beetles, which produce large localized populations. Feeding usually begins at the top of the plant, and the beetles move down the plant as feeding continues. Grubs live in the soil and can damage turfgrass by feeding on the roots.

Timing

Adult beetles are active late May and throughout the summer. Adult females lay eggs in turfgrass during the summer. Juveniles (grubs) spend the fall feeding on roots, overwinter, and continue to feed on roots in the spring until they pupate. Adults emerge from the soil in June and immediately start feeding on the upper surface of leaves.

Management

Management of Japanese beetle infestations is difficult and requires control of both the adult and grub stages. Pheromone traps are not recommended because they attract large populations of beetles and could increase damage levels instead of reducing them. Control methods that target grubs include parasitic nematodes, *Bacillus thuringiensis galleriae*, and another *Bacillus* bacterium called milky spore. Cultural control methods include using resistant plants and increasing the distance between turf and susceptible plants. Insecticidal soaps and sprays can provide temporary protection from adult populations. If populations are high enough, insecticides can be applied in the summer after adults have begun congregating on host plants.

Adult Japanese beetle. Photo: William Fountain, University of Kentucky, Bugwood.org

Cluster of beetles feeding. Photo: M.G. Klein, USDA Agricultural Research Service, Bugwood.org

Foliar damage by Japanese beetles. Photo: William Fountain, University of Kentucky, Bugwood.org

May/June Beetle (June Bug)

– DEFOLIATORS –

Hosts

Variety of trees, shrubs, and other plants, including grasses.

Signs/Symptoms

Larvae (white grubs) feed on roots underground and can eliminate the entire root system of a plant, especially in young trees or shrubs growing in grassy areas. Patchy, dying turf spots that can easily be pulled from soil suggests grub damage. Adult beetles feed at night on leaves and small stems and are often found flying around lights. Chewing damage is most often seen on young tender foliage. This damage is usually minor, but heavy infestations can completely defoliate a tree or shrub in late spring.

Timing

The life cycle of May/June beetles is generally one year but can be longer. Adults emerge from the soil in May and June and feed on foliage. Eggs are laid in the soil and larvae spend the rest of the year feeding on roots and decaying vegetation underground. They move up and down in the soil depending on temperature.

Management

Monitor areas at night with lights for the presence of adult beetles. Insecticides are generally not warranted for adults feeding on foliage. Control for larval feeding on roots is sometimes recommended during heavy infestations. Treat turf with a product labeled for grub control in August since that is when eggs have hatched, and grubs are still feeding near the surface. Biological control with nematodes, bacteria, and fungi can also be effective.

Notes

White grubs are one of the most destructive insect pests of turfgrass and can destroy large areas of turf in a very short period of time.

Larva of a June beetle. Photo: Steven Katovich, Bugwood.org

Adult June beetle. Photo: Emmy Engasser, Hawaiian Scarab ID, USDA APHIS PPQ, Bugwood.org

May beetle adult and grub. Photo: Whitney Cranshaw, Colorado State University, Bugwood.org

Yellow-poplar Weevil

– DEFOLIATORS –

Hosts

Yellow-poplar, magnolia, and sassafras.

Signs/Symptoms

Small black weevils make tiny notches shaped like a grain of rice in the leaf. These oval- or crescent-shaped holes create brown splotches on the leaf surface, and larvae form additional mines as they feed. This repeated partial defoliation weakens trees. During outbreak years, tree damage may be unsightly and alarming, but is mostly just cosmetic and does not cause long-term harm to the trees.

Feedling damage with adult yellow-poplar weevils. Photo: Tim Tigner, Virginia Department of Forestry, Bugwood.org

Timing

Adult yellow-poplar weevils emerge in early June and feed on the leaves until midsummer when they go into a diapause period through the winter. The weevils will emerge next spring to mate and lay eggs on the underside of leaves. Newly-hatched larvae then feed as leaf miners for three to four weeks until they pupate in mined feeding areas. Weevil population outbreaks tend to occur every few years in Virginia when weevil populations surpass natural predator control capabilities.

Feeding damage by yellow-poplar weevils. Photo: VDOF

Management

Since the yellow-poplar weevil is a native pest in the eastern United States, control is usually not warranted. Natural predators normally regulate the population and keep it below damaging levels.

Aerial photo of yellow-poplar weevil outbreak. Photo: VDOF

Notes

The yellow-poplar weevil is a periodic problem in southwest Virginia, often over large areas. During outbreaks, weevils may be mistaken for ticks as they fall on people passing below an infested tree.

Gall Insects (generic)

– DEFOLIATORS –

Includes wasps, aphids, midges, sawflies, mites, adelgids, psyllids, beetles and moths.

Hosts

Many hardwoods and occasionally conifer species.

Sigsn/Symptoms

Galls are abnormal growths that occur on leaves, twigs, or branches. Galls often appear as lumps on twigs or leaves, but there is a wide variation in size and appearance. Infected trees may lose leaves or experience twig mortality, but the presence of galls is rarely fatal to the tree.

Timing

Galls form as a tree response to colonization, egg-laying, or feeding, and the gall itself is the tree's reaction to the gall-maker. Galls often grow as the organism inside grows, using nutrients from the tree as food. The biology of individual galls is highly variable.

Management

In most cases, natural enemies control populations of the gall-causing organism. Infected tissues can be manually removed and disposed of; pesticides can be used to control gall-forming organisms, but these are generally not recommended.

Notes

Most gall insects have only one host plant, and can be identified based on gall shape and the host plant.

Cynipid gall. Photo: Ronald F. Billings, Texas A&M Forest Service, Bugwood.org

Gall wasp damage on foliage. Photo: Steven Katovich, Bugwood.org

ROOT/SHOOT/TWIG INSECTS

Nantucket Pine Tip Moth

Hosts

Most southern pine species.

Signs/Symptoms

Young, small trees (less than 5 years old) are typically targeted by this pest. Tip moth larvae bore into and feed on the inner tissue of buds and shoots. This causes needles on infested shoots to turn yellow and brown, curl, and die. Dead shoots are hollow where larvae have fed. In severe and prolonged infestations, young trees may be killed, but damage is normally limited to growth reduction and deformation of the main stem.

Timing

Adult moths emerge in early spring and lay eggs on the current season's shoots. Larvae start feeding on the outside of new growth and then bore into shoot tips, conelets, and buds. Pupae overwinter in dead terminal shoots. There are multiple generations per year.

Management

Typically, no management is required for this pest as young trees can recover from an attack. For light infestations, remove damaged tips in July. Pesticides are available for high-value trees but timing of application is critical to ensure that the insecticide is applied when larvae are young. Treat with a contact insecticide in April and make sure to thoroughly wet all needles and shoots. Repeat application one to two times at 8-week intervals, preferably with a systemic insecticide.

Adult Nantucket pine tip moth. Photo: Christopher Asaro, University of Georgia, Bugwood.org

Dead shoot from tip moth feeding. Photo: VDOF

Damage to young pine caused by tip moth. Photo: VDOF

Pales Weevil

– ROOT/SHOOT/TWIG INSECTS –

Hosts

All pine species.

Signs/Symptoms

Damaged seedlings will be girdled near the ground and may show damage both above and below the soil line. Pitch oozes from feeding wounds and crystallizes as it dries. Needles on girdled trees rapidly turn red to brown and may drop. Adults are attracted to chemical odors emitted from recently-cut stumps or dying pines. As a result, these weevils can cause heavy mortality in recently-planted pines, particularly in areas planted soon after harvest.

Timing

Adults mate and lay eggs on the root collar or large roots. Larvae hatch and bore into the roots and feed on phloem. Adults feed on live roots, shoots, and buds of pine seedlings and trees.

Management

If possible, avoid planting seedlings within six months following a harvest. If the site was harvested after June, wait until the following year to plant. Many pine seedlings can be purchased pre-treated with an insecticide that will protect seedlings from reproduction weevil damage.

Notes

The pitch-eating weevil, *Pachylobius picivorous*, has a similar life cycle and causes the same damage. Pales and pitch-eating weevils are often referred to as "reproduction weevils".

Pales weevil damage on root collar. Photo: Mary Ann Hansen, Virginia Polytechnic Institute and State University, Bugwood.org

Pales weevil feeding damage. Photo: VDOF

Adult pales weevil. Photo: USDA Forest Service - Region 8 - Southern, Bugwood.org

White Pine Weevil

– ROOT/SHOOT/TWIG INSECTS –

Hosts

Eastern white pine, various spruce species.

Signs/Symptoms

Trees less than 20 feet in height are most frequently targeted. The first symptom is drops of resin on the stem in late March or early April that eventually dry to a white crust. This damage is caused by adult weevils chewing holes in the terminal leader. However, most damage is done by the larval stage as they chew and burrow completely around the stem causing the new growth to brown, wilt, and eventually die. The white pine weevil usually only attacks the upright terminal leader; a lateral branch will eventually grow upward to take the place of the damaged leader branch. This can result in a forked tree.

Adult white pine weevil feeding holes. Photo: Steven Katovich, Bugwood.org

Timing

Adults overwinter in leaf litter near or under their host trees. In spring, they move to the leaders of suitable hosts. In late spring, adults mate and lay eggs in feeding wounds on the terminal leader. Eggs hatch a few days later and larvae feed on the inner bark of the leader. Larvae reach maturity in mid to late July and pupate in the infested terminal.

Management

In spring, look for resin drops on the leader and look for curled terminal leaders in June. Infested leaders should be pruned and removed before midsummer to stop the life cycle of the pest. Prune all but one live lateral shoot just below the damaged terminal. This should promote single-stem dominance on the affected host plant. Application of a registered insecticide should be made to the impacted terminal leader in early spring before buds open.

White pine weevil. Photo: Juliana Cardona-Duque, University of Puerto Rico, Bugwood.org

Damaged leader due to weevil feeding. Photo: Steven Katovich, Bugwood.org

Twig Girdler/Pruner

Hosts

Commonly pecan, hickory, and oak, but hosts also include persimmon, maple, ash, elm, poplar, basswood, sweetgum, hackberry, poplar, honey-locust, dogwood, and some flowering fruit trees.

Signs/Symptoms

Both twig girdlers and twig pruners cause small branches to die, break from the tree, and fall to the ground. Adult twig girdlers cause damage when they chew circular notches around the twig and girdle it. They sever the twig from the outside so that the broken twigs have a rough central core. Damage from twig pruners occurs when larvae tunnel inside the branch, severing the twig by making circular cuts from the inside. This produces a clean cut with a hollowed-out space at the cut.

Timing

In the summer, twig girdlers lay eggs on the bark of branches just above where they girdle the twig. The twigs die and eventually fall to the ground where the larvae develop and overwinter in the fallen twig. Larval twig girdlers pupate and emerge as adults the following summer. Twig pruner eggs are deposited near the leaf axil. Larvae hatch and feed within the twig causing it to break off by the fall. Twig pruner larvae continue to feed on the severed twig and overwinter as pupae. Adults emerge in the spring.

Management

Gather and destroy fallen twigs in the fall to prevent adult emergence the following year. Chemical control is not practical for twig girdlers/pruners because it is difficult to treat insects inside the twigs.

Twig girdler. Photo: Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

Damage from twig girdler. Photo: Lacy L. Hyche, Auburn University, Bugwood.org

BARK BEETLES/WOOD BORERS

Southern Pine Beetle

Hosts

All southern pine species.

Signs/Symptoms

Once a tree is infested, needles quickly fade to yellow, red and eventually brown, and then drop. Southern pine beetle spots can expand rapidly and generally move downwind. Beetles are small, only about ⅛ inch long, and are dark red-brown to black in color. As beetles bore into the tree, white resin pitch tubes form between bark plates. S-shaped galleries are created in the inner bark as beetles tunnel in the cambium.

Timing

There are multiple generations per year and all life stages can overwinter. Females emerge in spring and seek out suitable hosts. They release pheromones to attract males and mate. Eggs are deposited in tunnels in the inner bark, larvae feed for several weeks before pupating in outer bark, then adults emerge and move to other nearby trees. A life cycle can be complete in a little more than a month.

Management

Proper forest management practices are essential for southern pine beetle prevention. Thinning pine stands improves forest health and lowers the risk of a beetle outbreak. During outbreaks, cut-and-remove is the best control method and involves felling and removing all infested trees as well as a 75- to 100-foot buffer of green healthy trees. If tree removal is not possible, cut-and-leave is the next best option. Insecticides are available for landscape trees but not practical in a forest setting since the stem and entire crown require treatment.

Notes

The southern pine beetle is the most destructive native forest pest in the southern U.S. It generally attacks trees that are already stressed but can overcome healthy trees in high populations.

Adult southern pine beetles. Photo: Erich G. Vallery, USDA Forest Service - SRS-4552, Bugwood.org

Southern Pine Beetle, continued

Pitch tubes between bark plates. Photo: Southern Forest Insect Work Conference, Bugwood.org

Southern pine beetle outbreak. Photo: Ronald F. Billings, Texas A&M Forest Service, Bugwood.org

Southern pine beetle bark galleries. Photo: Roger Anderson, Duke University, Bugwood.org

Ips Bark Beetle (Pine Engraver Beetle)

Hosts

All southern pine species.

Signs/Symptoms

Discolored foliage is the first sign of infestation. Pitch tubes form on the main trunk and stems on bark plates. Areas of infestation tend to be more scattered than those from southern pine beetle and are usually limited to a few trees. *Ips* bark beetles are attracted to trees that are already stressed, often from drought or lightning strikes.

Timing

Beetles are active throughout the growing season. Symptoms typically begin in late spring. Multiple generations exist each year and all life stages can overwinter. Females emerge in spring and fly to host trees to lay eggs in galleries in the inner bark. Larvae feed on the bark, pupate, then emerge and move to other trees. One life cycle can be completed in less than a month.

Management

Proper forest management is key. Minimize stress to trees. Scattered mortality does not usually warrant control. In larger infestations, infested trees should be cut and removed from the stand as populations can build in residual debris. When removing trees, take care to avoid injuring adjacent healthy trees. For high-value landscape trees, insecticides are available.

Notes

There are several native *Ips* species found in Virginia. The small southern pine engraver usually attacks small branches in the upper crown, the five-spined engraver attacks mid-crown, and the six-spined engraver attacks larger branches and main stem. *Ips pini* is native in mountainous regions. All *Ips* species have tiny spines on the lower portion of their hardened forewings.

Five-spined Ips beetle. Photo: Gerald J. Lenhard, Louisiana State University, Bugwood.org

Ips Bark Beetle, continued

Ips bark beetle galleries. Photo: VDOF

Stand damage from Ips beetles. Photo: VDOF

Ips bark beetle damage. Photo: VDOF

Black Turpentine Beetle

– BARK BEETLES/WOOD BORERS –

Hosts

All southern pine species.

Signs/Symptoms

Black turpentine beetles are attracted to stressed or wounded trees. Discolored foliage is the first symptom; needles turn yellow, red, and then brown. As the beetle bores into the tree, large pitch tubes form on the lower 10 feet of the trunk. These pitch tubes are larger than what is produced during a southern pine beetle infestation, usually the size of a half dollar and brown to purple in color. Some trees may survive attack.

Timing

Females emerge in spring and fly to host trees where they lay eggs in galleries in the inner bark. Larvae feed on the inner bark for months, then pupate and emerge as adults. There are multiple overlapping generations per year.

Management

Keeping trees healthy with proper forest management is the best prevention. Avoid mechanical injury to trees during logging operations or prescribed fires. In large infestations, remove wounded trees to stop the population from spreading. Insecticides may be applied to the main stem of infested and adjacent uninfested trees.

Pitch tubes at base of tree. Photo: Lacy L. Hyche. Auburn University, Bugwood.org

Black turpentine beetle pitch tube. Photo: VDOF

Adult black turpentine beetle. Photo: Erich G. Vallery, USDA Forest Service - SRS-4552, Bugwood.org

Pine Sawyer Beetle

– BARK BEETLES/WOOD BORERS –

Hosts

All pine species.

Signs/Symptoms

There are several species of pine sawyers in the genus *Monochamus*. Adults possess long antennae that extend one to three times the body length. Larvae are legless, white grubs with brownish heads and construct round tunnels underneath the bark. Large piles of sawdust often accumulate at the base of trees. Look for conical egg niches in the bark and round circular exit holes.

Timing

Pine sawyers do not have synchronized emergence, but adults are most active from May to September. Eggs are inserted into small niches in the bark. Larvae feed just underneath the bark constructing galleries filled with frass. They move to the heartwood as they continue to feed, and then return to the surface to pupate. Development and activity slows in cold weather.

Management

These beetles are most commonly associated with recently felled, stressed, dying, or dead trees; they rarely attack healthy trees. Prevention is the best control; maintain tree vigor. Pine sawyers quickly infest and degrade logs in warm weather, so it is best to cut logs in colder weather.

Notes

Larvae are known as roundheaded wood borers and frequently make loud clicking noises while they feed underneath the bark.

Adult pine sawyer beetle. *Photo: Whitney Cranshaw, Colorado State University, Bugwood.org*

Deodar Weevil

Hosts

All pine species.

Signs/Symptoms

Adult and larvae girdle stems which can kill small trees. Look for fading crowns in the fall or winter. The most distinctive sign of a deodar weevil infestation is the chip cocoons they construct underneath the bark. These circular chambers are visible once the bark starts sloughing off.

Timing

Adults emerge in the spring but are most active in the fall when they feed on leader and lateral branches of pine trees and lay eggs in punctures on the bark. Larvae hatch and feed under the bark in the fall and winter, then pupate in late winter or early spring.

Management

Deodar weevils generally only attack suppressed, unhealthy trees. They often prefer trees that have sustained mechanical damage or been previously infested with other bark beetles. Maintain tree vigor to prevent deodar weevil infestation. Plant pines where they are best suited to grow, avoid mechanical damage, and thin stands when appropriate.

Notes

Deodar weevils can be vectors of pitch canker.

Deodar weevil chip cocoon. Photo: Edward L. Barnard, Florida Department of Agriculture and Consumer Services, Bugwood.org

Deodar weevil. Photo: Gerald J. Lenhard, Louisiana State University, Bugwood.org

Hickory Bark Beetle

– BARK BEETLES/WOOD BORERS –

Hosts

Hickory, pecan, and butternut.

Signs/Symptoms

Beetles damage trees by creating galleries underneath the bark that may eventually girdle the tree. Foliage of infested trees will turn yellow, red, and finally brown as the tree dies. Some trees can survive attack. The hickory bark beetle tends to only attack trees that are already stressed due to drought, fire, storm damage, or disease. If you peel the bark off an infested tree, you may see galleries constructed by adults and larvae that are shaped like a centipede.

Timing

Adult beetles fly to the tops of trees and feed on terminal growth in late spring or early summer, and then bore into the bark of trunks and branches to lay eggs. Females construct vertical egg galleries underneath the bark and deposit eggs singularly in small niches along either side of the gallery. When eggs hatch, the larvae mine outwards away from the main gallery.

Management

Since this beetle attacks stressed trees, the best prevention is to keep your trees healthy with good cultural practices, such as thinning and irrigation. Remove dead or dying trees. To protect valuable trees, trunks and large branches should be thoroughly sprayed with an appropriate insecticide.

Adult hickory bark beetle. Photo: Natasha Wright, Cook's Pest Control, Bugwood.org

Galleries from tunneling hickory bark beetles. Photo: VDOF

Ambrosia Beetle

– BARK BEETLES/WOOD BORERS –

Hosts

Many different species of trees are impacted.

Signs/Symptoms

There are many species of ambrosia beetles. Most adult beetles are very small, and the larvae resemble small white grubs. Most beetles attack stressed, dying, or already dead trees, but a few introduced species can attack healthy trees. The primary sign of ambrosia beetles is whitish boring dust that accumulates at the base of the tree and in the bark crevices. Sometimes this sawdust sticks together with beetle frass and forms toothpick-like projections on the outside of the tree. Small entrance and exit holes may be visible; these are often the size of a pencil tip or smaller.

Timing

Depending on species, there can be multiple generations per year. Adult ambrosia beetles attack trees throughout the growing season and lay eggs in the sapwood. Ambrosia beetles differ from bark beetles in that they do not utilize the host wood material as a food source. Instead, they cultivate fungal gardens within galleries inside host trees. Adults and larvae feed on the fungus.

Adult ambrosia beetle. Photo: Gerald J. Lenhard, Louisiana State University, Bugwood.org

Management

The most effective method of control is to remove any dying or dead trees. Once felled, remove or debark the tree to ensure no populations can survive in the stand. Chemical control is not recommended in forest settings, but high-value trees can be treated with a registered insecticide in April. Treat the trunk and larger branches.

Frass toothpick. Photo: Albert (Bud) Mayfield, USDA Forest Service, Bugwood.org

Emerald Ash Borer

– BARK BEETLES/WOOD BORERS –

Hosts

All native species of ash in North America.

Signs/Symptoms

Symptoms may not be visible until a tree has already been infested for multiple years. The most obvious sign of an emerald ash borer infestation is often bark stripping by woodpeckers as they hunt for beetle larvae. As larvae feed underneath the bark, tree foliage wilts and canopy dieback occurs. Peeling bark will reveal winding S-shaped galleries where larvae have fed. When adult beetles emerge, they create D-shaped exit holes in the bark. After infestation, trees typically die within three to five years if untreated.

Emerald ash borer larva and S-shaped gallery. Photo: VDOF

Timing

Adults emerge in late spring (May) and feed on ash foliage. Females lay eggs on the bark of ash trees. Larvae hatch seven to 10 days later and bore into the tree. Larvae begin feeding on inner bark, then move onto the outer sapwood and xylem as they develop. They go through four larval stages, overwinter, pupate in April, and emerge as adults several weeks later.

Management

Landscape and high-value trees should be treated with a systemic insecticide. Most insecticides should be reapplied every one to two years. Preventative treatment is most effective. When more than 30 percent of the canopy has been lost, treatment may not be successful. Biological control with parasitic wasps in forested settings shows promise for future generations of ash.

Notes

A comprehensive guide for insecticide options for protecting ash trees can be found online here: https://extension.entm.purdue.edu/EAB/PDF/NC-IPM.pdf.

Adult emerald ash borer. Photo: Debbie Miller, USDA Forest Service, Bugwood.org

Woodpecker stripping. Photo: VDOF

Two-Lined Chestnut Borer

Hosts

Oaks.

Signs/Symptoms

Attacks trees that are already weakened or stressed. Wilted foliage on scattered branches is typically the first symptom followed by branch mortality and then crown decline. Repeated years of attack can kill the tree in as little as two to three years. Often these symptoms are similar to those of other tree stressors such as drought, root compaction, etc. The beetles themselves are elongated and black with two faint, yellowish stripes along their back. Larvae are white and about 1 inch long, similar to emerald ash borer larvae. Larvae bore and feed on the inner bark of these trees and pupate at the end of the tunnel.

Timing

Adults emerge in late spring and mate. Larvae hatch after two weeks and move into the cambial tissue where they feed until the end of summer. They overwinter as larvae and then pupate at the end of the tunnel in the early spring.

Management

Managing stressed trees and promoting vigor is the best way to control against this pest. Native parasitoids can also help control populations. Insecticides can be applied to high-value trees in the spring but should be done in conjunction with other plant-care measures since the presence of this insect indicates the tree is already in decline.

Adult two-lined chestnut borer. Photo: Robert A. Haack, USDA Forest Service, Bugwood.org

Crown decline of tree infested with two-lined chestnut borer.
Photo: Steven Katovich, Bugwood.org

Lilac Borer

– BARK BEETLES/WOOD BORERS –

Hosts

Lilac, ash, mountain ash, and privet.

Signs/Symptoms

Irregular-shaped entrance holes in the cracks or crevices of bark. Frass is often visible at the entrance hole. Circular exit wounds can also be seen above the entrance holes. The trunk becomes swollen at the base of infested branches and the bark cracks and breaks away from the wood.

Timing

Mature larvae overwinter in the heartwood of the host. Adults emerge in late spring to early summer. Adults mate within two weeks of emergence and females lay eggs in the grooves of the host's bark. Eggs hatch within two weeks and larvae bore into the tree, feeding as they tunnel through the sapwood.

Management

This pest is difficult to eradicate once it is established. Prevention is the best management method because lilac borers attack stressed trees. Prune older limbs near the base of potential host trees in the winter before adults emerge. Pheromone traps can be used to monitor adult flight. Insecticidal sprays can be applied in early May and again six weeks later to kill emerging as well as entering borers; larvae are protected from sprays once they have tunneled into the bark. Thorough wetting and soaking of the bark is necessary; foliage does not need to be treated.

Circular exit holes on trunk from lilac borer. Photo: Steven Katovich, Bugwood.org

Adult lilac borer. Photo: VDOF

Flatheaded Appletree Borer

Hosts

Apple, crabapple, dogwood, beech, elm, hawthorn, maple, oak, willow, sycamore, and numerous other deciduous tree species.

Signs/Symptoms

Damage occurs throughout the growing season while larvae feed. Feeding girdles the tree causing crown dieback, yellowing leaves, epicormic sprouting, and death. The bark above tunnels dies and oozing sap may be visible. Gnarled scars often develop as healthy tissue grows around wounds.

Timing

There is one generation per year. In late spring, adults emerge and begin laying eggs on tree bark. Young larvae move into the cambium and chew tunnels in the tree while growing and developing until fall when they move into the heartwood to overwinter. Visible symptoms may not be noticeable until feeding has continued for at least one year.

Management

There are several natural enemies, such as parasitoid wasps and woodpeckers, that control this pest. Chemical control is an option for fruit and landscape trees; treat bark of trunk and branches in early May, June, and July. Good cultural control practices, such as mulching, proper irrigation, and fertilization, can also reduce the risk of attack as stressed trees are more likely to be impacted.

Flatheaded appletree borer larva. Photo: James Solomon, USDA Forest Service, Bugwood.org

Adult flatheaded appletree borer. Photo: Natasha Wright, Cook's Pest Control, Bugwood.org

Locust Borer

Hosts

Black locust.

Signs/Symptoms

Tunneling by locust borer larvae weakens tree limbs and makes them susceptible to breakage. Tunneling damage may also lead to knots and swelling. Early season borer feeding often produces oozing sap and wet spots on the bark. Damage is not easily detected and may only be evident once infestations are severe. If this is the case, sawdust-like frass will gather around the base of the trunk and crown thinning will be evident.

Timing

Eggs are laid in cracks of the bark from late summer to early October. Larvae hatch and bore into the inner bark where they overwinter. Larvae become active in the spring and continue boring into the tree. Larvae pupate by midsummer, and adults typically emerge in August.

Management

Systemic insecticides can be applied preventatively as soil drenches before infestation occurs. Apply these in early spring. Otherwise, treat the trunk and larger branches in late August to mid-September with contact insecticides. Natural predators of the locust borer are woodpeckers and wheel bugs.

Adult locust borer. Photo: Kansas Department of Agriculture, Bugwood.org

Locust borer tunnels and larvae. Photo: Whitney Cranshaw, Colorado State University, Bugwood.org

Asian Longhorned Beetle

– BARK BEETLES/WOOD BORERS –

Hosts

Many hardwood trees, especially ash, birch, elm, maples, poplars, and willows.

Signs/Symptoms

Infestation by this beetle likely means death for the tree, as feeding damage can kill the tree, and the structural damage left by boring larvae renders the tree susceptible to breakage. Egg sites are round, dime-shaped depressions. Pencil-sized exit holes may be present and frothy sap may exude from exit holes. Bark cracking and galleries under outer bark may be visible. Sawdust-like frass can be found at the base of the trunk and on infested branches.

Timing

One generation per year. Adults chew depressions on tree bark and deposit an egg. When the egg hatches, the larva bores into the tree and feeds on phloem for several weeks, after which it bores into the wood and forms tunnels as it continues to feed. Larvae pupate in the wood, and adults chew their way out in the spring.

Management

Severely-infested trees do not recover. Damaged or dying infested trees should be removed and destroyed. Systemic insecticides can be used to protect trees or eradicate light infestations.

Notes

At the time of publication, the Asian longhorned beetle was not yet present in Virginia but has been discovered in other eastern U.S. states.

Asian longhorned beetle larva. Photo: Steven Katovich, Bugwood.org

Adult Asian longhorned beetle.
Photo: David Coyle, Clemson University

Asian longhorned beetle egg site and exit hole.
Photo: David Coyle, Clemson University

Dogwood Borer

– BARK BEETLES/WOOD BORERS –

Hosts

Primarily flowering dogwoods. Occasionally flowering cherry and apple trees.

Signs/Symptoms

The dogwood borer often feeds in burr knots and produces reddish-brown crumbly frass. Entrance holes with exuded sawdust can be found on the main trunk and larger branches. Crown die-back, adventitious growth along the trunk and main branches, and sloughing of the bark may also occur.

Timing

Adult clear-winged moths appear around the late spring to early summer, when the last of the petals have fallen from dogwood flowers. Eggs are laid on the bark in September. Newly-hatched larvae will burrow into the bark and cambial area, where they will feed for one year and pupate the following spring.

Management

Treat trunk and larger branches when adults appear in the late spring. Repeat after six weeks into early fall. The nematode *Steinernema carpocapsae* can be used as a biological control agent, and can be applied as a liquid spray directly to the trunk and main branches of the host. If infestations are low, this should be done in August or early September. If infestations are more severe, a second application should also be made in late April.

Dogwood bark damage. Photo: John A. Weidhass, Virginia Polytechnic Institute and State University, Bugwood.org

Adult dogwood borer. Photo: David Laughlin, Horticultural student, Bugwood.org

Carpenterworm

– BARK BEETLES/WOOD BORERS –

Hosts

Various hardwoods (including ash, birch, cottonwood, American elms, black locust, maple, oak, willow, fruit-bearing and ornamental fruit trees).

Signs/Symptoms

The earliest signs of an infestation are dark, oozing sap spots on the tree trunk. Large quantities of frass and sawdust will likely be exuding from entrance holes. Females usually lay eggs in bark crevices near existing gallery entrances and cause extensive scarring on bark tissue. Extensive feeding damage will lead to limb breakage. Pupal cases may remain in the tree sticking out of exit holes.

Timing

Larvae take two to four years to complete development. Adult emergence typically occurs May through July and eggs are laid shortly after emergence. Newly-hatched larvae bore into sapwood and feed while developing through several larval stages.

Management

Beneficial nematodes *Steinernema feltiae* or *S. carpocapsae* can be used as biological control agents. Apply nematodes with a squeeze-bottle applicator by inserting the applicator nozzle into each gallery after clearing frass from the tunnel entrance. Insecticides are not effective against larvae inside the tree and should only be used to control adults. Insecticides labeled for trunk and bark treatment may provide control if appropriately timed. Monitor trees beginning in late winter and spray bark when the first pupal cases appear.

Carpenterworm tunnels. Photo: James Solomon, USDA Forest Service, Bugwood.org

Carpenterworm larva. Photo: William H. Hoffard, USDA Forest Service, Bugwood.org

BIOTIC IMPACTS – ANIMALS

ANIMALS

Vole (Meadow Vole, Pine Vole)

Hosts
Many tree species.

Signs/Symptoms
Voles kill seedlings and saplings by girdling them, feeding on the roots, and eating the bark at ground level. During the growing season, they eat green vegetation and feed on roots and stems the rest of the year. To inspect for voles, start at the base of the seedling and work your way out from the stem in all directions. Look for worn trails about ¾ inch to 1½ inches in width meandering along the ground surface. Old trails may remain after being abandoned, and one should look for feces, small fresh grass clippings, or stored food materials along the trail as an indication of recent vole activity. To determine population levels, a monitoring program throughout the property of concern is necessary.

Adult vole. Photo: Maja Jurc, University of Ljubljana, Bugwood.org

Vole feeding damage. Photo: Paul Bachi, University of Kentucky Research and Education Center, Bugwood.org

Vole tunnels. Photo: David L. Clement, University of Maryland, Bugwood.org

Timing
Voles produce five to 10 litters per year. Populations can reach damaging levels quickly. Just one vole living near a tree or shrub may cause enough damage to kill the plant.

Management
A combination of habitat reduction, trapping or poison baiting, and predators is the best approach to reducing vole populations. If you're managing trees in a developed area, avoid laying thick mulch flush against the trunk of the tree. This provides desirable vole habitat that allows them to burrow up to the tree to feed. Continue to monitor vole sites in early spring and again each fall to detect populations before plants are damaged.

Deer (Whitetail Deer)

Hosts
Many tree species.

Signs/Symptoms
Bucks rubbing antlers on trees (called "buck rubs") can severely damage stems, leading to secondary pests and diseases, stem breakage, and sometimes mortality. Deer browsing can weaken or kill small seedlings and saplings. Buck rubs look like deep abrasions on saplings and branches, where most of the bark is often stripped off, sometimes hanging in pieces. Deer browse appears as a flat cut on the end of the twig (compared to rabbit feeding, which leaves twigs or seedlings cut at about a 45-degree angle).

Timing
Whitetail deer breed from October through January. Peak breeding activity usually occurs in mid-November. Deer eat the leaves, stems, and buds of woody plants all year.

Management
Little can be done in natural areas short of installing a deer-proof fence to keep animals out of the area. In landscape situations, foul-smelling sprays (usually sulphur-based) can be effective repellents; these spray-on formulations will need to be reapplied after rains. If appropriate, regulated hunting will lower populations while providing a public resource.

Damage to seedling from deer browse. Photo: Southern Forest Insect Work Conference, Bugwood.org

Deer rub damage on bark.
Photo: David Mooter, Prairie Silvics, Inc., Bugwood.org

Woodpecker

Hosts
Many tree species.

Signs/Symptoms
Most woodpeckers do not negatively impact trees. Woodpeckers are predators of insects that feed inside living, stressed, or dead trees, and can help control insect populations. Woodpeckers often stand at a sharp angle on the sides of trees so they can hammer into the bark and wood with their beaks. Feeding holes are round to oval with jagged, messy edges. All woodpeckers build nesting cavities in tree trunks. Some, like the yellow-bellied sapsucker, form feeding holes in straight horizontal lines where they eat sap and insects attracted to the sap.

Timing
Woodpecker damage may occur any time of year. Activity is highest in the fall and spring when male woodpeckers hammer to mark their territory and attract mates.

Management
No management necessary. Standing dead trees are good habitat for woodpeckers.

Sapsucker feeding holes.
Photo: Randy Cyr, Greentree, Bugwood.org

Woodpecker hole. *Photo: Terry Spivey, USDA Forest Service, Bugwood.org*

Pileated woodpecker holes.
Steven Katovich, Bugwood.org

Beaver

Hosts
Many tree species.

Signs/Symptoms
Beavers mainly eat the cambium layer just under the bark of woody plants. Beavers also cut down trees for food and for building materials. On large trees, beavers will feed by removing all the bark within easy reach around the tree. This prevents moisture and nutrients from moving from roots to leaves and causes the tree to die. Beaver dams can lead to flooding, and rising waters can lead to tree mortality.

Timing
Beavers can be active year-round. Mating takes place during January and February, and kits (young beavers) are born in May or June.

Beaver damage. Photo: VDOF

Management
Beavers fulfill an important role in creating wetlands and providing new habitat for a variety of wildlife. If damage is light, it is best to leave them alone. Preventative measures can be taken to protect valuable trees, especially if the property is shore-lined. Wrapping valuable trees with hardware cloth or heavy-gauge woven wire fence can deter beavers. Make sure to leave enough room for tree growth (1 to 2 inches) and wrap at least 3 feet tall. Repellent is available and most effective when used at the first indication of beaver presence or in areas where beavers are most actively feeding. This bitter tasting liquid can be painted or sprayed on trees. Frequent reapplication will likely be necessary to maintain control. To remove dams or control population levels, first contact your local game warden at the Virginia Department of Wildlife Resources. State regulations may limit the types of traps, trapping methods, and seasons in which beavers may be trapped or shot.

Beaver dam. Photo: Joseph OBrien, USDA Forest Service, Bugwood.org

Tree stripped by beavers. Photo: David Stephens, Bugwood.org

BIOTIC IMPACTS – DISEASES

RUSTS

Cedar-Apple Rust

Hosts

Requires two hosts: a juniper species, primarily eastern redcedar, and an apple, crabapple, hawthorn, or quince species.

Signs/Symptoms

Golf-ball-like galls form on eastern redcedar branches, from which orange gelatinous telial horns emerge. Twigs beyond the galls occasionally die and infection may weaken the redcedar, but the disease rarely causes severe long-term damage. On apple, spores germinate and form circular yellow spots on the surface of leaves. Infection may damage the fruit and reduce yield.

Timing

The conspicuous orange telial horns are apparent after a warm spring rain in April to May. Telial horns produce basiospores, which blow to the alternate host in early summer. Here, they germinate and form orange or yellow spots that produce a sticky substance called spermatia that is attractive to insects. The insects transmit the fungus to new areas on the plant facilitating further spread and new infection. Wind caries spores back to cedar trees where they germinate and begin producing new galls.

Management

Remove alternate hosts to prevent inoculation of cedar trees. If infestation is light, prune out affected branches with galls on cedar trees in the winter before telial horns have emerged. Preventative fungicides can be applied to cedars and apple trees.

Orange telial horns emerging from a gall on cedar. Photo: VDOF

Discoloration on an apple leaf. Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org

White Pine Blister Rust

– RUSTS –

Hosts

Requires two hosts: eastern white pine and plants in the *Ribes* genus (e.g., gooseberry or currant).

Symptoms

Newly-infected needles have yellow/red spots that grow outwards until the whole needle is chlorotic. Rough, diamond-shaped, and often swollen cankers form on the main trunk or branches. Sap may ooze from these cankers and yellow-orange blisters develop in the spring. If cankers get large enough, branches die and tree mortality can occur. On infected *Ribes* plants, small orange dots develop on the underside of leaves in the spring and early summer.

White pine blister rust on pine. Photo: Andrej Kunca, National Forest Centre - Slovakia, Bugwood.org

Timing

The life cycle of this disease takes place over four to five years. Infection starts in pine needles and then moves to the branches. Cankers develop over a year or more and eventually release spores from blisters that infect the alternate host. Inoculum levels build on *Ribes*, and then eventually re-infect pine. Cool, wet weather is favorable for successful infection.

Management

Removing *Ribes* species from surrounding areas is the best form of control. Prune and destroy infected branches with cankers. Prune lower branches to make conditions less favorable for rust development. Fungicides are available for urban, nursery, or high-value sites as preventative treatment.

Notes

White pine blister rust fungus is native to Asia.

Blister rust infection on ribes. Photo: Petr Kapitola, Central Institute for Supervising and Testing in Agriculture, Bugwood.org

Blister rust spore stage. Photo: Steven Katovich, Bugwood.org

Fusiform Rust

– RUSTS –

Hosts

Requires two hosts: pine and oak (especially water, willow, and laurel oaks).

Signs/Symptoms

On pine, fusiform rust causes branch and stem cankers that result in breakage and stem deformity. Cankers may grow for many years before eventually girdling and killing stems. Cankers often attract secondary stem-boring insects. In spring, raised filaments are produced on branch and stem galls, turning bright orange as they produce wind-dispersed spores. On oaks, orange spores appear as short, black string-like structures on the lower surface of leaves.

Fusiform rust on canker in the spring. Photo: VDOF

Timing

Spores from pines infect the leaves of oaks; spores from infected oaks then re-infect succulent pine tissue. The fungus produces orange spores on pine galls in the early spring. Wind-blown spores infect newly-formed oak leaves. In turn, the fungus produces spores on oak leaves, completing the cycle by infecting pines from late April through the middle of June.

Management

The best management is to plant fusiform-resistant or less-susceptible trees. Fungicides are effective in nursery settings. Galled branches or individual trees can be removed (especially in landscape or urban settings). In natural areas or commercial forests, widespread damage may warrant complete removal of the stand and replacement with resistant or less-susceptible trees.

Notes

In Virginia, fusiform rust is historically found only in the Southeast; however, the range may be expanding. In general, fusiform is favored by warm, wet weather and occurs most often in well-drained, sandy loam soil.

Pine deformity from fusiform rust. Photo: VDOF

Pine Needle Rust

– RUSTS –

Hosts

Requires two hosts: pine and a species in the aster family (e.g., goldenrod).

Signs/Symptoms

Yellow-orange spots appear on pine needles in the spring. Needles may turn entirely yellow. In early summer, white tubes form on needles, breaking open to release orange spores. Infection causes pine needles to brown and eventually fall off. On plants in the aster family, infection causes yellow spots on the upper surface of leaves, and spore-filled pustules on the lower leaf surface.

Pine needle rust. Photo: VDOF

Timing

Fungi overwinter on pine and release spores from white, tube-like structures in early summer. These spores infect aster plants which produce spores all summer long to infect other asters. In fall, they produce a different type of spore that re-infects pines.

Management

This disease is mostly an aesthetic issue and rarely causes tree mortality. Management is usually not necessary or cost-effective. In nursery or landscape settings, remove nearby alternate hosts.

Foliage infested with pine needle rust. Photo: Elizabeth Bush, Virginia Polytechnic Institute and State University, Bugwood.org

White tubes producing pine needle rust spores. Photo: VDOF

ROOT ISSUES

Phytophthora Root Rot

Hosts

Many trees and ornamental shrubs.

Signs/Symptoms

Phytophthora root rot attacks the roots of many species, primarily impacting the fine roots responsible for absorbing nutrients from the soil. The noticeable above ground symptoms are chlorotic needles and bottom up decline. Looking below ground, roots are diminished, flaky, soft, and discolored. The disease thrives in poorly-drained sites and can spread in water runoff, splash from rain events, contaminated equipment, or plant material. Spores can also move through wet soils. A test is needed for official confirmation of this disease.

Timing

This pathogen can remain viable in the soil for many years. Infection occurs when weather is warm and soil is saturated. Symptoms are most noticeable during the growing season. Production of spores and infection typically occurs all growing season when conditions are favorable and soil is saturated.

Management

Avoid planting in areas with poor soil drainage or improve water drainage prior to planting. Ensure that susceptible plants are not planted in areas where the disease has been known to occur. Remove diseased plants in their entirety and destroy them. Thoroughly clean any tools that contact infected plants.

Notes

Phytophthora root rot is the general name for root diseases caused by species of water molds in the genus Phytophthora. A water mold is like a fungal spore but with a tail (flagellum), which it uses to move through water.

Trees impacted by phytophthora root rot. Photo: John Ghent, John Ghent, Bugwood.org

Phytophthora root rot. Photo: William M. Brown Jr., Bugwood.org

Procerum Root Disease

Hosts

Most commonly eastern white pine, but Scotch and Austrian pines can also be affected.

Signs/Symptoms

Caused by a fungal disease that attacks tree roots. Early symptoms include delayed bud break and stunted new bud growth in spring. As the disease progresses, trees decline from the top down. Foliage fades, turns brown, and drops. Resin may be visible on the bark at the base of the tree and a canker will develop that flattens the tree trunk. The cankerous wood beneath the bark will be tan or brown and bark beetle galleries may be present around canker.

Tree infected with procerum root disease. Photo: Robert L. Anderson, USDA Forest Service, Bugwood.org

Timing

Fungi enter the tree through the lower trunk and roots. Fungal spores can build up in the soil around roots and spread to other trees through runoff. Bark beetles and weevils sometimes serve as vectors and their galleries create entrances for fungal spores. This cycle takes place throughout the tree's growing season. Fungi can overwinter in infected trees and, to a lesser degree, in soil.

Management

Maintain tree health. Fungal spores favor wet environments for dispersal and readily infect stressed trees, so avoid planting on sites that are too wet. Remove and destroy diseased trees and roots and do not replant pines where diseased trees were removed.

Canker and resinosis. Photo: Manfred Mielke, USDA Forest Service, Bugwood.org

Staining damage from procerum root disease. Photo: Mary Ann Hansen, Virginia Polytechnic Institute and State University, Bugwood.org

Armillaria Root Rot

Hosts

Many woody species, both hardwood and conifers.

Signs/Symptoms

Infected trees appear stressed, exhibiting decline and dieback. Visible signs of the pathogen are clusters of tan- or orange-colored, gilled "honey" mushrooms on or near infected trees. Conifers may have stunted cones. White webs or sheets of mycelia can be found underneath the bark of infected trees on the lower stem and roots. Stringy, black fungal structures may also be present under bark and on roots. Infection can lead to increased tree decline, dieback, and mortality.

Timing

The fungus attacks tree roots and can grow from infected roots and stumps into nearby trees, while long-distance dispersal occurs via spores. Mushrooms are present in late summer through October. These fungi can survive years in old infected stumps and roots.

Management

Maintain healthy and injury-free trees through proper tree care and adequate safeguards during construction activities. Infected material (e.g., roots and stumps) should be removed to lessen the chance of future infections to other trees.

Notes

These common, opportunistic fungi often infect trees that are wounded or stressed. Armillaria root rot is a common contributing factor of oak decline in Virginia.

Honey mushrooms at base of tree infected with armillaria root rot. Photo: VDOF

White mycelial fan. Photo: William Jacobi, Colorado State University, Bugwood.org

Black rhizomorphs under bark. Photo: VDOF

Heterobasidium Root Disease

Hosts

All conifers are susceptible to this disease though it is most commonly seen in loblolly, slash, and eastern white pine.

Signs/Symptoms

The fungus attacks the tree's root system, impairing the tree's ability to acquire water and nutrients. Symptoms are usually visible a few years after a thinning occurs. Needles become discolored and distorted, and growth is reduced, which results in thinned crowns. Needles eventually turn brown and fall from the tree. Windthrown and standing dead trees are common in an infected stand. Infected trees have stringy, resin-soaked roots, and large, fruiting bodies (conks) may appear at the base of trees in the fall and winter.

Timing

Spores released from conks travel via wind to cut stumps or tree wounds. Spores may be present year-round but are most commonly released during cool temperatures. After infecting roots, the fungus can also spread through root grafts. Depending on level of infection, symptoms may show at any time of year. Damage (e.g., tree mortality, windthrow) usually occurs three to seven years after a thinning.

Management

Thin susceptible stands in the summer when it is warm since the spores need cool weather to germinate. Avoid mechanical damage during thinning. In high-hazard sites (e.g., well-drained, sandy soil), apply stump treatment immediately after cutting. Effective treatments include Borate-based chemicals and a biological fungicide that prevents Heterobasidion colonization. Clear-cut stands that are heavily infected and remove trees that are symptomatic. Be sure to sever connecting roots between a diseased tree and healthy trees.

Notes

Formerly known as annosum, annosus root rot, or fomes.

Borax treatment. *Photo: USDA Forest Service - Region 8 - Southern, Bugwood.org*

Heterobasidium Root Disease, continued

Windthrown tree in stand infected with heterobasidium root disease. Photo: USDA Forest Service, Bugwood.org

Fruiting structure (conk) at the base of a tree. Photo: Robert L. Anderson, USDA Forest Service, Bugwood.org

Stringy resin-soaked roots. USDA Forest Service - Northern and Intermountain Region, Bugwood.org

Littleleaf Disease

Hosts

Pines, especially shortleaf.

Signs/Symptoms

Littleleaf disease is a type of Phytophthora root rot, caused by *Phytophthora cinnamomi*. Look for chlorotic, shortened needles and shortened twigs. Other symptoms include overall canopy decline and reduced radial growth, and heavy cone production with smaller-than-normal cones. Fine root growth will be reduced. Mortality usually begins in dominant trees more than 20 years old.

Timing

Trees on poorly-drained soil are more susceptible, as *P. cinnamomi* is a water mold. *P. cinnamomi* can remain dormant in the soil or infected roots for several years, and symptoms show when trees are stressed. When conditions are right, *P. cinnamomi* breaks dormancy and infects root tips and root growth.

Management

On high-risk sites, improve soil drainage during site preparation. Plant tree species or cultivars that are tolerant or resistant to littleleaf disease, and keep existing trees stress-free through proper silviculture. Remove diseased trees and roots.

Notes

This is the worst disease to affect shortleaf pine, and contributed to the decline of shortleaf as a major commercial species.

Canopy decline from littleleaf disease. Photo: Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

Tree infected with littleleaf disease. Photo: Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

CANKERS

Pitch Canker

Hosts

Most common in loblolly, slash, and shortleaf pine, but all pines are susceptible.

Signs/Symptoms

A resin-soaked canker on branches or the main stem is the first sign of pitch canker. Mortality of the upper branches or terminal leader is also common. The bark will turn tan to brown, and peeling back to the sapwood will reveal resin-soaked wood. Because sapwood is disturbed, discolored foliage is common as well.

Timing

Spores are present year round but favor cool, wet weather for infection. A wound or entry on the host is needed for the spores to enter and start an infection.

Management

Avoid wounding trees during thinning or management operations, especially in cool and wet weather. The overuse of fertilizers high in nitrogen has also been attributed to increased incidence of pitch canker. There is no cure once a tree is infected, but not all trees die from pitch canker.

Notes

Usually trees are able to overcome small infections but occasionally the fungus can reach epidemic proportions, especially on younger trees.

Branch mortality on tree infected with pitch canker. *Photo: Joseph OBrien, USDA Forest Service, Bugwood.org*

Pitch canker resinosis. *Photo: Elizabeth McCarty, University of Georgia, Bugwood.org*

Biscogniauxia Canker

– CANKERS –

Hosts

Most often found in oaks but can also be seen in hickory, beech, maple, and other hardwood species.

Signs/Symptoms

This is a secondary fungus that impacts trees already very stressed and close to death. The most obvious way to identify biscogniauxia is by the large fungal mats that are found beneath the bark of trees. Eventually, these mats break through the bark and appear as flattened, smooth brown/tan areas. The mats eventually turn gray or black signaling that full tree mortality is not far away.

Timing

Spores are present year round but symptoms typically develop after a major stress event, such as drought or mechanical wounding. Often, cankers first appear in spring but aren't fully noticed until late summer.

Management

Management is not practical. By the time a tree shows signs of this fungus, it is already in severe decline. To prevent biscogniauxia, promote good tree vigor, such as watering, mulching, and fertilizing.

Notes

This disease used to be called hypoxylon canker. It is a contributing factor in oak decline.

Biscogniauxia on a dead tree. Photo: VDOF

Early brown fungal mat. Photo: Ronald F. Billings, Texas A&M Forest Service, Bugwood.org

Later stage fungal mat. Photo: USDA Forest Service - Region 8 - Southern, Bugwood.org

Seiridium Canker

– CANKERS –

Hosts

Trees in the cypress family, especially Leyland, Monterey, and Italian cypress, as well as spruce species.

Signs/Symptoms

Caused by *Seiridium* fungi, the disease progresses from lower to higher branches. Foliage becomes discolored, turning reddish-brown. Dark, sunken cankers develop on twigs and branches. Scraping under the bark will reveal more dead tissue. Cankers may also lead to large amounts of resin leaking from wood. Cankers can eventually spread to the main trunk and lead to tree death.

Timing

Spores are released by rain and new infections often begin in wet weather. The fungi are usually introduced through natural openings or already-present wounds. Symptoms are present year-round, but cankers are worse when weather is hot and dry.

Management

Because spores germinate in wet weather, this disease thrives in dense canopies that are damp and shady. To preventatively discourage fungal growth, prune limbs and thin trees to increase air circulation and sunlight. Remove diseased branches from infected trees. Do all pruning in dry weather to prevent spores from dispersing. Maintaining tree health will increase vigor and help the tree resist infection. In conjunction with cultural practices, broad-spectrum fungicides and growth regulators can help protect new foliage from infections.

Seiridium canker. *Photo: Elizabeth Bush, Virginia Polytechnic Institute and State University, Bugwood.org*

Branch flagging on tree infected with seiridium canker. *Photo: Jennifer Olson, Oklahoma State University, Bugwood.org*

Chestnut Blight

– CANKERS –

Hosts

American and European chestnut.

Signs/Symptoms

The fungus *Cryphonectria parasitica* causes cankers, dieback, and death. Cankers grow laterally between bark ridges and will be darker brown than the healthy bark. You may also see yellow-orange fibers developing on the canker. The fungus spreads rapidly and tissue beyond cankers is quickly girdled and dies; sprouts may grow out of tissue just below the canker. Ultimately all aboveground parts of the tree die, leaving just the root system alive.

Timing

The pathogens overwinter in bark lesions. In the spring, yellow-orange tendrils grow from the bark and produce spores. Rain, insects, and other animals move the spores to infect other parts of the tree or other chestnut trees. This spore dispersal may continue through the fall and even winter if temperatures remain mild.

Canker on a chestnut stem. Photo: Richard Gardner, Bugwood.org

Management

The only method of control is to remove and destroy infected limbs. If the trunk has symptoms, tree removal is recommended because no control strategies are available. Research is ongoing to develop resistant chestnut varieties.

Fruiting bodies of chestnut blight. Photo: Félix TENG, Walloon Agricultural Research Centre (CRA-W), Bugwood.org

Notes

The American chestnut was once a dominant tree species in North American forests. Chestnut blight was introduced to North America in the early 1900s and has functionally eliminated American chestnut from the landscape.

Thousand Cankers Disease

– CANKERS –

Hosts

Eastern black walnut and butternut.

Signs/Symptoms

This is a fungal disease vectored by the walnut twig beetle. The fungus causes the formation of small dark cankers on branches and stems, but these cankers are only visible if the outer bark is carefully stripped away. Eventually cankers coalesce and girdle branches. Look for yellowing or declining crowns, premature leaf loss, and twig and branch dieback. Epicormic sprouting is common and tiny round beetle emergence holes may be visible on twigs. Trees can die within three years once symptoms appear, though tree death is not guaranteed.

Timing

Adult walnut twig beetles carry spores of the fungus *Geosmithia morbida* and infect trees as they bore into the cambium to feed in the spring. Lesions appear at infection sites. Beetle larvae develop in the phloem and emerge as adults the following spring. This next generation of beetles spread the fungus to other trees.

Management

There is no prevention or cure once a tree has thousand cankers disease. Prevent the spread of the disease by not moving infected wood. Heat treatments can be used to sanitize wood prior to movement. Symptoms may be worse or accelerated during drought.

Walnut twig beetles. Photo: Whitney Cranshaw, Colorado State University, Bugwood.org

Crown dieback from thousand cankers disease. Photo: Karen Snover-Clift, Cornell University, Bugwood.org

Geosmithia morbida cankers. Photo: Karen Snover-Clift, Cornell University, Bugwood.org

Beech Bark Disease

– CANKERS –

Hosts

American beech.

Signs/Symptoms

This disease is caused by damage to the bark and vascular tissue by the beech scale (*Cryptococcus fagisuga*), followed by infection by *Nectria* fungi. The scale insects produce white, waxy filaments that form a waxy, woolly crust on tree trunks. An established scale population leads to yellowing, underdeveloped leaves, and a thinning canopy. The fungus colonizes scale feeding sites and cankers with small, red dots (sometimes associated with dark, reddish-brown fluid) develop in late summer and fall. Cankers grow and may connect, eventually girdling and killing the tree.

Timing

Nectria spores are transported by insects, wind, and rain splash. Adult scale insects begin feeding in the spring and lay eggs in June or July. Eggs hatch in August or September and crawlers move into bark fissures or are blown by the wind, further dispersing fungal spores. *Nectria* produces spores in the late summer and fall, with new infections typically occurring in the fall.

Management

Control of the disease requires management of the beech scale. Moderate infestations on only a few trees can simply be washed off by blasting water at scale insects. Horticultural oils and insecticides can also be used to target scale populations. A small percentage of beech trees are resistant; remove diseased trees from the stand to give resistant trees a better chance of survival.

Notes

This is a serious disease to beech trees and causes severe decline and death in both young and mature trees. However, in Virginia, the disease only appears to infect beech trees at elevations greater than 1,000 feet.

Beech tree infected with beech bark disease. Photo: VDOF

Oozing from cankers. Photo: Joseph OBrien, USDA Forest Service, Bugwood.org

Black Knot

– CANKERS –

Hosts

Trees in the *Prunus* genus: plum, peach, cherry, apricot, and chokecherry.

Signs/Symptoms

Black knot develops slowly. During the first season, small, olive-colored swellings appear on branches and twigs, darkening in color as the season progresses. Cracks, discoloration, and swelling may also be present at sites of infection. Galls grow quickly in the second season and hard, warty, uneven, black growths wrap around twigs and branches. New growth is girdled and dies.

Timing

The fungus overwinters and releases spores from established colonies in the spring when the weather is damp and temperatures are above 60 degrees Fahrenheit. Spores germinate on stems and begin to produce galls in the spring. Galls that are already present also continue to develop in the spring.

Management

Conduct regular inspections of trees in the winter and throughout the growing season. This disease must be caught in the beginning stages for control measures to be successful. Prune and destroy infected branches as soon as you see the small, olive-colored galls, knots, and large black galls. Fungicides can be used in conjunction with these sanitation methods. Lime sulfur and copper sprays can be applied during the growing season to limit spore production.

Gall caused by black knot. Photo: VDOF

Cherry tree twigs infected with black knot. Joseph OBrien, USDA Forest Service, Bugwood.org

Nectria Canker

– CANKERS –

Hosts

Most hardwoods with injuries, especially birch, black walnut, sassafras, red oak, maple, beech, and poplar.

Signs/Symptoms

Infection is caused by a *Nectria* fungus. Sunken areas appear at wound sites and callus tissue develops around the infection. These cankers can grow for years, becoming elongated and target-shaped. As invasion continues, cankers girdle and kill the branch or trunk if tree is young or stressed. Look for branches and twigs that do not leaf out in the spring. Pink- or cream-colored fungi form in the spring and early summer on cankers. Fungi darken with age.

Timing

Nectria invades wood damaged by freeze, hail, animals, or insects. The fungus is active all year as long as conditions are moist and temperatures are above freezing.

Management

Avoid wounding the tree, prune out branch cankers, and sterilize pruning tools during dry periods when spores are less abundant. Only prune limbs in dry weather; if limbs are pruned during wet autumn weather, *Nectria* can readily invade the wound.

Nectria fruiting bodies on a branch. Photo: John Hartman, University of Kentucky, Bugwood.org

Callous tissue from nectria canker infection. Photo: Joseph OBrien, USDA Forest Service, Bugwood.org

FOLIAGE

Fire Blight

Hosts

A variety of species in the rose family (apples, pears, cherries, plums, hawthorns, and mountain ash).

Signs/Symptoms

Leaves and infected branches blacken and curl, usually on new shoots first. Cankers can form on the branches and trunk, new growth turns brown, and lesions can form on fruit if present. Flowers will darken, droop, and shrivel.

Timing

Fire blight overwinters in old cankers. In the spring, bacteria oozes out from cankers and is spread by insects, wind, and rain to nearby trees. New infections can occur in blossoms, fresh wounds, or buds. Bacteria then travels through branches into the main stem and causes new cankers. Fire blight is most severe in warm, spring temperatures before and during bloom. Warm temperatures and open wounds allow the disease to spread quickly.

Management

Fungicides can be effective during bloom as a preventative treatment. Mechanical management involves pruning infected branches. It is recommended to prune 8 inches below cankerous/diseased tissue in the spring and summer but avoid pruning when plants are wet and sanitize tools after each cut. Reduce stress on plants through proper care.

Damaged foliage on tree infected by fire blight. *Photo: University of Georgia Plant Pathology, University of Georgia, Bugwood.org*

Fire blight branch canker. *Photo: University of Georgia Plant Pathology, University of Georgia, Bugwood.org*

Juniper Tip Blight

– FOLIAGE –

Hosts

Juniper, arborvitae, cedar, cypress, false-cypress, douglas fir, fir, and yew.

Signs/Symptoms

Younger trees are especially susceptible to infection. Dieback starts on the shoot tips of lower branches and spreads toward the main stem. Infected foliage and shoots turn yellow-green by late spring and brown by summer. Black fungal fruiting bodies can sometimes be seen in the summer on brown foliage. Newer foliage is typically damaged while older growth is resistant.

Timing

Juniper tip blight is caused by two different fungi: *Phomopsis juniperovora* or *Kabatina juniper*. Small, black fruiting bodies remain on the foliage year-round. In the spring when weather is warm and wet, fungal spores spread to new growth. If conditions are favorable, spores continue to germinate and infect young foliage.

Management

Prune and destroy infected twigs and branches in dry weather but avoid over-pruning and generally wounding the tree. Sanitize pruning equipment between cuts. Avoid planting seedlings too close together; wider-spaced planting promotes air circulation and makes the environment less favorable for disease. Fungicide control is effective when used in conjunction with the cultural controls described above.

Juniper tip blight damage. Photo: Robert L. Anderson, USDA Forest Service, Bugwood.org

Tip blight damage on branches. Photo: Bruce Watt, University of Maine, Bugwood.org

Diplodia Tip Blight

– FOLIAGE –

Hosts

Virginia, Austrian, red, Scotch, and other 2- or 3-needled pines.

Signs/Symptoms

New growth will turn brown, yellow, or gray. Needles may be stunted and the shoot often curls down. Branch dieback follows, and small, black fruiting bodies can be seen on needles, cones, and shoots. If infection is severe, cankers may appear on stems or branches and resin will ooze from infected needle bases.

Timing

The disease is present year-round. When the weather warms in early spring, fruiting bodies mature and release spores during wet weather. Spores are distributed by rain, wind, and animals, and germinate on new growth. The fungus continues this process through early fall and overwinters in infected needles, cones, and woody tissue.

Management

Maintain tree vigor through adequate watering and fertilization. Scout trees for symptoms and if infection is heavy, treat with fungicide. If only a few trees are infected, prune and remove infected shoots, twigs, branches, and cones during dry weather when fruiting bodies are not releasing spores. Be sure to burn the material you pruned as fungus can persist in dead tree tissue.

Nursery stock infected with diplodia tip blight.
Photo: Robert L. Anderson, USDA Forest Service, Bugwood.org

Diplodia tip blight damage in a pine plantation.
Photo: USDA Forest Service - North Central Research Station, Bugwood.org

Rhizosphaera Needle Cast

– FOLIAGE –

Hosts

Many conifers; Colorado blue spruce is the most susceptible.

Signs/Symptoms

The disease causes browning and loss of needles, first on interior lower branches, then moving upwards and outwards as the disease progresses. This creates a very thin canopy. Often, the youngest needles at the tips of branches remain green and appear healthy even though they may also be infected. You may be able to detect small, black spheres (fruiting bodies of the fungus) on the needles with a hand lens. Most cases of needle cast just impact tree aesthetics and don't cause serious damage to the tree.

Timing

Tiny black fruiting bodies on dead needles release spores, which are spread by wind or rain to infect young, emerging needles in spring and early summer. Fungi overwinter and infection symptoms appear the following spring.

Management

Maintain tree health with wide spacing and plant on a site with good drainage. Management is usually only necessary for high-value trees (e.g., Christmas trees). Cut infected branches back to the main trunk during dry weather. For severe infections, use fungicidal spray in spring or early summer when new needles are half elongated, and again when fully expanded.

Notes

"Needle cast" can refer to infections caused by many different fungi. The disease cycle varies among genera of fungi, but all needle casts cause needles to brown and eventually drop from the tree.

Rhizosphaera needle cast fruiting bodies on needles. Photo: Paul Bachi, University of Kentucky Research and Education Center, Bugwood.org

Rhizosphaera needle cast damage on tree. Photo: USDA Forest Service - North Central Research Station, Bugwood.org

Anthracnose

– FOLIAGE –

Hosts

Hardwoods, most often sycamore, dogwood, oak, maple, ash, and walnut.

Signs/Symptoms

Irregular patches of dead leaf tissue and premature leaf drop. Leaf blotches often occur along leaf veins. During severe infection, shoot and leaf blight, branch cankers, crown dieback, and death can occur.

Timing

Black spots develop on infected leaves in the late fall and early spring. Spores are released and may lead to secondary infections during the growing season and wet periods.

Management

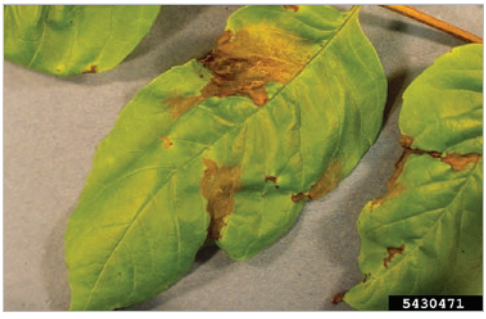
Clear vegetation away from highly-valued trees to increase circulation and make the environment less favorable for the fungus. Rake and remove fallen leaves. When infections are particularly severe, fungicides can be applied every seven to 10 days. Maintain plant health by watering during dry periods and pruning during hot and dry weather. Fungi flourish in wet periods and can spread easily if pruning occurs during wet weather. Anthracnose can cause particularly high mortality in dogwoods. If planting dogwood seedlings, maintain wide spacing and plant in partial sunlight if possible, or search for resistant cultivars.

Notes

Anthracnose is a group of fungal diseases that affect many species of hardwood trees. In Virginia, the disease is very common on dogwood and sycamore trees.

Dogwood anthracnose. *Photo: Penn State Department of Plant Pathology & Environmental Microbiology Archives, Penn State University, Bugwood.org*

Sycamore anthracnose. *Photo: William Jacobi, Colorado State University, Bugwood.org*



Ash anthracnose. *Photo: John Hartman, University of Kentucky, Bugwood.org*

Powdery Mildew

– FOLIAGE –

Hosts

Several different species of fungi, each with a different host range, cause mildews. Commonly infected species include oak, maple, dogwood, rhododendron, magnolia, azalea, catalpa, basswood and crabapple.

Signs/Symptoms

Initial symptoms are small, circular, powdery, white spots that look like dust on the leaf surface. These spots grow and eventually connect to form a grayish white felt-like mat covering the surface of leaves, stems, and buds. This disease is usually not fatal, but severe infections cause leaves to twist, distort, and turn yellow or brown before they wilt and die.

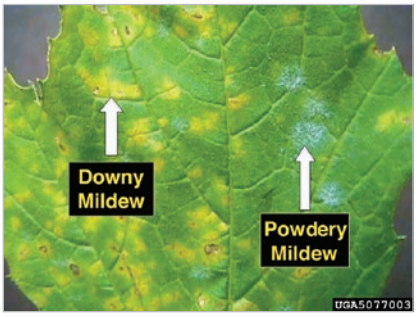
Timing

This disease is present year-round. Symptoms are most common in the spring and fall. When the weather warms up, the powdery mildew begins producing spores. High humidity and shade are good conditions for spore production and low humidity is better for dispersal. Spores are dispersed through the air and germinate when they land on a suitable host. The fungus overwinters and begins producing spores again once temperatures increase in the spring.

Management

In areas where powdery mildew frequently develops, prune trees and mow grass to increase air circulation and reduce shading. Remove infected leaves and stems, and prune suckers if present. Use of fungicides is usually not necessary, but they can be effective if applied at the first sign of infection.

Powdery mildew. *Photo: Gerald Holmes, Strawberry Center, Cal Poly San Luis Obispo, Bugwood.org*



Comparison of downy and powdery mildew. *Photo: David B. Langston, University of Georgia, Bugwood.org*

Downy Mildew

– FOLIAGE –

Hosts

Fruit trees (e.g., apple) are commonly infected.

Signs/Symptoms

Bluish fluffy white spores will grow on the underside of leaves and yellow spots will appear on the upper sides of foliage. Purplish-red spots on leaves are visible and can be irregularly shaped and angular and darken with time. As the mildew develops, the fluffy growth darkens to gray and the leaves may shrivel and drop. Twigs may have purple streaks and reddened areas may be present on stems.

Timing

The fungus overwinters on plant material. Downy mildew grows well in cooler conditions (50-75^{o}F) when humidity is high and leaf surfaces are damp. Because of this, growth is most common in the spring and fall.

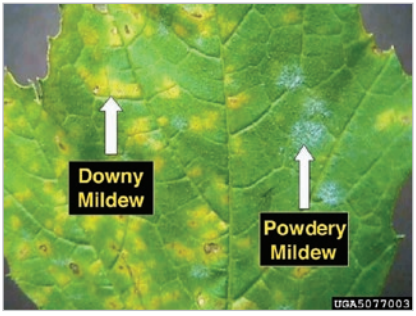
Management

Increase air circulation through pruning and thinning. If possible, remove the infected plant material and either bury, burn or dispose of it. Fungicide can be effective in controlling colonies and preventatively treating plants in cool, wet weather.

Notes

Although similar in name, downy and powdery mildews are distinct diseases caused by different organisms. Downy mildew produces greyish fuzzy spores on lower leaf surfaces while powdery mildews produce white flour-like colonies on upper leaves. Send samples to a plant disease clinic for confirmation.

Downy mildew on foliage. Photo: University of Georgia Plant Pathology, Bugwood.org



Comparison of downy and powdery mildew. Photo: David B. Langston, University of Georgia, Bugwood.org

Sooty Mold

– FOLIAGE –

Hosts

Sooty mold can grow on any tree species, but is common on maple, boxelder, elm, and linden trees.

Signs/Symptoms

Sooty molds grow on honeydew produced by piercing-sucking insects like aphids, scales, mealybugs, and psyllids. The honeydew is sticky and clings to the plant surface. Sooty mold spores blow onto honeydew and form fungal colonies. A layer of black mold develops on plant surfaces (needles, leaves, twigs, etc.). Sooty mold is usually just an aesthetic problem, but a thick coating can block light required for photosynthesis, thereby stressing plants and stunting growth.

Timing

Sooty molds thrive when temperatures are high and there is ample honeydew. Honeydew is produced during the growing season and may increase during dry weather.

Management

If sooty mold is fresh, it may be possible to wash off the honeydew on which it is growing. However, the sooty mold will likely reappear if steps aren't taken to control the insects producing honeydew. Inspect for insect pests and honeydew both on the affected plant and in the overstory, as honeydew can drip from above down to the understory if infestations are heavy enough. Horticultural oils can be used to control insect populations and loosen honeydew from the plant surface. Aphids, mealybugs, and whitefly populations can also be controlled with the appropriate insecticides. Insect species must be identified before determining the appropriate insecticide for treatment.

Sooty mold on foliage. Photo: VDOF

Sooty mold on foliage. Photo: VDOF

Leaf Spot

– FOLIAGE –

Hosts

Many species of hardwoods can be impacted by this condition, including many oaks, maples, black walnut, and hickory.

Signs/Symptoms

This is a collective term for many different species of fungi that impact foliar tissue. Most develop as scattered circular dead spots that can coalesce to cause discoloration, wilting, and early leaf drop. Cool, damp weather exacerbates symptoms. Leaf spot damage can be variable and hard to predict from year to year depending on weather conditions. Coloration of spots range from brown to yellow, purple, or black. Fungal fruiting bodies can form in the dead tissue of some spots. Fungi may also kill or deform buds, fruit, and flowers. Fungal leaf spot species are typically host specific, but there are exceptions.

Timing

Fungi typically overwinter in fallen leaves and infection spores are produced in early spring through summer. Water, wind, and occasionally insects spread spores. Once a rain event occurs, the infection process begins as the spores germinate on newly-expanded foliage or expanding buds. Many species have only a single generation per year although some have multiple generations annually.

Management

Practices that maintain tree health limit and reduce the impact of this condition. Remove fallen leaf material from trees that are susceptible or have been impacted in the past. Prune branches to thin out the crown and allow for air movement to dry foliage. Remove dead or diseased branches from trees that have been impacted. Fungicides can be applied to high value landscape trees but application must occur before infection has spread and requires repeat applications through the season.

Leaf spot on a leaf. Photo: Elizabeth Bush, Virginia Polytechnic Institute and State University, Bugwood.org

Leaf spot. Photo: VDOF

Beech Leaf Disease

– FOLIAGE –

Hosts

American beech

Signs/Symptoms

Early symptoms include striping on leaves as dark bands appear between lateral veins of leaves. This banding occurs in early spring and is most visible when viewing from below looking up into the canopy. Later symptoms include leaf curling and discoloration, aborted buds, reduced leaf production, and reduction in canopy. Mortality may occur in saplings within one to five years, while the disease progresses slower in larger trees.

Timing

Beech leaf disease appears to spread rapidly. The cause of this disease remains unknown, but nematodes are suspected.

Management

Little is known about this disease so management should focus on research to determine the cause and prevent spread and introductions. Report new cases of beech leaf disease to your local area forester or extension agent.

Notes

At the time of publication, beech leaf disease had not yet been discovered in Virginia.

Striping on leaves infected with beech leaf disease. Photo: Tom Macy, Division of Forestry, Ohio Department of Natural Resources

Beech leaf disease. Photo: Tom Macy, Division of Forestry, Ohio Department of Natural Resources

Beech leaf disease banding viewed from below. Photo: Tom Macy, Division of Forestry, Ohio Department of Natural Resources

VASCULAR

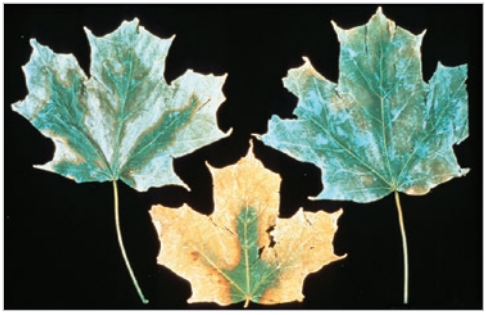
Verticillium Wilt

Hosts

Many tree species. Commonly infected species include maple, catalpa, magnolia, and tree-of-heaven.

Signs/Symptoms

Branches wilt suddenly. Leaves may turn yellow and leaf margins may look brown and scorched. Twig and branch death may occur. Infection can move at different speeds (over the course of a few weeks or several years). Sometimes long cankers can be seen on the bark and streaking in the sapwood if the disease is slow to progress.



Foliar symptoms of verticillium wilt. Photo: Joseph OBrien, USDA Forest Service, Bugwood.org

Timing

The causal fungus lives in the soil and can lie in dormancy for years. When the roots of susceptible plants grow close, the fungus germinates and infects the roots of the plants through wounds or natural openings. The fungus then spreads through the plant's vascular system and inhibits water movement. Symptoms are usually seen May-October.

Vascular streaking. Photo: USDA Forest Service - Northeastern Area, Bugwood.org

Management

Verticillium wilt fungus lives in the soil and is difficult to control. Remove diseased branches and sanitize tools between cuts. Maintain vigor and tree health. Severely infected trees should be removed and replaced with species that are less susceptible.

Tree damage from verticillium wilt. Photo: William Jacobi, Colorado State University, Bugwood.org

Notes

Since tree-of-heaven is an invasive plant, verticillium wilt is often considered a form of biological control when it infects this tree species.

Oak Wilt

– VASCULAR –

Hosts

Oaks, especially red oaks

Signs/Symptoms

Leaves on infected trees turn dull-green and wilt from the top of the tree downwards. Leaves then turn bronze with dying tissue along leaf margins and veins. Red oaks shed their leaves rapidly, just weeks after infection, but white oaks tend to retain their wilted leaves longer. Greyish staining occurs in twigs and stripping away bark will reveal this vascular discoloration in the outer xylem. Fungal mats may form just beneath the bark on trees killed by oak wilt, and are visible when the bark cracks.

Tree mortality from oak wilt. Photo: William M. Ciesla, Forest Health Management International, Bugwood.org

Timing

While the disease primarily spreads through root grafts, sap-feeding beetles (in the family Nitidulidae) can also vector oak wilt. Beetles are attracted to fungal mats during summer and then transport spores to fresh cuts or wounds when they move to healthy trees. Species in the red oak group are very susceptible and may die in as little as three weeks after infection. The white oak group is more resistant and can live for several years.

Foliar symptoms of oak wilt. Photo: Paul A. Mistretta, USDA Forest Service, Bugwood.org

Management

There is no cure for an infected tree. Reduce the chance of disease spread by pruning only during dormant periods. Prevent root-to-root transmission by trenching around local infections and severing root grafts. Infected trees should be removed and properly treated with debarking, chipping, and drying methods.

Crown dieback from oak wilt. Photo: Joseph OBrien, USDA Forest Service, Bugwood.org

Notes

Oak wilt is an aggressive disease and a serious threat to oaks in eastern United States. Although oak wilt was confirmed in western Virginia, it has not been detected again in Virginia for decades.

Bacterial Leaf Scorch

– VASCULAR –

Hosts

American sycamore, mulberry, grape, American elm, sweetgum, boxelder, dogwood, red maple, and sugar maple; oak species affected are bur, live, pin, scarlet, shingle, southern red, water, and willow.

Signs/Symptoms

This systemic disease causes premature leaf drop (usually occurring in summer) which gets worse over time, eventually leading to reduced leaf area and branch dieback. The disease is chronic and potentially fatal. The disease causes leaf discoloration; browning moves from the edge inward, as if a fire was "scorching" the leaf. In most (but not all) cases, a yellow line (sometimes called a "burn line") forms between the brown (scorched) and green (healthy) parts of the leaf. Damage begins in old leaves and spreads to new leaves.

Timing

The bacteria invade the xylem and can be spread by feeding insects or root grafts. Leaves will start to brown prematurely in midsummer. By late summer and fall, the leaf margins will be entirely brown. Bacterial leaf scorch is a slow death and trees may be infected for years before mortality occurs.

Management

The only way to confirm bacterial leaf scorch is through laboratory tests for the bacteria. There is no cure, though antibiotic treatments can help prolong the life of the tree. Reduce tree stress as much as possible through proper tree care. Water stress can exacerbate symptoms, so irrigate during drought conditions.

Notes

Xylem-feeding insects, primarily leafhoppers and spittlebugs, spread the bacteria when they feed on trees.

Bacterial leaf scorch foliar symptoms. Photo: Penn State Department of Plant Pathology & Environmental Microbiology Archives, Penn State University, Bugwood.org

Oak infected with bacterial leaf scorch. Photo: VDOF

Dutch Elm Disease

– VASCULAR –

Hosts

Elms

Signs/Symptoms

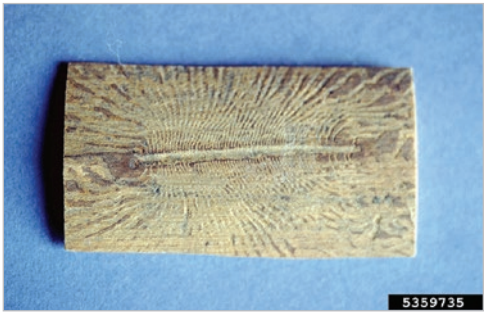
This disease effects the vascular system of the tree, so symptoms are drought-like in nature. Early symptoms include flagging, dieback, yellowing leaves that wilt, turn reddish-brown, and then die. Flagging typically occurs in the spring and summer, and is present at the end of branches. If you remove the bark, brownish-purple streaking will be present in the outer layer of wood.

Timing

This disease is spread by beetles (native elm bark beetle and smaller European elm bark beetle) and is closely linked to their life cycle. Beetles are attracted to stressed or dead elm wood. Adults tunnel into the bark and lay eggs in their galleries. The larvae overwinter in galleries and adults emerge from the tree in the spring. The Dutch elm disease fungus overwinters in the beetle galleries and is picked up by beetles as they feed. Beetles distribute the fungus to healthy trees after they emerge and fly to new food sources. The fungus grows throughout the tree's vascular system in the summer and can spread through root grafts.

Management

Remove diseased trees and sever root grafts between trees. If only a few branches show symptoms, prune limbs at least 5 feet below the last sign of streaking. Do not transport firewood. Either burn wood immediately or remove bark and cover in airtight plastic for one year. If diseased tree is highly valued, fungicides can be applied yearly and may save tree if infection is caught early enough. Plant resistant elm tree varieties.



Beetle galleries from insect vectors. Photo: William M. Brown Jr., Bugwood.org

Vascular discoloration. Photo: William Jacobi, Colorado State University, Bugwood.org

Decline from Dutch elm disease. Photo: Ward Upham, Kansas State University, Bugwood.org

Laurel Wilt Disease

– VASCULAR –

Hosts

All trees in the laurel (Lauraceae) family, including sassafras, avocado, swamp bay, silkbay, pondberry, pondspice, northern spicebush, laurel trees, and bay trees.

Signs/Symptoms

This fungus impacts the vascular system of trees, so symptoms are similar to those seen in drought. Infected bay trees often have brown leaves hanging on branches long after the tree dies, while infected sassafras trees exhibit wilted, yellow leaves which drop from the tree in a few weeks. If you remove the bark, streaking in sapwood will be present. Ambrosia beetles produce frass "toothpicks" that look like a stick of sawdust on the tree stem. This disease is fatal to nearly every tree that becomes infected.

Timing

Trees become infected with laurel wilt by the redbay ambrosia beetle, *Xyleborus glabratus*. The beetle enters the tree, boring into the stem to create galleries in which to cultivate the *Raffaelea lauricola* fungus. Beetle larvae feed on fungus growing in the galleries, and the fungus clogs the xylem of the host plant. After adult beetles emerge, they carry the fungus to a new host plant and start the disease cycle again.

Management

There is no cure for laurel wilt disease but keeping trees healthy and unstressed are good preventative measures. Do not move infected material – cut and leave or destroy diseased trees. Fungicides can protect high-value trees if applied preventatively. Researchers are working to develop resistant trees.

Notes

Laurel wilt disease is not yet present in Virginia, but is spreading to new territory rapidly. Diseased trees have been confirmed in neighboring states KY, TN, and NC.

Redbay infected with laurel wilt disease. Photo: VDOF

Vascular streaking from laurel wilt disease. Photo: VDOF

Bacterial Wetwood/Slime Flux

– VASCULAR –

Hosts

Many hosts including elm, maple, oak, sweetgum, sycamore, willow, fir, and hemlock.

Signs/Symptoms

Wetwood is a bacterial condition that causes water and gasses to build up in the wood of the tree. Wood looks soaked, discolored, and has a sour smell. Slime flux occurs when pressure builds beneath the bark surface, and fluids and gasses are released onto the surface of the tree. At this point, clear sap flows from the wound, darkens, and develops an unpleasant odor. There will often be grey, brown, or black streaks down the bark coming from cracks or wounds in the tree. Insects are attracted to the sap and various fungi and bacteria colonize the fluids once exposed to oxygen.

Timing

Symptoms appear in spring, summer, and less commonly in the fall.

Management

Avoid wounding trees and follow proper pruning protocols to ensure that wounds heal and close rapidly. Do not drill holes to "relieve pressure". Fluids can be washed away with a mild soap solution.

Bacterial wetwood. Photo: William Jacob, Colorado State University, Bugwood.org

Discolored wood from bacterial wetwood. Photo: VDOF

ABIOTIC IMPACTS

Burlap/Wire Baskets

Cause

Synthetic or treated burlap and wire baskets left on after planting is complete.

Signs/Symptoms

Visible burlap or wire basket when soil is pulled away from the base of the tree, girdled roots, overall state of decline.

Management

If roots of an already-planted tree have grown through the burlap or wire and have girdled, the tree may need to be removed. When replanting, remove all synthetic or treated burlap and, if possible, remove all of the basket. If needed, the lower one third of the wire basket can be left in place to aid in keeping the root ball intact. Stakes may be needed in the first few years of establishment, but should be removed once the tree has become established.

Large roots can be severed by synthetic burlap and wire basket material. Photo: Joe Murray, Treebio.com, Bugwood.org

Root barrier struggles to stretch as the tree grows with age. Photo: Joe Murray, Treebio.com, Bugwood.org

Roots struggle to grow through burlap that was left on the root ball of tree during planting. Photo: Joe Murray, Treebio.com, Bugwood.org

Girdling Roots

Cause

Trees planted too deep, shallow, or in a confined growing space. If container-grown trees outgrow their pots, roots begin to circle due to the restricted space. As the tree grows, these roots compress the adjacent trunk or roots, limiting diameter growth and restricting water and nutrient transport. Newly-transplanted trees are most susceptible.

Signs/Symptoms

No visible root flare, circling or shallow roots around the base, thinning canopy or canopy dieback, small chlorotic leaves, or premature leaf drop.

Management

It is best to correct girdling roots at the time of planting, or plant stock without girdling roots. If the tree has already been planted, excavate around the base of the tree and sever any small circling roots at the trunk. Remove the entire root if there is no threat to injuring the cambium or trunk. Large, circling roots may need to be removed in stages due to the amount of water and nutrients they supply the tree. Removing in stages will allow the tree time to produce new roots and reduce the likelihood of shock. Any dieback should be removed from the tree.

Girdling roots cause constriction along the base of a tree. Photo: VDOF

Circling roots can be a result of plant stock being left in a nursery pot for too long. Photo: VDOF

Circling roots evident following removal. Photo: VDOF

Planting Depth

Cause

Planting too shallow will expose roots and cause them to dry out. Planting too deep will suffocate the roots. Either will shorten the trees life expectancy.

Signs/Symptoms

Root flare not visible, early loss of leaves in the fall, slowed growth, root or stem girdling.

Management

If the tree is planted too deep, pull all soil away from the trunk of the tree until you reach the first few large roots and expose the root flare. If the tree is planted too shallow, gradually build up the grade around the tree with soil rich in organic matter, no more than 1 inch per year. When planting a tree, identify the root flare and dig a shallow, broad hole that is two to three times the width of the root ball. The hole should only be as deep as the current root ball. Remember, most of the tree's roots are found in the top 18 inches of the soil.

Soil excavated around a tree planted too deep. Photo: Eric Wiseman, Virginia Tech

Pruning away adventituous roots that have formed above the root flare. Photo: Luana Vargas, Desert Botanical Garden, Bugwood.org

Soil piled up to the base of the tree; root flare is buried. Photo: Luana Vargas, Desert Botanical Garden, Bugwood.org

Tree planted to shallow, leaving an exposed and vulnerable root system. Photo: Eric Wiseman, Virginia Tech

Volcano Mulching

Cause

Piling an excessive amount of mulch around and up the base of the tree.

Signs/Symptoms

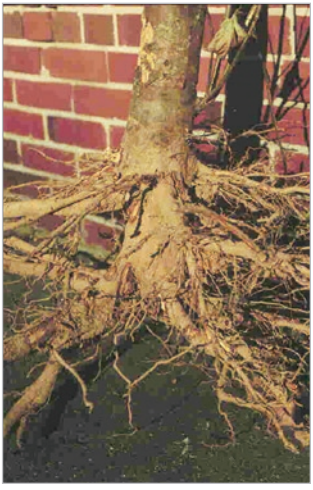
Excessive amounts of mulch on the main stem of the tree form a “volcano” shape around the stem. Adventitious roots and rot are likely to form where the excessive mulch is consistently present.

Management

Pull mulch 1 inch away from the stem of the tree to let air circulate near the base. Extend mulch out towards the dripline of the tree. Ensure the mulch is the proper thickness (roughly 2 to 4 inches) to dissipate compaction and hold moisture.

Excessive mulching buries the trunk of a tree. Photo: Robert Benjamin, Bugwood.org

Volcano mulching exposes the tree to the risk of rot among other negative unintended consequences. Photo: Stephen Curry, Lower Merion Twp., Bugwood.org



Volcano mulching encourages more lateral root growth into the mulch and not down into the soil. Photo: Bonnie Apppleton, Virginia Cooperative Extension

Adverse Site

Cause

Choosing to plant the "wrong tree in the wrong place."

Signs/Symptoms

Tree is outgrowing its planting area or is in an overall state of decline.

Management

When planting a tree, take a variety of factors into consideration. Planting space, hardiness zones, species, soil type, and utilities are just some of the variables that need to be considered to minimize potential future conflict. Taking time to match species with site will eliminate future safety hazards and expenses.

Large trees quickly outgrow small planting areas. Photo: Eric Wiseman, Virginia Tech

A small parking lot median is an unrealistic choice to grow a healthy, large specimen tree. Photo: Adam Downing, Virginia Cooperative Extension

Constricted roots will find various places to grow including under paved infrastructure. Photo: VDOF

Transplant Shock

Cause

The root system of a newly-transplanted tree is stressed and not able to support the plant.

Signs/Symptoms

Leaf scorch, wilted leaves, yellowing, leaf curling, or leaf rolling. On evergreens, needles may appear gray and tips of needles turn brown.

Management

Inspect plants before planting for new growth and vibrant color. Choose or prepare trees for transplant with adequate root ball diameters – a minimum of 10 times the diameter at breast height. Ensure roots of the plant are white and healthy. Plant during cooler months when trees are dormant and less likely to experience stress. Continuously monitor new plantings to ensure their watering and management requirements are being met.

Same species, planting site, and planting time with different results. Photo: VDOF

Browning pine needles. Photo: Joseph OBrien, USDA Forest Service, Bugwood.org

Leaf dieback. Photo: Eric Wiseman, Virginia Tech

Larger transplanted trees are more difficult to successfully establish. Photo: VDOF

Mower/Weedeater Damage

Cause

Any damage caused by lawn mowers, weedeaters, or other lawn maintenance equipment.

Signs/Symptoms

Scraped or missing bark and exposed cambium at the base of the tree or on large roots at the surface of the ground are early signs of damage. A girdled stem is the eventual result.

Management

Apply mulch surrounding the base of the tree that is 2 to 4 inches thick, extending out to the dripline. Mulch will conserve water, reduce compaction, and inhibit the growth of weeds or grass near the base of the tree. Any grass or weeds at the base of the tree should be removed by hand or with grass shears. Be mindful when using lawn maintenance equipment and give ample space. When planting a tree or shrub, keep in mind the need for future maintenance. A younger tree or one with thin bark is especially susceptible. Young trees can be protected with tree tubes or sections of corrugated pipe.

Wounds expose trees to decay-causing fungi. Photo: Eric Wiseman, Virginia Tech

Roots too shallow will experience repeated damage over time. Photo: Joseph OBrien, USDA Forest Service, Bugwood.org

Misformed tree base due to repeated mower damage. Photo: Jason Sharman, Vitalitree, Bugwood.org

Recently damaged tree base. Photo: Stephen Curry, Lower Merion Twp., Bugwood.org

Stem Girdling

Cause

Ring of cambium removed or constricted around the trunk, which interrupts water and nutrient transport.

Signs/Symptoms

Crown and branch dieback, pinched stem, ring of bark removed around stem, stake ties or signage left on the tree longer than needed.

Management

Remove or sever the object that is causing the girdling. Remove all deadwood from the tree and ensure that it is properly watered. If the object cannot be removed, add a thick layer of mulch towards the dripline of the tree. Ensure that the mulch does not touch the trunk.

Girdling roots constrict a tree base. Photo: Guy Meilleur, Better Tree Care, Bugwood.org

Planting supports left on longer than necessary can embed themselves into the tree. Photo: VDOF

Planting support embedded into the trunk of a tree. Photo: Eric Wiseman, Virginia Tech

Rope constricts a young tree. Photo: Ryan Armbrust, Kansas Forest Serice, Bugwood.org

Poor Structural Pruning

Cause

Excessive removal of branches or limbs resulting in poor form.

Signs/Symptoms

The presence of weak branch unions, major limb breakage, codominant stems, and included or ingrown bark signify poor pruning. The tree may have an unbalanced crown, which concentrates stress to one side of the tree.

Management

Pruning when the tree is young is the best way to establish proper structure. Identify a dominant, central leader and lowest branch in the permanent canopy. Space main branches intentionally along the central leader. Eliminate any branches that are more than one half of the trunk diameter or with weak branch unions. Suppress branches that grow upright. Pruning cuts should be made just to the outside of the branch collar. Continuously monitor the tree and make adjustments as it puts on growth. Reference ANSI A300 standards on proper pruning.

Large pruning wounds expose the tree to stress and decay. Photo: Luana Vargas, Desert Botanical Garden, Bugwood.org

Years of poor pruning practices on a crape myrtle. Photo: VDOF

Branch stubs on white pine. Photo: Joseph OBrien, USDA Forest Service, Bugwood.org

Excessive pruning. Photo: Charlottesville Area Tree Stewards

Low Temperatures/Cold Injury (including Frost Cracking)

Cause

Low temperature injury can occur on all parts of the tree. Symptoms are highly variable based upon the duration of abnormal temperature and the species, vigor and age of the tree. Fluctuating temperatures during the winter months cause the tree to come in and out of dormancy. Frost cracks occur when the inner wood stays warm and a sudden temperature drop causes the outer bark to freeze and contract resulting in bark cracking. New leaves, shoots, and young trees are highly sensitive to cold injury.

Signs/Symptoms

Bark is sunken, discolored, cracked, and peeling. Visible large, vertical cracks along the trunk of the tree with cambium exposed. Newly-emerged leaves can appear water-soaked, withered, and burned, while new shoots are often killed entirely. Canopy dieback can occur.

Management

Choose trees to plant that are appropriate for the hardiness zone. Allow cracks and discolored areas to heal naturally. Select species with thicker bark in areas with south/southwest sun exposure. Protect the bark of sensitive trees with a temporary seasonal wrap. Do not prune a cold-injured plant until the extent of the damage is entirely known because it may produce new foliage or resprout. Keep the damaged tree well-watered.

Newest leaves are more tender and discolor first on the plant. Photo: VDOF

Low Temperatures/Cold Injury, continued

Discolored or "burned" needles in evergreens are a common result of cold injury. Photo: Steven Katovich, Bugwood.org

A tree is unable to close a large wound after extensive frost cracking damage. Photo: VDOF

Trees with thin bark are particularly susceptible. Photo: VDOF

Leaf dieback due to cold injury. Photo: VDOF

Ice/Snow Damage (including Hail Damage)

Cause

Extreme weather systems and cool temperatures resulting in hailstorms or ice/snow accumulation that increase the weight load on the tree.

Signs/Symptoms

Accumulation of ice/snow on stems that weigh down limbs throughout the tree. Split stems, toppled trees, broken limbs and branches, bent crowns, and damaged or ripped bark are all common indicators.

Management

Wait until the ice/snow has fully melted from the tree before taking action. Prune torn branches and bark as soon as it is safe to do so. Trees with 75 percent canopy still intact are expected to recover over time. Properly pruning trees will result in a tree more resilient to adverse weather systems. Young trees are most susceptible to hail damage but tend to bend and recover when faced with ice accumulation. Reference ANSI A300 standards for proper pruning techniques.

Deciduous snow load. Photo: Steven Katovich, Bugwood.org

Evergreen snow load. Photo: Andrew Koeser, International Society of Arboriculture, Bugwood.org

Numerous small slits on bark and leaves following a hailstorm event. Photo: VDOF

Ice/Snow Damage, continued

Breakage resulting from an ice storm. Photo: Joseph OBrien, USDA Forest Service, Bugwood.org

Heavy snow exposes plants to catastrophic damage. Photo: VDOF

Heavy, wet snow can load down even the most mature of trees. Photo: VDOF

Lightning

Cause

Trees are often the tallest structures in an area making them susceptible to lightning strikes during summer thunderstorms or extreme weather events.

Signs/Symptoms

Presence of a vertical scar extending the length of the trunk. The scar may be straight down the trunk, or it may wind around the trunk. Cracked, blackened, or charred areas are also an indication. A large lightning strike may cause branches and leaves to be blown off the tree.

Management

Wait a full growing season to determine the extent of damage. Prune broken branches and remove loose bark. Ensure tree is properly watered and mulched to encourage recovery. Lightning protection systems can be installed to protect trees in advance of a lighting strike.

Bark blown off a tree from lightning. Photo: Adam Downing, Virginia Tech Cooperative Extension

Callused lightning scar. Photo: Elizabeth Moss, West Virginia State University, Bugwood.org

Lightning scar. Photo: Paul A. Mistretta, USDA Forest Service, Bugwood.org

Drought

Cause

Prolonged hot or dry conditions typically in the summer months.

Signs/Symptoms

Wilting, leaf scorch, browning or yellowing, early fall color, early leaf or needle drop, or dry and dusty soil.

Management

Short periods of drought and heat will not harm trees and is quite common in summer months. Extended periods of drought conditions may require deep and frequent watering. If drought symptoms persist, water the plant on a 10-day cycle. Perform a soil test and observe how quickly or slowly your soil drains. Match irrigation rate to soil infiltration rate to avoid runoff. Simulate up to 1 inch of rainfall per week when rain is inadequate during the growing season. Understand the requirements for the tree species and mulch plantings to encourage water retention.

Curled leaves from drought. Photo: Charles Hoysa, Virginia Cooperative Extension, Bugwood.org

Discolored wilting leaves from drought. Photo: Eric Wiseman, Virginia Tech

Drought damage on pine. Photo: William M. Brown Jr., Bugwood.org

Extensive leaf dieback from drought. Photo: Paul A. Mistretta, USDA Forest Service, Bugwood.org

Flooding/Overwatering

Cause

Slow draining or standing water around the roots resulting in oxygen depletion and anaerobic soil conditions.

Signs/Symptoms

Early signs of damage include chlorosis, early fall color or leaf drop. As time passes, crown dieback, emerging watersprouts, or reduced leaf size will also be visible indicators.

Management

Trees are especially susceptible during the growing season. Inspect trees after flooding water has receded. It may take several months for symptoms to show. Remove dead, dying, and broken branches but only prune trees during dormant season to reduce the likelihood of infection and pest infestation. Remove deposited sediment from the base of the tree and aerate the soil. Add mulch to eliminate weeds and conserve moisture. Continue to monitor the trees for a full planting season as some effects can be delayed. As with any tree – a tree that is healthy before the flooding occurs has the best chance of recovering. Any trees that are partially uprooted need to be removed by a professional arborist. Plant flood-tolerant species native to riparian environments and swamps in flood-prone areas.

Flooded pine. Photo: William Fountain, University of Kentucky, Bugwood.org

Standing water depletes the soil of oxygen and can introduce pathogens. Photo: Tony Pernas, USDI National Park Service

Crown dieback and thinning canopy are obvious signs of too much water. Photo: Tony Pernas, USDI National Park Service

Flooding/Overwatering, continued

Newly-planted pine trees sitting in oversaturated soil. Photo: Eric Wiseman, Virginia Tech

Water sits at the base of a tree causing rot. Photo: Gerald Holmes, Strawberry Center, Cal Poly San Luis Obispo, Bugwood.org

Wind

Cause

Intense seasonal storms and sustained wind events exceeding 30 mph.

Signs/Symptoms

Prolonged wind exposure depletes the water from leaves causing them to brown or become lopsided. High winds can cause broken branches or entire stem failure.

Management

Inspect tree for dying, dead, or broken branches and remove them. Prune poor branch attachments and growth habits according to ANSI A300 standards. The establishment of windbreaks or screens can protect sensitive plants. Do not overly thin crowns or top trees to aid in wind movement; this creates openings for pest and disease establishment.

Snapped tree. Photo: Jim Skiera, International Society of Arboriculture, Bugwood.org

Large tree uprooted in Big Stone Gap. Photo: VDOF

Tornado damage. Photo: VDOF

Tornado damage at Holiday Lake State Park.
Photo: VDOF

Compaction

Cause

Increased pressure on soil surface causing reduced soil volume and porosity. The reduction in pore space inhibits the ability of water, nutrients, and air to pass through the soil to the root system of the tree.

Signs/Symptoms

Water runoff, increased erosion, hard soil, standing water, surface crust, loss of vegetation, poor plant growth.

Management

Prevent soil compaction by installing barriers, such as fencing, around trees. Mulch the critical root zone of the tree (from trunk to dripline) and avoid working with wet soils. Soil amendments, aeration, and air excavation are options for loosening soil on existing sites. Maintaining soil organic matter at a high level will help preserve soil structure against compaction.

Top soil removed and subsoil compacted around the bases of the tree. Photo: Eric Wiseman, Virginia Tech

Patchy turf in high-traffic areas is another sign of compaction. Photo: Eric Wiseman, Virginia Tech

Urban trees planted in tree pits are compacted by both pedestrian and vehicle traffic. Photo: Luana Vargas, Desert Botanical Garden, Bugwood.org

Construction Activities

Cause

Any damage to the trunk, branches, or root system that is a direct result of construction projects.

Signs/Symptoms

Wilted or scorched leaves, chlorosis, broken branches, scraped trunk, grade changes, or other obvious mechanical wounds. Prolonged damage can be indicated through early leaf drop, crown dieback, or presence of early fall color.

Management

Perform a preconstruction evaluation to determine which trees to remove, prune, relocate, or preserve. Follow ANSI 300 standards Part 5 for tree preservation. Roots that are encompassed within the dripline are crucial to a tree's survival. Mark the critical root zone (CRZ) with signage to help ensure that no construction occurs in these areas. Prior to and following construction, mulch the CRZ and make sure the tree has been well watered to minimize stress. If tree is damaged during construction, invite a certified arborist to evaluate the tree. Not all trees can be saved but with proper planning and monitoring, careless mistakes can be avoided.

Construction activities compact the critical root zone. Photo: Eric Wiseman, Virginia Tech

Foundation is very close to this maturing tree. Photo: Andrew Koeser, International Society of Arboriculture, Bugwood.org

Severed root zone will cause extensive dieback and decline over time. Photo: Eric Wiseman, Virginia Tech

Topping

Cause

Extensive reduction cuts made to the crown and lateral branches to establish uniform height (also called heading, dehorning, or stubbing).

Signs/Symptoms

Numerous wounds line the crown and lateral branches in a uniform pattern. These excessive cuts promote the growth of watersprouts and expose the tree to decay. Prolonged topping will result in tree decline and eventually tree death.

Management

When planting a tree, keep its expected height at maturity in mind. Crown reduction pruning can be performed to reduce the overall height of the tree. This method prunes large branches back to laterals that are at least one third of the diameter of the branch that is being removed. Proper crown reduction pruning reduces the likelihood of watersprouts and weak branch unions. A mature tree should be assessed and pruned on a three- to five-year cycle to ensure proper structure is maintained. Prune without cutting into the branch collar and without leaving a stub. If the tree has already been topped, assess it for decay and elevated pest activity. Pay attention to new branches that form and prune out any with weak unions. Topped trees can be corrected over time with repeated restoration pruning. Ensure the tree is properly mulched and watered to minimize additional stress. Sometimes a tree cannot be saved – this determination can be made by a certified arborist.

Trees and powerlines do not mix! Photo: Fred Baker, Utah State University, Bugwood.org

Repeated topping will eventually kill the tree. Photo: VDOF

Watersprouts form in response to severe reduction cuts. Photo: VDOF

Salt Injury

Cause

An abundant amount of salt becomes concentrated in the surrounding soil. Natural sodic or saline soils can damage species of trees that are not salt tolerant. Excessive amounts of salt added when de-icing roadways, overfertilizing yards, or when applying soil amendments are other causes.

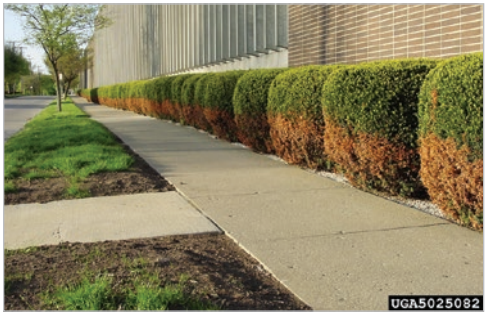
Signs/Symptoms

Early indications of salt injury include leaf necrosis, defoliation, chlorosis, brown or brittle needles, and premature fall color. Eventually, the tree could exhibit stunted growth and reduced leaf size. Continuation of excessive salt exposure will result in tree death.

Management

Trees exhibiting signs of salt injury should be watered and mulched to decrease the likelihood of additional stress. Prune damaged branches from the tree to prevent attracting insects and disease. Some species are more tolerant of salt than others. Any trees that are particularly sensitive should be planted away from salt spray drift zones and slush-accumulation areas. Irrigate soils to leach salt out of the root zones and apply gypsum to displace sodium concentration.

Salt-burned pines will drop damaged foliage and resprout new needles at a later date. Photo: USDA Forest Service - Northeastern Area, Bugwood.org



Burned foliage due to salt applications on busy sidewalks. Photo: Joseph LaForest, University of Georgia, Bugwood.org

Pines along a busy roadway exhibit brown needles due to de-icing salt applications. Photo: USDA Forest Service - North Central Research Station, Bugwood.org

Fertilizer Damage

Cause

Overapplication of fertilizer or the use of an incorrect fertilizer.

Signs/Symptoms

Leaves or needles will appear scorched or "burned" shortly after exposure. Repeated exposure will cause deformed foliage, stunted shoots and leaves, and defoliation. Depending on the location and amount of damage, branch dieback, root rot, or full tree decline could result.

Management

Overapplying fertilizer can alter the pH and salinity of the soil. Before applying fertilizer, perform a soil test to determine exactly what nutrients are lacking. Often natural soil amendments, such as compost, can be added in place of fertilizers. If fertilizers are needed, a slow-release organic fertilizer is less likely to cause plant damage. Always follow the label regarding directions for application. Do not fertilize newly-planted trees.

Fertilizer damage to northern red oak. Photo: VDOF

Fertilizer burn on young pine seedlings. Photo: Lacy L. Hyche, Auburn University, Bugwood.org

Herbicide Drift

Cause

Herbicides move from the application site area to nearby areas through air, water, or soil.

Signs/Symptoms

Similar to fertilizer damage, the leaves or needles will appear scorched or "burned" shortly after exposure. Repeated exposure will cause deformed foliage, stunted shoots and leaves, and defoliation. Depending on the location and amount of damage, branch dieback, root rot, or full tree decline could result.

Management

Trees are most susceptible in the spring when they are leafing out. Follow the product label and limit application to days and seasons that are cool with low wind speed to decrease the likelihood of volatilization. Pay attention to surrounding properties with sensitive vegetation – gardens, vineyards, etc. Adjust spray nozzles to a coarser setting. When possible, use alternative weed control tactics such as mulching or weeding.

Line of pines with needles burnt due to herbicide drift from neighboring property. Photo: Jason Sharman, Vitalitree, Bugwood.org

Herbicide toxicity on witchhazel. Photo: Penn State Department of Plant Pathology & Environmental Microbiology Archives, Bugwood.org

Herbicide Drift, continued

Soil sterilant damage to a tree in a suburban yard. Photo: William Jacobi, Colorado State University, Bugwood.org

Spruce tip burn. Photo: Jason Sharman, Vitalitree, Bugwood.org

Air Pollution (Ozone, Sulfur Dioxide, and Peroxyacetyl Nitrate)

Cause

The presence of phytotoxic air pollutants.

Signs/Symptoms

Foliage symptoms include chlorosis, flecking, stippling, necrosis, tip burn, bronzing, and mottling.

Management

Select tolerant species for areas prone to phytotoxic levels of pollution. Plant sensitive species away from areas of concentrated pollution.

Ozone damage to a maple leaf. Photo: Robert L. Anderson. USDA Forest Service, Bugwood.org

Pollution particulates collected on a tulip-poplar leaf. Photo: Robert L. Anderson, USDA Forest Service, Bugwood.org

Sulfur dioxide injury to oak leaves. Photo: USDA Forest Service - Region 8 - Southern, Bugwood.org

Tip burn resulting from phytotoxic air pollutants. Photo: Elizabeth Bush, Virginia Tech, Bugwood.org

Spiral of Decline

Cause

Long-term stress that exposes the tree to more acute problems ultimately sending the entire tree into decline. Common abiotic factors that initiate or contribute to decline include improper soil conditions for the species, root system damage, mechanical damage, prolonged drought, or inundation of water.

Signs/Symptoms

Trees exhibiting signs of decline will display an over-production of seed as a last-ditch effort to reproduce before dying. Early signs include chlorosis, early fall color, and root/shoot dieback. Final factors include borers, fungal disease, and other opportunistic organisms.

Management

A combination of numerous factors ultimately lead a tree into decline. If a specific problem can be identified, follow targeted treatment recommendations for that stressor. Once a tree exhibits multiple signs that it is in a spiral of decline, the best course of action may be to remove the specimen and plant a new one.

Gradual canopy decline along one half of the tree. Photo: Jason Sharman, Vitalitree, Bugwood.org

Branch dieback on a declining tree. Photo: VDOF

Thinning foliage or flagging are indicators of decline. Photo: VDOF

Vandalism

Cause
Intentional human-caused damage or destruction of a tree.

Signs/Symptoms
Intentional damage including carving, scraping or cutting into bark, breaking stems, girdling, and painting.

Management
Management depends on the extent of damage to the tree. Work with a certified arborist to evaluate and monitor. Not all vandalized trees can be saved but educating the public and raising awareness of the issue can discourage vandalism.

Shotgun spray along the stem of a pine tree. Photo: Joseph OBrien, USDA Forest Service, Bugwood.org

Love notes can have unintended consequences! Photo: VDOF

Soil pH

Cause

Excessive soil alkalinity (high pH) or acidity (low pH) that affects nutrient availability is often determined by the parent material and geology. Human disturbance (e.g., farming and development) and overfertilization can also affect soil pH. Trees planted in very low pH (<5.0) soils can have aluminum, copper, and manganese toxicity. They also show symptoms of phosphorus deficiencies because this nutrient is immobile. Trees planted in high pH (>7.0) soils often have iron, manganese, or zinc deficiencies due to nutrient immobility.

Signs/Symptoms

Chlorosis, stunted growth, discolored roots, leaf distortion, or necrosis.

Management

Perform a soil test or foliar nutrient test to determine pH value and what supplemental nutrients are needed. If the soil pH is not between 5.5 and 7.0, nutrient availability decreases. There could also be an overabundance of specific nutrients resulting in toxicity damage to the plant. Administer soil amendments as needed. Choose plants that are adapted for the type of soil on site. Lowering pH is more difficult than raising pH.

Tree showing signs of chlorosis along a roadway. *Photo: Mary Ann Hansen, Virginia Polytechnic Institute and State University, Bugwood.org*

Dark leaf veins against lighter leaf margins is a cause for investigation. *Photo: VDOF*

Nutrient Deficiencies

Cause

Disturbed or natural soil profile lacking in essential macro or micronutrients.

Signs/Symptoms

Common examples include:

- Nitrogen – Chlorosis, necrosis, reduced shoot growth and leaf size, early leaf drop
- Phosphorus – Purple or red leaf edges, distorted leaves, leaf or needle dieback from bottom up
- Potassium – Marginal or interveinal chlorosis on older leaves, necrosis, shoot/needle dieback
- Calcium – Chlorotic young leaves with necrotic tips, reduced shoot growth, terminal dieback
- Magnesium – Marginal or interveinal chlorosis on older leaves, leaf necrosis
- Sulphur – Uniform pale green leaf chlorosis on younger leaves
- Iron – Chlorotic young leaves or needles, twig dieback, and defoliation
- Manganese – Yellow with wide green bands along veins of young leaves, leaf margins are wavy, crinkled, or curled, or stunted growth
- Zinc – Shortened internodes resulting in tufts of leaves, stunted growth, or dieback

Management

Perform a soil test to determine what nutrient(s) are missing from the soil. Soil amendments or foliar applications can be applied to mitigate the issue. Avoid overwatering and compaction.

Nutrient deficiency or toxicity disfigures buds on an apple tree. Photo: William M. Brown Jr., Bugwood.org

Chlorosis from a nutrient deficiency. Photo: Jason Sharman, Vitalitree, Bugwood.org

Nutrient Deficiencies, continued

Magnesium deficiency displays as interveinal chlorosis on older leaves. Photo: John Ruter, University of Georgia, Bugwood.org

Iron deficiency displays as interveinal chlorosis on new growth and younger leaves. Photo: John Ruter, University of Georgia, Bugwood.org

Nitrogen deficiency displays first as pale green-yellow chlorosis on older leaves. Photo: John Ruter, University of Georgia, Bugwood.org

GLOSSARY

Adventitious roots – roots that form on non-root material in response to stress conditions

ANSI A300 standards – national tree care industry standards for tree care in the United States

Arborist – an individual professionally trained in the art and science of planting, caring for, and maintaining trees

Biological control – the practice of using living organisms to suppress the population of a pest species and reduce the impact of that pest

Branch collar – swollen area of tissue that forms between branch unions

Branch union – where two branches or stems meet or where a branch meets the trunk

Cambium – the layer between the phloem and xylem of vascular plants that creates new cells and secondary growth

Cankers – local tissue death that can occur on stems, branches, twigs, or bark; often caused by fungi

Chlorosis – yellowing of plant tissue, which would normally be green

Conifer – a cone-bearing tree, usually evergreen

Conks – a specific type of fruiting body produced by some wood decay fungi species

Crawler – the active first life stage of a scale or adelgid insect

Critical root zone – the area encompassing all of the roots extending to the dripline of the tree

Crown – the area at the top of the tree, which encompasses the leaves and branches

Diapause – a period of dormancy where the insect reduces metabolic functions and stops development

Deciduous – a tree or shrub that sheds its leaves annually

Dripline – outermost circumference of the tree's canopy

Epicormic sprout – a shoot that emerges as a stress response from a dormant bud on the trunk or branch of a tree

Exit hole – results from adult insects chewing their way out of the tree after completing development within the tree

Exoskeleton – an insect's supporting structure on the outside of the body

Frass – insect excrement

Frass tube – a mix of insect excrement and plant material; these are produced by ambrosia beetles

Fruiting body – a reproductive structure produced by some species of bacteria and fungi

Gallery – a tunnel-like pattern caused by insects feeding underneath the bark

Galls – the swelling or excessive growth of plant tissue caused by attack from insects, fungi, or bacteria

Girdle – to damage a ring of tissue responsible for the tree's ability to move water and nutrients

Hardiness zone – average minimum winter temperatures in a geographical region relevant to plant growth and survival

Hardwood – trees that are broad-leaved, produce a fruit or a nut, and often go dormant during winter

Heartwood – the inner part of the tree trunk yielding the hardest wood

Honeydew – sugary fluid excreted from plant-sucking insects

Instar – the developmental stages of an insect

Larva – the immature stage of an insect between egg and pupa

Leaf scorch – browning of plant tissues

Lesion – a plant injury caused by pathogen growth

Milky spore – bacterial treatment using *Paenibacillus popilliae* to control white grubs

Mycelium – a mass of hyphae (tubular filaments making up the structure of fungi)

Natural enemies – organisms that reduce population numbers of another organism by limiting the reproductive potential or through predation and parasitism

Nematode – a free-living microorganism with a stylet that feeds on plant cells

Necrosis – localized death of living tissue

Nymph – the immature stage of an insect that does not have a pupal stage

Overwinter – refers to the ability of an insect or fungus to survive the winter

Parasitoid – an insect whose larvae parasitize and kill another insect species

Pheromone – a substance released by an individual to cause a specific reaction in another individual of the same species

Phloem – the vascular tissue in a plant that moves sugars and other nutrients from the leaves down to the rest of the plant

Pitch tube – resin that has hardened on the bark at the insect's point of entry

Pupa – a nonfeeding, inactive stage where insects transform from larva to adult

Quarantine – prevents the entry, establishment, and spread of regulated pests by restricting movement of the pest and host material

Resin soaked – refers to staining and saturation of the sticky liquid excreted by trees after a wound

Root flare – the area around the base of the tree where support roots extend from the trunk

Sapwood – the layer of xylem tissue that moves water and nutrients from the roots to the crown

Secondary pest – insects or diseases that arrive after a tree has been weakened

Shot hole – feeding pattern by insects where holes are chewed in the leaf blade

Silviculture – the practice of forest management; establishment, management, and composition

Skeletonize – an insect feeding pattern where insects feed on all tissue except leaf veins leaving a lacy appearance on the foliage

Spore – reproductive unit of fungi and bacteria that consists of one or more cells

Sticky band – bands of material (paper, plastic) covered with a sticky product and wrapped around tree trunks to catch mobile insects

Stippling – damage pattern on foliage that appears as small dots of yellowing tissue

Stylet – a needle-like structure used by insects with piercing, sucking mouthparts

Terminal leader – a shoot that exerts apical dominance on lateral shoots, originating from the tip of a branch

Tunneling – insect movement under the bark; causes galleries

Watersprouts – vigorous, upright shoots developing from dormant buds along the trunk and branches

HOST TREE SPECIES INDEX

Search for common biotic tree issues by host tree species.

Alder

pest Aphid
pest Broadleaf Sawfly
pest Fall Webworm
pest Forest Tent Caterpillar
pest Gypsy Moth
pest Lace Bug
pest Leafminer
disease Nectria Canker
disease Powdery Mildew
disease Sooty Mold

Apple

pest Ambrosia Beetle
pest Aphid
pest Armored Scale
pest Broadleaf Sawfly
pest Brown Marmorated Stink Bug
pest Dogwood Borer
pest Eastern Tent Caterpillar
pest Fall Cankerworm
pest Fall Webworm
pest Flatheaded Appletree Borer
pest Gypsy Moth
pest Lace Bug
pest Leafhopper
pest Japanese Beetle
pest May/June Beetle
pest Mite
pest Periodical Cicada
pest Soft Scale
pest Spotted Lanternfly
pest Yellownecked Caterpillar
pest Variable Oakleaf Caterpillar
disease Anthracnose
disease Armillaria Root Rot
disease Cedar-Apple Rust
disease Downy Mildew
disease Fire Blight
disease Leaf Spot
disease Nectria Canker

Apple, continued

disease Phytophthora Root Rot
disease Powdery Mildew
disease Sooty Mold

Ash

pest Ambrosia Beetle
pest Aphid
pest Armored Scale
pest Asian Longhorned Beetle
pest Boxelder Bug
pest Carpenterworm
pest Eastern Tent Caterpillar
pest Emerald Ash Borer
pest Fall Cankerworm
pest Fall Webworm
pest Flatheaded Appletree Borer
pest Forest Tent Caterpillar
pest Lilac Borer
pest Mite
pest Periodical Cicada
pest Soft Scale
pest Spotted Lanternfly
pest Twig Girdler/Pruner
disease Anthracnose
disease Armillaria Root Rot
disease Leaf Spot
disease Nectria Canker
disease Sooty Mold
disease Verticillium Wilt

Basswood/Linden

pest Ambrosia Beetle
pest Aphid
pest Armored Scale
pest Fall Cankerworm
pest Forest Tent Caterpillar
pest Gypsy Moth
pest Japanese Beetle
pest Lace Bug
pest Leafhopper
pest Leafminer
pest Soft Scale
pest Spotted Lanternfly

Basswood/Linden, continued

pest Twig Girdler/Pruner
pest Variable Oakleaf Caterpillar
pest Walnut Caterpillar
pest Yellownecked Caterpillar
disease Anthracnose
disease Leaf Spot
disease Nectria Canker
disease Phytophthora Root Rot
disease Powdery Mildew
disease Sooty Mold
disease Verticillium Wilt

Bald Cypress

pest Bagworm
pest Fall Webworm
pest Mealybug
pest Mite
pest Soft Scale
pest Spider Mite
disease Seiridium Canker

Beech

pest Ambrosia Beetle
pest Aphid
pest Armored Scale
pest Fall Cankerworm
pest Flatheaded Appletree Borer
pest Leafhopper
pest Soft Scale
pest Spotted Lanternfly
pest Variable Oakleaf Caterpillar
pest Yellownecked Caterpillar
disease Armillaria Root Rot
disease Beech Bark Disease
disease Beech Leaf Disease
disease Biscogniauxia Canker
disease Leaf Spot
disease Nectria Canker
disease Phytophthora Root Rot
disease Powdery Mildew
disease Sooty Mold

Black Walnut

pest Armored Scale
pest Fall Webworm
pest Lace Bug

Black Walnut, continued

pest Mite
pest Soft Scale
pest Spider Mite
pest Spotted Lanternfly
pest Variable Oakleaf Caterpillar
pest Walnut Caterpillar
pest Walnut Twig Beetle
pest Yellownecked Caterpillar
disease Anthracnose
disease Leaf Spot
disease Nectria Canker
disease Thousand Cankers Disease

Black Locust

pest Carpenterworm
pest Locust Borer
pest Locust Leafminer
pest Periodical Cicada
disease Leaf Spot
disease Powdery Mildew
disease Verticillium Wilt

Birch

pest Ambrosia Beetle
pest Aphid
pest Armored Scale
pest Asian Longhorned Beetle
pest Carpenterworm
pest Fall Webworm
pest Forest Tent Caterpillar
pest Gypsy Moth
pest Japanese Beetle
pest Lace Bug
pest Leafhopper
pest Leafminer
pest Orange-Striped Oakworm
pest Periodical Cicada
pest Spotted Lanternfly
pest Yellownecked Caterpillar
disease Anthracnose
disease Armillaria Root Rot
disease Bacterial Leaf Scorch
disease Leaf Spot
disease Nectria Canker
disease Phytophthora Root Rot
disease Powdery Mildew

Birch, continued
disease Sooty Mold

Boxelder
pest Aphid
pest Armored Scale
pest Asian Longhorned Beetle
pest Boxelder Bug
pest Flatheaded Appletree Borer
pest Soft Scale
pest Spider Mite
pest Variable Oakleaf Caterpillar
disease Armillaria Root Rot
disease Bacterial Leaf Scorch
disease Bacterial Wetwood/Slime Flux
disease Leaf Spot
disease Powdery Mildew
disease Sooty Mold
disease Verticillium Wilt

Catalpa
pest Armored Scale
pest Brown Marmorated Stink Bug
pest Catalpa Caterpillar (Worm)
disease Anthracnose
disease Armillaria Root Rot
disease Leaf Spot
disease Powdery Mildew
disease Verticillium Wilt

Cherry
pest Ambrosia Beetle
pest Aphid
pest Armored Scale
pest Dogwood Borer
pest Eastern Tent Caterpillar
pest Fall Webworm
pest Flatheaded Appletree Borer
pest Forest Tent Caterpillar
pest Japanese Beetle
pest Lace Bug
pest Leafhopper
pest Soft Scale
pest Spotted Lanternfly
disease Anthracnose
disease Armillaria Root Rot
disease Black Knot

Cherry, continued
disease Fire Blight
disease Leaf Spot
disease Phytophthora Root Rot
disease Powdery Mildew
disease Sooty Mold

Chestnut
disease Chestnut Blight
disease Leaf Spot
disease Phytophthora Root Rot
disease Powdery Mildew

Dogwood
pest Ambrosia Beetle
pest Aphid
pest Armored Scale
pest Broadleaf Sawfly
pest Dogwood Borer
pest Flatheaded Appletree Borer
pest Leafhopper
pest Locust Leafminer
pest Periodical Cicada
pest Soft Scale
pest Spider Mite
pest Spotted Lanternfly
pest Twig Girdler/Pruner
disease Anthracnose
disease Armillaria Root Rot
disease Bacterial Leaf Scorch
disease Nectria Canker
disease Phytophthora Root Rot
disease Powdery Mildew
disease Sooty Mold

Elm
pest Ambrosia Beetle
pest Aphid
pest Armored Scale
pest Asian Longhorned Beetle
pest Carpenterworm
pest Eastern Tent Caterpillar
pest Elm Bark Beetle
pest Elm Leaf Beetle
pest Fall Cankerworm
pest Fall Webworm
pest Flatheaded Appletree Borer

Elm, continued

pest	Forest Tent Caterpillar
pest	Japanese Beetle
pest	Lace Bug
pest	Leafhopper
pest	Locust Leafminer
pest	Soft Scale
pest	Spotted Lanternfly
pest	Twig Girdler/Pruner
pest	Variable Oakleaf Caterpillar
pest	Yellownecked Caterpillar
disease	Bacterial Leaf Scorch
disease	Bacterial Wetwood/Slime Flux
disease	Dutch Elm Disease
disease	Leaf Spot
disease	Nectria Canker
disease	Sooty Mold
disease	Verticillium Wilt

Fir

pest	Aphid
pest	Armored Scale
pest	Bagworm
pest	Balsam Wooly Adelgid
pest	Pales Weevil
pest	Spider Mite
disease	Armillaria Root Rot
disease	Bacterial Wetwood/Slime Flux
disease	Diplodia Tip Blight
disease	Heterobasidium Root Disease
disease	Juniper Tip Blight
disease	Phytophthora Root Rot
disease	Sooty Mold

Hawthorn

pest	Aphid
pest	Armored Scale
pest	Broadleaf Sawfly
pest	Eastern Tent Caterpillar
pest	Fall Webworm
pest	Flatheaded Appletree Borer
pest	Lace Bug
pest	Leafhopper
pest	Locust Leafminer
pest	Mealybug
pest	Variable Oakleaf Caterpillar
pest	Periodical Cicada

Hawthorn, continued

pest	Soft Scale
pest	Spider Mite
disease	Cedar Apple Rust
disease	Fire Blight
disease	Leaf Spot
disease	Powdery Mildew
disease	Sooty Mold

Hemlock

pest	Armored Scale
pest	Bagworm
pest	Hemlock Woolly Adelgid
pest	Mite
pest	Pales Weevil
pest	Spider Mite
disease	Bacterial Wetwood/Slime Flux
disease	Phytophthora Root Rot
disease	Sooty Mold

Hickory

pest	Aphid
pest	Armored Scale
pest	Fall Cankerworm
pest	Fall Webworm
pest	Flatheaded Appletree Borer
pest	Gypsy Moth
pest	Hickory Bark Beetle
pest	Orange-Striped Oakworm
pest	Periodical Cicada
pest	Soft Scale
pest	Spider Mite
pest	Spotted Lanternfly
pest	Twig Girdler/Pruner
pest	Walnut Caterpillar
pest	Yellownecked Caterpillar
disease	Anthracnose
disease	Armillaria Root Rot
disease	Biscogniauxia Canker
disease	Leaf Spot
disease	Sooty Mold

Holly

pest	Ambrosia Beetle
pest	Armored Scale
pest	Leafminer
pest	Soft Scale

Holly, continued

pest Spider Mite
disease Armillaria Root Rot
disease Leaf Spot
disease Nectria Canker
disease Sooty Mold

Honeylocust

pest Aphid
pest Bagworm
pest Leafhopper
pest Soft Scale
pest Spider Mite
pest Twig Girdler/Pruner
disease Leaf Spot
disease Sooty Mold

Hornbeam

pest Forest Tent Caterpillar
pest Leafhopper
disease Anthracnose
disease Armillaria Root Rot
disease Powdery Mildew

Horsechestnut

pest Aphid
pest Armored Scale
pest Asian Longhorned Beetle
pest Bagworm
pest Japanese Beetle
pest Mealybug
pest Spider Mite
disease Anthracnose
disease Nectria Canker
disease Phytophthora Root Rot
disease Powdery Mildew
disease Sooty Mold
disease Verticillium Wilt

Juniper

pest Armored Scale
pest Bagworm
pest Pales Weevil
pest Spider Mite
disease Cedar-Apple Rust
disease Diplodia Tip Blight
disease Heterobasidium Root Disease
disease Juniper Tip Blight

Juniper, continued

disease Phytophthora Root Rot
disease Seiridium Canker

Magnolia

pest Ambrosia Beetle
pest Armored Scale
pest Leafminer
pest Soft Scale
pest Yellow-poplar Weevil
disease Leaf Spot
disease Powdery Mildew
disease Verticillium Wilt

Maple

pest Ambrosia Beetle
pest Aphid
pest Armored Scale
pest Asian Longhorned Beetle
pest Bagworm
pest Boxelder Bug
pest Carpenterworm
pest Fall Cankerworm
pest Fall Webworm
pest Flatheaded Appletree Borer
pest Forest Tent Caterpillar
pest Japanese Beetle
pest Leafhopper
pest May/June Beetle
pest Orange-Striped Oakworm
pest Periodical Cicada
pest Soft Scale
pest Spider Mite
pest Spotted Lanternfly
pest Twig Girdler/Pruner
pest Yellownecked Caterpillar
disease Anthracnose
disease Armillaria Root Rot
disease Bacterial Leaf Scorch
disease Bacterial Wetwood/Slime Flux
disease Biscogniauxia Canker
disease Leaf Spot
disease Nectria Canker
disease Phytophthora Root Rot
disease Powdery Mildew
disease Sooty Mold
disease Verticillium Wilt

Pecan

pest	Ambrosia Beetle
pest	Aphids
pest	Armored Scale
pest	Brown Marmorated Stink Bug
pest	Fall Webworm
pest	Flatheaded Appletree Borer
pest	Hickory Bark Beetle
pest	Mite
pest	Twig Girdler/Pruner
pest	Walnut Caterpillar
disease	Anthracnose
disease	Biscogniauxia Canker
disease	Downy Mildew
disease	Leaf Spot
disease	Powdery Mildew
disease	Sooty Mold

Oak

pest	Ambrosia Beetle
pest	Aphid
pest	Armored Scale
pest	Carpenterworm
pest	Fall Cankerworm
pest	Fall Webworm
pest	Flatheaded Appletree Borer
pest	Forest Tent Caterpillar
pest	Gall Insects
pest	Gypsy Moth
pest	Lace Bug
pest	Leafhopper
pest	Leafminer
pest	May/June Beetle
pest	Orange-Striped Oakworm
pest	Periodical Cicada
pest	Soft Scale
pest	Spider Mite
pest	Spotted Lanternfly
pest	Twig Girdler/Pruner
pest	Two-Lined Chestnut Borer
pest	Variable Oakleaf Caterpillar
pest	Yellownecked Caterpillar
disease	Anthracnose
disease	Armillaria Root Rot
disease	Bacterial Leaf Scorch
disease	Bacterial Wetwood/Slime Flux

Oak, continued

disease	Biscogniauxia Canker
disease	Fusiform Rust
disease	Leaf Spot
disease	Nectria Canker
disease	Oak Wilt
disease	Phytophthora Root Rot
disease	Powdery Mildew
disease	Sooty Mold

Pear

pest	Ambrosia Beetle
pest	Aphid
pest	Armored Scale
pest	Brown Marmorated Stink Bug
pest	Flatheaded Appletree Borer
pest	Forest Tent Caterpillar
pest	Soft Scale
disease	Fire Blight
disease	Leaf Spot
disease	Phytophthora Root Rot
disease	Powdery Mildew
disease	Sooty Mold
disease	Verticillium Wilt

Pine

pest	Aphid
pest	Armored Scale
pest	Bagworm
pest	Black Turpentine Beetle
pest	Deodar Weevil
pest	Ips Bark Beetle
pest	Mealybug
pest	Nantucket Pine Tip Moth
pest	Pales Weevil
pest	Pine Bark Adelgid
pest	Pine Bark Beetle
pest	Pine Sawfly
pest	Pine Sawyer Beetle
pest	Pine Spittlebug
pest	Pine Webworm
pest	Soft Scale
pest	Southern Pine Beetle
pest	Spider Mite
pest	White Pine Weevil
disease	Armillaria Root Rot
disease	Diplodia Tip Blight

Pine, continued

disease Fusiform Rust
disease Heterobasidium Root Disease
disease Littleleaf Disease
disease Nectria Canker
disease Pine Needle Rust
disease Pitch Canker
disease Procerum Root Disease
disease Rhizosphaera Needle Cast
disease Sooty Mold
disease White Pine Blister Rust

Redbud

pest Ambrosia Beetle
pest Armored Scale
pest Forest Tent Caterpillar
pest Leafhopper
pest Soft Scale
pest Spider Mite
disease Anthracnose
disease Leaf Spot
disease Verticillium Wilt

Rhododendron

pest Ambrosia Beetle
pest Aphid
pest Armored Scale
pest Lace Bug
pest Leafhopper
pest Mite
pest Soft Scale
pest Spider Mite
disease Armillaria Root Rot
disease Leaf Spot
disease Phytophthora Root Rot
disease Powdery Mildew

Sassafras

pest Aphid
pest Armored Scale
pest Broadleaf Sawfly
pest Japanese Beetle
pest Lace Bug
pest Redbay Ambrosia Beetle
pest Yellow-poplar Weevil
disease Leaf Spot
disease Fire Blight

Sassafras, continued

disease Laurel Wilt
disease Nectria Canker
disease Powdery Mildew
disease Sooty Mold
disease Verticillium Wilt

Serviceberry

pest Ambrosia Beetle
pest Aphid
pest Armored Scale
pest Broadleaf Sawfly
pest Japanese Beetle
pest Lace Bug
pest Leafminer
pest Spotted Lanternfly
disease Leaf Spot
disease Fire Blight
disease Powdery Mildew
disease Sooty Mold
disease Verticillium Wilt

Spruce

pest Aphid
pest Armored Scale
pest Bagworm
pest Pales Weevil
pest Spider Mite
pest White Pine Weevil
disease Armillaria Root Rot
disease Diplodia Tip Blight
disease Heterobasidium Root Disease
disease Rhizosphaera Needle Cast
disease Seiridium Canker
disease Sooty Mold

Sweetgum

pest Ambrosia Beetle
pest Aphid
pest Armored Scale
pest Bagworm
pest Fall Webworm
pest Forest Tent Caterpillar
pest Gypsy Moth
pest Lace Bug
pest Leafhopper
pest Soft Scale

Sweetgum, continued

pest	Twig Girdler/Pruner
disease	Armillaria Root Rot
disease	Bacterial Leaf Scorch
disease	Bacterial Wetwood/Slime Flux
disease	Leaf Spot
disease	Nectria Canker
disease	Phytophthora Root Rot
disease	Sooty Mold

Sycamore

pest	Aphid
pest	Armored Scale
pest	Asian Longhorned Beetle
pest	Bagworm
pest	Fall Webworm
pest	Flatheaded Appletree Borer
pest	Japanese Beetle
pest	Lace Bug
pest	Leafhopper
pest	Soft Scale
disease	Anthracnose
disease	Armillaria Root Rot
disease	Bacterial Leaf Scorch
disease	Bacterial Wetwood/Slime Flux
disease	Leaf Spot
disease	Phytophthora Root Rot
disease	Powdery Mildew
disease	Sooty Mold

Tuliptree/Yellow-poplar

pest	Ambrosia Beetle
pest	Aphid
pest	Asian Longhorned Beetle
pest	Bagworm
pest	Fall Webworm
pest	Soft Scale
pest	Spotted Lanternfly
pest	Twig Girdler/Pruner
pest	Yellow-poplar Weevil
disease	Leaf Spot
disease	Nectria Canker
disease	Phytophthora Root Rot
disease	Powdery Mildew
disease	Sooty Mold
disease	Verticillium Wilt

Viburnum

pest	Aphid
pest	Armored Scale
pest	Mealybug
pest	Spider Mite
disease	Armillaria Root Rot
disease	Downy Mildew
disease	Leaf Spot
disease	Phytophthora Root Rot
disease	Powdery Mildew
disease	Sooty Mold
disease	Verticillium Wilt

Willow

pest	Ambrosia Beetle
pest	Aphid
pest	Armored Scale
pest	Asian Longhorned Beetle
pest	Carpenterworm
pest	Dogwood Borer
pest	Eastern Tent Caterpillar
pest	Fall Webworm
pest	Flatheaded Appletree Borer
pest	Gypsy Moth
pest	Japanese Beetle
pest	Lace Bug
pest	Leafhopper
pest	Spider Mite
pest	Spotted Lanternfly
disease	Armillaria Root Rot
disease	Bacterial Leaf Scorch
disease	Bacterial Wetwood/Slime Flux
disease	Leaf Spot
disease	Nectria Canker
disease	Powdery Mildew
disease	Sooty Mold

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