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A GUIDE TO

Pests, Problems, and Identification of Ornamental Shrubs and Trees in Montana

MONTANA STATE UNIVERSITY | EXTENSION
USDA National Institute of Food and Agriculture
U.S. DEPARTMENT OF AGRICULTURE

PURPOSE OF THE GUIDE

This guide is designed as a resource for identifying and managing common pests and problems that may affect trees and shrubs in Montana residential areas. It also provides information to identify our most frequently planted trees and shrubs. Using this guide, practitioners will be able to identify common pests and problems of these plants and to implement management strategies based on integrated pest management (IPM) principles.

Integrated pest management is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices to manage pest damage by the most economical means and with the least possible hazard to people, property, and the environment. Important steps in an IPM program to manage woody plant pests include: pest identification; monitoring and assessing pest numbers and damage; setting guidelines for when pest management is required; preventing pests; using a combination of control methods including cultural, biological, mechanical or physical, and chemical; and assessing the effectiveness of pest management.

This guide is not meant to be an all-inclusive reference to pests and problems of woody plants. Instead, commonly encountered pests and disorders found on widely planted trees and shrubs are described. More comprehensive guides to plant, insect, and disease identification and management can be found under “Additional Resources” at the end of the guide.

HOW TO USE THE GUIDE

The first step in identifying a problem with a tree or shrub is to identify the plant. Insects and diseases are often associated with specific hosts, so knowing the host will help to narrow down the list of potential problems. Identifying characteristics of common trees and shrubs in Montana can be found on pages seven to 62. Once the host tree or shrub is determined, common insects and diseases grouped by host plant can be found on pages 63 to 68.

Observe the symptoms on your tree or shrub. Which part is showing symptoms of concern? What do the symptoms looks like? Find the common insect and disease issues for your host plant on pages 69 to 190 of this guide. If you find a pest that matches the symptoms you observe, read about the pest in detail as well as management options.

Although insects and diseases are typically blamed for plant issues, most problems with ornamental plants are abiotic (non-living) issues, such as over-watering or nutrient deficiencies. Descriptions of the most common abiotic disorders associated with Montana trees and shrubs are found on pages 191 to 218 of this guide.

If you need further assistance with identifying or managing pests on ornamental trees and shrubs, contact your local Extension office or other trusted resource.

CHEMICAL AND PESTICIDE USE DISCLAIMERS

Common chemical and trade names are used in this publication for clarity of the reader. Inclusion of a common chemical or trade name does not imply endorsement of that particular product or brand of herbicide and exclusion does not imply non-approval.

Pesticide usage suggestions provided in MSU Extension materials are intended to serve only as a guide and are published for educational purposes. If any suggestions conflict with a product label, follow the product label instructions. Read and follow all product labels carefully.

ACKNOWLEDGEMENTS

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PLANT ID

Apple/Crabapple

Malus species

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Oval, round, or pyramidal to vase-shaped; 15 to 20 feet

LEAVES Simple; alternate; two to three inches long; serrated margins; glossy green on upper leaf, downy below

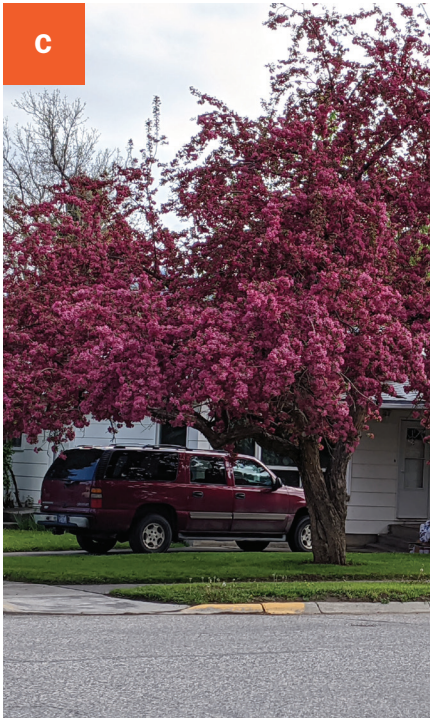
FLOWER Five petals; white, pink and/or red; fragrant; flowers may be single, double, or semi-double

FRUIT/SEED/CONE Crabapple diameter is two inches or less; apple diameter is larger than two inches; non-fruiting and persistent fruit cultivars available

BARK Smooth when young, thin and flaking in maturity


A


B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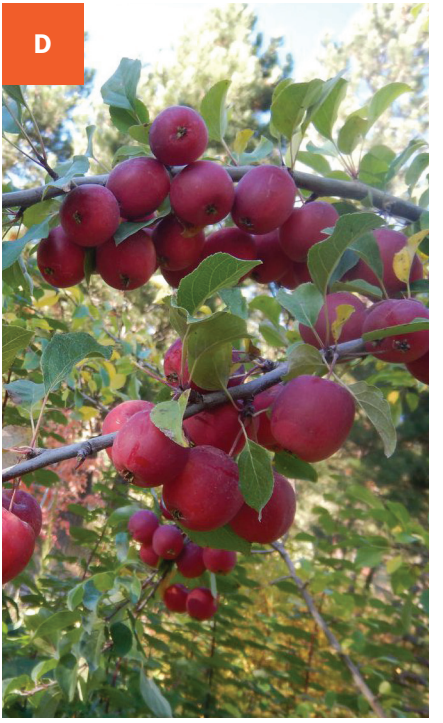

D

Arborvitae

Thuja species

CLASSIFICATION Evergreen conifer

HABIT/SIZE Pyramidal to rounded; upright branching habit; shrub to large tree, under three feet to greater than 40 feet

LEAVES Scale-like; opposite; overlapping and appressed

FRUIT/SEED/CONE Small cone; ovate to oblong; mature cone yellow to light brown

BARK Fibrous with shallow fissures, scales; reddish-brown to grey


A


B


C

Birch

Betula species

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Oval to pyramidal; medium tree; 40 feet tall

LEAVES Simple; alternate; usually ovate and sometimes lobed; toothed margins; medium green to dark green

FLOWER Monoecious; male catkins are long and cylindrical at the end of branches; female catkins stand upright on limbs

FRUIT/SEED/CONE Cone-like clusters

BARK Reddish-brown in immaturity turning white to shades of grey in maturity; often peeling


A


B


C


D

Boxelder

Acer negundo

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Large tree 30 to 50 feet tall

LEAVES Pinnately compound with three to five (sometimes seven) long and pointed leaflets; opposite; six to eight inches long; irregularly toothed; resemble green ash

FLOWER Dioecious with male and female flowers occurring on separate trees; female flowers are yellowish to greenish pendulous clusters (racemes)

FRUIT/SEED/CONE Fruits only on female trees; pairs of winged seeds (samaras) hanging in clusters; persistent into winter

BARK Brown with surface ridges in maturity; younger branches have waxy layer


A


B


C

Callery Pear/Bradford Pear

Pyrus calleryana

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Upright-branched tree; pyramidal to columnar in youth but tends to spread with age; 30 to 50 feet tall

LEAVES Simple; alternate; leathery, glossy, and dark green

FLOWER White with five petals; three-quarter-inch wide; appears in early spring in dense corymbs; does not smell good

FRUIT/SEED/CONE Small, one-half-inch diameter; inedible; greenish-yellow

BARK Brown and shiny when young; gray-brown, furrowed in maturity; Callery pears have thorns, while Bradford pears do not


A


B


C


D

Sour Cherry/Pie Cherry/Tart Cherry

Prunus cerasus

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Small to medium tree from 8 to 15 feet tall; shrubby; limbs are slender and tend to sag

LEAVES Simple; alternate; three inches long; elliptic to ovate with leaves ending in pointed tips; serrated margins; glossy dark green

FLOWER White or pink with five petals; grouped in clusters; self-fertile

FRUIT/SEED/CONE Red to dark red drupe with long stalks

BARK Grey-brown or red-brown with lenticels as a young tree; scale-like in maturity


A


B


C

Cotoneaster/Hedge Cotoneaster

Cotoneaster lucidus

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Upright shrub with spreading branches; eight to ten feet tall

LEAVES Simple; alternate; up to one and three-quarter inches; elliptic-ovate to oblong-ovate; shiny green above, hairy underneath

FLOWER Small pink flower clusters

FRUIT/SEED/CONE Round; three-quarter inch diameter; berry-like fruit; persistent

BARK Brown with lenticels; can become peeling with maturity


A


B


C


D

Douglas-Fir

Pseudotsuga menziesii

CLASSIFICATION Evergreen conifer

HABIT/SIZE Pyramidal; open; tiered branches; lower branches drooping; large tree 80 to 150 feet tall

LEAVES Spirally arranged but may appear two-ranked; shiny; two stomatal white bands on underside of needles; one inch long; flattened; blue green to grey green

FRUIT/SEED/CONE Female (seed) cones on the tips of branches; pendulous; tan; three to four inches long with obvious three-pronged bracts protruding between scales

BARK Thick, fissured; reddish-brown in maturity


A


B


C


D

Elm

Ulmus species

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Arching, oval, upright and vase-shaped; large tree 40 or more feet tall

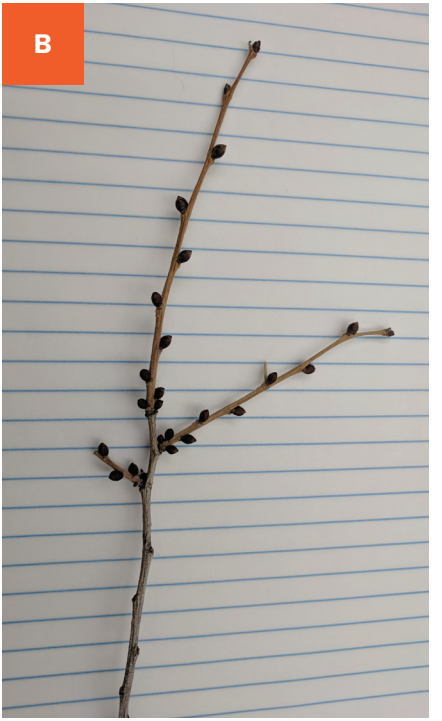
LEAVES Simple; alternate; oval and pointed with asymmetrical bases (at the base of the leaf one side is shorter); doubly-toothed margins; dark green with prominent veins

FLOWER Inconspicuous and lacking petals

FRUIT/SEED/CONE Small, oval, winged fruits (samara) appear on twigs before the leaves

BARK Grayish-brown; deeply furrowed in maturity


A


B


C


D

Fir

Abies species

CLASSIFICATION Evergreen conifer

HABIT/SIZE Pyramid-shaped; narrow crown; medium to large tree, up to 100 feet

LEAVES Flat, soft needles around one inch long; spirally-arranged; most species with two white stomatal bands; grayish-green to light bluish-green

FRUIT/SEED/CONE Female seed cones are upright, barrel shaped and around four inches long; resinous; at the top of the tree. Male (pollen) cones are bluish and found beneath the leaves.

BARK Immature bark is greyish-green with resin blisters. Mature bark is gray to white with resin swellings.


A


B


C


D

Grape

Vitis species

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Woody perennial vine

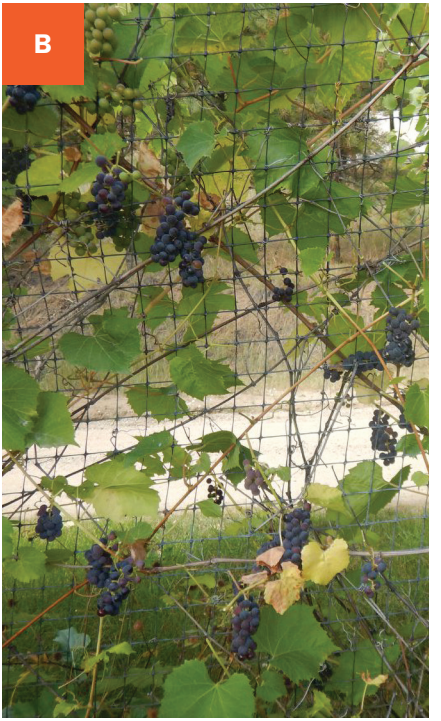
LEAVES Simple; alternate; toothed and lobed

FLOWER Insignificant individually; inflorescences may be large clusters

FRUIT/SEED/CONE Berries occur in clusters; light green or deep red to purplish-black

BARK Flaking or shredding in strips on older stems


A


B


C

Green Ash

Fraxinus pennsylvanica

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Upright, rounded, large tree; 50 to 60 feet tall

LEAVES Compound, usually with five to seven leaflets; opposite; toothed leaf margins; dark green

FLOWER Male and female flowers on separate trees

FRUIT/SEED/CONE Flattened with a paper-like wing; usually in clusters

BARK Gray and furrowed with loose ridges


A


B


C


D

Hackberry

Celtis occidentalis

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Oval to vase-shaped tree; large tree 40 to 60 feet

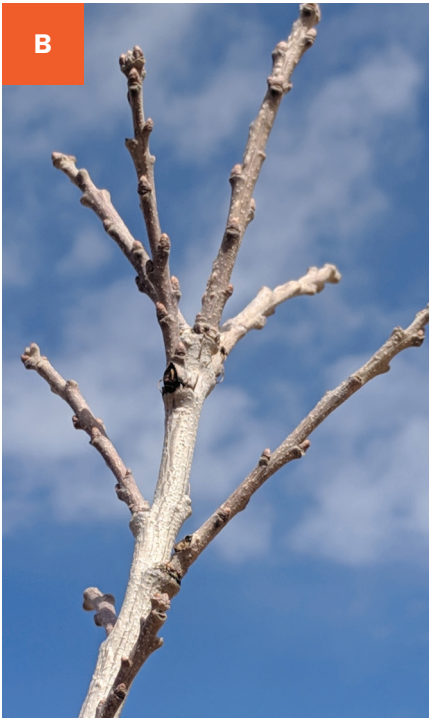
LEAVES Simple; alternate; two to five inches long; ovate; medium green above, lighter underneath

FLOWER Greenish-yellow; inconspicuous

FRUIT/SEED/CONE Berry is a one-third-inch drupe; reddish-purple; can be persistent

BARK Smooth gray bark while young; with corky ridges in maturity


A


B


C


D

Hawthorn

Crataegus species

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Small to medium tree

LEAVES Simple; alternate; usually toothed; may or may not be lobed; glossy green

FLOWER White to pink flowers with five petals; usually in clusters at top of branches

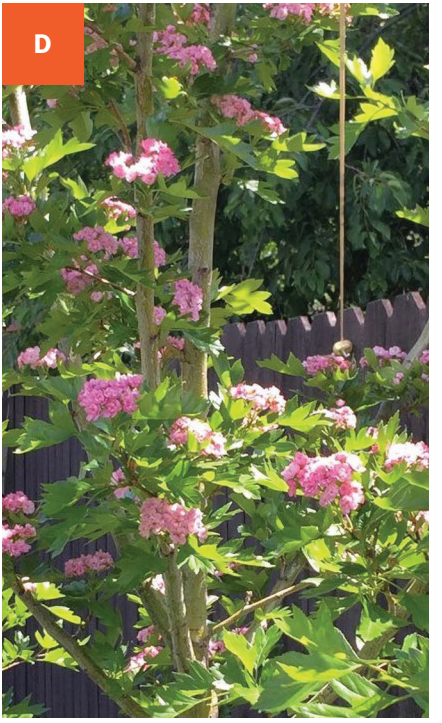
FRUIT/SEED/CONE Persistent red or yellow pome (fruit)

BARK Shaggy, rough texture with maturity


A


B


C


D

Thornless Honeylocust

Gleditsia triacanthos f. inermis

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Large tree up to 70 feet

LEAVES Compound (pinnate or bipinnate) with 20 to 30 oval leaflets; alternate; up to seven inches long

FLOWER Inconspicuous; light yellow-green flowers in spikes in spring

FRUIT/SEED/CONE Flat, red-brown, curling pods around eight inches long can be persistent; some cultivars are nonfruiting

BARK Gray, flat plates that lift at edges


A


B


C

Buckeye and Horsechestnut

Aesculus species

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Upright and oval; large tree 50 to 75 feet tall and 40 to 65 feet wide

LEAVES Palmately compound with five to seven long and pointed leaflets; opposite; three to six inches long; doubly-serrate margins; dark green

FLOWER Upright terminal flower clusters/panicles appear in late spring

FRUIT/SEED/CONE Shiny, dark brown seeds inside a bristly husk

BARK Becomes gray with maturity


A


B


C


D

Juniper

Juniperus species

CLASSIFICATION Evergreen conifer

HABIT/SIZE Small ground cover shrub to tree

LEAVES Opposite or in whorls around the stem; scale-like; blueish-green

FRUIT/SEED/CONE Female seed cone is a purple-black, berry-like cone with a bloomy, blue, waxy coating. Plants are dioecious, with male and female cones on separate plants.

BARK Scaly, thin, shreddy; brown to reddish-brown; peeling off in strips


A


B


C

Lilac

Syringa species

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Multi-stem shrub to small tree

LEAVES Simple; opposite; heart-shaped at the base with a pointed tip

FLOWER Purple to white in large clusters; fragrant; large conical to narrow-pyramid-shaped panicles; single or double flowers

FRUIT/SEED/CONE Brown, flattened seed capsules which persist into winter

BARK Younger stems are lustrous brownish-gray with small raised lenticels. Older stems are gray with smooth bark and prominent horizontal lenticels.


A


B


C

Linden

Tilia species

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Large to medium tree with a pyramid shape

LEAVES Simple; alternate; four to eight inches long; heart-shaped with oblique base; margin coarsely-toothed; dark green above and lighter green on the underside

FLOWER Five-petaled yellow flowers in pendulous clusters (cymes); fragrant

FRUIT/SEED/CONE Dry nutlets with a long, strap-like bract

BARK Gray; ridged and furrowed


A


B


C


D

Maple

Acer species

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Small shrub to large tree

LEAVES Simple; opposite; palmately-lobed

FLOWER Yellow or greenish-yellow flowers; in pendulous clusters; appear in early spring before leaves open

FRUIT/SEED/CONE Winged samaras in pairs

BARK Gray-brown and smooth on young trunks; older trunks furrowed with long, irregular plates


A


B


C


D

European Mountain Ash

Sorbus aucuparia

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Small to medium tree from 20 to 30 feet

LEAVES Pinnately compound with nine to fifteen leaflets per leaf; alternate; six to eight inches long; slightly serrated leaf margins

FLOWER White, five-petaled flowers in flat-topped clusters

FRUIT/SEED/CONE Small bright red to orange or yellow pome (fruit); clusters

BARK Smooth gray to coppery-brown bark with prominent lenticels; rougher bark on mature trees


A


B


C


D

Bur Oak

Quercus macrocarpa

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Irregular, round shape; large tree 70 to 80 feet tall

LEAVES Simple; alternate; four to eight inches long; five to seven rounded lobes; glossy, dark green above and pale green below

FLOWER Small spikes for female, drooping catkins for male

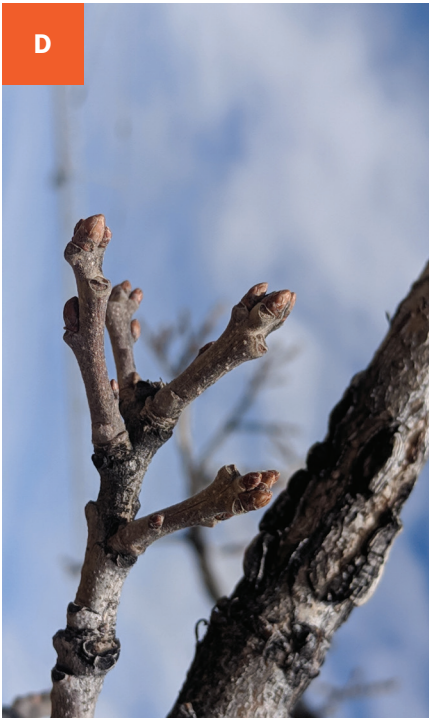
FRUIT/SEED/CONE Large, two-inch diameter, fringed acorns

BARK Dark gray to gray-brown; becoming deeply ridged and furrowed when mature


A


B


C


D

Pine

Pinus species

CLASSIFICATION Evergreen conifer

HABIT/SIZE Small shrub to large tree

LEAVES Borne in clusters of two, three, or five; persist for two or more years; sharply pointed

FRUIT/SEED/CONE Cones are variable in size and shape and may be persistent on the tree for several years. Separate male and female cones are on the same tree.

BARK Majority have thick, scaly bark, but can be thin and flaky, reddish-brown to gray in color


A


B


C


D

Quaking Aspen/Poplar/ Cottonwood

Populus species

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Medium to large tree

LEAVES Simple; alternate; finely-toothed margins; size, color, and shape variable

FLOWER Dioecious. Male and female flowers are dangling catkins that appear before the leaves.

FRUIT/SEED/CONE Fruit is a drooping cluster of capsules containing many seeds

BARK Grayish-white and furrowed in maturity


A


B


C


D

Colorado Blue Spruce

Picea pungens

CLASSIFICATION Evergreen conifer

HABIT/SIZE Conical or pyramid-shaped with stiff horizontal branches; large tree 50 to 150 feet tall

LEAVES One to two inches long; four-sided and flat with a sharp pointed tip; prickly; stomatal white lines on each side. A peg-like stalk supports each needle. Green to blue-green due to wax

FRUIT/SEED/CONE Cylindrical cones two to five inches long; light brown with thin papery scales; usually found near top of tree; seeds are dark brown and three-quarters of an inch long

BARK Grey with large scales


A


B


C


D

Virginia Creeper

Parthenocissus quinquefolia

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Woody vine; 30 to 50 feet long or more

LEAVES Palmately compound with five leaflets; alternate; dark green

FLOWER Small; yellow-green with five petals

FRUIT/SEED/CONE Blue-black berries are round and five to eight millimeters wide

BARK Rough and gray-brown with concave leaf scars; becomes woodier with age


A
B
C
D

White Willow/Golden Willow

Salix alba

CLASSIFICATION Deciduous broadleaf

HABIT/SIZE Arching, upright, large tree from 75 to 100 feet

LEAVES Simple; alternate; up to four inches long; lanceolate; toothed margin; bright green to dark green

FLOWER Male and female flowers appear as catkins on separate trees.

FRUIT/SEED/CONE Seeds are within a two-valved capsule

BARK Yellow to golden twigs and young branches; brown to yellow-brown bark is deeply furrowed in maturity


A


B


C


D

PESTS LISTED BY HOST

APPLE/CRABAPPLE (*Malus*)

Aphids
Apple Scab
Blister Mites
Cedar-Apple Rust
Cedar-Hawthorn Rust
Codling Moth
Cytospora Canker
Fire Blight
Forest Tent Caterpillars
Nectria Canker
Oystershell Scale
Pear Sawfly or Pearslug
Powdery Mildew
Two-Spotted Spider Mite

ARBORVITAE (*Thuja*)

Aphids
Phomopsis Tip Blight
Spruce Spider Mite

ASH (*Fraxinus*)

Anthracnose
Aphids
Ash Bark Beetles
Ash Flower Gall Mite
Ash Plant Bug
Cytospora Canker
Eriophyid Mites
Forest Tent Caterpillars
Leafcurl Ash Aphid
Oystershell Scale
Powdery Mildew
Two-Spotted Spider Mite

BIRCH (*Betula*)

Aphids
Bronze Birch Borer
Cytospora Canker
Two-Spotted Spider Mite

BOXELDER (*Acer*)

Cottony Maple Scale
Bacterial Wetwood
Eriophyid Mites
Powdery Mildew

BUR OAK (*Quercus*)

Anthracnose
Oak Leaf Blister
Powdery Mildew
Rough Bulletgall Wasp

CHERRY/PLUM (*Prunus*)

Aphids
Black Knot
Coryneum Blight (Shot Hole Disease)
Cytospora Canker
Eriophyid Mites
Forest Tent Caterpillars
Pear Sawfly or Pearslug

COTONEASTER (*Cotoneaster*)

Aphids
Fire Blight
Nectria Canker
Oystershell Scale
Pear Sawfly or Pearslug

DOUGLAS-FIR (*Pseudotsuga*)

Cooley Spruce Gall Adelgid
Cytospora Canker
Douglas-Fir Tussock Moth
Engraver Beetles
Giant Conifer Aphids
Mountain Pine Beetle
Pine Needle Scale
Rhabdocline Needle Cast
Rhizosphaera Needle Cast
Spruce Bud Scale
Spruce Spider Mite
Swiss Needle Cast
Western Spruce Budworm

ELM (*Ulmus*)

Aphids
Bacterial Wetwood/Slime Flux
Cytospora Canker
Dutch Elm Disease
Eriophyid Mites
European Elm Scale

FIR (*Abies*)

Cooley Spruce Gall Adelgid
Cytospora Canker
Douglas-fir Tussock Moth
Engraver Beetles
Giant Conifer Aphids
Mountain Pine Beetle
Pine Needle Scale
Rhizosphaera Needle Cast
Spruce Spider Mite
Spruce Bud Scale
Western Spruce Budworm

GRAPE (*Vitis*)

Aphids
Leafhoppers
Powdery Mildew
Root Weevils

HACKBERRY (*Celtis*)

Aphids
Cottony Maple Scale
Eriophyid Mites

HAWTHORN (*Crataegus*)

Aphids
Cedar-Hawthorn Rust
Fire Blight

HONEYLOCUST (*Gleditisia*)

Bacterial Wetwood/Slime-flux
Cottony Maple Scale
Cytospora Canker
Eriophyid Mites
Nectria Canker

JUNIPER (*Juniperus*)

Cedar-Apple Rust
Cedar-Hawthorn Rust
Giant Conifer Aphids
Kabatina Tip Blight
Phomopsis Tip Blight
Spruce Spider Mite

LILAC (*Syringa*)

Bacterial Blight of Lilac
Eriophyid Mites
Oystershell Scale
Powdery Mildew
Root Weevils

LINDEN (*Tilia*)

Aphids
Bacterial Wetwood/Slime-flux
Cottony Maple Scale
Cytospora Canker
Nectria Canker

MAPLE (*Acer*)

Anthracnose
Aphids
Bacterial Wetwood/Slime-flux
Cottony Maple Scale
Cytospora Canker
Eriophyid Mites
Leafhoppers
Nectria canker

MOUNTAIN-ASH (*Sorbus*)

Aphids
Cytospora Canker
Eriophyid Mites
Fire Blight
Nectria Canker

PEAR (*Pyrus*)

Aphids
Blister Mites
Cedar-Hawthorn Rust
Codling Moth
Cytospora Canker
Eriophyid Mites
Fire Blight
Forest Tent Caterpillars
Nectria Canker
Oystershell Scale
Pear Sawfly or Pearslug
Two-Spotted Spider Mite

PINE (*Pinus*)

Diplodia Tip Blight
Dothistroma Needle Blight
Giant Conifer Aphids
Engraver Beetles
Eriophyid Mites
Mountain Pine Beetle
Pine Needle Scale
Rhizosphaera Needle Cast
Spruce Spider Mite
Western Gall Rust
White Pine Weevil

POPLAR/ASPEN/COTTONWOOD (*Populus*)

Aphids
Aspen Blotch Leafminer
Bacterial Wetwood/Slime-flux
Crown Gall
Cytospora Canker
Eriophyid Mites
Forest Tent Caterpillars
Marssonina Leaf Spot
Oystershell Scale
Poplar Borer
Powdery Mildew
Venturia Leaf and Shoot Blight

SPRUCE (*Picea*)

Cooley Spruce Gall Adelgid
Cytospora Canker
Douglas-Fir Tussock Moth
Engraver Beetles
Eriophyid Mites
Giant Conifer Aphids
Mountain Pine Beetle
Pine Needle Scale
Rhizosphaera Needle Cast
Sudden Needle Drop
Spruce Bud Scale
Spruce Spider Mite
Stigmina Needle Cast
Western Spruce Budworm
White Pine Weevil

VIRGINIA CREEPER (*Parthenocissus*)

Aphids
Leafhoppers
Root Weevils
Powdery Mildew

WILLOW (*Salix*)

Aphids
Black Canker of Willow
Cytospora Canker
Eriophyid Mites
Forest Tent Caterpillars
Marssonina Leaf Spot
Oystershell Scale
Two-Spotted Spider Mites
Willow Redgall Sawfly

DISEASES

Anthracnose

Colletotrichum gloeosporioides, Discula fraxinea and other host-specific fungi (fungus)

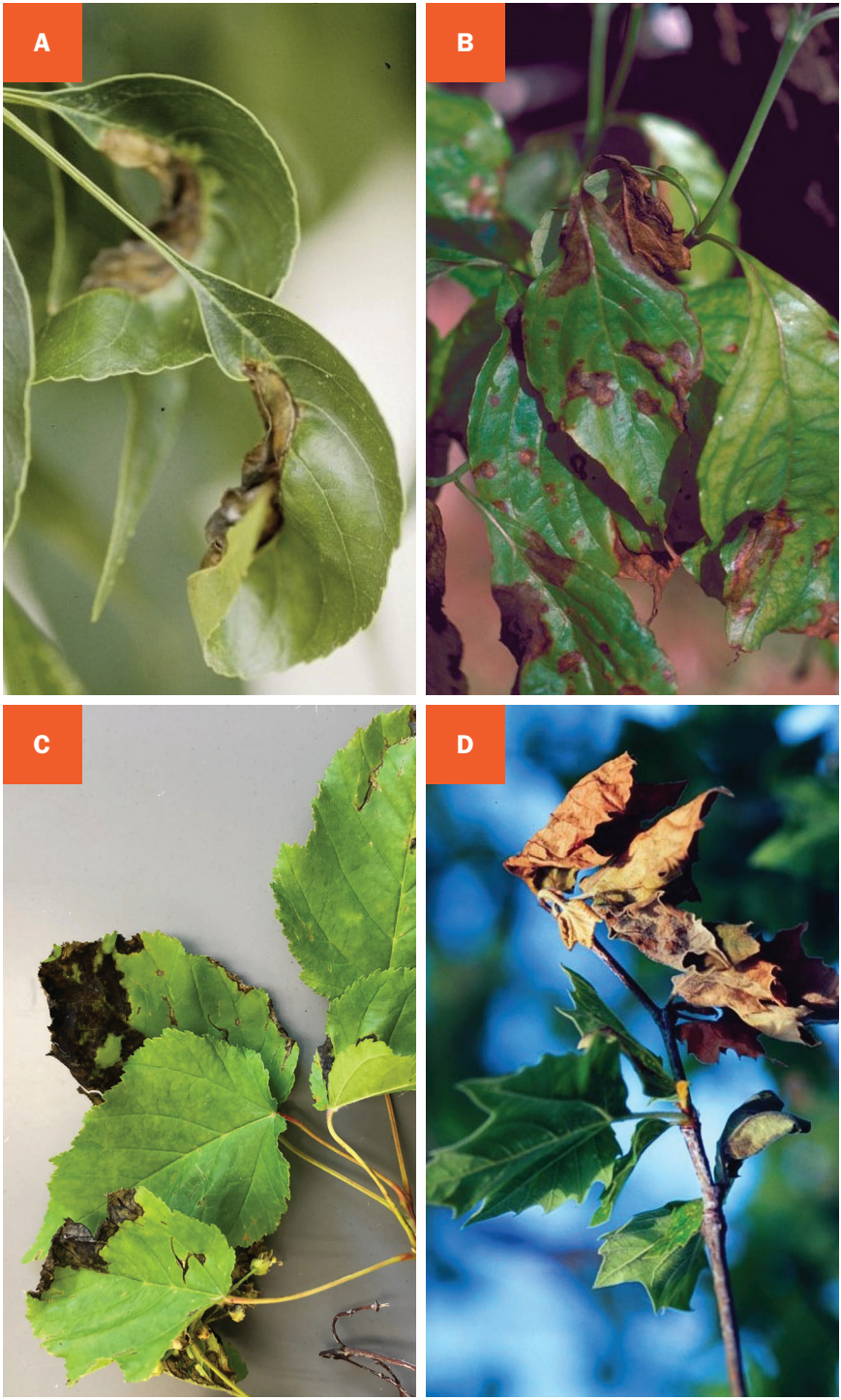
HOST Many shade trees including ash, maple, oak, elm

DAMAGE/SYMPTOMS Anthracnose is a foliar disease caused by numerous plant pathogenic fungi. In spring, tan to brown blotches appear on new leaves along leaf veins. The blotches enlarge and often cause distortion of the leaves. Young, infected leaves may drop in late spring. Leaves on lower branches are most often affected. Cankers may develop on branches and young shoots may die back. Infection is most severe under cool, wet conditions.

DISEASE CYCLE The fungus overwinters in infected leaf debris on the ground or in cankers on branches. In spring, spores are produced on the old leaf debris and canker tissues. The spores are dispersed by wind and rain and infect newly emerging leaves. New spores are produced on the newly infected leaves, which then infect new growth as long as the temperatures stay low and sufficient moisture is available.

MANAGEMENT Anthracnose infection does not result in tree death and trees usually push out new leaves by summer. Rake up fallen leaves and prune out infected twigs and branches. Disinfect pruning tools after each cut with 70% ethyl alcohol or a standard household disinfectant spray. Chemical treatments are generally not recommended unless the disease is a continuing problem. High value trees can be protected by applying chlorothalonil- or copper-containing fungicides in early spring when buds first start to open. One to two additional sprays should be applied in 10- to 14-day intervals, strictly following instructions on the pesticide labels.

A One-sided distortion of leaves. **B** Brown necrotic areas on leaves. **C** Necrotic areas on leaves increase in size. **D** Shoot dieback caused by anthracnose infection.


A
B
C
D

Apple Scab

Venturia inaequalis (fungus)

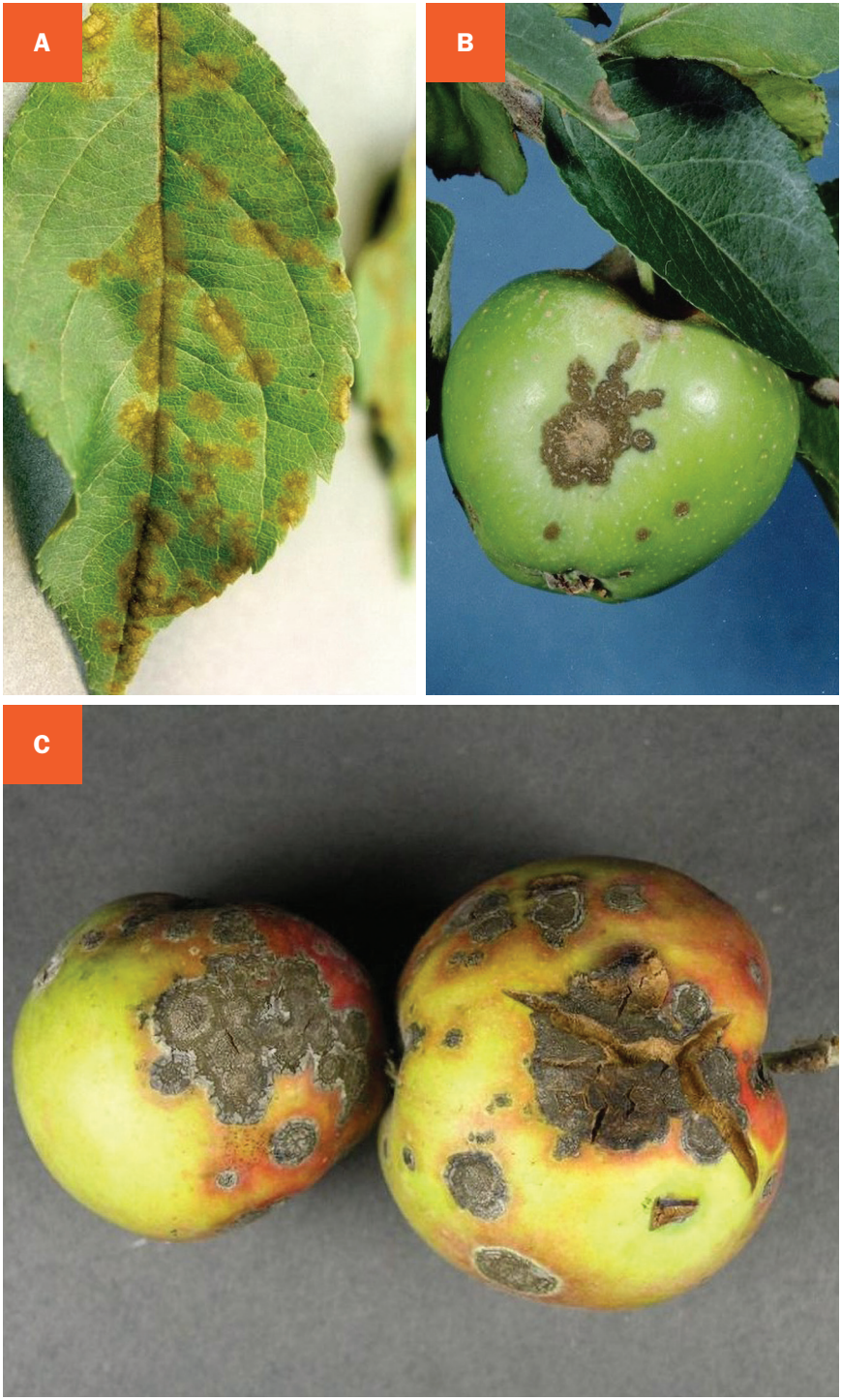
HOST Apple and crabapple trees

DAMAGE/SYMPTOMS Round, olive-green leaf spots with fringed borders appear on leaves in late spring. Spots on fruits can also appear. Leaf spots turn brown to black with age. Affected leaves turn yellow and may drop mid-summer. Infected fruits develop corky tissue and may become deformed and cracked.

DISEASE CYCLE The apple scab fungus overwinters in infected leaf debris on the ground. In spring, spores are produced on the leaf debris and dispersed by wind and rain and infect new leaves. Infection is most severe under wet conditions. Secondary infections occur throughout the growing season when spores are produced on the newly developed leaf spots which infect adjacent leaves. The secondary infections are more severe under warm and moist conditions.

MANAGEMENT Plant apple scab-resistant cultivars whenever possible. The key to controlling apple scab is to prevent the primary infection in spring. Remove fallen, infected leaves to reduce the level of inoculum. Avoid wetting the foliage for prolonged times during the growing season. Prune trees to optimize air circulation. Fruit trees can be treated with fungicides in seven- to ten-day intervals starting from green tip stage until flower petal fall. Products with the active ingredients chlorothalonil, copper, or lime-sulfur are effective in controlling this disease. Strictly follow instructions on the pesticide labels.

A Apple scab lesions on apple leaf. **B** Apple scab lesions on apple fruit.
C Apple scab lesions and cracks expanding on apple fruits.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Bacterial Blight of Lilac

Pseudomonas syringae pv. *syringae* (bacterium)

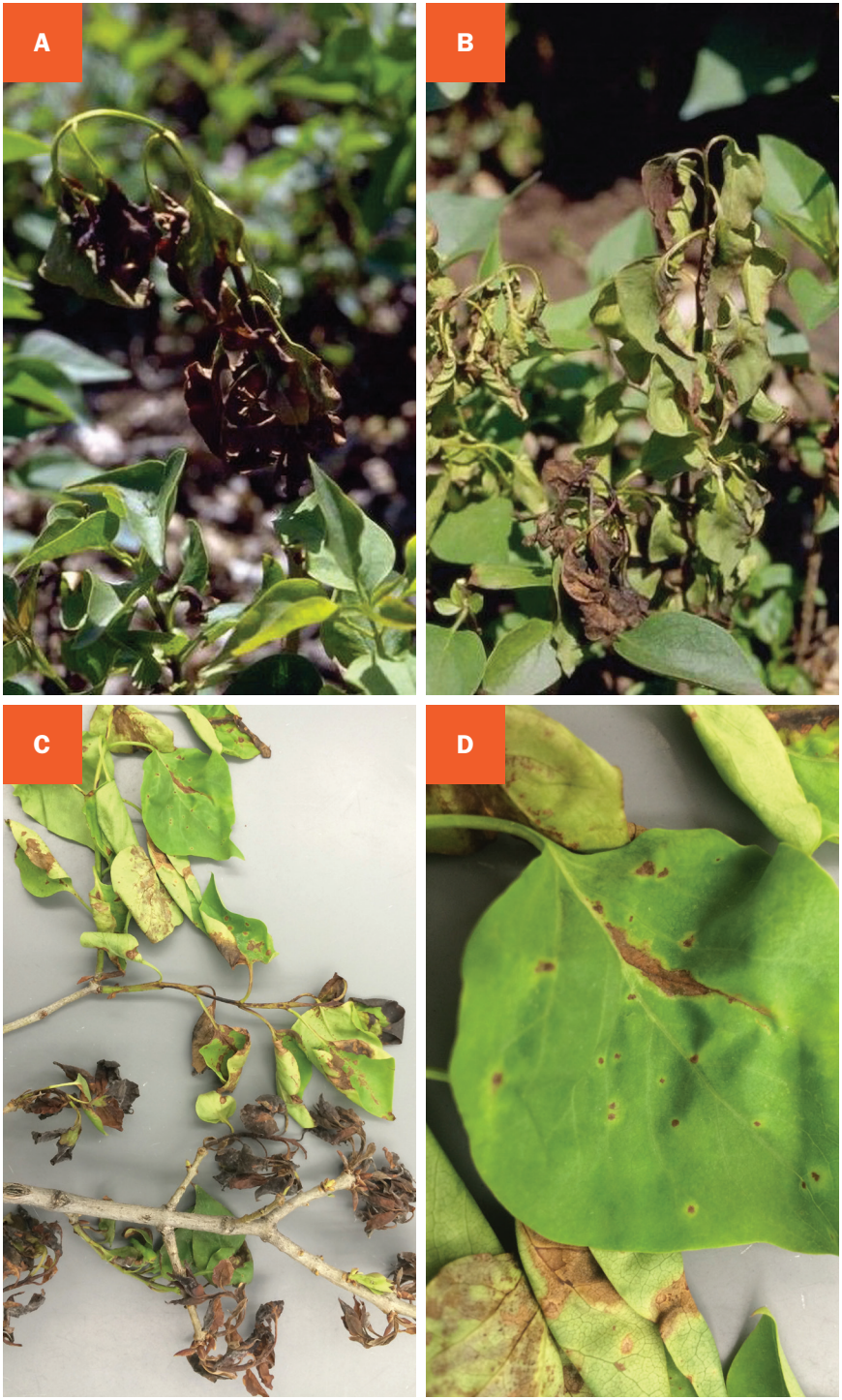
HOST All lilac shrubs and trees

DAMAGE/SYMPTOMS In spring, small, water-soaked lesions appear on the leaves. Lesions may expand and coalesce into larger brown areas. Affected young shoots are quickly girdled, and show wilting and blackening of stems, leaves, and/or flower clusters. Dark streaks may be visible on affected shoots.

DISEASE CYCLE The bacterium can overwinter in infected twigs and cankers on the plant, in dead plant debris, on neighboring plants, or in the soil surrounding the plant. In the spring, the bacterium can then be spread to susceptible plants by splashing water, insect vectors, or pruning tools. *Pseudomonas* spp. infect through open wounds in the plant.

MANAGEMENT Focus on supporting plant vigor by providing adequate water and nutrients during the growing season. Prune out and discard infected branches and leaves. Make the pruning cut 10 to 12 inches below the visible symptoms of disease and sterilize your tools between cuts with 70% ethyl alcohol or a standard household disinfectant spray. Avoid hitting the foliage during sprinkler irrigation to minimize possible spread of the bacteria. Consider healthy pruning to increase air flow and light penetration. Chemical control is not recommended in the urban setting.

A Shoot dieback following bacterial infection. **B** Multiple young shoots affected by bacterial blight. **C** Dark brown leaf spots with light green margins and dieback of branches due to bacterial blight infection. **D** Dark brown leaf spots with light green margins.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Bacterial Wetwood or Slime-flux

Several species of bacteria including *Enterobacter, Klebsiella,* and *Pseudomonas*

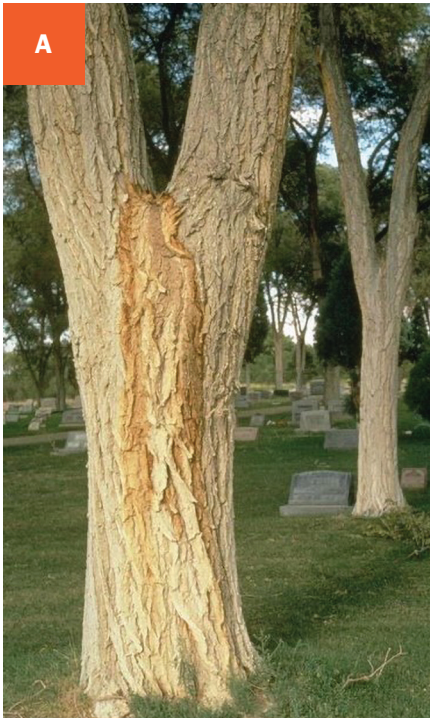
HOST Aspen, cottonwood, elm, boxelder, maple, oak, linden, cherry, honeylocust, fir, poplar

DAMAGE/SYMPTOMS Bacterial wetwood often develops in the roots or the lower part of the trunk but may also affect branches. Affected trees may show discolored and water-soaked areas of the heartwood down the trunk, just below the area of infection. Infected wood may appear yellow, olive-green, or dark brown in color. The emitted sap may have a reddish or brown color and a foul odor. After drying up, the sap appears yellow, brown, or gray. Infections usually do not kill the tree but may inhibit wound healing.

DISEASE CYCLE Wetwood-causing bacteria live naturally in soil and water and infect trees through wounds. After initial infection, bacteria grow within their host, using the plant sap as a nutrient source and emitting gasses which are produced during fermentation processes. The build-up of gas pressure is released by discharging liquid through a branch crotch, pruning cut, or wound. The liquid is a mixture of the wetwood bacteria, yeast, and water.

MANAGEMENT No preventive treatments are available. The best management practice is to support plant health by providing adequate water and nutrients during the growing season and avoiding any wounding of plants. Branches affected by bacterial wetwood can be pruned out. Disinfect pruning tools between cuts with 70% ethyl alcohol or a standard household disinfectant spray.

A Bacterial wetwood on the main trunk. **B** Multicolored bacterial wetwood on main trunk. **C** Sap oozing out of an area of active wetwood.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Black Canker of Willow

Glomerella miyabeana (fungus)

HOST Willow

DAMAGE/SYMPTOMS Brown, irregular leaf spots appear on leaves in late spring and early summer. The fungus grows rapidly from the leaf blade through the petiole into the twig. Infected leaves may wither and die. Cankers develop on infected twigs and may girdle the twigs from within, resulting in dieback. Twigs may appear wilted with drooped or crooked tips.

DISEASE CYCLE The fungus overwinters in infected twigs. In spring, spores and/or conidia are released from the canker tissues and infect new leaves and twigs. The disease is spread by splashing rain and secondary infections may occur during warm and humid weather throughout the growing season.

MANAGEMENT Prune out and dispose of infected branches to reduce disease severity. Disinfect tools with 70% alcohol or a standard household disinfectant spray between cuts. Healthy pruning will also optimize air circulation and shorten periods of wet leaves. Support tree vigor by providing adequate water and nutrients during the growing season. Avoid wetting the foliage for prolonged times. Fungicides are usually not recommended in an urban setting.

A Dieback of branches on willow tree affected by black canker disease. **B** Dark brown cankers develop on willow branches resulting in dieback.


A


B

Black Knot

Apiosporina morbosa (fungus)

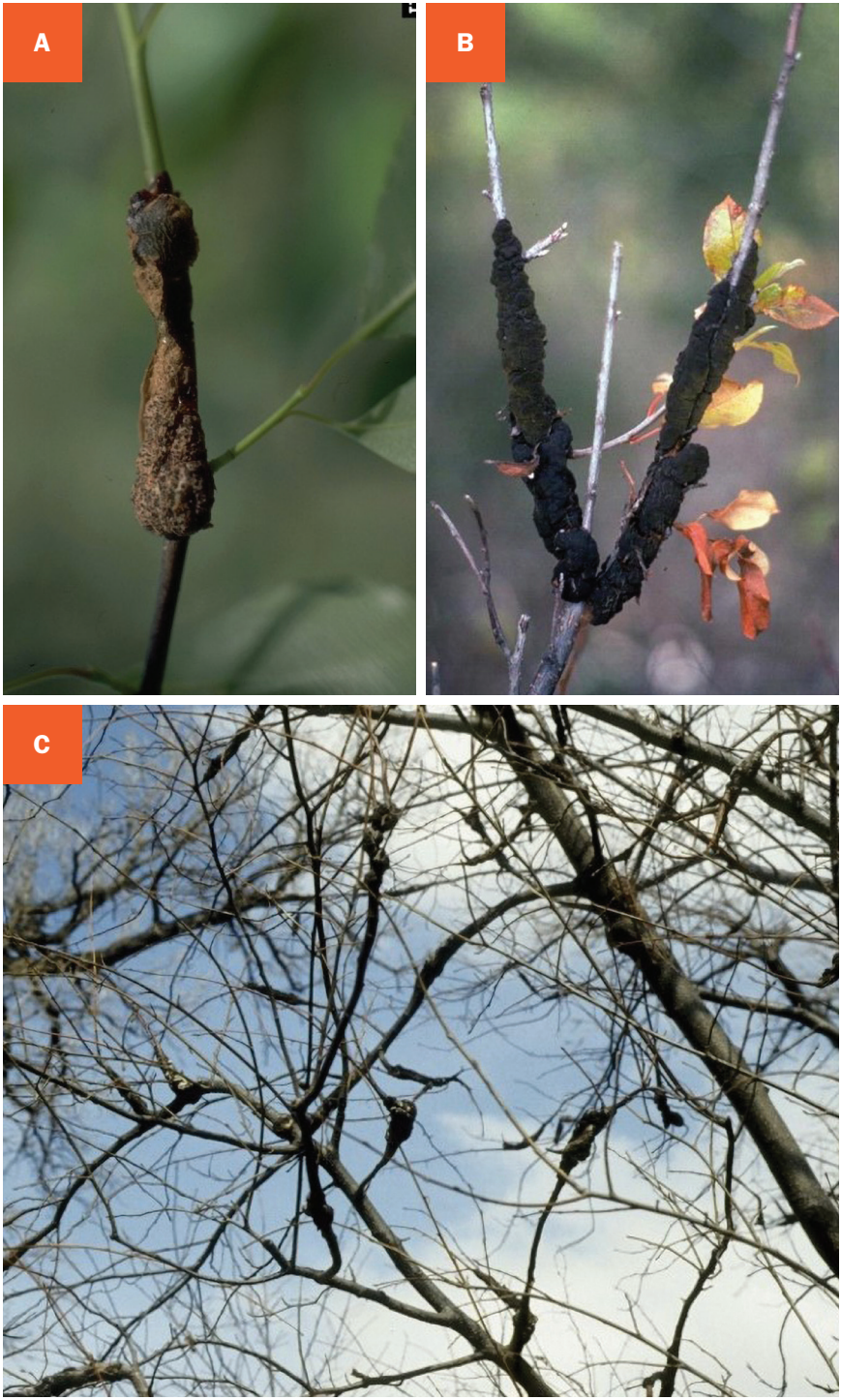
HOST Cherry, chokecherry, plum, and other ornamental *Prunus* species

DAMAGE/SYMPTOMS This fungal disease is characterized by the development of thick, black, gall-like swellings on twigs and branches. The galls can girdle the branches of highly susceptible trees, causing leaf wilt and branch dieback beyond the galls.

DISEASE CYCLE The fungus overwinters in the black, knobby galls. During wet periods in the spring, spores are released and infect young green shoots or wounded branches. New galls develop during the summer and early fall and may be covered in olive-green spores in the following spring. The new galls turn black and hard two years after infection.

MANAGEMENT Black knot can be managed by pruning out existing galls in late winter. Make the pruning cut at least four inches below the infection. Disinfect pruning tools between cuts with 70% ethyl alcohol or a standard household disinfectant spray. Dispose of the galls to reduce inoculum levels. Fungicides can be applied in spring to protect young or highly susceptible trees. Fungicide treatments must be applied when flower buds are beginning to open and may have to be repeated depending on the product used, label instructions, and weather conditions. Fungicides with one of the following active ingredients have shown good control of black knot: chlorothalonil or thiophanate-methyl. Strictly follow instructions on the pesticide labels.

A Black knot gall developing on young shoot. **B** Mature black knot galls causing dieback of branches. **C** Tree with multiple black knot galls.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Cedar-Apple Rust

Gymnosporangium juniperi-virginianae (fungus)

HOST Eastern red cedar, Rocky Mountain juniper, common and prostrate junipers; Alternate hosts: apple, crabapple, occasionally hawthorn

DAMAGE/SYMPTOMS **Juniper/cedar:** Bulbous, brown to reddish-brown galls of various sizes form on evergreen twigs/branches that were infected the previous year. After rainy periods in spring, bright orange to yellow gelatinous tendrils form on the galls. Galls can cause dieback of small twigs. **Apple/crabapple:** Bright orange/yellow spots appear on leaf surfaces in late spring to early summer. The spots enlarge and form finger-like structures on the underside of leaves. Affected leaves may drop during the summer. On fruits, orange/yellow spots can also form. Infection reduces fruit quality and may lead to premature fruit drop.

DISEASE CYCLE In spring, orange-yellow spores are produced on galls of infected juniper plants and dispersed by wind, infecting apple and/or crabapple trees in late spring to early summer. Leaf spots on alternate hosts produce a new set of spores on finger-like structures formed on the undersides of leaves in midsummer. This new set of spores is dispersed by wind and carried to juniper hosts.

MANAGEMENT Ideally the two hosts should be physically separated. Plant resistant varieties whenever possible. Remove galls on junipers in early spring to reduce the inoculum. Disinfect pruning tools between cuts with 70% ethyl alcohol or a standard household disinfectant spray. Consider applying a protectant fungicide (active ingredient myclobutanil, copper, or sulfur) that is labeled for rust. Apply to emerging leaves of ornamental alternate hosts during the time when the galls on the junipers are orange and gelatinous. Multiple applications might be necessary depending on the selected product.

A Cedar-apple rust gall on juniper and bright colored leaf spots on apple leaf. **B** Orange-yellow leaf spots on alternate host. **C** Orange spores developing on galls in spring. **D** Fully developed gelatinous gall on juniper host.


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Cedar-Hawthorn Rust

Gymnosporangium globosum (fungus)

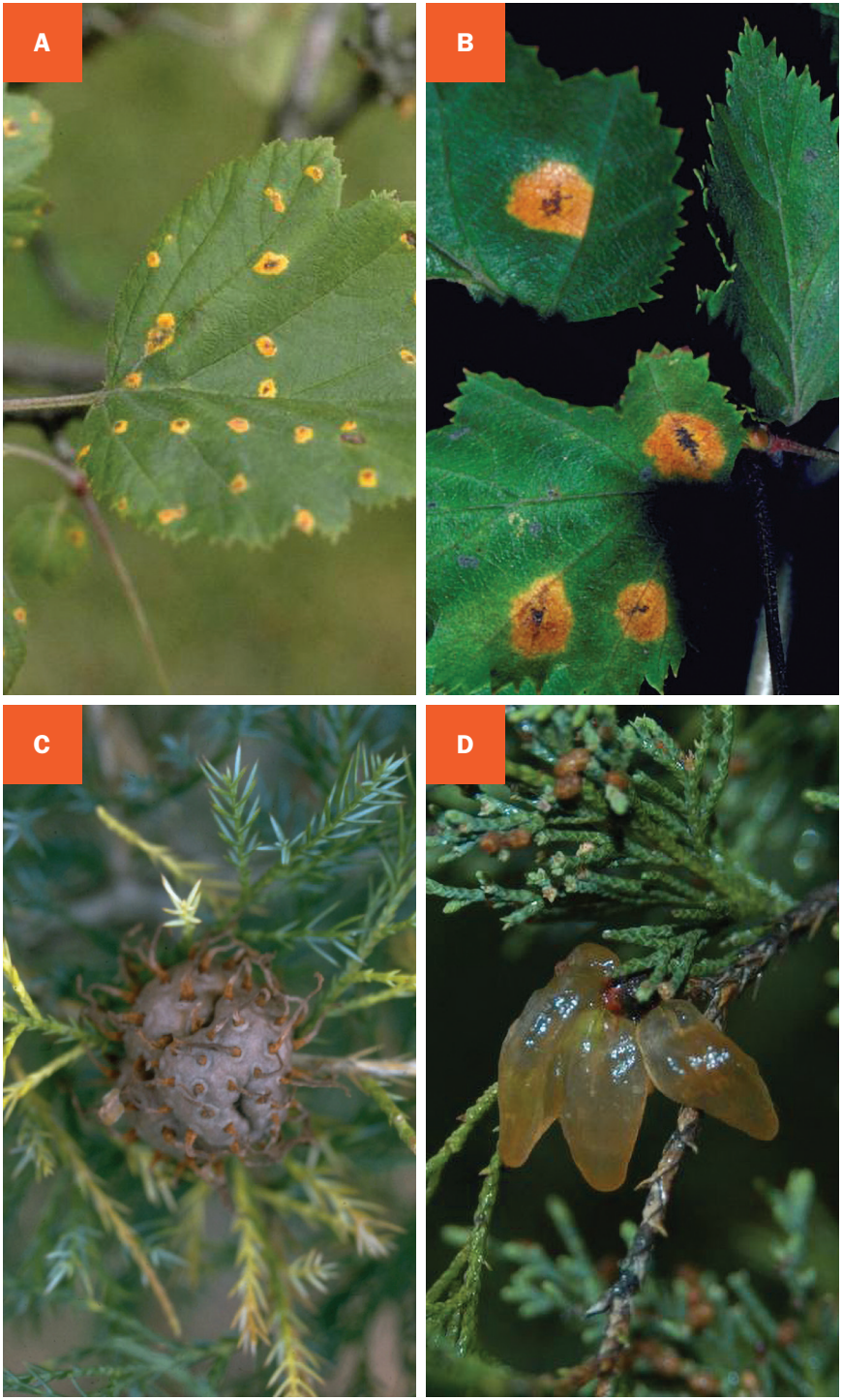
HOST Evergreen hosts: Eastern red cedar, Rocky Mountain juniper, occasionally on creeping and low junipers; Alternate hosts: hawthorn, apple, crabapple; occasionally serviceberry, quince, pear

DAMAGE/SYMPTOMS **Juniper/cedar:** Small, brown to reddish-brown galls form on evergreen twigs/branches that were infected the previous year. After rainy periods in spring, bright orange gelatinous tendrils form on the galls. Galls can cause dieback of small twigs. **Hawthorn/apple/crabapple:** Bright orange/yellow spots appear on leaf surfaces in late spring to early summer. The spots enlarge and form whitish finger-like structures on the underside of leaves. Affected hawthorn leaves turn completely yellow and are dropped prematurely.

DISEASE CYCLE In spring, orange/yellow spores are produced on galls of infected evergreen plants, dispersed by wind and infect hawthorn, apple and/or crabapple trees in late spring to early summer. Leaf spots on alternate hosts produce a new set of spores on finger-like structures formed on the undersides of leaves in midsummer. This new set of spores is dispersed by wind and can infect the evergreen hosts.

MANAGEMENT Plant resistant varieties whenever possible. Remove galls on evergreen plants in early spring to reduce the inoculum. Disinfect pruning tools between cuts with 70% ethyl alcohol or a standard household disinfectant spray. High value plants can be treated with a rust-labeled protectant fungicide containing the active ingredient myclobutanil, copper, or sulfur. Apply to emerging leaves of ornamental alternate hosts during the time when the galls on the junipers are orange and gelatinous. Multiple applications might be necessary depending on the selected product.

A Bright yellow leaf spots on hawthorn. **B** Mature leaf spots with black fungal fruiting structures developing in centers. **C** Mature gall on cedar branch with emerging gelatinous spore structures. **D** Fully developed gelatinous gall on evergreen host.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Crown Gall

Agrobacterium tumefaciens (bacterium)

HOST Affects a wide variety of woody plants; often on poplar

DAMAGE/SYMPTOMS Soft, spherical, white to cream colored galls form at the base of stems/trunks, root crown, or on roots. Young galls can be mistaken as callus tissue. As galls mature, their shape becomes irregular and they turn brown or black. The tissue can be sponge-like or woody. The size of the galls increases with the growth of affected trees. Infected plants may appear stunted and express a lack of vigor due to water stress caused by a diseased root system.

DISEASE CYCLE Crown gall bacteria are common soil inhabitants. They survive free-living in soils with good aeration and on the root surface of weeds. The bacteria enter plants through fresh wounds inflicted by cultural practices like grafting or mowing or by natural causes (wind, hail). They then stimulate the host cells to grow rapidly and irregularly, resulting in formation of galls.

MANAGEMENT There is no cure for crown gall infection. Remove young plants that are infected to minimize spread of the disease. Avoid any type of wounding during cultural practices. Consider raising the soil level above exposed tree roots to avoid spreading infection during mowing practices. Disinfect your tools with 70% ethyl alcohol or a standard household disinfectant spray after being in contact with crown galls.

A Crown gall developing on the main stem close to the base. **B** Young crown gall at the base of a young tree. **C** Mature crown gall in lawn on root of established aspen tree.


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Cytospora Canker

Cytospora spp. (fungus); sexual form: *Valsa* spp. or *Leucostoma* spp.

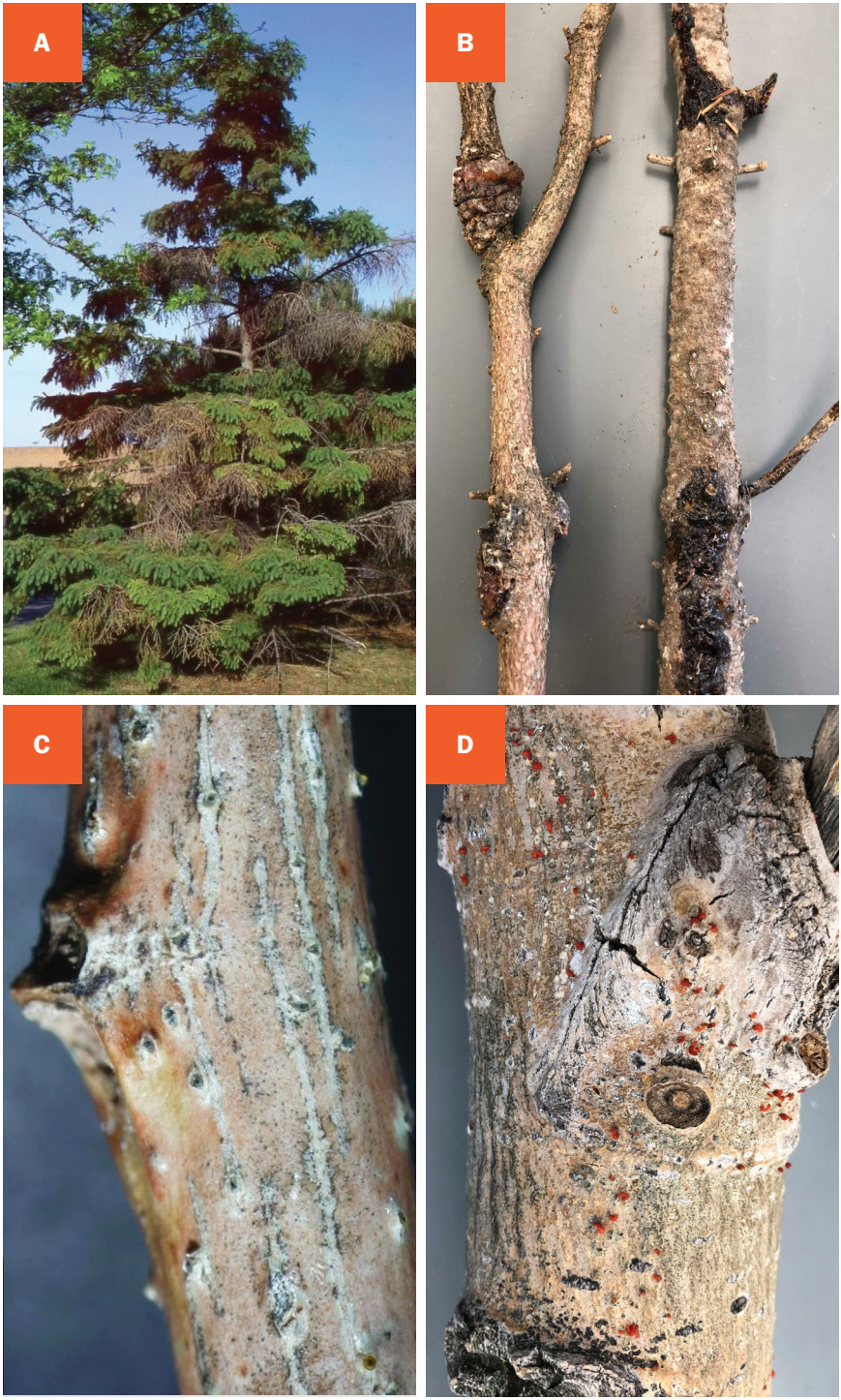
HOST Cottonwood, aspen, ash, spruce, apple, maple, birch

DAMAGE/SYMPTOMS This disease mainly affects stressed trees. **Spruce:** cankers form on infected branches and are often covered in a whitish-bluish resin. The fungus girdles the branches from within, resulting in yellowing or browning of needles and dieback of the branch above the canker. Branches appear to die in an upwardly progressing spiral pattern. **Deciduous trees:** cankers on the branches and/or trunk often are different in color than the rest of the branch. Bark might appear yellowish, brown, reddish-brown, grayish, or black. Small, black, pimple-like fruiting structures may appear on the cankers. During wet conditions, orange spirals of spores emerge from the fruiting structures. Aspen trees might emit a liquid ooze while cherry or peach trees discharge a gummy ooze.

DISEASE CYCLE The fungus overwinters in canker tissue on affected branches and/or trunks. During wet weather, spores are released from the fruiting structures and dispersed by splashing rain and wind. The spores infect stressed trees through fresh wounds.

MANAGEMENT Reduce stress on trees by providing adequate water and nutrients during the season. Avoid wounding the branches and trunks during cultural practices (lawn mower, weed trimmer). Remove and dispose of affected branches during dry weather. Disinfect pruning tools after each cut with 70% ethyl alcohol or a standard household disinfectant spray. Consider planting resistant varieties.

A Spruce tree affected by cytospora canker. **B** Young cankers on branches of spruce trees. **C** Dark colored fruiting bodies developing on infected branch. **D** Orange spores oozing out of fruiting bodies of a cottonwood tree branch.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Diplodia Tip Blight

Diplodia pinea (fungus)

HOST Two- and three-needle pines (Austrian, Scots, and Mugo pine), fir, spruce, juniper

DAMAGE/SYMPTOMS Initial infection may cause large amounts of resin to ooze out of branches. Black fruiting bodies are visible at the base of infected needles late summer to fall. Current year branch tips turn brown and die. New needles may appear stunted and change color from yellow to brown. Cankers may develop on branches. Symptoms are more severe on lower branches and infection may kill trees over time. Trees 30 years and older and weak trees are more prone to infection.

DISEASE CYCLE The fungus survives in infected needles, branches, and cones. In late spring to early summer, fruiting bodies discharge spores during wet conditions which infect young needles of the current season. The fungus grows within the needles and moves towards the base of needles and eventually into the twig. Infected needles turn brown and cankers are produced on the twigs/branches.

MANAGEMENT Focus on supporting tree vigor and provide adequate water and nutrients during the growing season. Remove and dispose of fallen needles, cones, and infected branches during dry weather. Spores can invade branches through wounds, therefore avoid pruning trees from late spring to early summer. Disinfect pruning tools with 70% ethyl alcohol or a standard household disinfectant spray before each cut to minimize spreading the disease. Fungicides with the active ingredient thiophanate-methyl, propiconazole, or chlorothalonil may be applied at budbreak, at half candle, and at full candle.

A Pine trees affected by diplodia. **B** Brown and stunted needles on young shoot. **C** Shoot tip dieback on pine tree. **D** Black fungal fruiting bodies on infected needles.


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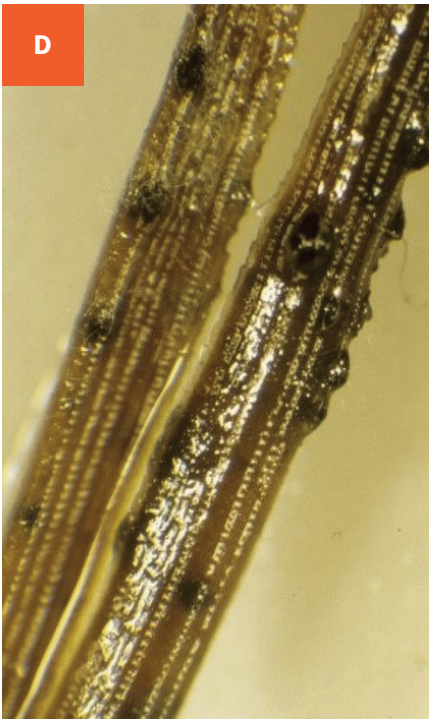
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Dothistroma Needle Blight

Dothistroma septosporum (syn. *Mycosphaerella pini*) (fungus)

HOST Austrian pine, Ponderosa pine

DAMAGE/SYMPTOMS Reddish-brown spots appear randomly on needles in late summer to fall. The spots can enlarge into reddish-brown bands and encircle the needles. The tips of infected needles turn brown as the bases stay green. As infection continues, needles die and drop off. Infection is more severe on lower branches closest to the trunk. Small black fruiting bodies might emerge out of infected needles.

DISEASE CYCLE The fungus survives in infected needles. Throughout the growing season, spores are released from affected needles and infect two- to three-year-old needles during periods of cool, wet weather. Young needles are mostly resistant until they reach maturity.

MANAGEMENT Remove fallen needles to reduce inoculum levels. Good spacing of trees will improve air circulation and minimize duration of wetness on needles. Avoid hitting the tree canopy during irrigation. Affected trees can be treated with fungicide containing the active ingredient copper. Apply fungicides in spring when new needles have grown half their mature length. A second treatment should be applied three to four weeks later when new needles are full grown. Strictly follow instructions on the pesticide labels. Fungicide applications will not cure already-infected needles but will prevent new infections.

A Pine trees affected by dothistroma needle blight. **B** Discolored pine needles. **C** Red-brown bands on infected pine needles. **D** Black fungal fruiting bodies emerging out of infected needles.


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Dutch Elm Disease

Ophiostoma novo-ulmi and *Ophiostoma ulmi* (fungi)

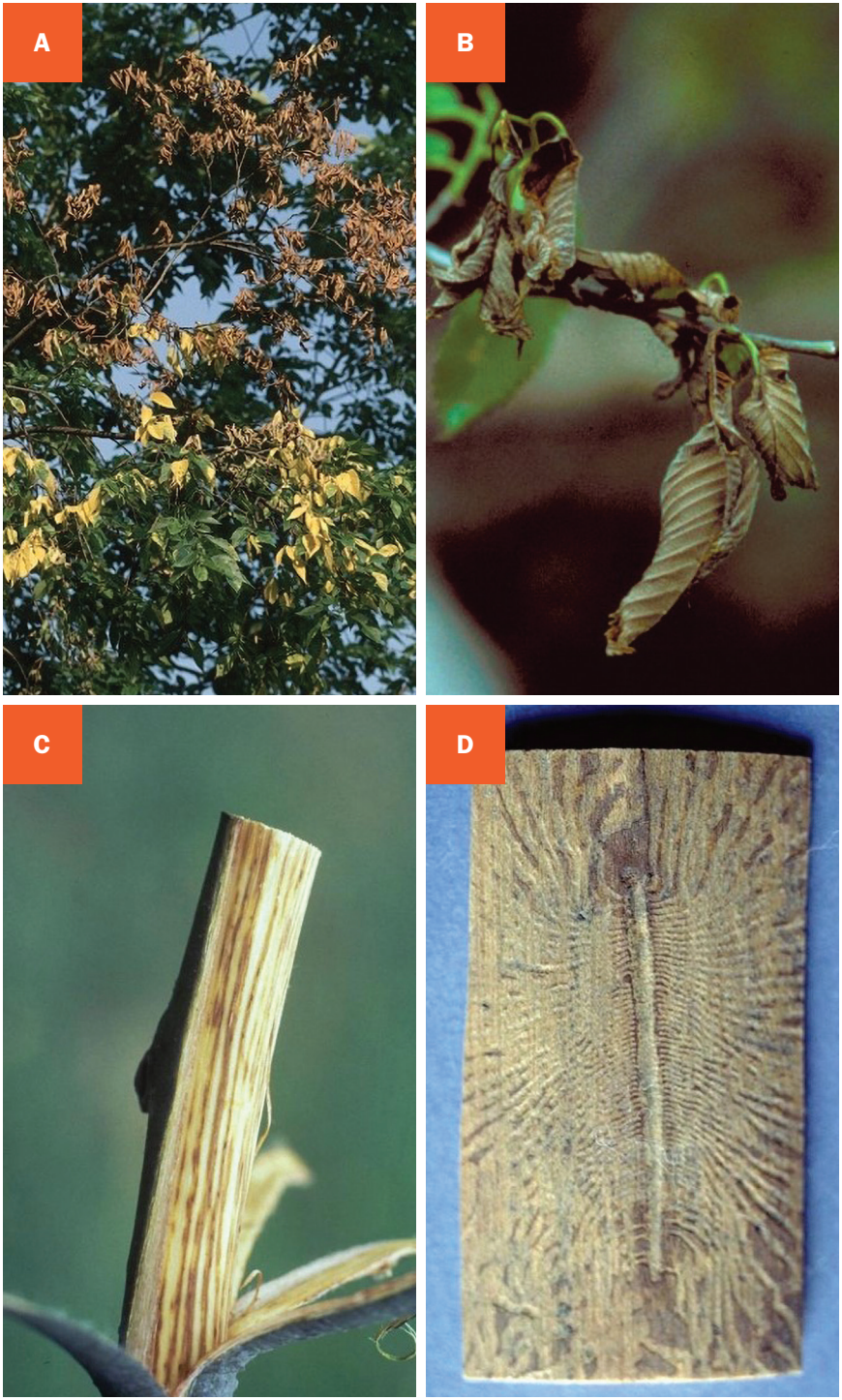
HOST American elm, European elm

DAMAGE/SYMPTOMS Starting in summer, leaves on infected branches of the upper canopy curl up, wilt, and turn a grayish-green or yellow color ("flagging"). As the disease progresses, adjacent branches show similar symptoms and major dieback in the canopy may become visible. Distinct longitudinal brown streaks are visible in the wood underneath the bark. Drought stress may intensify symptom development.

DISEASE CYCLE The pathogens overwinter in infected trees and are spread by the native elm bark beetle, the European elm bark beetle, and through root grafts. Beetles breed under the bark of dying or dead elm trees, including diseased trees. Hatching larvae feed on the inner bark and sapwood and form a distinct gallery network. *Ophiostoma* spp. grow in those galleries and spores attach to the adult beetles as they emerge to fly to new trees. As the beetles feed on new elm trees, spores are transferred to xylem vessels of trees where they germinate and grow into the water-conducting system. Root grafts, the connection of infected roots with healthy roots, can spread the disease by transferring infected water to healthy trees.

MANAGEMENT Plant only resistant varieties. Starting mid-June, scout for any flagging in the upper canopy. Immediately prune out and destroy any symptomatic branches and check for vascular discoloration. Disinfect pruning tools between cuts with 70% ethyl alcohol or a standard household disinfectant spray. High value trees may be treated with fungicide injections. Contact your local Extension professional for specific recommendations.

A Branch dieback on elm tree due to Dutch elm disease. **B** Dieback of young shoot on an elm tree. **C** Brown discoloration of infected wood underneath bark. **D** Feeding galleries of bark beetle larva in wood.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Fire Blight

Erwinia amylovora (bacterium)

HOST Fire blight affects plants in the Rosaceae family including apple, pear, crabapple, mountain-ash, hawthorn, and cotoneaster

DAMAGE/SYMPTOMS Infected blossoms develop a water-soaked appearance and turn a grey-green color. Over time the tissue shrivels and turns black, giving it a burned appearance. During periods of high humidity, amber colored drops might exude from the discolored tissues. Infected shoots may wilt rapidly and form a "shepherd's crook." Leaves on infected branches turn brown to black and may persist on the branches during fall and winter. Sunken cankers may also develop on branches.

DISEASE CYCLE The bacteria overwinter in cankers and ooze out of infected tissues in spring when the humidity is high. Insects are attracted to the ooze and transfer the bacteria to flowers. The bacteria can also be transferred by splashing rainwater and during cultural practices (e.g., pruning). The bacteria grow when temperatures are between 70 to 80°F, multiplying and invading surrounding plant tissues.

MANAGEMENT Select disease-resistant cultivars. Prune out and remove all infected twigs and branches during dry winter weather. Make the pruning cut 10 to 12 inches below the infected area. Disinfect pruning tools between cuts with 70% ethyl alcohol or a standard household disinfectant spray to avoid spreading the bacteria. Check plants regularly in spring and prune out symptomatic tissues. Copper sprays can be applied in early spring, just before buds swell, to manage this disease. Avoid using copper products every year and strictly follow instructions on the product label. Antibiotic spray applications are not recommended in the urban setting.

A Bacteria oozing out of infected plant tissue. **B** Tree branch is turning black with progressing fire blight infection. **C** Dark, sunken canker indicates a fire blight infection. **D** Dieback of branches due to fire blight infection.


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Kabatina Tip Blight

Kabatina juniperi (fungus)

HOST Primarily juniper

DAMAGE/SYMPTOMS Symptoms appear in early spring. Small, black fruiting bodies appear on at least one-year-old tissues. Dieback begins on shoot tips and progresses back toward the main stem. Tips of affected branches turn yellow or brown and drop their foliage in late spring. New infections occur later in the fall when *Kabatina* sp. spores enter the plants through wounds.

DISEASE CYCLE The fungus overwinters in infected branches. Fruiting bodies produce spores which cause new infections on at least one-year-old growth in the fall. Symptoms of infection become visible in the next spring. Stressed plants are more prone to infection.

MANAGEMENT Plant resistant juniper species whenever possible. Provide good spacing between plants to increase air circulation and avoid overhead irrigation and wounding of plants. Prune out and discard affected branches/shoots during dry weather. Make the cut about two inches into the healthy wood and disinfect your pruning tools with 70% ethyl alcohol or a standard household disinfectant spray before each cut to minimize spreading the disease.

A Browning of young tips on juniper. **B** Browning and emerging fungal fruiting bodies on juniper. **C** Mature, dark fruiting bodies on dying plant tissue.


A


B


C

Marssonina Leaf Spot

Marssonina spp. (fungus)

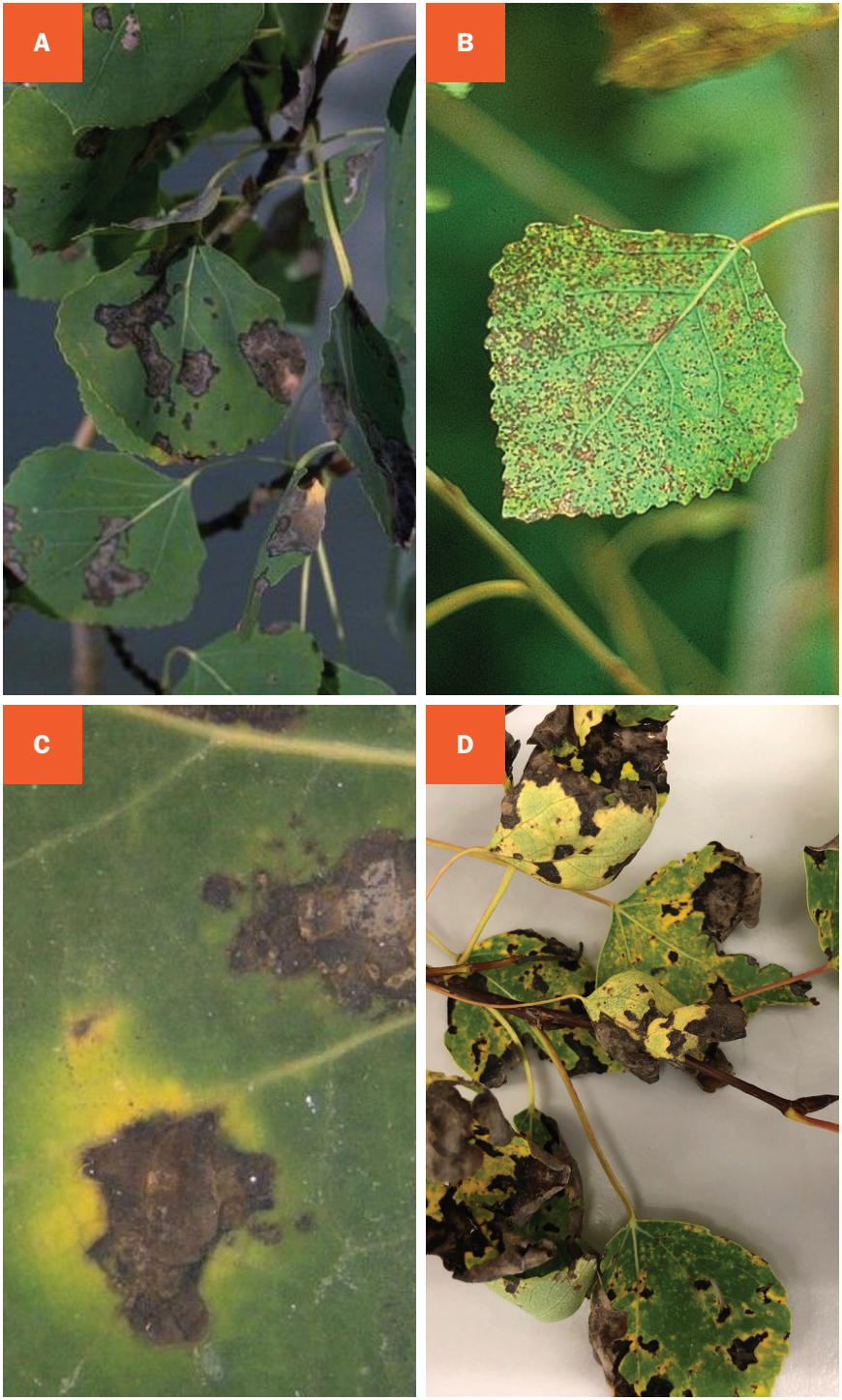
HOST Aspen, cottonwood, willow

DAMAGE/SYMPTOMS In spring, small dark-brown spots, often with yellow margins, develop on young leaves. The spots may coalesce to form larger lesions on leaves. Leaves may be stunted and drop prematurely. Young shoots are also susceptible to infection and may show lesions. Infections over several consecutive years will weaken the tree.

DISEASE CYCLE The fungus overwinters in infected leaf debris on the ground and infected shoots. In spring, spores are produced on previously infected tissues and dispersed by wind and rain, infecting new leaves. Infection is most severe under wet conditions. A second set of spores is produced on the newly infected leaf spots in late summer which infect adjacent leaves. This secondary infection is more severe under warm and moist conditions.

MANAGEMENT This disease may be unsightly, but it typically does not cause severe damage. Remove infected leaves that fall onto the ground and prune out affected shoots to reduce the level of infection. Disinfect pruning tools with 70% ethyl alcohol or a standard household disinfectant spray between cuts. Avoid wetting the foliage for prolonged times. Fungicides are not usually recommended unless the disease is a continuing problem. High value trees can be treated with a fungicide application in early spring when the buds start to swell. Applications may have to be repeated at 10- to 14-day intervals in spring as long as wet weather conditions continue. Products with the active ingredient chlorothalonil are effective in controlling this disease. Strictly follow instructions on the pesticide labels.

A Brown to tan spots on aspen leaves. **B** Brown leaf spots with yellow margins. **C** Close-up of *Marssonina* spp. leaf spots with distinct yellow margin. **D** Large necrotic areas on leaves due to *Marssonina* spp. infection.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Nectria Canker

Nectria spp. (fungus)

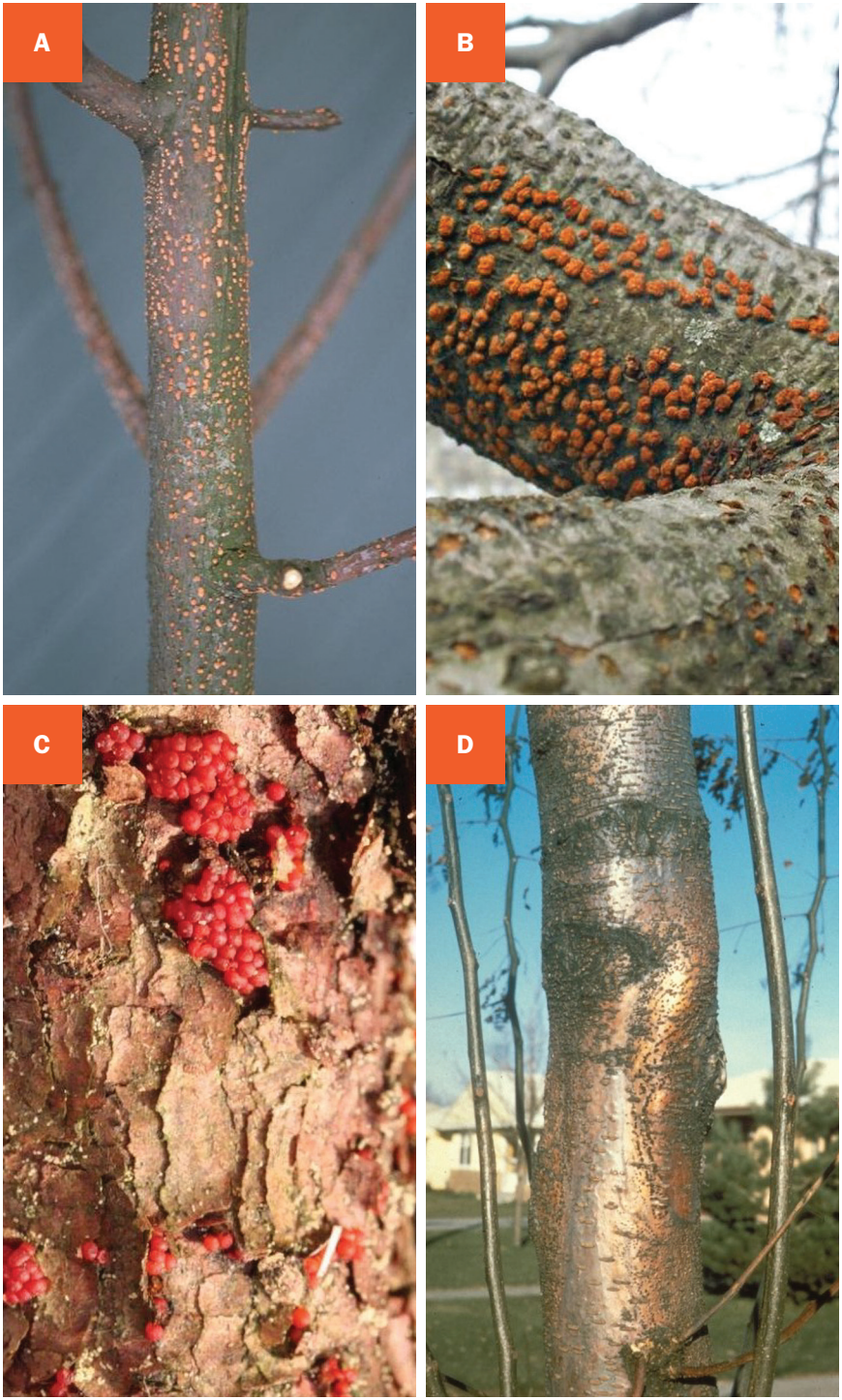
HOST Elm, honeylocust, maple, cotoneaster

DAMAGE/SYMPTOMS Following infection in spring, leaves and shoots of twigs and branches wilt. Cankers develop on branches and twigs and girdle the tissues from within, resulting in dieback. Clusters of spherical orange-colored fungal fruiting bodies (coral spots) emerge from infected bark. This disease can significantly damage newly planted, as well as established trees and shrubs.

DISEASE CYCLE *Nectria* spp. survives in canker tissue where fruiting bodies are produced. Spores emerge from the fruiting bodies and infect through wounds or weakened plant tissue. Stressed plants are especially susceptible. Infections result in the formation of cankers and in dieback of leaves, shoots, and branches.

MANAGEMENT Support plant health by providing adequate water and nutrients during the season. Avoid wounding plants. Remove and dispose of affected branches during dry weather. Disinfect pruning tools after each cut with 70% ethyl alcohol or a standard household disinfectant spray. Infections in the next season may be reduced by applying a fixed copper-containing fungicide to affected trees in early fall when leaves begin to drop.

A Coral-colored fungal fruiting structures on branch. **B** Tree severely infected by nectria canker. **C** Close-up of coral-colored fruiting bodies. **D** Canker development on tree trunk.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Oak Leaf Blister

Taphrina caerulescens (fungus)

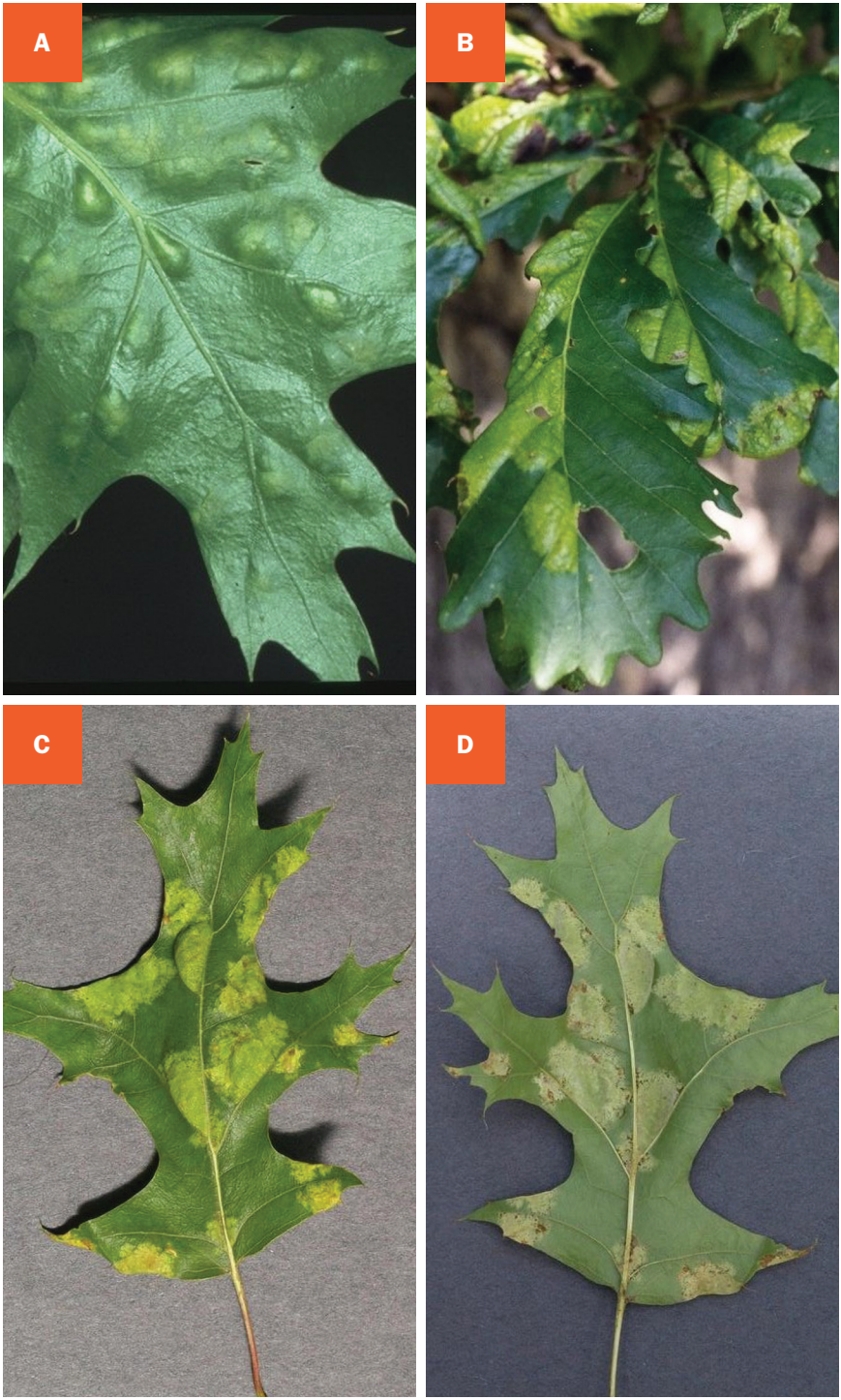
HOST Oak

DAMAGE/SYMPTOMS Symptoms appear early in the summer as blisters, bulges, or depressions on the upper leaf surface. The lower side of the leaves turns a grayish color in affected areas. The blistered areas may merge and change color from yellow to brown over time. Infection may also result in leaf distortion. Mature leaves are usually resistant to infection.

DISEASE CYCLE The fungus overwinters in infected buds, bud scales, and leaf debris. Spores are dispersed in spring and infect newly emerging leaves just after bud break. Infection is most severe under cool, wet conditions. Blisters form on the leaves and produce new spores by midsummer.

MANAGEMENT This disease may be unsightly, but it typically does not cause severe damage. Remove infected leaves that fall onto the ground to reduce the level of infection. Avoid wetting the foliage for prolonged times. Fungicides are not usually recommended unless the disease is a continuing problem. High value trees can be treated with a fungicide application in early spring when the buds start to swell. Products with the active ingredient chlorothalonil are effective in controlling this disease. Strictly follow instructions on the pesticide labels.

A Young blisters appear on leaves after infection. **B** Large areas on leaves affected by oak leaf blister disease. **C** Blisters on upper surface of an oak leaf. **D** Gray-green areas of blisters on the lower surface of an oak leaf.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Phomopsis Tip Blight

Phomopsis juniperovora (fungus)

HOST Creeping and Rocky Mountain junipers, Douglas-fir, fir, arborvitae, larch

DAMAGE/SYMPTOMS In spring, small grayish lesions appear on the terminal four to five inches of the newest shoots. The lesions enlarge and may girdle and kill the new shoots. Infected branches turn from green to reddish-brown to a grayish color. Small, black, fungal fruiting bodies can be found on the dead branches. This disease can kill the entire plant.

DISEASE CYCLE The fungus survives in infected branches. Spores can be produced in fruiting bodies throughout the growing season, depending on favorable weather conditions. While most infections occur in springtime during wet weather and when new shoots grow, late summer infections may appear when plants are water stressed and over fertilized.

MANAGEMENT Plant resistant juniper species. Prune out and discard affected branches/shoots during dry weather. Make the cut about six inches below visible symptoms and disinfect pruning tools with 70% ethyl alcohol or a standard household disinfectant spray before each cut to minimize spreading the disease. Fungicides with the active ingredient copper or mancozeb can be applied starting in spring when new shoots are growing. Multiple applications may be necessary depending on the weather conditions and the selected product.

A Browning tips on juniper shrub. **B** Dieback on young evergreen plants.
C Close-up of shoot dieback. **D** Dark fungal fruiting bodies on dead plant tissue.


A
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Powdery Mildew

Various host-specific fungi

HOST Apple, lilac, oak, chokecherry, caragana, honeysuckle, clematis, Virginia creeper, ninebark

DAMAGE/SYMPTOMS The fungus covers buds, flowers, leaves, and fruits with a white, dusty mat. Young leaves are frequently more severely affected. Infected leaves may be distorted and yellow and may fall prematurely. In late summer, small, dark, round fruiting bodies of the fungus might be visible on the lower side of leaves. Infected fruit has a network of lines which is often referred to as russeting.

DISEASE CYCLE The fungus overwinters in buds and infected plant debris. In spring, spores germinate and invade the newly emerging leaves and flowers. Infected blossoms turn brown and shrivel. Emerging leaves are often completely covered with a white mat and appear distorted and curled. When conditions are moist, multiple cycles of infection occur. Infections of expanded leaves have round, cottony patches on the surface. Infected leaves are prematurely shed from the tree.

MANAGEMENT Plant resistant varieties. Consider healthy pruning of affected trees to promote good air circulation and light penetration. Dormant pruning of infected twigs will reduce inoculum for the next growing season but is only slightly effective. It is often not practical to prune since there are no obvious symptoms visible. Chemical control should begin when buds start to open and new inoculum is released. Fungicides containing wettable sulfur or myclobutanil provide control, but sulfur can result in leaf burn. Potassium bicarbonate products provide organic alternatives to chemical fungicides.

A Oak leaves covered with powdery mildew. **B** White mycelium and dark fruiting bodies (cleistothecia) on oak leaf. **C** Close-up of young and mature cleistothecia. **D** Symptom of russeting on apple fruit.


A
B
C
D

Rhabdocline Needle Cast

Rhabdocline weirii (fungus)

HOST Douglas-fir

DAMAGE/SYMPTOMS In late summer to fall, yellow/brown spots appear on the upper and lower sides of needles that were infected in the current year. The spots enlarge and turn reddish-brown by late winter or early spring. Margins of the splotches are very distinct. Needles on lower branches are more severely affected. Infected needles turn brown over time and are dropped prematurely. Trees express reduced vigor and are prone to insects and other plant pathogens.

DISEASE CYCLE The fungus overwinters in infected needles. During wet weather in spring, the fungus produces fruiting bodies under the epidermis of spots. Under wet and cool conditions, the epidermis of affected tissues splits lengthwise and masses of spores are released. The spores are dispersed by wind and rain and infect newly emerging needles.

MANAGEMENT Plant resistant varieties in full sun whenever possible. Prune out and discard infected branches during dry weather. Disinfect pruning tools between cuts with 70% ethyl alcohol or a standard household disinfectant spray. Affected trees can be treated with fungicides containing the active ingredient copper hydroxide, copper sulfate, mancozeb, or thiophanate-methyl. Apply fungicides in spring when new needles have grown half their mature length. A second treatment should be applied three to four weeks later when new needles are full grown. Depending on the weather conditions and the product used, a third application might be necessary. Strictly follow instructions on the pesticide labels. Fungicide applications will not cure infected needles but will prevent new infections.

A Epidermis of affected needle tissues splits lengthwise. **B** Close-up of split epidermis. **C** Browning needles on Douglas-fir. **D** Brown spots on infected needles.


A
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D

Rhizosphaera Needle Cast

Rhizosphaera kalkhoffii (fungus)

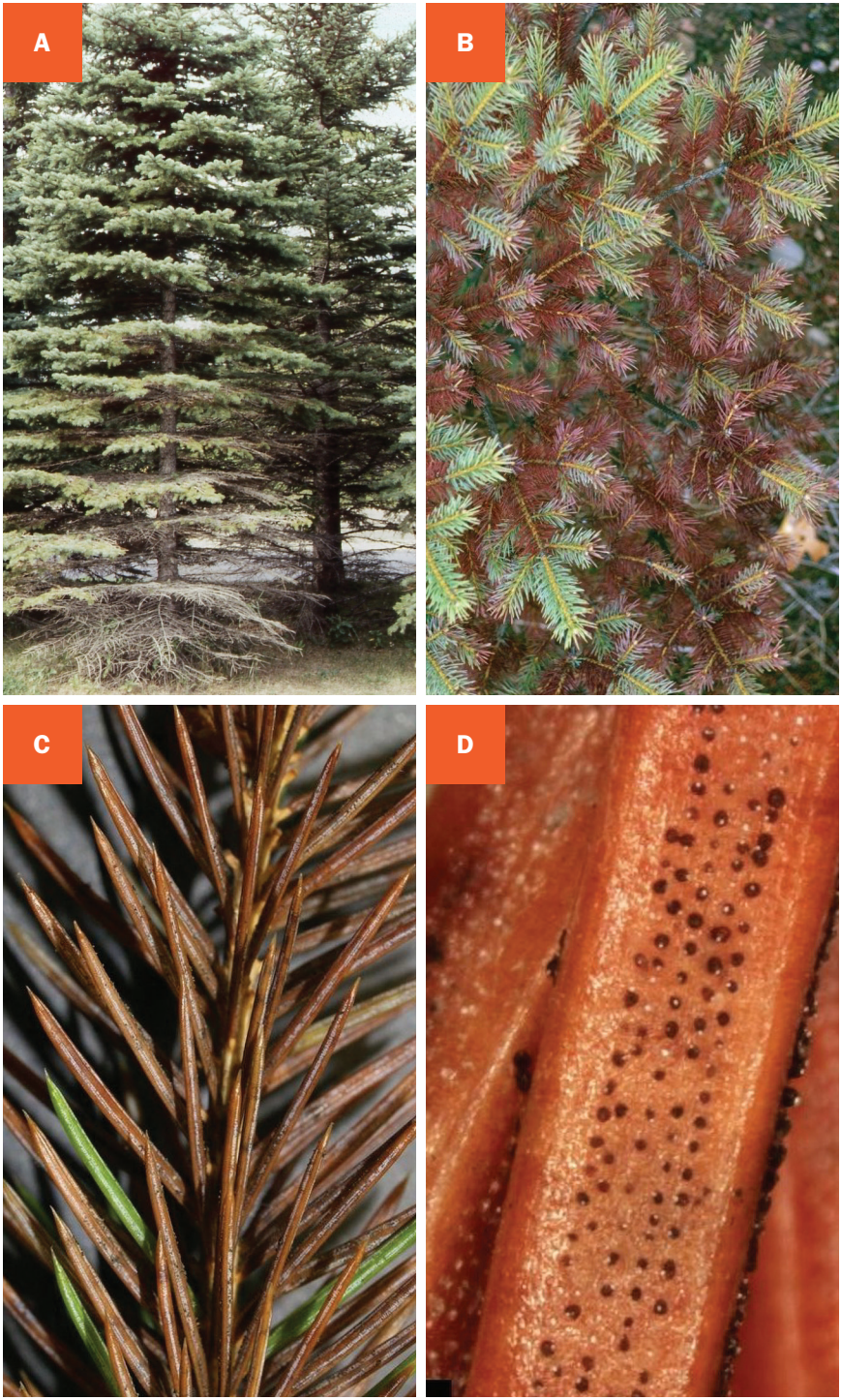
HOST Colorado blue spruce, Engelmann spruce, Douglas-fir, fir, pine, Western hemlock

DAMAGE/SYMPTOMS In spring or early summer, older innermost needles turn brown to purple while younger needles at branch tips stay green. Small, black spheres (fruiting bodies) emerge in rows out of stomata of infected needles. Infected, discolored needles fall off in late summer or fall. Symptoms are more severe on lower branches. The branches of affected trees thin over time.

DISEASE CYCLE The fungus overwinters in infected needles still living on the tree and in needles on the ground. Starting in spring, spores are released throughout the growing season from the black fruiting bodies and distributed to new needles by wind and splashing water. New needles are infected during mild and wet weather. Old needles may be infected due to high pathogen pressure and favorable environmental conditions. Affected needles are dropped approximately 12 months after initial infection.

MANAGEMENT Rake up infected needles and prune out and dispose of affected branches to reduce the disease source. Disinfect pruning tools between cuts with 70% ethyl alcohol or a standard household disinfectant spray. Provide good spacing between trees to optimize air circulation. Re-direct sprinklers to avoid hitting the tree canopy during irrigation. Affected trees can be treated with fungicides containing the active ingredient copper hydroxide or chlorothalonil. These fungicides can only protect new needles, as infected needles can't be cured. Apply fungicides in spring when new needles have grown half their mature length. A second treatment should be applied three to four weeks later when new needles are full grown. Strictly follow instructions on the pesticide labels.

A Spruce tree affected by rhizosphaera needle cast disease. **B** Bronze-brown colored older needles. **C** Dark fungal fruiting bodies emerge out of infected needles. **D** Dark, round fruiting bodies emerge out of stomata of infected needles.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Shot Hole Blight or Coryneum Blight

Wilsonomyces carpophilus (fungus)

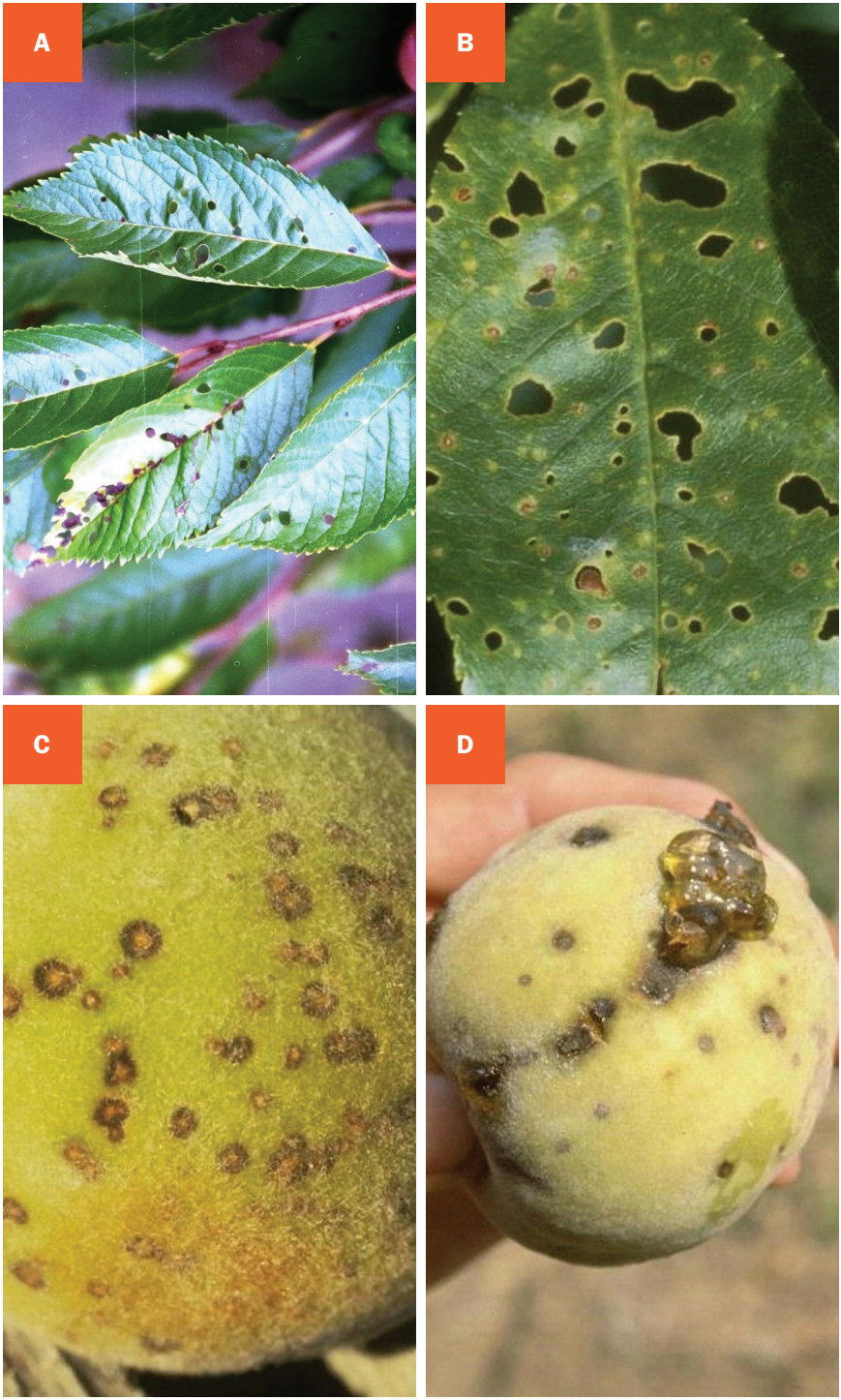
HOST Stone fruit trees including cherry, apricot, peach, and almond (ornamental)

DAMAGE/SYMPTOMS Leaf infection in spring results in small, round, purplish to brown lesions. The spots may enlarge, and the infected leaf tissue can drop out of the leaf blade, leaving a "shot hole." Cankers develop after infection and may result in killing of the twig. Infected buds are darker than healthy ones and may show gummosis. Infection of fruits starts as small purple spots which can enlarge to grayish lesions and may show gumming. Severe infection will result in fruit loss.

DISEASE CYCLE The fungus overwinters in canker tissue on twigs and in infected buds. Spores are released during rainy periods in spring and infect new buds. Susceptible tissues can also be infected later in the season if the weather conditions are favorable for the pathogen.

MANAGEMENT Effective control measures include pruning out and destroying of infected branches during the dormant season. Disinfect pruning tools between cuts with 70% ethyl alcohol or a standard household disinfectant spray. Use low-volume sprinklers or drip irrigation to avoid wetting the foliage. In fall after leaf drop, consider applying a fixed copper or chlorothalonil product to protect buds during the dormant season. High value plants can be re-treated in spring before buds start to swell. Strictly follow instructions on the pesticide labels.

A Infected leaf tissue drops out of leaves, leaving "shot holes" behind. **B** Brown leaf spots and shot holes on leaves following infection. **C** Shothole disease causes spots on infected fruits. **D** Spots and gumming on infected fruit.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Stigmina Needle Cast

Stigmina lautii (fungus)

HOST Colorado blue spruce, black spruce, white spruce, Norway spruce

DAMAGE/SYMPTOMS Symptoms are very similar to Rhizosphaera needle cast. In spring or early summer, older needles on mainly the lower branches turn yellow to brown. Small, black fuzzy-looking fruiting bodies emerge in rows out of stomata of previous season's needles. Discolored needles fall off in late summer or fall one to two years after infection. This disease results in severe thinning of the needles on the lower branches.

DISEASE CYCLE The fungus overwinters in infected needles on the tree and on the ground. In spring, during mild and wet weather, spores are released from the black fruiting bodies and distributed by wind and splashing water to newly emerging needles. Infected needles are dropped approximately one to two years after initial infection.

MANAGEMENT Plant trees that are well adapted to your area. Rake up infected needles and prune out and dispose of affected branches to reduce the disease source. Disinfect pruning tools between cuts with 70% ethyl alcohol or a standard household disinfectant spray. Provide good spacing between trees and avoid hitting the tree canopy during irrigation. Affected trees can be treated with fungicide containing the active ingredient copper or chlorothalonil to protect newly emerging needles. Apply fungicides in spring when new needles have grown half their mature length. A second treatment should be applied three to four weeks later when new needles are full grown. Strictly follow instructions on the pesticide labels.

A Spruce tree branches affected by stigmina needle cast disease. **B** Dark, round fruiting bodies with hair-like tendrils sporulate on needle. **C** *Stigmina* sp. spores.


A
B
C

Sudden Needle Drop

Setomelanomma holmii (fungus)

HOST Colorado blue spruce, white spruce, Norway spruce

DAMAGE/SYMPTOMS Older needles turn yellow and/or brown and are shed by fall. Only newest needles may stay green at the tip of branches. Affected branches may be scattered throughout the tree. The canopy of affected trees may thin out over time.

DISEASE CYCLE This problem only affects stressed trees. The fungus overwinters in infected branches. Small, black fruiting bodies can be found on the branches, bud scales, and on the woody tissue at the base of needles but not on/in the needles. Since this is a relatively new problem, not many details are known about its life cycle.

MANAGEMENT Control measures applied to control Rhizosphaera needle cast disease appear to manage sudden needle drop as well. Provide good spacing between trees to optimize air circulation. Re-direct sprinklers to avoid hitting the tree canopy during irrigation. Affected trees can be treated with a fungicide containing the active ingredient copper or chlorothalonil. Apply fungicides in spring when new needles have grown half their mature length. A second treatment should be applied three to four weeks later when new needles are full grown. Strictly follow instructions on the pesticide labels.

A Spruce tree affected by needle cast disease. **B** Dark fruiting bodies emerge on branches. **C** Close-up of fruiting bodies.


A


B


C

Swiss Needle Cast

Phaeocryptopus gaeumannii (fungus)

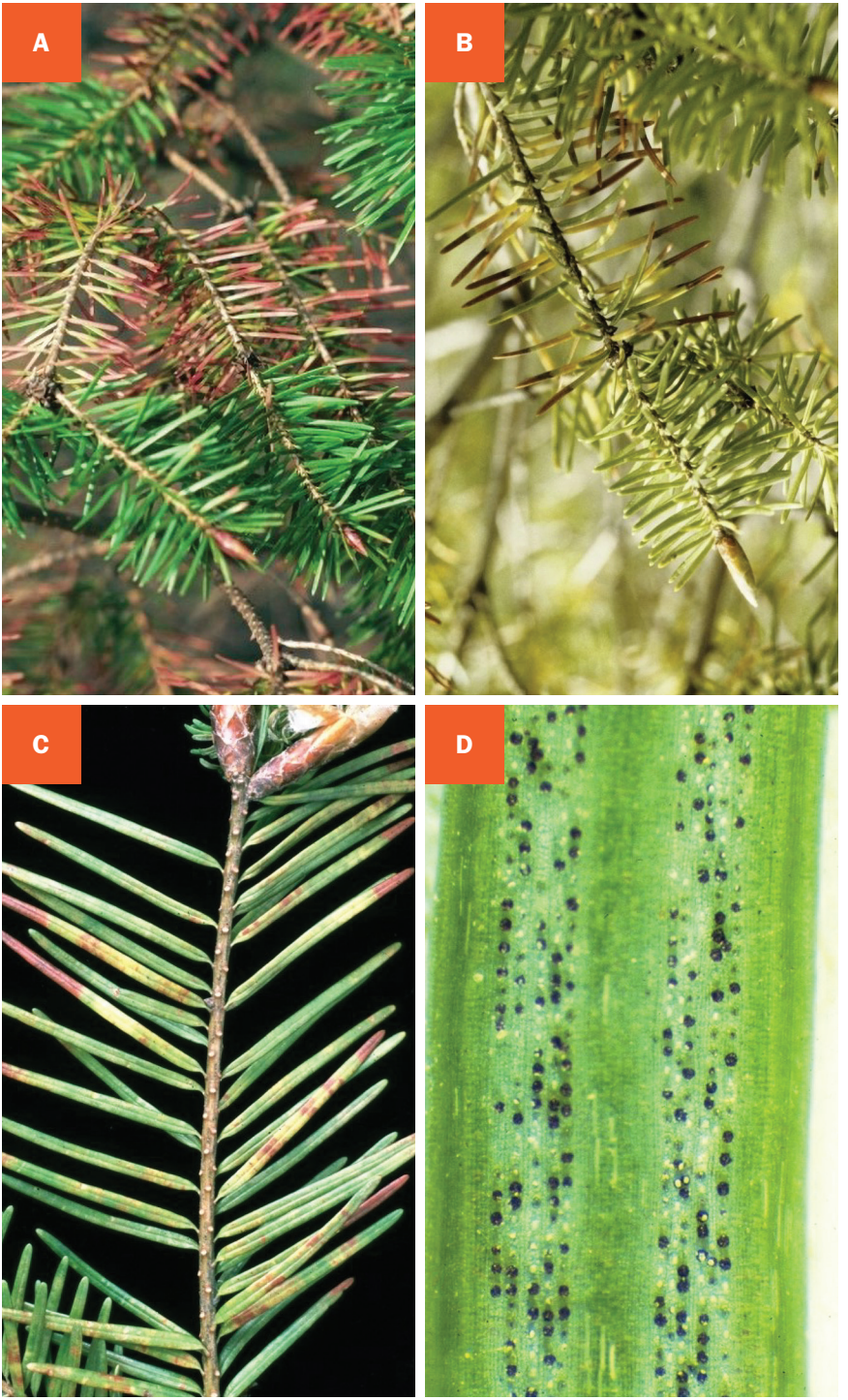
HOST Douglas-fir

DAMAGE/SYMPTOMS Infected needles turn a dull green or yellow color, followed by browning of the needle tips. Older needles are usually more severely affected. Small, black spheres (fruiting bodies) emerge in parallel rows on the lower surface of infected needles. Brown needles drop over time with only the newest needles remaining on the tips of branches.

DISEASE CYCLE The fungus overwinters in infected needles. In spring, spores are released from the black fruiting bodies and distributed to newly emerging needles by wind and splashing water. New needles are primarily infected during cool, wet weather. After infection, needles may remain on the tree and produce spores for several seasons before being dropped.

MANAGEMENT Rake up infected needles and prune out and dispose of affected branches to reduce the disease source. Disinfect pruning tools between cuts with 70% ethyl alcohol or a standard household disinfectant spray. Provide good spacing between trees to optimize air circulation. Re-direct sprinklers to avoid hitting the tree canopy during irrigation. Affected trees can be treated with a fungicide containing the active ingredient chlorothalonil or mancozeb. Fungicides can only protect new needles; infected needles can't be cured. Apply fungicides in spring when new needles have grown half their mature length. A second treatment should be applied three to four weeks later when new needles are full grown. Strictly follow instructions on the pesticide labels.

A Browning needles on Douglas-fir. **B** Discolored, infected needles. **C** Brown spots and yellowing of infected needles. **D** Dark fruiting structures emerge out of stomata of infected needles.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Venturia Leaf and Shoot Blight

Venturia populina (fungus)

HOST Eastern cottonwood, Lombardy poplar, aspen

DAMAGE/SYMPTOMS In late spring, black, necrotic areas develop on leaves and shoots which may be mistaken as frost damage. The rapid dieback of shoots leads to drooping branch tips often referred to as a "shepherd's crook." Young and immature shoots are very susceptible. Necrotic leaf areas and affected shoots may be covered in olive-green spores. This disease is most severe on young trees. Recurring infection may lead to stunted and misshapen trees.

DISEASE CYCLE The fungus overwinters in infected shoots. During wet spring weather, spores are produced in infected plant tissues and dispersed by splashing rain and wind. New infections start as black leaf spots or necrotic tissue at leaf margins. Necrotic areas increase quickly and may kill leaves and/or shoots.

MANAGEMENT Prune out and dispose of infected shoots during dry weather. Make the pruning cut at least eight inches below the symptomatic area. Disinfect pruning tools with 70% ethyl alcohol or a standard household disinfectant spray before each cut to minimize spreading the disease. Avoid overhead irrigation to reduce leaf wetness. Focus on supporting plant vigor by providing adequate water and nutrients. Consider planting resistant varieties.

A Blackening and shepherd's crook on aspen shoot. **B** Dieback of young shoot affected by *Venturia* sp.


A


B

Western Gall Rust

Endocronartium harknessii (fungus)

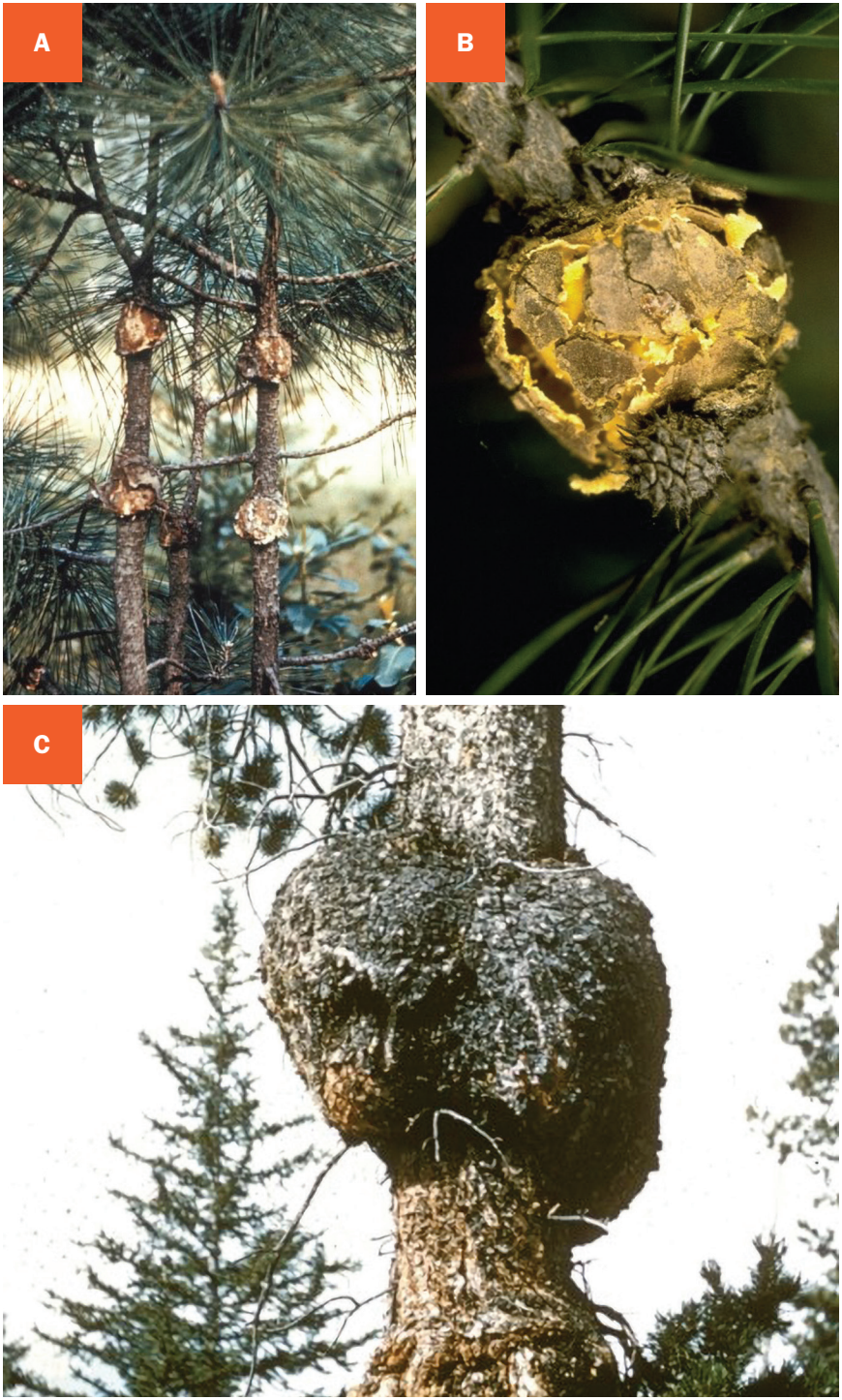
HOST Two- and three-needle pines like lodgepole pine, Mugo pine, Scots pine, Austrian pine, Ponderosa pine

DAMAGE/SYMPTOMS Rough, spherical galls develop on branches or trunks. Yellow to orange spores are produced on galls in late spring. Foliage of affected limbs may become stunted beyond the galls. Affected tree limbs are more prone to breakage where the galls grow. This disease may kill young trees but on mature trees, galls can grow and expand for many years. Severely affected limbs will die over time.

DISEASE CYCLE This fungus doesn't require an alternate host to complete its life cycle. In late spring, during shoot elongation, yellow to orange spores are produced on the galls and dispersed by wind and splashing rain and infect new shoots. Shoots are prone to infection from budbreak through shoot elongation.

MANAGEMENT Remove affected trees whenever possible, especially if their structural stability becomes compromised. Prune out and remove infected branches during the dormant season (October to January). Disinfect pruning tools between cuts with 70% ethyl alcohol or a standard household disinfectant spray. Fungicide applications are not recommended in urban areas.

A Young galls on pine trees. **B** Bright yellow to orange spores on gall.
C Mature galls on older tree.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INSECTS

Aphids

Family Aphididae

HOST Several hosts

DAMAGE/SYMPTOMS Aphids are sap-sucking insects and the saliva they release from feeding can cause discoloring, curling, distortion, or overall lack of vigor.

LIFE CYCLE The aphid life cycle varies significantly between species. In general, aphids overwinter in the egg stage on a host and reproduce in large numbers asexually during the growing season. Later in the summer, most aphids produce winged generations and move to a second host. In the fall, they return to their primary host, mate, and lay eggs.

MANAGEMENT A strong spray of water alone can effectively remove aphids. Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen, as this produces flushes of succulent growth. Avoid excessive watering and use slow-release fertilizers. Placing cardboard wraps around the tree that are covered with a sticky substance, such as Tanglefoot, can prevent ants from climbing. Ants have a mutualistic relationship with aphids; they hoard the honeydew released from aphids and then defend the aphids from their natural enemies in return. There are a variety of lower toxicity contact products available including soaps, oils, and botanicals. Good coverage with contact pesticides is essential. Systemic insecticides are particularly useful when contact is difficult and to protect new growth over time (active ingredients such as imidacloprid and dinotefuran).

A Rose aphids. **B** Green peach aphid. **C** Black cherry aphids.


A


B


C

Ash Bark Beetles

Hylesinus spp.

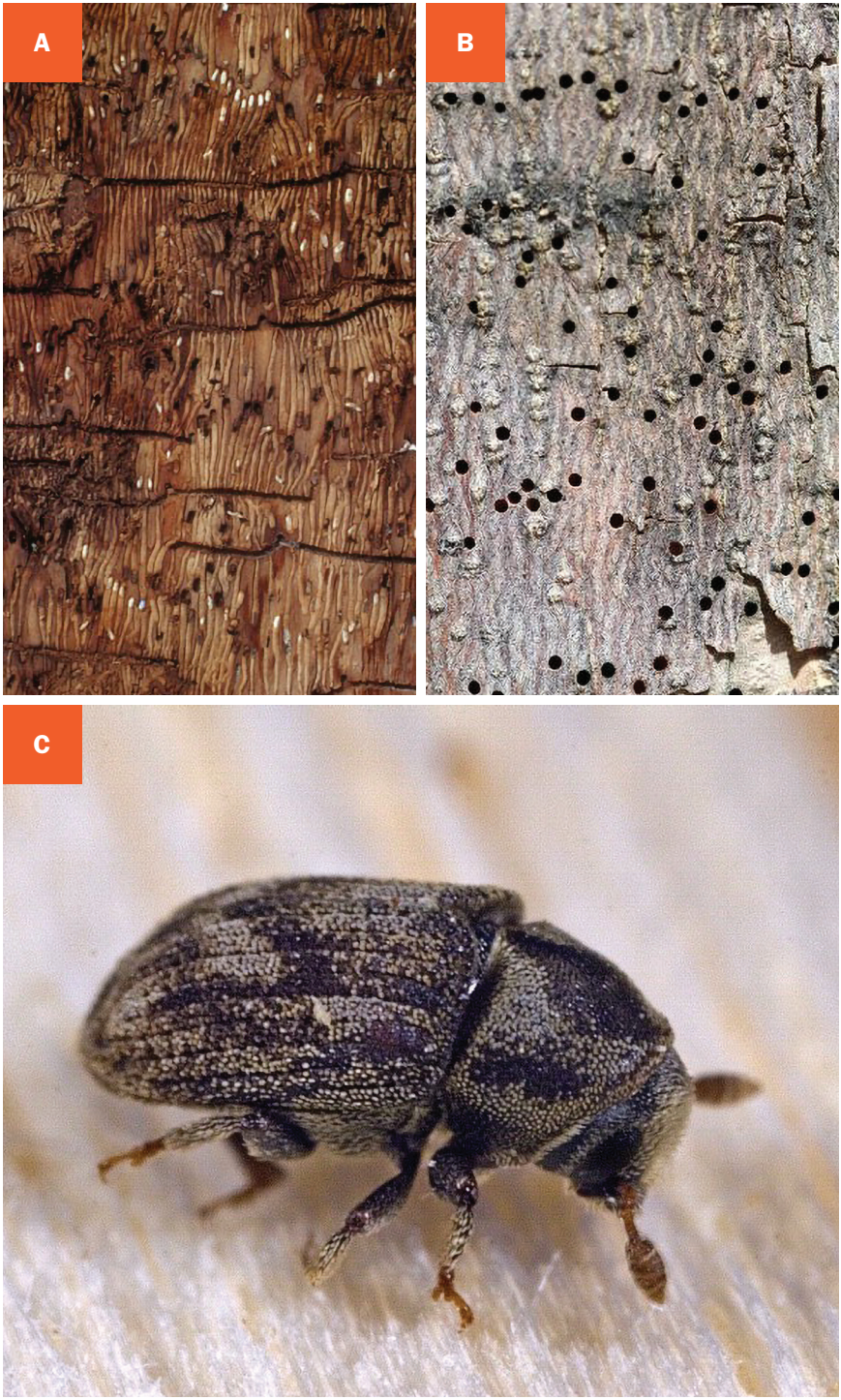
HOST Ash

DAMAGE/SYMPTOMS The small beetles (three to four millimeters) make a pattern of ventilation holes that form a ring around the branch. They prefer to breed in recently cut, broken, and stressed trees. They also infest trees weakened by mechanical injury, disease, or fire.

LIFE CYCLE The adult bark beetles emerge in the spring and fly to trunks or limbs of recently felled, dying, or weakened trees. They mate and lay eggs in branches. The larvae burrow under the bark where they continue to develop and feed, pupate, and then emerge as adults. The larvae either overwinter under the bark or the adults cut niches in the outer trunk in which they overwinter.

MANAGEMENT Stressed trees will attract the beetles. Infested branches can be identified with the presence of wilted leaves. Pruning is most successful in the spring before the adult beetles emerge from the bark. Maintain the health and vigor of the tree and prune infested branches. Preventive insecticides can be applied during adult egg-laying periods in mid-spring. An additional insecticide application can be applied in late summer around the base of the trunk to kill populations of overwintering beetles. Insecticides with the active ingredients carbaryl, bifenthrin, and permethrin can be used.

A Ash bark beetle galleries under the bark. **B** Beetle exit holes. **C** Eastern ash bark beetle adult.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Ash Flower Gall Mite

Eriophyes fraxiniflora

HOST Ash

DAMAGE/SYMPTOMS Damage is caused by a small, microscopic mite called an eriophyid mite. The mite distorts the male flowers of the ash. These galls are originally a greenish-yellow color but dry out and turn brown.

LIFE CYCLE Female mites overwinter under bud scales and protected areas. In the spring, females actively feed and lay eggs on the buds. The male flowers disfigure and form gall-like tissue where the mites continue to develop. The mites leave these galls later in the summer and move to bud scales to overwinter.

MANAGEMENT The pests are generally secondary and infest stressed trees. The galls rarely affect the health of the tree. Due to the protection of the mites within the galls, insecticide treatments are often minimally effective in controlling mite densities and often kill beneficial natural enemies of the mites. Larger trees are difficult to treat effectively. If chemical controls become necessary, a contact insecticide or miticide labeled for the host can be applied when the first blossoms appear. Also, a dormant oil can be applied prior to bud break.

A Ash flower gall mite early-season distortion. **B** Ash flower gall mite distortion during summer. **C** Late-season galls.


A


B


C

Ash Plant Bug

Tropidosteptes spp.

HOST Ash

DAMAGE/SYMPTOMS Plant bugs puncture the plant tissue and cause stippling on the upper surface of the leaf. Some of these areas will coalesce to form larger chlorotic spots. The bugs leave brown fecal spots on the underside of the leaf. If infestations are heavy, leaves can become severely distorted and drop to the ground.

LIFE CYCLE Plant bugs lay eggs under loose bark. The nymphs hatch in late April or early May and begin to feed on lower leaves. The adults mature by early June and insert eggs along the leaf midribs. There are typically two generations per year.

MANAGEMENT The damage from this plant bug is usually minor and the trees will recover. Smaller trees can be shaken, or water can be used to dislodge the nymphs when they are present on the leaves earlier in the year.

A Ash plant bug damage.


A

Aspen Blotch Leafminer

Phyllonorycter spp.

HOST Aspen, poplar, cottonwood

DAMAGE/SYMPTOMS The caterpillar feeding and mining cause white blotches on the underside of the leaves. Heavy outbreaks can cause reduced tree growth and branch dieback.

LIFE CYCLE Adult moths emerge from overwintering sites and feed on nectar. Females mate and deposit several eggs on newly emerging leaves. The larvae develop and feed within the leaf, causing blotchy looking tissue. They pupate, and the adults emerge in late summer as leaves are starting to senesce.

MANAGEMENT The leafminers attack stressed trees. Normally, no treatment is necessary, and the pests are controlled by natural enemies later in the summer. Keep aspen and cottonwood trees well cared for with frequent watering. Pick off the mined leaves and dispose of them (if there are only a few—sometimes this leafminer can be found on the majority of a tree's leaves). Rake up and dispose of leaves in the fall to reduce overwintering populations of the moths. Chemical controls are only moderately effective in controlling the pest and have sometimes made the populations worse by killing many of the natural enemies of the caterpillars. If insecticides are necessary in the future, they are most effective at the egg-laying stage of the moth (right after the tree leafs out). Products that could be used include those with the active ingredients spinosad, permethrin, bifenthrin, carbaryl, and zeta-cypermethrin. Systemic insecticides (active ingredients such as imidacloprid and dinotefuran) are not effective against larvae.

A Aspen blotch leafminer damage.


A

Blister Mites

Phytoptus spp.

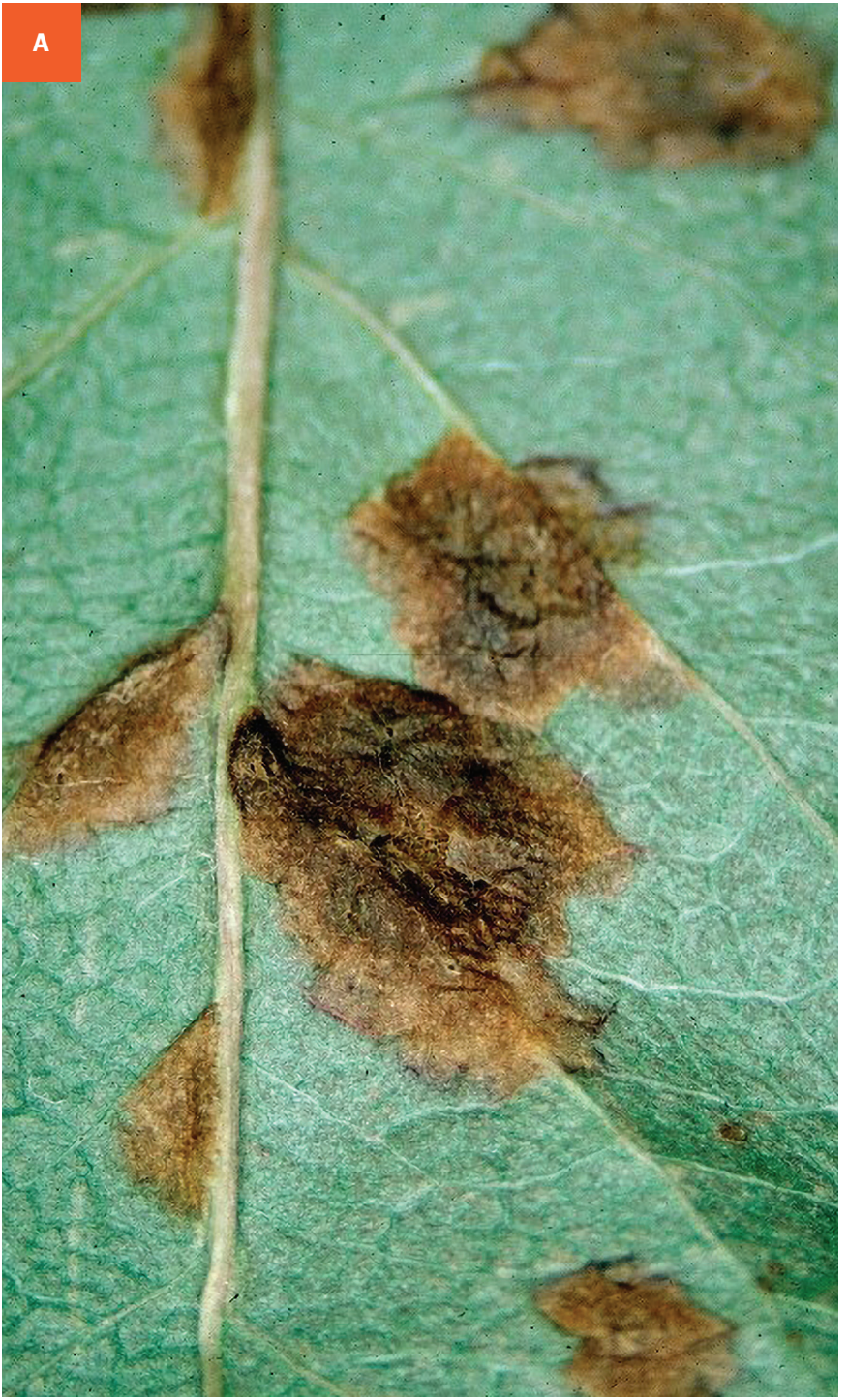
HOST Apple, crabapple, pear

DAMAGE/SYMPTOMS Eriophyid mite feeding creates a "blister" on the leaf surface, and the mites reside within this protected area.

LIFE CYCLE The mites overwinter as adults beneath bud scales. When the buds start to grow in the spring, mites attack the emerging leaves. Their activity increases in the summer with two to three generations per year.

MANAGEMENT The mites normally do not affect the health of the tree. If a small portion of the leaves are damaged, prune and dispose of them. Eriophyid mites are also controlled naturally by predatory mites, predatory thrips, and minute pirate bugs later in the summer. To control the mites chemically, a dormant oil can be applied prior to bud break. Neem oil, insecticidal soap, a miticide, sulfur and those insecticides with the active ingredients bifenthrin, deltamethrin, and permethrin can be applied as contact insecticides in the spring following bud break. Systemic insecticides with the active ingredients imidacloprid and dinotefuran can also be used against the pest and should be applied in the spring.

A Blister mite damage on apple leaf.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Bronze Birch Borer

Agrilus anxius

HOST Birch

DAMAGE/SYMPTOMS Girdling injuries cause dieback of limbs in the crown. D-shaped exit holes will be present on trunks and branches on parts of the tree that are unshaded. The infestations will also cause raised ridges in the bark. The galleries that are formed from boring underneath the bark make a zig-zag pattern and are packed with sawdust.

LIFE CYCLE Females lay eggs in bark crevices or in other protected sites. Egg laying begins in the upper crown of the tree or in branches (usually less than-half-inch thick) and then continues to thicker portions of the tree. The eggs will hatch after about two weeks. The larvae overwinter within the cambium and pupate in early spring. The adults exit the trees in late May or early June. There is one generation/year.

MANAGEMENT Birch are often stressed, making them more susceptible to the borer. Provide a large mulched area around the tree to conserve moisture and to protect the root system. Any limbs showing signs of infestation should be pruned out prior to beetle emergence in the spring. Preventive insecticides can be applied as trunk sprays (active ingredients include bifenthrin, permethrin, and carbaryl) and should be timed to coincide with egg laying in the summer. Systemic insecticides with the active ingredients imidacloprid, emamectin benzoate, azadirachtin, or dinotefuran can also be applied in the spring to prevent future infestations.

A Bronze birch borer adult. **B** Bronze birch borer damage on trunk.


A
5454856
B

Codling Moth

Cydia pomonella

HOST Apple, pear, crabapple

DAMAGE/SYMPTOMS Caterpillars tunnel inside the fruit and deposit insect excrement. Holes and egg-laying spots are also evident on the outside of the fruit.

LIFE CYCLE Codling moths overwinter as pupae in tree bark cracks and soil near trees. As temperatures warm in the spring (approximately above 50°F), adults emerge, mate and begin laying eggs near fruit sites on trees. After eggs hatch, larvae feed on leaves and shoots, and later burrow into fruit until they pupate to emerge again as adults. Depending on temperatures, there can be up to three generations in Montana per growing season.

MANAGEMENT Pick up and dispose of dropped fruit. In small plantings, individual fruits can be protected by pruning each cluster when the apples are about the size of a quarter. This can reduce larval burrowing between touching fruit. Remove small or weakly attached fruits until there are about one to two apples per cluster. Then fruit can be wrapped in nylon footlets. Staple the footlet at the top. Trees can also be wrapped in corrugated cardboard, which can help trap larvae that are leaving the apples to find a place to pupate. The cardboard should be removed and destroyed before adults emerge. Mating disruption is a management technique that involves releasing a male sex attractant into the air. This works optimally with areas of 10 acres or greater. Several contact insecticides are available for chemical control. The timing of chemical controls is critical and coincides with egg laying, which is after flowering and dependent on the number of accumulated degree days (based on weather). Never apply a chemical spray during bloom. Some reduced-risk contact insecticides include those with the active ingredients *Bacillus thuringiensis* (*kurstaki* strain), kaolin clay, horticultural oil, spinosad and the codling moth granulovirus. Other insecticides include broad-spectrum insecticides with the active ingredients carbaryl, permethrin, and malathion.

A Codling moth adult. **B** Codling moth caterpillar. **C** Codling moth damage on apples.


A
B
C

Cooley Spruce Gall Adelgid

Adelges cooleyi

HOST Spruce, Douglas-fir

DAMAGE/SYMPTOMS Adelgids resemble aphids and form cone-like galls on the new growth of spruce trees. At the end of the summer, the galls resemble miniature pinecones.

LIFE CYCLE The insects use both Douglas-fir and spruce as hosts. On Douglas-fir, the adelgids overwinter as nymphs and mature in May. Some will disperse to spruce trees. On spruce, winged adelgids lay eggs which hatch in the spring around bud break. The nymphs move to the base of the needles to begin feeding. Gall formation occurs on spruce only, and the adelgids will continue to feed and develop within the galls.

MANAGEMENT The galls on spruce rarely harm the tree, and most trees have a high resistance to them. The damage on Douglas-fir is minimal. Once the galls have turned brown, the insects have already left the galls; removing them will not remove the insects or reduce future populations of the insects. For chemical control, a contact insecticide can be applied prior to gall formation or a systemic insecticide can be applied to the spruce tree in early spring.

A Galls on terminals of spruce. **B** Brown galls on terminals. **C** Developing galls.


A
B
C

Cottony Maple Scale

Pulvinaria innumerabilis

HOST Hackberry, honeylocust, linden, maple, boxelder

DAMAGE/SYMPTOMS The scale damages its host plant by sucking the sap from the tree, which can cause dieback of twigs and branches. It secretes excessive honeydew as a waste product. This can be unattractive underneath the tree, can attract nuisance wasps, and can also attract sooty mold.

LIFE CYCLE The scale overwinters as a fertilized adult female on branches of the tree. Feeding activity resumes in the spring. A waxy, cottony egg sac is produced in late spring. Egg hatch occurs in late June through July, and the crawlers then move to the leaves.

MANAGEMENT Cottony maple scale is attacked by several natural enemies, including lady beetles, predatory flies and wasps, and sparrows. Dormant oils can be used in early spring prior to bud break. The crawlers are clear and flattened and can be monitored with a white piece of paper placed underneath the vegetation. Contact insecticides, such as bifenthrin and permethrin, can be applied to the crawler stage of the scale (late June through July). Systemic insecticides, containing the active ingredients imidacloprid and dinotefuran, can be applied in the spring.

A Cottony maple scale on maple branch. **B** Cottony maple scale adult.


A


B

Douglas-Fir Tussock Moth

Orgyia pseudotsugata

HOST Douglas-fir, spruce, fir

DAMAGE/SYMPTOMS Caterpillar feeding and defoliation typically starts on new, succulent foliage at the top of the tree and continues downward. Sometimes the defoliation can be severe, especially if occurring over repeated seasons. Caterpillars may be found under webbing and silk harborages on the branches.

LIFE CYCLE They overwinter as egg masses on twigs and branches. The eggs hatch in the spring at bud break, often in late May, and caterpillars begin feeding on the new growth. They then move to feed on older needles. Adults emerge in late summer (late July through mid-August). There is one generation per year.

MANAGEMENT A variety of predators and natural enemies normally keep populations down, including parasitic wasps, tachinid flies, spiders, and birds. If chemical control is necessary, contact insecticides are most effective during the early spring when caterpillars are younger. Monitoring for caterpillars is critical for the proper timing of insecticide applications. Some reduced-risk options for control include insecticides with the active ingredients *Bacillus thuringiensis* (*kurstaki* strain) and spinosad. Other contact insecticides include those with the active ingredients cyfluthrin, permethrin, and lambda-cyhalothrin.

A Douglas-fir tussock moth cocoon. **B** Douglas-fir tussock moth damage.
C Douglas-fir tussock moth caterpillar. **D** Douglas-fir tussock moth adult.


A
B
C
D

Engraver Beetles

Ips spp.

HOST Pine, spruce

DAMAGE/SYMPTOMS Dieback at the top of the tree is evident with *Ips* beetle infestations but this can also be confused with many abiotic-related issues. At the base of the tree, the beetles leave a yellow or reddish/brown dust from boring activity. Shot-hole sized exit holes are evident on the outside of the bark. Galleries from larval feeding are apparent just below the outer bark.

LIFE CYCLE Adults overwinter underneath the bark. The larvae create galleries surrounding egg-laying areas. There can be up to four generations per year.

MANAGEMENT Once *Ips* beetles are in the tree, it is hard to kill the beetle and to correct the damage. Slash should be piled and burned prior to adult beetle emergence in May. Beetles can potentially be prevented from infecting other trees. Preventive contact insecticides (active ingredients bifenthrin, permethrin, and carbaryl) can be sprayed on the trunk of the tree prior to egg laying in May or to protect surrounding healthy trees.

A Pines damaged by *Ips* beetle infestations. **B** Galleries from *Ips* beetles. **C** *Ips pini* adult.


A


B


C
1 mm

Eriophyid Mites

Family Eriophyidae

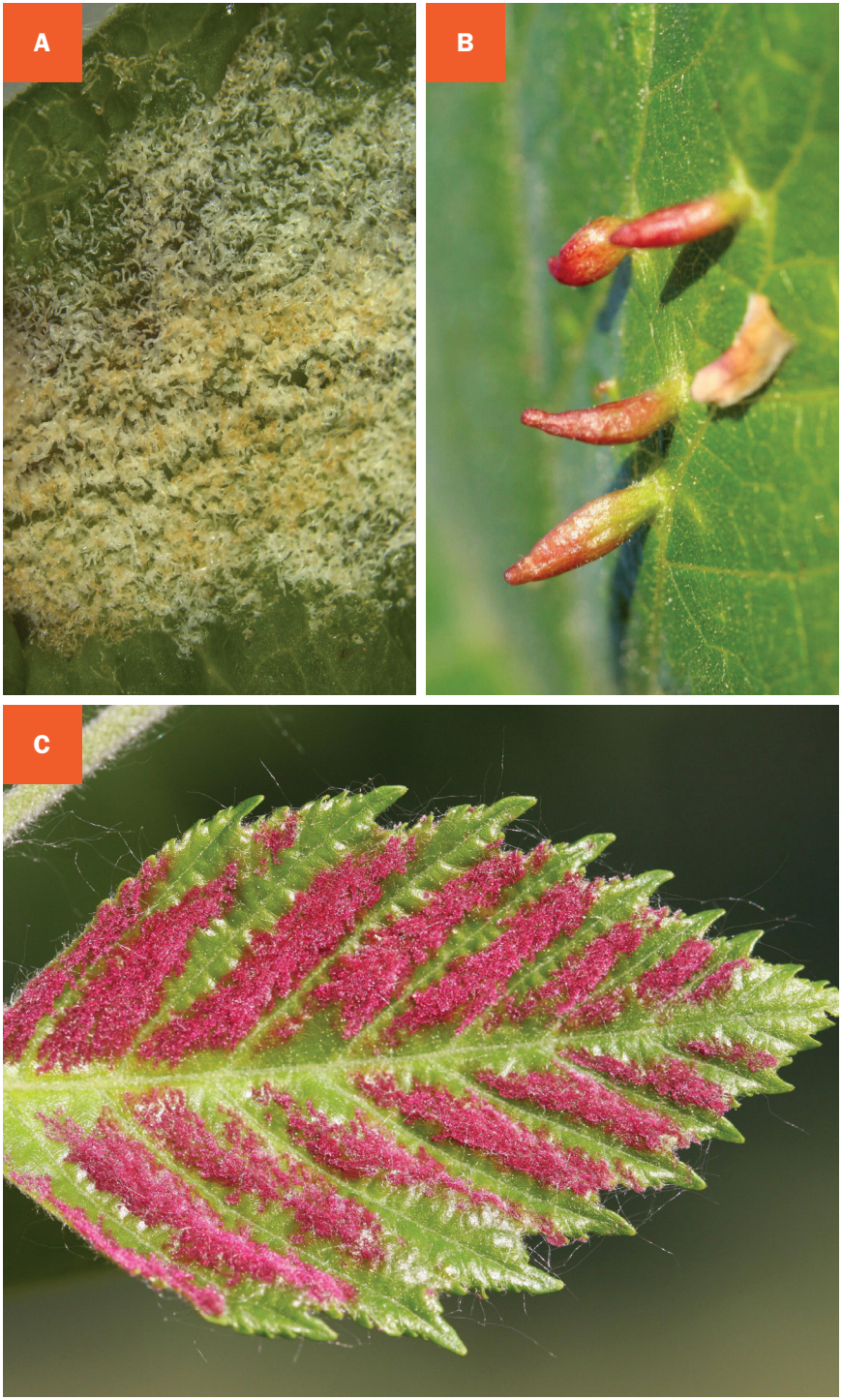
HOST Several hosts

DAMAGE/SYMPTOMS The damage caused from these microscopic mites rarely causes serious harm to the plant. The mites will pierce the leaf tissue and feed within the damaged areas. This results in either distortions or galls that can take the form of a blister, finger, hair, pouch, felt-like patch, witches' broom, or bump.

LIFE CYCLE Mites typically overwinter as fertilized adult females under bud scales or other covered areas. The females will emerge following bud break, and several generations are produced throughout the growing season.

MANAGEMENT Galls or injuries sustained by the mites are generally cosmetic and are not known to harm the tree. If practical, galls can be pruned out and discarded. Dormant oils can be applied in early spring to control the overwintering mites if several branches and leaves are affected. A miticide labeled for the host can be used at bud break to manage emerging females.

A Erinea galls on *Viburnum*. **B** Finger-like galls on lilac. **C** Felt-like galls on river birch.


A
B
C

European Elm Scale

Gossyparia spuria

HOST Elm

DAMAGE/SYMPTOMS The scale extracts fluids from the phloem of the tree, causing premature yellowing of leaves, especially on the lower branches. Heavy infestations can cause twig drop. The scale excretes excessive amounts of honeydew as a waste product, and black sooty mold can develop on this honeydew.

LIFE CYCLE The scale overwinters as a nymph at the base of buds in cracks of bark or twigs. At the end of June through early July, the female lays eggs that hatch into bright yellow active crawlers within several days. The crawlers will reside within grooves along the midrib and prominent veins on leaf undersides. The scale remains immobile at these sites for the remainder of the summer. There is one generation per year.

MANAGEMENT The scale can be controlled prior to bud break with dormant oils. It can also be controlled during the crawler stage with a contact insecticide. Resistance to systemic insecticides with the active ingredient imidacloprid has occurred with this scale insect.

A European elm scale adult. **B** European elm scale on bark.


A


B

Forest Tent Caterpillars

Malacosoma spp.

HOST Poplar, willow, ash, aspen, fruit trees, other hardwoods, currant

DAMAGE/SYMPTOMS The caterpillars feed on leaves and cause defoliation of trees and shrubs.

LIFE CYCLE Forest tent caterpillars overwinter in the egg stage. The caterpillars emerge in the spring and start constructing tents in the crotches of branches. They feed nightly through July, pupate, and emerge as adults in late summer. There is one generation per year.

MANAGEMENT The "tent" or webbed shelter can be cut out of the plant. Several natural enemies, such as parasitic wasps, help control the caterpillars. Since this tent is a resting area, it is easy to capture them during the day. However, wearing gloves is essential because of the irritating hairs on the caterpillar. If necessary, the young caterpillars can be controlled chemically with contact insecticides. Reduced-risk insecticides include those with the active ingredients *Bacillus thuringiensis* (*kurstaki* strain) and spinosad. Other contact insecticide options include the broad-spectrum active ingredients carbaryl, permethrin, and cyfluthrin.

A Western tent caterpillar. **B** Western tent caterpillar damage. **C** Western tent caterpillar damage. **D** Western tent caterpillar adult.


A


B


C


D

Giant Conifer Aphids

Cinara spp.

HOST Conifers

DAMAGE/SYMPTOMS In large groups, the aphids can often blend in with the bark. Aphids feed on the sap from woody areas of the tree. Heavy infestations can cause needle drop, yellowing, curling of the needles, and dieback. The aphids also produce copious amounts of honeydew.

LIFE CYCLE Females lay eggs on needles in late summer. In the spring, eggs hatch and aphids reproduce asexually throughout the summer. Early season populations are on the terminal growth and upper areas of the tree.

MANAGEMENT Heavy aphid populations can be a sign of stress, and evergreens often suffer from environmental stress due to planting issues (planted too deep) or being underwatered. Aphid populations tend to be higher in plants or trees that are highly fertilized. Hose off aphids with a strong stream of water. Placing cardboard wraps with Tanglefoot around the tree can also help (see management discussion under "Aphids"). Aphids are controlled by natural enemies when populations are low. For chemical control, contact insecticides that are labeled for the host can be used in early to late spring.

A Giant conifer aphids clustering at base of needles. **B** Giant conifer aphids on juniper.


A


B

Leafcurl Ash Aphids

Prociphilus fraxinifolii

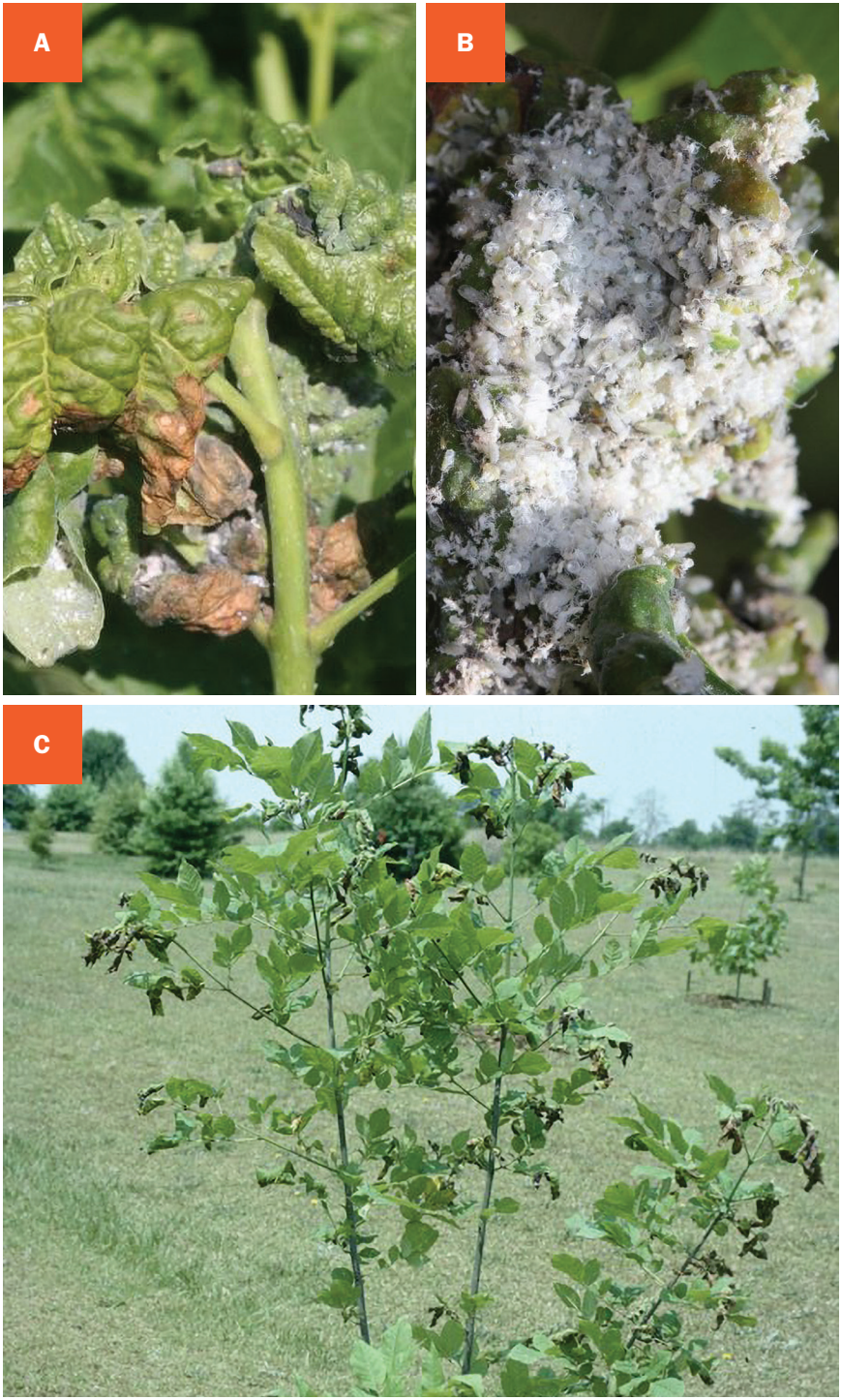
HOST Ash

DAMAGE/SYMPTOMS Aphid feeding creates tightly rolled and thickened leaves. Feeding damage is often referred to as a "pseudo gall" because it causes some distortion and twisting of the twigs next to the damaged leaves. The aphids are found inside the leaves with a waxy-cottony-type covering.

LIFE CYCLE Winged stages disperse to new growth of ash after bud break. Aphids continue to feed within the curled leaves and produce several generations. Populations decline after the new growth stops. Aphids oversummer or overwinter in debris below or near the ash tree.

MANAGEMENT Affected trees should recover from the leaf curling, and the aphids normally disperse from the tree shortly following the development of the new growth. Damage is generally cosmetic and doesn't typically harm the tree. Keep ash trees adequately watered. Refrain from fertilizing the tree; aphids respond to higher nitrogen concentrations. Pruning has not been very effective due to the high mobility of the aphid. Natural enemies come in later in the season and are an active part of control. Spraying or chemical control with a contact insecticide should be done prior to leaf curling. Once the leaves have curled, a contact insecticide will not be effective, and a systemic insecticide (active ingredients imidacloprid and dinotefuran) needs to be applied for control.

A Curling damage from aphids. **B** Aphid infestation within the leaf. **C** Damage on ash from the leafcurl ash aphid.


A
B
C

Leafhoppers

Erythroneura spp.

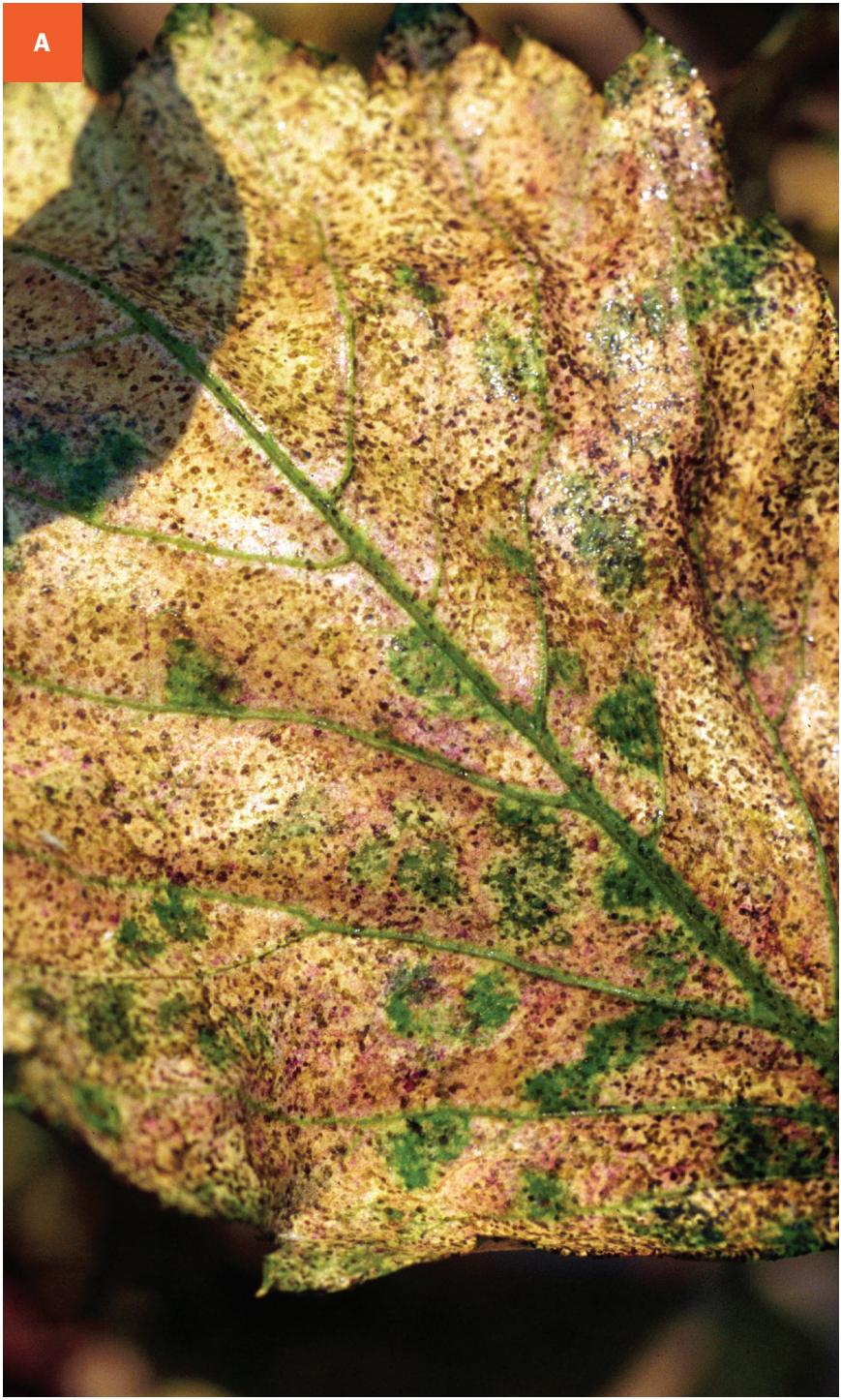
HOST Grape, Virginia creeper, maple

DAMAGE/SYMPTOMS Leafhoppers are sap-sucking insects. Their feeding results in stippling and flecking of the leaves. Heavier infestations can cause graying of the foliage and defoliation.

LIFE CYCLE Leafhoppers overwinter as adults in debris or sheltered areas around previously infested plants. The adults emerge in the spring and deposit eggs below the leaf surface. Eggs hatch within one to two weeks, and the nymphs begin feeding on the leaves. They become adults in approximately three weeks. There are three to four generations per year.

MANAGEMENT Most leaves and vines can tolerate relatively high populations of leafhoppers without affecting plant health. It is important to remove weeds and debris in late winter to early spring to reduce overwintering populations. The leafhoppers can be dislodged or trapped by shaking the plant and holding a sheet or piece of paperboard underneath with a sticky substance (such as Tanglefoot). They have many natural enemies, such as lady beetles, spiders, and parasitoid wasps in the genus *Anagrus* (attack leafhopper eggs). Several contact insecticides are available for control, including horticultural oils, insecticidal soaps, and those with the active ingredients *Beauveria bassiana* and spinosad. Insecticides with the active ingredient carbaryl can also be used. Complete coverage of the foliage is critical. To protect pollinators, apply only during late evening, night, or early morning when bees are not active.

A Feeding damage from leafhoppers on a Virginia creeper leaf.


A

Mountain Pine Beetle

Dendroctonus ponderosae

HOST Pine, Douglas-fir, fir, spruce

DAMAGE/SYMPTOMS Needles from infested trees turn a reddish-brown. Boring dust next to the tree is also a sign of infestation. Pink popcorn-like resin spots are often on the trunk.

LIFE CYCLE Mountain pine beetle adults are active in June and move to new trees in July through August. Females lay eggs under the bark. The larvae spend the winter developing in the phloem of the tree, forming distinct galleries. There is one generation per year, and beetle outbreaks occur every 10 to 30 years.

MANAGEMENT Once bark beetles enter the tree, the trees are not likely to survive. One preventive treatment option to protect healthy trees from attack is verbenone pine beetle repellent, which is an anti-aggregation pheromone. The verbenone pouches should be applied prior to beetle flight, which can be as early as late May in some locations. The pouches are only effective for one season and need to be replaced annually. A contact insecticide labeled for the host (active ingredients carbaryl, permethrin, and bifenthrin) can also be applied as a trunk spray in June through August (according to the label) for preventive measures on healthy trees.

A Mountain pine beetle adult. **B** Pitch tubes from mountain pine beetle infestations. **C** Galleries on the bark from mountain pine beetle infestations.


A
B
C

Oystershell Scale

Lepidosaphes ulmi

HOST Aspen, ash, cotoneaster, willow, lilac

DAMAGE/SYMPTOMS Branch dieback can occur with heavy infestations.

LIFE CYCLE Eggs hatch around mid to late May. The crawlers then feed, settle, mate, and produce an armored shell on branches for overwintering. The female produces eggs and remains protected underneath the shell throughout the winter.

MANAGEMENT In small numbers, oystershell scale rarely affects plant health. The scale is typically controlled by natural enemies later in the season. If practical, scrub the branches lightly with a plastic brush. If chemical control is necessary, apply a dormant oil before bud break. Monitor for the crawler stage and follow up with a contact spray if populations are heavy. The systemic insecticide and active ingredient dinotefuran can be applied in early May. The active ingredient imidacloprid is not very effective against hard scales such as the oystershell scale.

A Scale infestation on aspen. **B** Oystershell scale eggs. **C** Oystershell scale adult and eggs.


A
B
C

Pear Sawfly or Pearslug

Caliroa cerasi

HOST Pear, cherry, plum, quince, apple, cotoneaster

DAMAGE/SYMPTOMS These insects are not actually true "slugs" but are closely related to wasps. The damage is quite distinctive, showing a skeletonizing effect on the leaf surface. They can cause browning of the leaves, premature leaf drop, and reduced fruit size or production the following season.

LIFE CYCLE Adults emerge in late June to July. Females lay eggs on the upper surface of the leaves. The larvae feed on the upper leaf and drop to the soil to pupate. A second generation of adults emerge within a couple of weeks. The second generation can often be more damaging to the leaf tissue.

MANAGEMENT Pearslugs can be washed off with vigorous jets of water. Wood ash or dirt thrown on the slugs will help to dry them out and kill them. There are several contact insecticides labeled for chemical control, including horticultural oils, neem oil, or products with the active ingredient spinosad.

A Pearslug larvae on leaf. **B** Pearslug damage on peach leaf.


A


B

Pine Needle Scale

Chionaspis pinifoliae

HOST Pine, spruce, Douglas-fir

DAMAGE/SYMPTOMS White scale coverings appear on the needles. Heavy infestations can cause yellowing, lack of vigor, and needle drop.

LIFE CYCLE The pine needle scale overwinters on the needles in several different stages under the armored shell of the female. Egg hatch occurs from late April to June, depending on the temperature. The crawler stage happens to coincide with lilac bloom. The scale nymphs settle on the needles and remain immobile for the remaining season. The white shell of the female is formed in late July.

MANAGEMENT Heavy infestations are often indicative of a stressed tree. Low populations of pine needle scale will not harm the tree, and predators are very important for control of the scale. If chemical control becomes necessary, a dormant oil can be applied before bud break (note: some oils can cause discoloration of spruce needles). Check for the active crawler stage by putting a white piece of paper underneath some pine branches and shaking the vegetation. If the crawlers are active (about the size of a pin head), they will fall and move on the piece of paper. Follow up with a contact spray for the crawler stage, if necessary.

A Scale infestation on needles. **B** Pine needle scale adults.


A


B

Poplar Borer

Saperda calcarata

HOST Aspen, cottonwood, poplar

DAMAGE/SYMPTOMS The larvae bore into the sapwood and girdle trees. Heavily infested trees will establish a blackish stain on the bark below the attack. During high winds, branches can break off, which can allow for further invasion of wood rot.

LIFE CYCLE The adults are active from June through August. The females feed on the leaves and shoots for a couple of weeks. They then lay eggs on the surface of the bark, and the larvae will ultimately move into the sapwood. The larvae are a cream or yellow color, and they can reach over an inch long when mature. The larvae pupate in late spring beneath the bark. Adults start emerging in June. The life cycle of this beetle can reach up to three years.

MANAGEMENT Make sure the tree receives adequate water. Plant aspen trees in large groups so the trunks can be shaded. If the tree is heavily infested or showing major damage, it should be removed as it can negatively affect other trees in the area. For biological control, there are insect-attacking nematodes that can be injected into the borer holes. Contact insecticides can be sprayed on the trunk prior to egg laying to prevent further infestation in the tree. Applications should concentrate mainly around infested areas of attack, if any, and on the middle areas of the tree. Systemic insecticides have shown limited success in controlling larvae that are already present in the tree. Some active ingredients include dinotefuran, bifenthrin, permethrin, and carbaryl. Trunk injections can be done with the active ingredients emamectin benzoate and azadirachtin.

A Poplar borer adult. **B** Frass from insect tunneling. **C** Multiple stages of the poplar borer under the bark.


A
B
C

Root Weevils

Several species (*Otiorhynchus* spp. and many others)

HOST Lilac, dogwood, grape, peony, spirea, many deciduous shrubs

DAMAGE/SYMPTOMS The characteristic damage from adults includes notching along the leaf margins from chewing. The larvae feed on plant roots.

LIFE CYCLE The weevils generally overwinter as full-grown larvae in the roots of plants. Pupation occurs in the spring, and adults emerge in early June. Some will survive as adults and overwinter in buildings or structures.

MANAGEMENT Most often, no management is necessary. If damage or dieback is evident on the woody ornamental, treatment might be necessary. Treatment is most effective when adults emerge in late May through early June. Contact insecticides that contain the active ingredients bifenthrin, cyfluthrin, or lambda-cyhalothrin can be applied in the evening when the adult beetles are active.

A Black vine weevil. **B** Strawberry root weevil. **C** Root weevil damage on lilac.


A
B
C

Rough Bulletgall Wasp

Disholcaspis quercusmamma

HOST Bur oak, white swamp oak

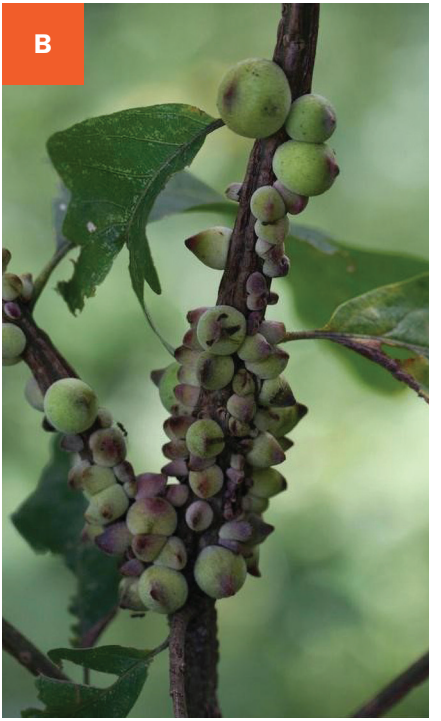
DAMAGE/SYMPTOMS In the summer, dark green swellings will develop on the current season's twigs, becoming almost knuckle-sized by August. The galls become woody on the branches. Branch dieback can occur with heavy infestations.

LIFE CYCLE There are two generations. A female-only generation (asexual generation) emerges from the hardened twig galls in late fall (late October through early November), and eggs are laid in the terminal growth of dormant buds. The following spring, as new shoot growth begins, pale- or cream-colored bud-shaped galls form (later turning a tan color), each containing an individual larva. Adult male and female wasps (sexual generation) emerge from these galls, mate, and lay eggs in the newly developing green twigs. After several weeks, dark green swellings appear and eventually form round galls. The galls are initially a reddish color but then turn brown and harden with subsequent development. A sweet substance similar to honeydew is released from the galls. Wasp larvae continue to feed and develop into pupae within the galls throughout the summer and into the fall.

MANAGEMENT The galls can cause dieback and significant damage if they become heavy on branches and start to weigh down the tree. Predators and parasitoid wasps are important for management of the pest. The active ingredient emamectin benzoate has been moderately effective in reducing future galling by the insects; however, the active ingredient is only commercially available, and it must be applied by a certified arborist. The wasps are difficult to control chemically because they are protected within the galls.

A Rough bulletgall wasp damage. **B** Early-season galls. **C** Adult wasp.


A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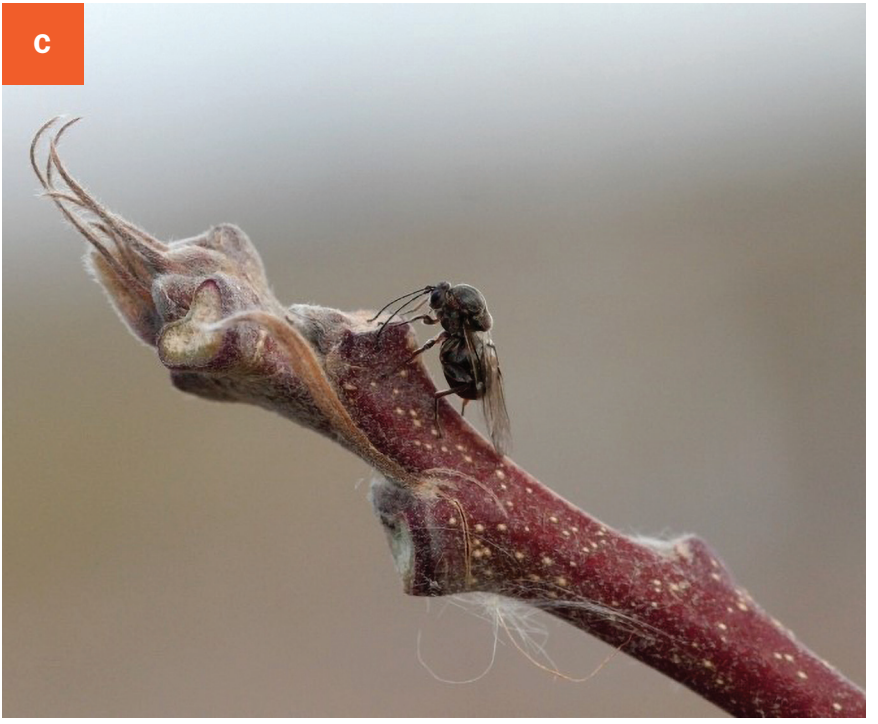

C

Spruce Bud Scale

Physokermes spp.

HOST Spruce

DAMAGE/SYMPTOMS The reddish-brown covering surrounding the scale resembles a spruce bud. Because of this, they are often unrecognized. The scale releases copious amounts of honeydew that can attract black sooty mold. Heavy infestations can cause dieback of lower branches.

LIFE CYCLE The scale nymphs spend the winter on the spruce needles or bud scales. In late spring, mating occurs followed by egg laying. Egg hatch occurs in June through early July. The crawlers migrate to the needles to start feeding and then move to the twigs later in the spring. There is one generation per year.

MANAGEMENT Provide spruce trees with adequate water. Dormant oils applied in early spring followed by a contact insecticide in late June (during the crawler stage) are recommended for management. Horticultural oils and some other oils can cause discoloration of the spruce needles. A systemic insecticide with the active ingredients imidacloprid or dinotefuran can be applied in the spring.

A Spruce bud scale at base of twig.


A

Spruce Spider Mite

Oligonychus ununguis

HOST Spruce, fir, pine, juniper, arborvitae, Douglas-fir, yew

DAMAGE/SYMPTOMS The spider mite is a sap-sucking arthropod, and its feeding results in flecking and greyish spots. Mites usually attack the older needles in the lower portions of the tree. With heavier infestations, needles will prematurely drop, and stunting of the needles can occur. Silk can also be evident on the needles.

LIFE CYCLE Eggs hatch in the spring, and they develop into adults in about a month. The spider mites are dormant in the warmer months and are more of a cool-season pest. There are typically two generations per year.

MANAGEMENT Spider mites respond to stressed trees. If practical, increase the humidity on the trees by jetting them with water on a regular basis. Mites have several natural enemies, such as predatory mites, plant bugs, and spiders to help control them. If chemical control is necessary, miticides, horticultural oil, neem oil, and insecticidal soap will minimize damage to the natural enemies of spider mites, which are important for spider mite control. Spider mites are resistant to many insecticides, and broad-spectrum insecticides should be avoided due to the killing of beneficial insects and other arthropods. The best time to treat spruce spider mite infestations is in May and again in September (second generation).

A Mite webbing on needles. **B** Adult mite.


A


B

Two-Spotted Spider Mite

Tetranychus urticae

HOST Wide range of deciduous trees, shrubs

DAMAGE/SYMPTOMS The spider mites pierce plant cells and suck the sap out, causing flecking injuries and yellowing. They also cause premature leaf drop. Leaves will start to look wilted, and heavy infestations can cause serious damage to plants.

LIFE CYCLE The spider mites typically overwinter under debris near host plants. Mites reach adulthood in about 10 days, and females can lay up to 60 eggs in two to three weeks. They seek shelter later in the summer and cease feeding activity.

MANAGEMENT Populations of spider mites increase with dryness and warm temperatures. Minimize drought by spritzing plants frequently. If chemical control is necessary, miticides, horticultural oil, neem oil, and insecticidal soap will minimize damage to the natural enemies of spider mites, which are important for spider mite control. Spider mites are resistant to many insecticides, and broad-spectrum insecticides should be avoided due to the killing of beneficial insects and other arthropods.

A Adult spider mites. **B** Spider mite damage on bean leaves.


A


B

Western Spruce Budworm

Choristoneura freemani

HOST Douglas-fir, fir, spruce, larch

DAMAGE/SYMPTOMS On the needles, insect excrement and webbing are present. The caterpillars can cause defoliation, deformation of the needles, and chewing damage.

LIFE CYCLE The caterpillars emerge in the spring and begin feeding. They pupate and reach adulthood in July. The females lay eggs, which hatch in about 10 days. In late July, young caterpillars create a cocoon-like structure to spend the rest of the season.

MANAGEMENT Beneficial predators can help to control populations of the budworms. Monitoring for the caterpillars allows for properly timed chemical applications. Several contact insecticides, including the bacterium *Bacillus thuringiensis* variety *kurstaki,* are available for caterpillar control.

A Western spruce budworm damage. **B** Western spruce budworm pupa and damage. **C** Western spruce budworm caterpillar.


A
B
C

White Pine Weevil

Pissodes strobi

HOST Spruce, white pine

DAMAGE/SYMPTOMS Feeding by the developing insects causes the top of the tree to suddenly wilt and die in early summer. This is often referred to as a "shepherd's crook." Once the top leader is killed, some side branches will change their growth habit and will grow upward to replace the dead leader.

LIFE CYCLE The weevil adults become active in early spring. They feed on the main branches near the leader and insert eggs into feeding cavities. Eggs hatch in about two weeks, and the larvae will tunnel under the bark. The larvae pupate, and adults emerge in late July through August. The adults overwinter in leaf litter and debris around spruce trees.

MANAGEMENT The infested terminal can be clipped, and a new leader can be trained. This should be done when the larvae are still inside the branch (before the end of July). Terminals should be cut only as far down as necessary to remove the weevil larvae. Destroy the pruned terminals. Rake up the needles and debris under the tree in the fall. Since the top leader and upper branches are the only parts of the tree affected by the insect, non-chemical controls are suitable. Chemical options are only recommended if necessary, and the timing of application is critical. Contact insecticides are most effective when sprayed at the terminal of the tree in the spring when adults are actively feeding and will not be as effective once the larvae have burrowed underneath the bark. Some active ingredients include permethrin, bifenthrin, and cyfluthrin. This can be difficult to time, but adult activity usually starts on warm, sunny days in late spring. A systemic insecticide (active ingredients including imidacloprid, emamectin benzoate, dinotefuran, or abamectin) can be applied as a soil drench in the spring followed by several days of watering to allow for sufficient root uptake.

A White pine weevil damage on blue spruce. **B** Weevil exit holes on top of tree. **C** Pupal chambers within the infested terminal.


A


B


C

Willow Redgall Sawfly

Pontania proxima

HOST Willow

DAMAGE/SYMPTOMS The sawflies produce bean-shaped swellings on the leaves.

LIFE CYCLE The adults emerge in the spring and lay eggs on the leaves. The larvae, which resemble green caterpillars, will feed and induce gall formation. The larvae then drop to the ground to spin a cocoon, and adults emerge within several days. There can be up to two generations per year.

MANAGEMENT Willow redgall sawfly damage is primarily a cosmetic issue and is not known to significantly affect the health of the tree. Rake up leaves and dispose of them off site at the end of the season. Natural enemies come in later in the season to help control the sawflies.

A Sawfly damage on leaf. **B** Sawfly adult.


A


B

ABIOTIC ISSUES

Deep Planting/Grade Change

DAMAGE/SYMPTOMS There are several signs that a tree might have been planted too deep. The most obvious sign is the lack of trunk flare, which is where the tree widens near the soil surface. Trees planted incorrectly tend to lack vigor and have a shortened life expectancy. They exhibit premature leaf drop, wilting, scorch, chlorosis, and stunted growth. When the trunk is excavated, adventitious and girdling roots are often found.

OCCURRENCE Recently planted trees are extremely susceptible to damage due to deep planting. Balled and burlapped trees can also be planted too deep due to where the soil is deposited on the trunk during the packaging process. Landscape construction in the vicinity of trees and grade changes in a landscape can also lead to trees being lodged too deep.

SUSCEPTIBILITY/TOLERANCE Any tree is susceptible to damage from deep planting. Improper planting is a major reason for premature tree death. Most tree roots grow in the top six inches of soil where water, nutrients, and air are readily available. When excess soil is deposited on top of the existing soil it limits the tree's ability to access these resources.

MANAGEMENT Recently planted trees can be lifted and replanted correctly. A root collar excavation can be done on established trees. Excess soil and mulch can be removed from the circumference of the trunk to the point where the trunk flares out into root growth.

A Adventitous roots growing from trunk where it had been buried too deep. **B** Trunks that show no flare where they enter the soil are planted too deep. **C** A hackberry planted too deep displays chlorosis and canopy dieback.


A


B


C

Deer

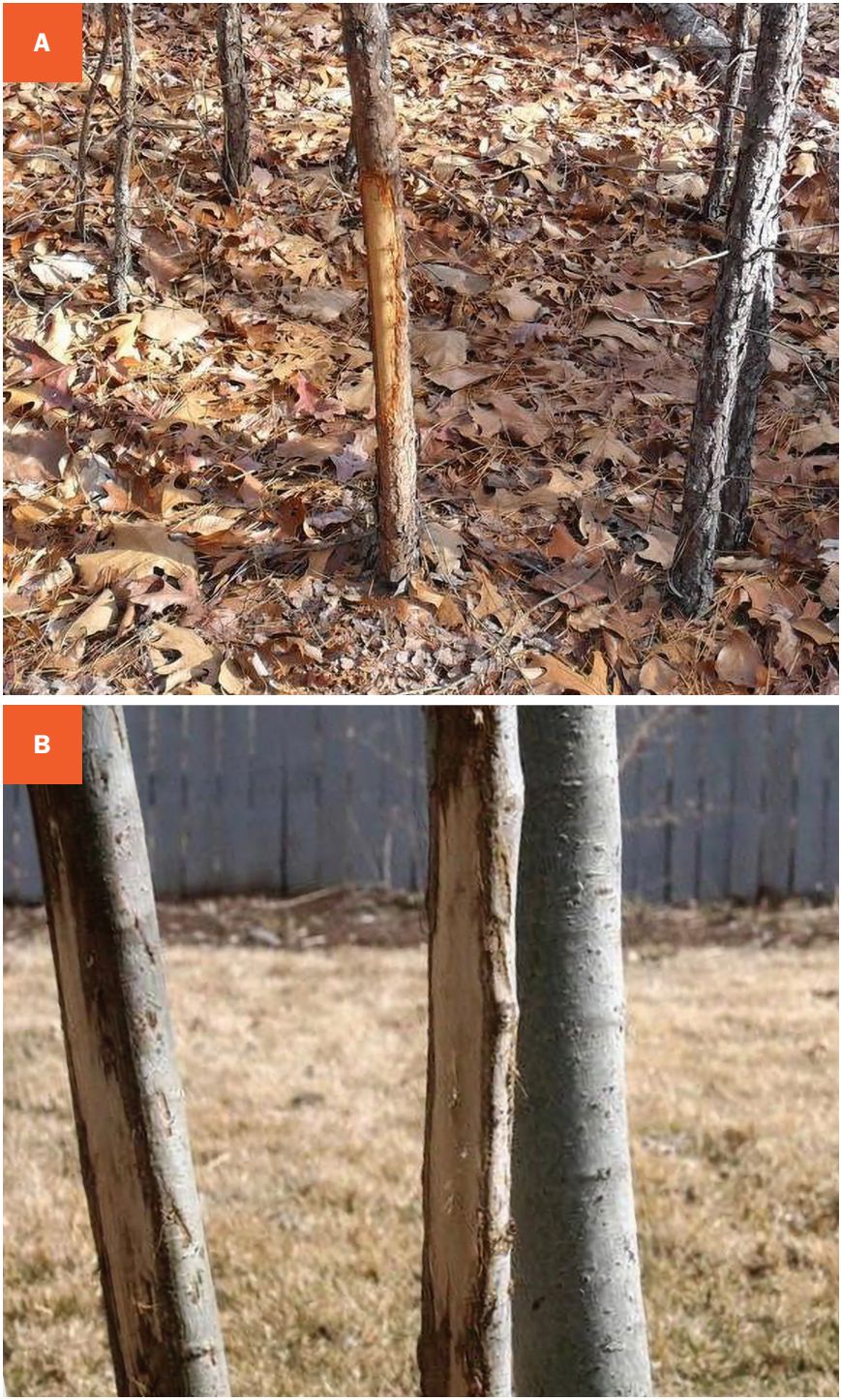
DAMAGE/SYMPTOMS Bark scraping and shredded bark are evidence of antler rubbing by deer. Bucks rub or scrape the velvet from their antlers on trees. Deer may also feed on trees. Mule deer and white-tailed deer lack upper incisors. Because of this, they leave no teeth marks. They often leave a jagged or torn surface on twigs or stems that they feed on.

OCCURRENCE In the fall and early winter, male deer will rub on trees to remove velvet and to mark trees. Deer will feed on trees throughout the year, but less in the summer due to abundant food sources.

SUSCEPTIBILITY/TOLERANCE Deer prefer to rub on immature trees with smooth bark and no limbs.

MANAGEMENT Install trunk guards/tree protectors to susceptible trees. Plant native trees and shrubs that are more tolerant of browsing or deer-resistant plants. Use fencing to exclude deer from certain areas. There are also repellents available to deter deer.

A Damage to trunk by deer rubbing. **B** Deer prefer smooth-barked trees, like aspen, for rubbing.


A
B

Drought Stress

DAMAGE/SYMPTOMS Drought stress is most apparent in areas of the tree crown that are in full sun. Chlorosis, leaf scorch, wilting, reduced growth, fewer/smaller leaves, and shorter growth between leaf buds are all symptoms of drought stress. Early leaf/needle drop (premature senescence) and lowered energy reserves for survival through winter are also issues. Drought-stressed trees have decreased resistance to pests, so they are more vulnerable to secondary attacks.

OCCURRENCE Newly planted trees are the most vulnerable to drought stress due to an underdeveloped root system. Drought stress occurs when the plant is unable to extract enough water from the soil to properly function. Under drought conditions, soil might bind available moisture, making it unavailable to the plant. For instance, clay soils can inhibit absorption.

SUSCEPTIBILITY/TOLERANCE Well-established trees are less likely to show symptoms of drought stress. Trees planted within three years or less are more likely to sustain permanent injuries due to drought. Trees native to Montana are more tolerant of drought conditions.

MANAGEMENT Water trees weekly in the fall until the ground freezes. This will reduce the chance of stress in the summer. Removing competing vegetation such as grass from beneath a tree's canopy will make more resources available to the tree and may reduce drought stress. Use three to four inches of mulch to the edge of the tree canopy to insulate the fine feeder roots from drying out. Water slowly and deeply rather than quickly and shallowly.

A Premature coloration of maple leaves due to drought. **B** Dogwood with damaged leaves from effects of drought. **C** A conifer exhibiting browning and premature casting of needles due to drought stress.


A


B


C

Fasciation

DAMAGE/SYMPTOMS Fasciation is a symptom. It most often occurs in stems and causes them to take on a flattened appearance. The contorted tissue may have an elongated or ribbon-like appearance. Flowers with fasciation may have a bushy growth habit. Some affected plants are propagated intentionally due to their tendency towards fasciation.

OCCURRENCE Fasciation occurs in plants due to abnormal activity in the meristem or growing tip of the plant. It can be the result of hormonal or genetic factors. It can also be caused by pathogens (bacterial, fungal, or viral), insect damage, or animal damage. Abiotic issues, such as chemical exposure, mechanical injury and frost, can also cause fasciation.

SUSCEPTIBILITY/TOLERANCE All plants can exhibit fasciation. Trees in the *Prunus* or *Salix* genera and the Rosaceae family are examples of plants that display fasciation most often.

MANAGEMENT Affected parts can be pruned out. There is no treatment for fasciation.

A Lilac with a fasciated limb. **B** Some plants like *Veronicastrum sibericum* are propagated because of their fasciation.


A


B

Frost Crack

DAMAGE/SYMPTOMS Frost cracks are vertical splits that occur in tree trunks and bark after severe, rapid temperature changes in the winter. Damage usually occurs on the south or southwest side of vulnerable trees because those sides experience the greatest fluctuation in temperature. Frost cracks can reopen and enlarge in subsequent winters and may extend to the center of the tree.

OCCURRENCE When temperatures are below 15 degrees, frost cracks may form due to the shrinking and expansion of wood in relation to water movement and ice formation. Young trees and smooth barked trees are more likely to sustain damage.

SUSCEPTIBILITY/TOLERANCE Maple, birch, poplar, apples, and ash are susceptible to frost cracks.

MANAGEMENT To avoid frost cracks in young trees, a trunk guard can be installed. These guards are usually white and reflect sunlight from vulnerable surfaces. They should be installed in the fall and removed in the spring. Leaving them on year-round can promote fungal and insect issues. If damage occurs, monitor trees for the development of decay. Reduce stress and encourage tree vigor through proper watering and pruning. Do not treat frost cracks with "wound paint", as these products do not reduce the chance of decay.

A Green ash often show frost crack damage. **B** Frost cracks generally appear on the south and southwest sides of trees.


A


B

Herbicide Injury–Glyphosate

DAMAGE/SYMPTOMS Leaves appear narrow and chlorotic. Branches may die back starting at the tip, and growth from buds below the dieback portion of the branch may be chlorotic and distorted with excessive sprouting called "witch's broom."

OCCURRENCE Glyphosate is commonly used around trees to control weeds. This practice is usually safe for trees since glyphosate is not generally absorbed by plant roots or mature bark. However, if glyphosate contacts aboveground growth such as leaves or root suckers, it can impact the tree. Glyphosate may also be absorbed through young bark or exposed roots.

SUSCEPTIBILITY/TOLERANCE Glyphosate is non-selective, meaning all types of plants are susceptible.

MANAGEMENT Monitor the tree to see if it recovers. Support tree health and limit further exposure to herbicides. To limit stress to the tree during recovery, do not prune or fertilize the tree for one growing season. Injury symptoms may occur for more than one year. To prevent glyphosate damage, be sure to protect all desired plants from contact with this herbicide.

A Glyphosate injury on deciduous tree.


A

Herbicide Injury–Synthetic Auxins

DAMAGE/SYMPTOMS Various growth abnormalities including twisting, cupping, and curling of leaves, stems, and twigs on broadleaf trees are common. Conifers can also show symptoms of needle and shoot distortion.

OCCURRENCE Synthetic auxin herbicides such as 2,4-D and dicamba are used to control broadleaf weeds in lawns and along roadsides. Drift of these herbicides occurs when spray particles move through the air during application or when they form a gaseous vapor due to volatilization after application.

SUSCEPTIBILITY/TOLERANCE Broadleaf trees and conifers are susceptible.

MANAGEMENT Wait and see if the tree recovers. Support tree health and limit further exposure to herbicides. Injury symptoms may occur for more than one year. To prevent damage from this type of herbicide, make sure to read and follow product labels. Avoid applying these herbicides under tree canopies. Also, avoid using these herbicides during windy weather, or when temperatures are forecast to be above 80 degrees.

A 2,4-D injury on grape. **B** 2,4-D injury to pine.


A


B

Leaf Chlorosis

DAMAGE/SYMPTOMS Leaf chlorosis generally progresses from light green earlier in the season to yellow later in the season. Leaf veins may remain bright green while the leaf tissue yellows. Advanced stages of chlorosis can cause reduced leaf size, browning of the leaf margins, subsequent tissue deterioration, and premature leaf drop.

OCCURRENCE Chlorosis can be caused by a single issue such as a nutrient deficiency, but more commonly it is due to multiple factors influencing the health of the plant. Drought, over watering, compacted soils, limited planting areas, and poorly drained soils can impact a plant's vulnerability to chlorosis. Soil pH can influence leaf chlorosis because it has a significant role in a plant's ability to uptake available nutrients. For example, some nutrients such as iron can be less available to plants as soil pH increases.

SUSCEPTIBILITY/TOLERANCE Certain trees are more prone to chlorosis such as apple, maple, and poplar. Trees and shrubs that are more tolerant of alkaline soils and less likely to show leaf chlorosis are linden, ash, boxelder, oak, elm, hawthorn, and honeylocust.

MANAGEMENT Planting trees that are tolerant of alkaline soils is important in managing chlorosis. Supplemental watering during drought conditions can reduce tree stress and the risk of chlorosis. Removing grass at the base of trees will reduce the competition for water. Mulching with two to three inches of compost to retain soil moisture will also reduce the risk of chlorosis.

A Browning of leaf margins in advanced stages of chlorosis. **B** Certain tree species, like maple, are more susceptible to chlorosis. **C** Light green leaf tissue along with darker veins can indicate chlorosis.


A


B


C

Leaf Scorch

DAMAGE/SYMPTOMS Leaf scorch usually appears as brown necrotic areas on the margin of leaves which move from the leaf tip downward and from the margins inward. Scorch can cause leaves to turn dark brown to black and fall off prematurely.

OCCURRENCE Scorch is a physiological disorder. Adverse environmental conditions can result in leaf scorch. For instance, hot summer days will cause many trees, shrubs, flowers, and vegetables to develop dry, brown leaf margins. Windy conditions that reduce leaf moisture also contribute to leaf scorch and dehydration. Minimal soil moisture in the winter and spring will contribute to leaf scorch development.

SUSCEPTIBILITY/TOLERANCE Aspen, maple, ash, oak, linden, birch, and horse chestnut are most susceptible to leaf scorch. Scorch can affect a variety of plant species.

MANAGEMENT Leaf scorch is irreversible; however, proper water management may help the plant recover. To prevent scorch, water more deeply and less often to ensure that the water is deeply penetrating the soil, for deep root development. Mulching around the tree can also help conserve soil moisture, improving the tree's condition. Winter watering is another way to help prevent scorch.

A Brown necrotic areas on the margin of leaves. **B** Leaf scorch can cause leaves to turn brown and prematurely fall.


A


B

Seasonal Needle Drop

DAMAGE/SYMPTOMS Seasonal needle drop is the gradual yellowing or browning and eventual loss of older interior needles. Needles that drop due to age may have some spots and blemishes; however, they do not display typical symptoms of disease or insect damage.

OCCURRENCE Seasonal needle drop occurs in late summer to early fall. This casting of needles is triggered by weather and the time of year, and many evergreens are likely to show symptoms at the same time.

SUSCEPTIBILITY/TOLERANCE The amount of needle loss is dependent upon species, temporal factors, and environmental conditions. White pines are seriously affected. Third- and even second-year needles yellow and fall throughout the entire tree. Austrian and Scotch pines typically lose only fourth-year needles. Cedars often display browning of leaves and flagging of older branchlets. Eventually entire branchlets are shed. Spruce and fir generally maintain many years of growth. Seasonal needle drop is typically not obvious but can be visible on inner branches. Larch and tamarack trees lose all of their needles every fall.

MANAGEMENT Management for seasonal needle drop is not necessary. If the yellowing and needle drop is restricted to older needles and is not extreme, it is likely not a problem. Maintain tree health. Irrigating evergreens thoroughly before the ground freezes will help to minimize the possibility of winter injury through desiccation.

A Browning of older needles in a pine.


A

Transplant Shock

DAMAGE/SYMPTOMS Leaf scorch, wilting, reduced leaf size, and chlorosis can all be attributed to the pressures that occur during transplanting. Delayed growth is common after recent planting.

OCCURRENCE Compromised roots are the primary cause of transplant shock. Tree roots are frequently damaged because of the way they were packaged for sale. In addition to the symptoms listed above, plants that are under stress from transplant shock are also more vulnerable to disease and insect infestations.

SUSCEPTIBILITY/TOLERANCE Transplant shock is common in newly installed trees. Balled and burlapped trees may have sustained a significant reduction of root mass, due to the excavation process. Bare root trees and containerized trees can also exhibit transplant issues.

MANAGEMENT Woody ornamentals can take up to five years to establish themselves in a new location depending on the size of the tree planted. Smaller stock is less susceptible to transplant shock. Watering properly is essential when trees are establishing. Regular watering for the first year is crucial. Pruning of newly planted trees should be limited to those limbs that are diseased, damaged or dead. Excessive pruning of newly planted trees will increase stress.

A Watering is essential when trees are establishing. **B** Compromised roots are the primary cause of transplant shock. **C** Transplant shock is common in newly installed trees.


A


B


C

Voles

DAMAGE/SYMPTOMS Tiny marks from vole incisors can be seen on the bark of trees and shrubs. Bark damage is usually on the lower eight to ten inches of the trunk where it is protected by snow.

OCCURRENCE Vole damage to trees and shrubs primarily takes place in the fall and winter. During winter months and sometimes during drought, voles will move from surrounding uncultivated areas into landscaped yards and gardens to find food.

SUSCEPTIBILITY/TOLERANCE Voles primarily eat grasses but will eat a wide assortment of vegetation including bark during the winter months.

MANAGEMENT Habitat modification, such as removing ground covers, eliminating debris, and lawn mowing, are strategies to reduce vole numbers. Exclusion is another approach for limiting vole damage. Install hardware cloth at least six inches below the ground and extending at least 14 inches above ground. Protect seedlings or young trees with trunk guards or poly wrap. Repellents like capsaicin, the compound of chili peppers that makes them hot, are registered for voles in Montana. They can be sprayed on non-crop/feed plants, such as ornamental trees, shrubs, fruit bushes, and vines. Trapping is a tool for controlling voles in areas with a few acres or less. Unbaited mouse snap traps can be placed perpendicular to their paths with the trigger in their trail. Baited snap traps are also effective but should be protected by an overhead cover to prevent injury to non-target animals.

A Vole paths become more apparent as snow melts in the spring. **B** Bark removed from juniper due to vole feeding. **C** Vole damage to the base of a tree.


A


B


C

Woodpeckers and Sapsuckers

DAMAGE/SYMPTOMS Sapsuckers are a type of woodpecker that peck horizontal holes in limbs to create hollows to feed on sap. These holes fill with sap and the birds also feed on insects trapped in this sap. Other woodpeckers peck at wood searching for insects. Woodpeckers and sapsuckers both excavate roosting/nesting cavities in trees.

OCCURRENCE Most damage occurs during the breeding season, which occurs from February through June.

SUSCEPTIBILITY/TOLERANCE Woodpeckers most often attack trees that are already weakened by insects, disease, or fire, but also damage healthy trees.

MANAGEMENT Hardware cloth can be used to protect trees from woodpecker and sapsucker damage. Wrap branches and trunks loosely to avoid girdling as the tree grows. Devices hung in the tree that flash or reflect light when moved by the wind may frighten the birds. Tactile repellents like polybutene-based gels are registered for repelling birds from surfaces.

A Close-up photo of a sapsucker. **B** A red-naped sapsucker perched on a limb with previous pecking damage. **C** Woodpeckers and sapsuckers excavate cavities in dead trees for nesting. **D** Sapsucker damage on a birch limb.


A


B


C


D

VOCABULARY

Abiotic	Relating to nonliving agents, including physical and environmental factors. Examples: precipitation, temperature, mechanical, and chemical influences.
Active ingredient	The ingredient in a pesticide product that controls the target pest.
Alkaline	Having basic (non-acidic) properties; a pH greater than 7.
Alternate leaf arrangement	Only a single leaf is attached at each stem node.
Alternate host	One of two kinds of plants on which a pathogenic fungus must develop to complete its life cycle. Example: cedar-apple rust.
Annual	A plant that normally completes its life cycle of seed germination, vegetative growth, reproduction, and death in a single year.
Appressed	Lying flat or pressed closely against something.
Arthropod	A group of animals characterized by having an exoskeleton made of chitin, bilateral symmetry, and segmented appendages.
Asexual	A type of reproduction in the absence of males.
Balled and burlapped	Nursery trees or shrubs that have been dug with soil surrounding the roots and wrapped with material.
Bare root	Pertaining to tree seedlings raised in open fields and lifted from the soil prior to transplanting.
Beneficial organism	An individual plant, animal, or microorganism that can provide a benefit to an aspect of plant growth, pollination, or pest management.
Biological control	The action of parasites, predators, or pathogens in maintaining another organism's population density at a lower average level than would occur in their absence.
Biotic	Relating to living organisms. Examples: pathogens (fungi, bacteria), insects, mites, and vertebrates.

Blight	Sudden, severe withering of leaves, flowers, shoots or fruit.
Broadleaf	Plants with leaves that have a flat, relatively wide surface compared to those with needle-like leaves.
Broad-spectrum	Insecticides that lack selectivity to a particular insect.
Canker	Dead, discolored, often sunken area (lesion) on a root, trunk, stem, or branch.
Candle	The new growth on pine and spruce trees.
Catkin	A tassel-like spike of closely clustered, small, unisexual flowers without petals. Examples: birch and willow have catkins.
Chlorosis	Yellowing of leaves, veins, or areas of leaves between the veins.
Complete metamorphosis	An insect's change in form during development that involves egg, larval, pupal, and adult stages.
Compound leaf	A leaf divided into discrete leaflets.
Conifer	Cone-bearing plant.
Contact insecticide	A pesticide that is intended to directly contact the insect and that is absorbed through the exterior of the insect.
Corymb	A flat-topped flower cluster.
Crawlers	Scale insects in their active stage.
Crown	The part of the tree where the trunk or main stem joins the roots and the upper canopy.
Deciduous	Trees or shrubs that lose their leaves every year.
Dioecious	Male and female flowers on separate plants; both must be present for the female to produce fruit.

Disease cycle	Stages of disease development and the effect on the host.
Dormant oil	A horticultural oil that is applied prior to bud break to target overwintering insects.
Drupe	Fleshy fruit with one or more stony seeds.
Evergreen	Plants that retain most of their leaves throughout the year.
Exclusion	The use of barriers to separate pests and diseases from susceptible plants.
Exit holes	The area of a tree or branch from where an adult wood-boring insect emerges.
Frass	Excrement produced by insects and other arthropods.
Fungus	A multicellular organism lacking chlorophyll, such as mold, mildew, smut, or rust.
Gall	Swelling or outgrowth of plant tissue, often formed in response to the action of a pathogen or other pest.
Galleries	Etchings in the wood formed from the larvae of wood-boring beetle feeding and activity.
Girdling	Injury to the bark, cambium, and sapwood that completely encircles the trunk or branch of a tree.
Gummosis	The reaction of a tree to outside stimuli like weather, pathogens, or insects, resulting in the discharge of a gummy substance.
Herbicide	A pesticide designed to control or kill plants.
Honeydew	A waste product excreted from sap-sucking insects, such as aphids, mealybugs, whiteflies, and soft scales.
Horticultural oil	Highly-refined oil used to control soft-bodied insects and insect eggs in the summer and the dormant season.
Host	A plant or animal that provides nourishment for another organism.

Inflorescence	The arrangement of flowers on a plant.
Lanceolate	Leaf shape that is longer than wide, with the widest point below the middle of the leaf.
Larvae	The immature stage of an insect that goes through complete metamorphosis.
Least toxic	Pest management products and techniques that have low or no toxicity to humans or are formulated and/or applied in a manner that minimizes exposure to humans and other nontarget organisms.
Lenticel	Pores in the bark of woody plants that allow gases to pass between the outside atmosphere and the interior of the plant.
Microorganism	An organism of microscopic size, such as a bacterium, virus, or fungus.
Monitoring (scouting)	Regular collection of information related to the activity, growth, development, and abundance of organisms or other factors.
Monoecious	Having both, male and female flowers, on the same plant.
Mosaic	A symptom of a plant viral disease that displays regular, light green, or yellow patches of tissue on leaves.
Mulch	A layer of material placed on the soil surface to prevent weed growth and reduce moisture loss.
Natural enemy	An organism known to control a pest species, including a predator, parasitoid, or pathogen.
Necrosis	Death of plant tissue accompanied by dark brown discoloration usually occurring in a well-defined part of a plant.
Necrotic	Dead or discolored brown plant tissue.
Nutlet	A small nut.

Nymph	The immature stage of an insect that goes through simple metamorphosis.
Opposite leaf arrangement	Two leaves are paired at the same node, one on each side of the stem.
Organic	A production or management system that utilizes fertilizers and pesticides that are naturally derived; a compound that contains molecules of carbon.
Ovate leaf	Egg-shaped leaf that is broadest at the base.
Overwinter	A stage of reduced activity and metabolism for an insect during the dormant season.
Palmate	Pattern of leaf veins radiating from a common point at the base of the leaf to the tips of the leaf lobes or leaflets.
Panicle	A branched flower cluster or inflorescence where flower stalks attach individual flowers to the stem.
Pathogen	A microganism capable of causing disease. Examples: fungi, viruses, and bacteria.
Perennial	A plant that can live three or more years and flowers at least twice.
Persistent	Attached to the plant beyond the usual time of falling.
Pest	An organism that causes a problem to humans concerns. Examples: insects, mites, pathogens, nematodes, plants, vertebrates, microbes.
pH	Numerical designation of acidity and alkalinity.
Phenological	Related to the stages of the life cycle of a plant. Examples: bud break, leafing out, or flowering.
Phloem	A layer of living cells below the bark responsible for transporting nutrients and plant food compounds; the innermost layer of bark.
Pinnate	A compound leaf that has leaflets arranged on either side of a common stalk, sometimes in pairs opposite each other.

Predator	An animal that feeds on other living organisms.
Preventive insecticide	A pesticide applied to inhibit the infestation of insects on susceptible trees or woody ornamentals.
Pupa	The stage of an insect between the larva and the adult that is primarily inactive and does not feed.
Resistance	A change in the sensitivity of a pest population to a pesticide, which results in a failure of the pesticide to control the pest.
Samara	Dry, winged fruit that does not split at maturity.
Sapwood	The living outer portion of the wood between the cambium and heartwood.
Scorch	Burned appearance of leaf edges caused by either environmental factors or infection.
Sensescence	Aging or death of plant tissue.
Serrated	Leaf margin with continuous, forward-pointing teeth.
Sign	The pathogen or its structures or products that are visible on a host plant.
Simple leaf	An undivided leaf where the blade is not divided into leaflets.
Simple metamorphosis	An insect's change in form during development that involves egg, nymph, and adult stages.
Skeletonizing	A pattern of insect damage that involves chewing mainly on one side of the leaf while also leaving the main vein intact.
Soil drench	An application of a chemical solution directly to soil at the base of the tree or woody ornamental.
Sooty mold	Black, powder-like fungi that grow on the honeydew secretions of sap-sucking insects.

Spike	A flower cluster or inflorescence that is not branched; each flower is attached directly to the main stem with no stalk.
Stippling	Small, white flecking injuries to leaf surfaces due to sap-feeding insects.
Stomata	Tiny pores in plant leaves and needles that facilitate gas exchange.
Sunscald	Trunk and limb tissue injury resulting from rapid temperature changes, most commonly occurring in the winter.
Symptom	Internal or external reaction of a plant as a result of disease or injury.
Systemic	A pesticide that is absorbed through the leaves and roots of the plant and moves within the plant.
Target pest	A pest species that a control action is intended to destroy.
Threshold	A set level of insect or disease infection that must be reached before treatment is required. Examples: economic or aesthetic thresholds.
Two-ranked	Leaves or needles arranged in two vertical lines on opposite sides of the stem.
Two-valved	Fruit splits down both sides when ripe.
Vector	An organism able to transport and transmit a pathogen to a host.
Whorled leaf arrangement	More than two leaves are found at the same node.
Wilt	The loss of water from leaves, causing collapse.

ADDITIONAL RESOURCES

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Bacterial Blight of Lilac

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Bacterial Wetwood or Slime-flux

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Black Knot

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Crown Gall
A Lesley Ingram, Bugwood.org
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Cytospora Canker
A Joseph OBrien, USDA Forest Service, Bugwood.org
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Diplodia Tip Blight
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B Susan K. Hagle, USDA Forest Service, Bugwood.org
C Ronald S. Kelley, Vermont Department of Forests, Parks and Recreation, Bugwood.org
D Joseph OBrien, USDA Forest Service, Bugwood.org

Dothistroma Needle Blight
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C George Hudler, Cornell University, Bugwood.org
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B Elizabeth Bush, Virginia Polytechnic Institute and State University, Bugwood.org
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D Rebekah D. Wallace, University of Georgia, Bugwood.org

Kabatina Tip Blight
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Marssonina Leaf Blight
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C William Jacobi, Colorado State University, Bugwood.org
D Eva Grimme, Montana State University

Nectria Canker
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Rhabdocline Needle Cast
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Rhizosphaera Needle Cast
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Shothole Blight
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Stigmina Needle Cast
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Sudden Needle Drop
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Swiss Needle Cast
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Aphids
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B D. Cappaert, Bugwood.org #5422731
C Cranshaw, CSU, Bugwood.org #2200050

Ash Bark Beetles
A J. Solomon, USFS, Bugwood.org #3067012
B W. Cranshaw, CSU,

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C D. Cappaert, Bugwood.org #5371044

Ash Flower Gall Mite
A S. Katovich, Bugwood.org #5202097
B D. O'Brien, Cornell University, Bugwood.org #5458338
C A. Munson, USFS, Bugwood.org #1470186

Ash Plant Bug
A S. Katovich, Bugwood.org #1398085

Aspen Blotch Leafminer
A S. Katovich, Bugwood.org #5443552

Blister Mites
A W. Cranshaw, CSU, Bugwood.org #1325070

Bronze Birch Borer
A S. Valley, ODA, Bugwood.org #545856
B S. Katovich, Bugwood.org #1457024

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A Clemson University -USDA Cooperative Extension Slide Series, Bugwood.org #1435202
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Cooley Spruce Gall Adelgid
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B Pennsylvania DCNR-Forestry, Bugwood.org #5018062
C W. Ciesla, FHMl, Bugwood.org #758020

Cottony Maple Scale
A E. Nelson, Bugwood.org #5360709
B D. Blackford, USFS, Bugwood.org #2181096

Douglas-fir Tussock Moth
A W. Guy, Bugwood.org #1587117
B D. Powell, USFS, Bugwood.org #1212015
C USFS-Region 2, Bugwood.org #1441052
D W. Ciesla, FHMl, Bugwood.org #5346085

Engraver Beetles
A S. Katovich, Bugwood.org #1398232
B S. Tunnock, USFS, Bugwood.org #2253083
C K. Walker, Museum Victoria, Bugwood.org #5403413

Eriophyid Mites
A Lauren Kerzicnik, Montana State University
B M. Zubrik, FRI, Slovakia, Bugwood.org #5379452
C S. Katovich, Bugwood.org #5424246

European Elm Scale
A J. Berger, Bugwood.org #5402456
B W. Cranshaw, CSU, Bugwood.org #5303021

Forest Tent Caterpillars
A W. Ciesla, FHMl, Bugwood.org #5537850
B W. Ciesla, FHMl, Bugwood.org #5509373
C W. Ciesla, FHMl, Bugwood.org #5509369
D W. Ciesla, FHMl, Bugwood.org #5509359

Giant Conifer Aphids
A B. Hammon, CSU, Bugwood.org #5495188
B W. Cranshaw, CSU, Bugwood.org #1476087

Leafcurl Ash Aphid
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B W. Cranshaw, CSU, Bugwood.org #5445325
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Leafhoppers
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Mountain Pine Beetle
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B W. Cranshaw, CSU, Bugwood.org #5382166
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Oystershell Scale
A W. Ciesla, FHMl, Bugwood.org #1254050
B W. Cranshaw, CSU, Bugwood.org #5509538
C W. Cranshaw, CSU, Bugwood.org #1325097

Pear Sawfly
A J. Payne, USDA-ARS, Bugwood.org #1224178
B L. Ingram, Bugwood.org #5401602

Pine Needle Scale
A J. Hanson, USFS, Bugwood.org #0949066
B US National Collection of Scale Insects Photographs, USDA-ARS, Bugwood.org #5111063

Poplar Borer
A J. Solomon, USFS, Bugwood.org #3046001
B W. Cranshaw, CSU, Bugwood.org #1476104
C J. Solomon, USFS, Bugwood.org #284067

Root Weevils
A C. Moorehead, Bugwood.org #5211047
B W. Cranshaw, CSU, Bugwood.org #5499242
C W. Cranshaw, CSU, Bugwood.org #5561106

Rough Bulletgall Wasp
A W. Ciesla, FHMl, Bugwood.org #5579319

B S. Katovich, Bugwood.org #5497086
C W. Cranshaw, CSU, Bugwood.org #5083021

Spruce Bud Scale
A S. Katovich, Bugwood.org #1593006

Spruce Spider Mite
A W. Strong, BC Ministry of Forests, Bugwood.org #5445600
B W. Strong, BC Ministry of Forests, Bugwood.org #5445597

Two-spotted Spider Mite
A F. Peairs, CSU, Bugwood.org #5361242
B W. Cranshaw, CSU, Bugwood.org #5369738

Western Spruce Budworm
A W. Ciesla, FHMl, Bugwood.org #758022
B W. Ciesla, FHMl, Bugwood.org #5466869
C W. Ciesla, FHMl, Bugwood.org #5466872

White Pine Weevil
A D. Herms, OSU, Bugwood.org #1523048
B S. Katovich, Bugwood.org #1199034
C W. Cranshaw, CSU, Bugwood.org #1326028

Willow Redgall Sawfly
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ABIOTIC ISSUES

Deep Planting/Grade Change
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B Luana Vargas, Desert Botanical Garden, Bugwood.org
C Sarah Eilers, Montana State University

Deer
A David Stephens, Bugwood.org
B Whitney Cranshaw, Colorado State University, Bugwood.org

Drought Stress
A Robert L. Anderson, USDA Forest Service, Bugwood.org
B Charles Hoysa, Virginia Cooperative Extension, Bugwood.org
C Susan K. Hagle, USDA Forest Service, Bugwood.org

Fasciation
A Sarah Eilers, Montana State University
B Richard Krott, Tizer Botanical Gardens

Frost Crack
A Sarah Eilers, Montana State University
B Sarah Eilers, Montana State University

Herbicide Injury–Glyphosate
A Ansel Oommen, Bugwood.org

Herbicide Injury–Sythetic Auxins
A Brian Dintelmann; University of Missouri Weed Science Program
B Minnesota Department of Natural Resources, Bugwood.org

Leaf Chlorosis
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Leaf Scorch
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Seasonal Needle Drop
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Transplant Shock
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C Joseph OBrien, USDA Forest Service, Bugwood.org

Voles
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B Elizabeth Bush, Virginia Polytechnic Institute and State University, Bugwood.org
C Richard Krott, Tizer Botanical Gardens

Woodpeckers and Sapsuckers
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B Alice Siebecker
C Joseph OBrien, USDA Forest Service, Bugwood.org
D Sarah Eilers, Montana State University

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