

Table 1. Common diseases of woody ornamentals in Massachusetts, host plants, and associated management options.

DISEASE	PATHOGEN*	HOSTS	SYMPTOMS & MANAGEMENT	ACTIVE INGREDIENT(S)
Needle Casts & Blights: Cause premature needle loss, typically on lower, heavily shaded branches. Disease establishment generally favored by rainy and mild weather in the spring.	<i>Rhizosphaera</i> (55-56)	Spruce (<i>Picea</i> ; especially <i>P. pungens</i> and <i>P. glauca</i>) Fir (<i>Abies</i>) Secondary hosts include: Pine (<i>Pinus</i>) True cedar (<i>Cedrus</i>) Hemlock (<i>Tsuga</i>) Douglas-fir (<i>Pseudotsuga</i>) Arborvitae (<i>Thuja</i>)	New infections are initiated in late spring after wet periods, but symptoms may not appear until the autumn, and in some cases, symptoms may not appear until 12-15 months after infection. Symptoms appear as brown/purple needles, especially on interior sections near the main trunk. The disease typically develops on lower canopy branches first, then progresses upward in the canopy. Small, dark purple to black pads of fungal tissue may be visible on needles and resemble a black powder. Prune dead branches to remove needles harboring the pathogen and to increase air-flow; rake up or cover fallen needles with mulch; apply fungicides when young needles are partially elongated and again after 21 days if wet conditions persist.	Chlorothalonil (R) Chlorothalonil+Thiophanate-methyl (R) Copper Salts of Fatty and/or Rosin Acids Copper Hydroxide Copper Hydroxide+Mancozeb Mancozeb Thiophanate-methyl
	<i>Mycosphaerella dearnessii</i> (brown needle spot) (26-29)	Pine (<i>Pinus</i> ; especially <i>P. strobus</i>)	New infections develop in the spring, and recent epidemics have been linked to very wet conditions in spring months. Symptoms first appear as necrotic spots, which may coalesce over time. Lower branches are most susceptible. Infections are initiated in the spring and typically spread from needle tips to the base. Promote sunlight and air-flow; heavily infected branches may be pruned to reduce inoculum in the infected tree. If the infection is severe, fungicides can be applied at bud break, with reapplication necessary if wet conditions persist.	Chlorothalonil+Thiophanate-methyl (R) Copper Salts of Fatty and/or Rosin Acids Mancozeb Thiophanate-methyl
	<i>Mycosphaerella pini</i> (also known as <i>Dothistroma septosporum</i>) (Dothistroma needle blight) (28-29)	Pine (<i>Pinus</i> ; especially <i>P. nigra</i>)	New infections can develop from late spring through autumn. Symptoms typically first appear in the autumn as tan-brown to reddish-brown foliar lesions. Needle tips often die back to the spot of the lesions until they completely die later on. The disease leads to premature needle shedding and stunted growth. When severe, trees can suffer serious needle loss.	Chlorothalonil+Thiophanate-methyl (R) Copper Salts of Fatty and/or Rosin Acids Mancozeb Thiophanate-methyl
	<i>Canavirgella</i> (50-51)	Eastern white pine (<i>Pinus strobus</i>)	Symptoms appear as yellow to tan lesions that expand towards needle tips, while the base remains a healthy green. Elongated black strips of fungal tissue may be visible on infected needles but are not always present. Maintain plant vigor, promote sunlight and air-flow to reduce moisture and prune heavily infected branches, if possible. Remove heavily infected trees.	Chemical management not warranted
	<i>Lophodermium</i> (46-47)	Pine (<i>Pinus</i>) Secondary hosts include: Fir (<i>Abies</i>) Spruce (<i>Picea</i>) Incense cedar (<i>Calocedrus</i>) False-cypress (<i>Chamaecyparis</i>) Juniper (<i>Juniperus</i>) Arborvitae (<i>Thuja</i>)	Symptoms appear as patchy, brown necrotic lesions of the needles. Small, football-shaped black pads of fungal tissue are often visible with the naked eye at any time of the year. New infections are initiated in late summer to early autumn, when the fungus sporulates from dead needles. Symptoms may appear shortly after infection or the following spring. For chemical control to be effective, it must take place between July and September; apply three to four treatments at 14-21 day intervals during this time.	Azoxystrobin, Chlorothalonil (R) Chlorothalonil+Thiophanate-methyl (R) Copper Hydroxide+Mancozeb Mancozeb Triadimefon
	<i>Ploioderma</i> (48-49)	Pine (<i>Pinus</i> ; mostly two- and three-needle species)	New infections occur during the late spring to early summer, during wet periods. However, visible symptoms do not develop until the following winter and spring and appear as yellow to orange spots scattered along the needles. Over time, the spots coalesce and the tissue becomes tan to brown. Symptoms typically appear on needle tips, leaving the needle base green. Maintain tree vigor during extended dry periods by watering, especially for young landscape and Christmas trees. Fungicide application should occur when new shoots are 0.5-2" long and new needles are just emerging; reapplications can be made at 14-21 day intervals, depending on environmental conditions.	Chlorothalonil (R) Chlorothalonil+Thiophanate-methyl (R) Copper Hydroxide Copper Hydroxide+Mancozeb Mancozeb
	<i>Rhabdocline</i> (58-59)	Douglas-fir (<i>Pseudotsuga menziesii</i>)	New infections develop just after bud break, when immature needles are expanding. Symptoms first appear as scattered yellow to reddish-brown lesions on needles in late summer or autumn. By the following spring (one year after infection), the lesions may appear as raised, brown callus tissue. Over time, lesions coalesce to kill needles, leading to defoliation. Avoid overhead watering and planting on moist and shaded sites. Promote air-flow and maintain good light exposure, especially on lower branches. Mow or prune underlying vegetation to reduce free moisture on needles. Chemical control requires multiple (up to four) applications, so follow the label carefully regarding the timing of each application.	Chlorothalonil (R) Copper Hydroxide Copper Hydroxide+Mancozeb Copper Salts of Fatty and/or Rosin Acids Copper Sulfate Thiophanate-methyl

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Needle Casts & Blights (continued):	<i>Phaeocryptopus</i> (Swiss needle cast) (58-59)	Douglas-fir (<i>Pseudotsuga menziesii</i>)	New infections initiate in the spring when the current season's needles are developing. Symptoms first appear as scattered yellowing of older needles and over time, numerous older needles die and are shed prematurely. While current year's needles are infected, they remain green and asymptomatic until the following year. Small, black pads of fungal tissue may be visible on the underside of needles, appearing as a fine black powder. Maintain proper spacing and control weeds around the base to promote air-flow. Apply fungicides if wet conditions occur when new shoots are 0.5-2 inches long and reapply 14-21 days later if wetness persists.	Azoxystrobin Chlorothalonil (R) Chlorothalonil+Thiophanate-methyl (R) Mancozeb Thiophanate-methyl
	<i>Meria</i> (60-61)	Larch (<i>Larix</i>)	Infection and the onset of symptoms develop quickly after long periods of rain in the spring and appear as yellow to brown lesions scattered along the needle surface. If wet conditions persist, the entire needle becomes chlorotic and many needles are shed early. Remove fallen needles to reduce inoculum at the site. For high-value trees, apply fungicides if wet conditions occur at bud break; reapplications can be made at 14-21 day intervals.	Chlorothalonil (R) Propiconazole
Stem Cankers & Shoot Blights: Generally characterized as opportunistic pathogens exploiting stressed and weakened trees and shrubs.	<i>Botryosphaeria</i> (120-129)	Numerous hardwoods and conifers	Infection can occur at any time from spring to autumn, but most infections are initiated in late spring to early summer. Symptoms include stem cankers and foliar dieback. Stress is often linked to disease incidence and severity. Prune and discard twigs and infected branches. Promote sunlight and air-flow as moisture and shade favor the pathogen. For severe infections or high-value trees and shrubs, apply fungicides in spring during new shoot development.	Azoxystrobin Azoxystrobin+Propiconazole Chlorothalonil (R) Boscalid+Pyraclostrobin Copper Salts of Fatty and/or Rosin Acids Copper Hydroxide Mancozeb Thiophanate-methyl Trifloxystrobin
	<i>Sphaeropsis sapinea</i> (also known as <i>Diplodia pinea</i>) (130-131)	Pine (<i>Pinus</i> ; mostly two- and three-needle species)	New infections develop most often in the spring, after prolonged wet periods. Symptoms appear as stunted and chlorotic needles, bud dieback and stem cankers. Prune and remove blighted buds and shoots and also remove and destroy fallen cones, as the pathogen will overwinter in all these types of tissue. Promote sunlight and airflow to reduce moisture. Abiotic stresses, especially drought, are linked to disease incidence and severity. Apply fungicides just prior to bud break and reapply until needles are fully elongated. Avoid nitrogen fertilization on trees known to be infected; fertilization promotes succulent shoot growth that is susceptible to infection.	Azoxystrobin Azoxystrobin+Propiconazole Chlorothalonil+Propiconazole (R) Chlorothalonil+Thiophanate-methyl (R) Copper Hydroxide Copper Hydroxide+Mancozeb Copper Salts of Fatty and/or Rosin Acids Mancozeb Potassium Bicarbonate Propiconazole Thiophanate-methyl Triadimefon
	<i>Botryodiplodia hypodermia</i> (also known as <i>Sphaeropsis ulmicola</i>) (132-133)	Elm (<i>Ulmus</i> ; especially <i>U. americana</i>)	Symptoms appear as flagging and wilt of small-diameter branches, typically higher in the canopy. Infected stems may exhibit brown to black, water-soaked stem lesions. Infections most often occur on small diameter branches (less than 4" in diameter). Wilt and dieback symptoms mimic Dutch elm disease, so careful inspection of vascular tissue is necessary to rule out the latter. Prune and destroy infected stems to reduce inoculum and promote sunlight and air-flow, especially for heavily shaded trees. Apply fungicides during wet periods in the spring and early summer to protect young shoots.	Azoxystrobin Azoxystrobin+Propiconazole Chlorothalonil+Thiophanate-methyl (R) Copper Hydroxide Copper Hydroxide+Mancozeb Copper Salts of Fatty and/or Rosin Acids Mancozeb Thiophanate-methyl
<i>Phytophthora</i> spp. (bleeding canker of deciduous hardwoods) (354-357)	European beech (<i>Fagus sylvatica</i>) Maple (<i>Acer</i>) Oak (<i>Quercus</i>) Horsechestnut (<i>Aesculus</i>) Dogwood (<i>Cornus</i>) Linden (<i>Tilia</i>) Elm (<i>Ulmus</i>) Numerous other hardwoods	Symptoms appear as water-soaked stem and branch cankers, often with profuse resin/sap flow from the damaged site. Depending on canker size, crown wilting and dieback may also occur. However, resin/sap production is a generalized host response and is not caused by <i>Phytophthora</i> alone. On some hosts, small branches, stems, foliage and fruit may also be infected and symptomatic.	Copper Salts of Fatty and/or Rosin Acids Mefenoxam/Metalaxyl Phosphorous Acid	

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Stem Cankers & Shoot Blights (continued)	<i>Phytophthora</i> spp. (shoot and foliar blight of rhododendron) (358)	Rhododendron/azalea (<i>Rhododendron</i> spp.) Japanese holly/andromeda (<i>Pieris japonica</i>)	Infections typically initiate during warm and humid weather when spores are splashed from the soil to the foliage of susceptible plants. Symptoms first appear as water-soaked, dark green spots and blotches at the base of buds and on the foliage. Within three days of infection, the diseased tissue becomes brown and necrotic. Infections sometimes expand beyond the foliage to the succulent shoots. Once established in the canopy, spores are blown or splashed to nearby leaves and plants. Therefore, do not irrigate using overhead watering if the disease is a concern. The disease causes early leaf drop and the pathogen then survives in dead plant parts that remain moist over the winter. Generally speaking, winter conditions are often too cold for pathogen survival in the soil or in desiccated plant tissues. Nurseries and greenhouses can often harbor the pathogen because of moderate winter temperatures. Regular scouting should take place for recently planted shrubs during hot and humid weather.	Copper Salts of Fatty and/or Rosin Acids Mefenoxam/Metalaxyl
	<i>Phomopsis</i> (also known as <i>Diaporthe</i>) (138-151)	Numerous conifers and hardwoods, including: maple (<i>Acer</i> ; especially <i>A. palmatum</i>), dogwood (<i>Cornus</i> ; especially <i>C. kousa</i>), juniper (<i>Juniperus</i>), hemlock (<i>Tsuga</i>), spruce (<i>Picea</i>) and rhododendron/azalea (<i>Rhododendron</i>)	New infections can develop anytime from spring to autumn but many develop in late spring to early summer. Symptoms include foliar/needle blight, stem cankers and branch dieback. Evergreen shrubs (holly, rhododendron, azalea) can suffer both foliar and stem blight. Prune and destroy infected leaves and stems and clean up all fallen leaves and stems. Avoid overhead watering and excessive pruning, which creates additional infection sites. Fungicides are often not effective in controlling <i>Phomopsis</i> , but can be applied to newly developing shoots and foliage on high-value trees and shrubs during the spring to help prevent new infections.	Azoxystrobin Azoxystrobin+Propiconazole Chlorothalonil (R) Chlorothalonil+Thiophanate-methyl (R) Copper Hydroxide Copper Hydroxide+Mancozeb Copper Salts of Fatty and/or Rosin Acids Copper Sulfate Debacarb+Carbendazim Mancozeb Thiophanate-methyl Trifloxystrobin
	<i>Leucostoma kunzei</i> (also known as <i>Cytospora kunzei</i>) (168-169)	Fir (<i>Abies</i>), larch (<i>Larix</i>) spruce (<i>Picea</i> ; especially <i>P. pungens</i>), pine (<i>Pinus</i>), Douglas-fir (<i>Pseudotsuga</i>) and hemlock (<i>Tsuga</i>)	Blue spruce is the most susceptible to this pathogen. Symptoms appear as scattered branch dieback, usually in the lower canopy. Infected branches often exhibit cankers with callused margins and resin flow, which appears white once it has hardened. Small, black pads of fungal tissue can often be observed at the outer margins of the cankers. Prune out and discard cankered branches before infections become severe on mature trees. Disease severity intensifies with drought stress and high levels of shade, so plant susceptible trees in full sun with good air-flow and water younger trees during prolonged dry periods.	Copper Hydroxide Copper Salts of Fatty and/or Rosin Acids Debacarb+Carbendazim
	<i>Valsa persoonii</i> (also known as <i>Leucostoma persoonii</i>) (170-171)	Hawthorn (<i>Crataegus</i>), apple (<i>Malus</i>), cherry/peach/plum (<i>Prunus</i>), pear (<i>Pyrus</i>), among other hardwoods	Sap flow is a primary symptom of infection, along with open cankers that may have rough callus tissue at the margins. On stone fruits, "gummosis" (excessive resin production from cankers with hardened masses of resin) is a common symptom. Prune and destroy infected branches to reduce inoculum and avoid overhead watering or planting trees in deep shade. Water trees with a thorough soaking of the roots during extended dry periods to avoid stress.	Copper Hydroxide Copper Salts of Fatty and/or Rosin Acids Debacarb+Carbendazim (microinjections)
	<i>Valsa</i> and <i>Leucostoma</i> spp. (also known as <i>Cytospora</i> spp.) (166-167; 172-175)	Numerous hardwoods, especially: maple (<i>Acer</i>), dogwood (<i>Cornus</i>), cherry (<i>Prunus</i>), poplar (<i>Populus</i>). Numerous conifers, especially: fir (<i>Abies</i>), juniper (<i>Juniperus</i>), larch (<i>Larix</i>) spruce (<i>Picea</i>), pine (<i>Pinus</i>), Douglas-fir (<i>Pseudotsuga</i>) and hemlock (<i>Tsuga</i>).	Flagging, wilt and general dieback are symptoms of infection. Abiotic stress and attack from other pathogens and insects can predispose trees and shrubs to infection. Prune and destroy infected stems and branches and avoid overhead watering and deep shade that limits air-flow.	Copper Hydroxide Copper Salts of Fatty and/or Rosin Acids Debacarb+Carbendazim (microinjections)
	<i>Pestalotiopsis</i> (190-191)	Numerous conifers and some hardwoods, including: juniper (<i>Juniperus</i>), arborvitae (<i>Thuja</i>), Japanese holly (<i>Cryptomeria</i>), true cedar (<i>Cedrus</i>), false cypress (<i>Chamaecyparis</i>), rhododendron/azalea (<i>Rhododendron</i>) and holly/inkberry (<i>Ilex</i>)	Symptoms vary by host, but typically include shoot tip and leaf/needle margin dieback. Small, eruptive pads of fungal tissue can often be seen on blighted plant parts. Prune and remove infected branches and foliage and avoid pruning during wet periods. Rake up and destroy any fallen leaves that may be harboring the pathogen. Apply fungicides to high-value plants in the spring during new shoot and leaf development. Drought is a major predisposing stress, so thorough watering during dry periods can limit disease development on infected plants.	Chlorothalonil+Thiophanate-methyl (R) Copper Hydroxide Copper Salts of Fatty and/or Rosin Acids Debacarb+Carbendazim (microinjections) Mancozeb Thiophanate-methyl

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Stem Cankers & Shoot Blights (continued)	<i>Kabatina</i> (146-147)	Juniper (<i>Juniperus</i>); secondary hosts include: arborvitae (<i>Thuja</i>), Japanese cedar (<i>Cryptomeria</i>), cypress (<i>Cupressus</i>), Douglas-fir (<i>Pseudotsuga</i>), fir (<i>Abies</i>) and yew (<i>Taxus</i>)	(Chemical management is only warranted in extreme cases). Symptoms include dieback and death of one-year-old stems and needles, occasionally attacking older parts. Infection occurs in the spring with the pathogen invading insect wounds and snow and ice damage. Symptoms and signs of the pathogen (small, black eruptive pads of fungal mycelium on diseased parts) resemble those caused by <i>Phomopsis</i> , which is a more common pathogen. Prune and destroy infected plant parts and sanitize pruning tools between plants.	Azoxystrobin Thiophanate-methyl
	<i>Sirococcus</i> (118-119)	Numerous conifers, especially: spruce (<i>Picea</i>), pine (<i>Pinus</i>) and hemlock (<i>Tsuga</i>)	Primary symptoms include branch tip dieback (hemlock), stem cankers, oozing and hardened resin on stems and branch dieback. Prune and destroy infected branches to reduce inoculum. Apply fungicides during wet periods when new needles are forming; repeat at 21-28 day intervals if wet conditions persist.	Azoxystrobin Mancozeb Propiconazole Triadimefon
	<i>Calonectria pseudonaviculata</i> (also known as <i>Cylindrocladium buxicola</i>) (boxwood blight) (N/A)	Boxwood (<i>Buxus</i> ; all varieties)	Primary symptoms include rapid dieback and death of branches, leading to defoliation and death of the plant. Dark brown to black circular lesions occur on leaves and stems. Regular scouting for branch dieback on newly planted shrubs is necessary for early detection. Prior to planting new boxwoods, cease all fungicide treatments and quarantine the plants for several weeks to ensure symptoms do not develop. Avoid overhead watering, which facilitates spore production and dissemination. Maintain proper spacing between shrubs and carefully sanitize all pruning equipment. If plants are diseased, remove immediately and discard them off-site. Contact supplier/grower to inform them of disease incidence.	Boscalid+Pyraclostrobin Chlorothalonil (R) Chlorothalonil+Propiconazole (R) Chlorothalonil+Thiophanate-methyl® Fludioxonil+Cyprodinil Mancozeb Myclobutanil Kresoxim-methyl (R) Propiconazole Pyraclostrobin Tebuconazole Thiophanate-methyl Trifloxystrobin Triflumizole
	<i>Volutella buxi</i> (N/A)	Boxwood (<i>Buxus</i> ; all varieties)	Symptoms appear as brown foliage, stunted shoots and general wilt and dieback. In many cases, salmon-colored spore masses are visible on the underside of infected leaves and on stems, especially after periods of rain. Prune and destroy diseased branches, making sure to sanitize pruning equipment frequently and avoid overhead watering. Promote air-flow through proper spacing and limit drought stress and insect feeding, especially from boxwood leaf miner. Fungicides generally have little effect against <i>Volutella</i> .	Copper Hydroxide Copper Salts of Fatty and/or Rosin Acids Mancozeb Myclobutanil Thiophanate-methyl
	<i>Apiosporina</i> (syn. <i>Dibotryon</i>) (black knot) (152-153)	Cherry/ plum/ peach (<i>Prunus</i>)	New infections occur in the spring during wet weather. The pathogen overwinters in the knots, allowing it to spread easily to nearby canopy branches. Primary symptoms include swelling and galls on small branches and stems. Over time, galls can become very large, occurring on main branches and occasionally on the trunk. The galls are a combination of fungal and host tissue. Prune and destroy galls on small twigs and stems, preferably during dormant periods when galls are easier to locate. Sanitize pruning equipment frequently. Chemical management is often not practical, especially when numerous galls are present throughout the canopy.	Chlorothalonil (R) Chlorothalonil+Thiophanate-methyl (R) Copper Hydroxide Thiophanate-methyl
	<i>Monilinia</i> (brown rot of stone fruits) (76-77)	Cherry/ plum/ peach (<i>Prunus</i>)	Blossom and twig blight occurs primarily in the spring, facilitated by periods of rain and wind. Blossoms wilt within 3-6 days after infection, and stem and branch dieback mostly occurs within a month of infection. Fruit rot occurs later in the summer, usually within a few weeks of a typical harvest period. Fruit rot can occur rapidly and fruits that remain on the tree become "mummified". A sign of the pathogen includes gray tufts of mycelium on infected fruit and blossoms. Remove and destroy all mummified fruits (from the tree and ground) and prune stem cankers that harbor the pathogen. Spores of the pathogen are spread via wind, running and splashing rain, pruning tools and insect vectors. The timing of pesticide application varies widely between chemicals, read the label carefully prior to application.	Azoxystrobin Azoxystrobin+Propiconazole Boscalid+Pyraclostrobin Chlorothalonil (R) Iprodione Iprodione+Thiophanate-methyl Mancozeb Myclobutanil Propiconazole Tebuconazole Thiophanate-methyl Triflumizole
	<i>Nectria</i> (176-182)	Numerous hardwoods and some conifers, especially: maple (<i>Acer</i>), boxwood (<i>Buxus</i>) and elm (<i>Ulmus</i>)	Symptoms typically appear as sporadic dieback of small twigs and branches. Infected areas are often sunken and may appear water-soaked as sap flows from the lesions on larger branches. Over time, sloughing bark and rupturing cankers appear on the branches. Signs of the pathogen include salmon to pink-colored spore masses oozing from the canker margins. The infected host may produce callus tissue surrounding the canker. Prune and destroy blighted stems, pruning several inches below the canker (if possible). Avoid pruning during wet weather and sanitize pruning equipment frequently between branches.	Chemical management not warranted.

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Stem Cankers & Shoot Blights (continued)	<i>Neonectria</i> (beech bark disease and target canker) (184-185)	Hardwoods, especially: American beech (<i>Fagus grandifolia</i>) and birch (<i>Betula</i>)	On beech, symptoms appear as rough, irregular cankers on the bark, leading to bird scaling and infection from wood-decay fungi. On birch, symptoms appear as target-shaped cankers surrounded by host callus tissue. <i>Neonectria</i> does not decay wood; the fungus parasitizes the cambium, killing the bark tissue. Cankers often develop on the main trunk, making cultural management impossible. Cankers developing on birch branches can be pruned when trees are small but cankers often develop on the main trunk, negating any cultural control methods.	Chemical management not warranted.
	<i>Ophiognomonium clavignenti-juglandacearum</i> (previously known as <i>Sirococcus c-j</i>) (butternut canker) (116-117)	butternut (<i>Juglans cinera</i>)	The pathogen initiates new infections from early spring to mid-autumn. Cankers can develop on twigs, branches, the main trunk and root flares. They are often elliptical in shape and accompanied by sap flow that stains the bark. The disease is lethal and there are no known control measures, aside from pruning out cankered twigs and branches. The fungus ultimately girdles the main trunk. Butternuts are often infected by additional pathogens (e.g. <i>Armillaria</i>) that hasten their decline.	Chemical management not warranted.
	<i>Fusarium</i> (186-189)	Numerous hardwoods and conifers	In New England, <i>Fusarium</i> is often a secondary disease agent acting in concert with other pathogens and abiotic stresses. Canker symptoms mimic many others described here and there are no diagnostic signs unique to this pathogen.	Etridiazole+Thiophanate-methyl Iprodione Iprodione+Thiophanate-methyl Mancozeb Thiophanate-methyl
	<i>Seiridium</i> (192-193)	Fir (<i>Abies</i>)	Symptoms appear as stem cankers, and shoot and bud blight. Trees predisposed by needle cast, drought, freeze or sunscald injury, and mechanical damage are especially susceptible. Often occurs as secondary pathogen after pathogen/insect attack and abiotic stress.	Chemical management not warranted.
	<i>Botrytis</i> (gray mold) (72-73)	Numerous hardwoods and conifers, especially: dogwood (<i>Cornus</i>), apple (<i>Malus</i>) and rose (<i>Rosa</i>)	Primary symptoms include flower and bud blight, and dieback of young, succulent stems. A sign of the pathogen is a gray, fuzzy mold (mycelium) occurring on blighted buds, stems and foliage. When present on stems, <i>Botrytis</i> is often a secondary colonizer of plant parts damaged by disease, insect and abiotic stresses. On woody plants, the pathogen often causes disease on senescing plant parts in the autumn during cool and wet periods.	Chlorothalonil (R) Copper Hydroxide Copper Salts of Fatty and/or Rosin Acids Copper Sulfate Iprodione Thiophanate-methyl
	<i>Erwinia</i> (fire blight) (376-377)	Members of the Rosaceae, including: <i>Cotoneaster</i> , hawthorn (<i>Crataegus</i>), quince (<i>Cydonia</i>), apple (<i>Malus</i>), firethorn (<i>Pyracantha</i>), pear (<i>Pyrus</i>), raspberry (<i>Rubus</i>) and mountain-ash (<i>Sorbus</i>)	New infections occur in the spring, especially during the flowering period. The bacterium is spread through pollinating insects, and splashing/running rainwater. Disease spread can occur rapidly in orchards. Symptoms of infection include blighted buds and new shoots (that appear black or burnt and could be confused with spring frost damage) and bacterial ooze from lenticels. Infected fruits and stems are often colonized secondarily by cankering fungi like <i>Botryosphaeria</i> and <i>Phomopsis</i> . CAUTION: some bactericides are not for use on fruit intended for human consumption. Read labels carefully.	Copper Hydroxide Copper Hydroxide+Mancozeb Copper Salts of Fatty and/or Rosin Acids Copper Sulfate Fosetyl-Aluminum Mancozeb Phosphorous Acid Streptomycin Sulfate
	<i>Pseudomonas</i> (bacterial blight) (368-371)	Numerous hardwoods, especially: cherry/plum/peach (<i>Prunus</i>), pear (<i>Pyrus</i>) and lilac (<i>Syringa</i>)	Water-soaked lesions and gummosis are the primary symptoms of infection. Prune and destroy infected plant material during dry and dormant periods to avoid spreading the pathogen. Always disinfect pruning equipment frequently between pruning cuts. Apply bactericides in the spring to protect newly emerging shoots. CAUTION: some bactericides are not for use on fruit intended for human consumption. Read labels carefully.	Copper Hydroxide Copper Hydroxide+Mancozeb Copper Salts of Fatty and/or Rosin Acids Copper Sulfate Mancozeb Phosphorous Acid Streptomycin Sulfate

Anthracnose: Symptoms include: bud and shoot blight, early leaf drop, angular, water-soaked foliar lesions occurring along the leaf veins, or as numerous circular leaf spots and stem cankers on larger branches that are typically elongated with splitting bark.

A complex of fungal genera are collectively described as anthracnose. Important members and their hosts are listed below. Because of the confused fungal taxonomy, diseases are sorted by primary hosts.

Wet and cool periods in the spring favor canker establishment and expansion, in addition to new shoot and bud blight which may delay leaf-out. Anthracnose fungi typically go dormant during hot and dry periods in mid-summer only to re-emerge during cool periods in the fall. Trees and shrubs in fog pockets or near bodies of water, in deep shade or forest settings are more susceptible. Foliar lesions are often angular and occur along leaf veins and margins. Stem cankers are often elongated in the direction of the stem.

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DISEASE	PATHOGEN*	HOSTS	SYMPTOMS & MANAGEMENT	ACTIVE INGREDIENT(S)
Anthracnose (continued)				
	Sycamore anthracnose (<i>Apiognomonina veneta</i> ; previously known as <i>Discula platani</i>) (102-103)	American sycamore (<i>Platanus occidentalis</i>); London planetree (<i>P. x acerifolia</i>) is resistant but not immune	During wet springs, sycamores are severely defoliated and may push several sets of leaves before the disease subsides with drier weather. Foliar lesions are angular in shape and often occur along leaf veins or the leaf midrib. The pathogen also causes elongated stem cankers and is the primary cause of the right angle branching pattern exhibited by sycamores. However, only occasionally does the disease cause severe crown dieback or death and chemical management is rarely warranted.	Chlorothalonil (R) Copper Hydroxide Copper Hydroxide+Mancozeb Copper Salts of Fatty and/or Rosin Acids Copper Sulfate Debacarb+Carbendazim Mancozeb Propiconazole Thiabendazole Hypophosphite
	Dogwood anthracnose (<i>Discula destructiva</i>) (106-107)	Flowering dogwood (<i>Cornus florida</i>) and occasionally on kousa dogwood (<i>C. kousa</i>)	Symptoms of infection include leaf spots and blotches, early leaf drop, defoliation of lower branches, elongated stems cankers, crown dieback and outright death. Epicormic sprouts are often formed on diseased trees, usually near the site of stem cankers on larger branches. Prune out and discard cankered and blighted branches, regularly sanitize pruning tools when working with diseased trees, avoid overhead watering and plant trees in full sun with good air-flow to promote drying of leaves and stems.	Chlorothalonil (R) Chlorothalonil+Propiconazole (R) Mancozeb Myclobutanil Potassium Bicarbonate Propiconazole Trifloxystrobin
	Numerous hardwoods and some conifers (<i>Glomerella</i> spp.; also known as <i>Colletotrichum</i>) (114-115)	Broad host range, including: maple, birch, oak, pear, privet, honey locust, cherry, elm, basswood, hawthorn, lilac, azalea, magnolia, redbud, dogwood, tulip poplar, hydrangea, rhododendron, burning bush and many others	Foliar symptoms range from numerous small, circular leaf spots to large, irregularly-shaped necrotic lesions. Elongated cankers with rough, callused margins can also occur on twigs and small branches. Signs of the pathogen include pinkish spore masses oozing from the margins of stem cankers and on blighted foliage. The pathogen is widespread on the landscape, making eradication impossible. Cleaning up downed foliage and pruning out cankered branches can help mitigate disease pressure in subsequent years on infected trees and shrubs.	Azoxystrobin Azoxystrobin+Propinconazole Copper Hydroxide Chlorothalonil (R) Iprodione Iprodione+Thiophanate-methyl Propiconazole Thiophanate-methyl Thiophanate-methyl+Mancozeb Triadimefon Triadimefon+Trifloxystrobin Trifloxystrobin
	Maple anthracnose (<i>Aureobasidium apocryptum</i> , <i>Discula campestris</i> , <i>D. umbrinella</i> and <i>Glomerella</i> spp. [described above]) (110-111)	Maple (<i>Acer</i>)	Irregularly-shaped, angular spots and blotches occur along the leaf veins and midrib or along the leaf margins. Lesions often first appear water-soaked and over time, become brown and cause leaf curling. When severe, infection can lead to premature defoliation. Symptoms can develop anytime between spring and late summer after wet periods. The pathogen overwinters on fallen leaves and possibly in killed twigs and buds. Thoroughly clean up all fallen leaves and downed twigs and remove them from the site. Fungicide application is often unnecessary but chemicals can be applied near bud break and at 7-14 day intervals afterwards, depending on rainfall.	Chlorothalonil (R) Chlorothalonil+Thiophanate-methyl (R) Copper Hydroxide+Mancozeb Mancozeb Propiconazole
	Oak anthracnose (<i>Apiognomonina errabunda</i> ; previously known as <i>Apiognomonina quercina</i> and <i>Discula quercina</i>) (100-101)	Oak (<i>Quercus</i> ; <i>Q. alba</i> is highly susceptible)	Irregularly-shaped lesions develop in spring and early summer. Foliar lesions are often confined by leaf veins or central midrib. Twig blight can also occur in the spring to early summer, depending on rainfall. The fungus overwinters in leaves, buds and twigs and can cause disease at any time during the growing season as long as environmental conditions are conducive.	Chlorothalonil (R) Copper Hydroxide Copper Hydroxide+Mancozeb Copper Salts of Fatty and/or Rosin Acids Copper Sulfate Debacarb+Carbendazim Mancozeb Propiconazole Thiophanate-methyl+Mancozeb Triadimefon+Trifloxystrobin
	Birch anthracnose (<i>Ophiognomonina</i> spp.; previously known as <i>Discula betulina</i>) (108-109)	Birch (<i>Betula</i>)	To date, five species of <i>Ophiognomonina</i> are known to attack birch in North America. Symptoms develop in the spring and range from numerous scattered leaf spots, to large necrotic blotches occurring along the leaf margins. The pathogen overwinters on fallen leaves and is not known to produce stem cankers. Thoroughly rake up and destroy all fallen leaves in the autumn to prevent the pathogen from overwintering and reinfesting the tree in the spring.	Chemical management not warranted
	Elm anthracnose (black spot) (<i>Gnomonia ulmea</i> ; previously known as <i>Stegophora ulmea</i>) (96-97)	Elm (<i>Ulmus</i>)	Black spot can cause serious defoliation during wet years. Symptoms first appear as small, circular leaf spots that are yellow in color. Over time, they develop a black center and become raised. Spots often coalesce to cause a complete foliar blight. Early leaf drop and death of succulent shoots can occur (especially in conjunction with cankering fungi). Rake up and destroy fallen foliage and prune branches exhibiting symptoms of severe dieback. Monitor closely for Sphaeropsis canker and Dutch elm disease. Several elm varieties are resistant to black spot.	Copper Hydroxide+Mancozeb Mancozeb

Table 1. Common diseases of woody ornamentals in Massachusetts, host plants, and associated management options.

DISEASE	PATHOGEN*	HOSTS	SYMPTOMS & MANAGEMENT	ACTIVE INGREDIENT(S)
Anthracnose (continued)	Ash anthracnose (<i>Plagiostoma fraxini</i> ; previously known as <i>Discula fraxinea</i> and <i>Gnomoniella fraxini</i>) (98-99)	Ash (<i>Fraxinus</i>)	Irregularly-shaped, angular, water-soaked lesions appear in the spring after prolonged wet periods. In wet springs, young leaves and shoots can be killed, leading to a second flush of foliage. Symptoms sometimes resemble frost injury. Successive years of defoliation can lead to significant crown dieback. The fungus overwinters in twigs, petioles, leaves and on seeds. The pathogen does not cause stem cankers on established branches and twigs.	Copper Hydroxide+Mancozeb Mancozeb
	Walnut, Hickory and Pecan anthracnose (<i>Ophiognomonia</i> spp.) (104-105)	Walnut (<i>Juglans</i>) Hickory and pecan (<i>Carya</i>)	Symptoms appear as small, irregular leaf spots scattered across the foliage, primarily near leaf veins. Symptoms generally appear late in the season after annual growth by the host has been accomplished. Therefore, the pathogen does little damage. Rake up and destroy fallen leaves that harbor the pathogen to reduce inoculum. Chemical management is only warranted in extreme cases.	Copper Hydroxide+Mancozeb Mancozeb
Leaf Spots, Blights & Powdery Mildew: Diverse group of fungal pathogens causing a wide array of symptoms. Some diseases are mostly cosmetic while others can cause severe damage through early leaf drop, stunted growth and susceptibility to other pests/pathogens.	<i>Venturia</i> (apple scab) (86-92)	Primary host is apple (<i>Malus</i>); secondary hosts include: <i>Cotoneaster</i> , firethorn (<i>Pyracantha</i>), pear (<i>Pyrus</i>) and mountain-ash (<i>Sorbus</i>)	Symptoms develop in the spring and appear as olive-brown to black circular spots on leaves and fruit. Fruit lesions are superficial and do not penetrate beyond the cuticle. During wet years, numerous foliar spots can develop, leading to yellowing of leaves and early leaf drop. Rake up and destroy fallen leaves and fruit to reduce inoculum at the site. In most landscape settings, apple scab is a cosmetic disease that does not warrant chemical management. CAUTION: some fungicides are not for use on fruit intended for human consumption. Read labels carefully. Also note that azoxystrobin is phytotoxic on certain apple cultivars.	Azoxystrobin Chlorothalonil+Propiconazole (R) Copper Hydroxide Kresoxim-methyl Mancozeb Myclobutanil Phosphorous Acid Propiconazole Tebuconazole+Trifloxystrobin Triadimefon+Trifloxystrobin Triflumizole
	<i>Phyllosticta</i> (purple-eye leaf spot) (42-43)	Maple (<i>Acer</i>), dogwood (<i>Cornus</i>), hazelnut (<i>Corylus</i>), witch-hazel (<i>Hamamelis</i>) among other hardwoods	New infections and associated symptoms develop in the spring and appear as (mostly) circular leaf spots with brown centers and purple margins. As the lesions dry, the center may fall out. Partial defoliation or early leaf drop may occur on trees or branches in deep shade. When conditions are optimal, witch-hazels can suffer a severe foliar blight. Remove fallen leaves in the autumn to reduce inoculum at the site.	Chemical management not warranted
	<i>Guignardia</i> (40-41)	Horse-chestnut and buckeye (<i>Aesculus</i> spp.; especially <i>A. hippocastanum</i>)	Infections initiate on emerging leaves in late spring and blotches begin to appear two to four weeks after infection. Symptoms consist of large, irregularly-shaped foliar lesions (blotches). When the lesions are actively expanding, they often appear water-soaked. Over time, blighted foliage dries and curls. Remove fallen leaves in the autumn to reduce inoculum at the site; promote sunlight and air-flow to reduce moisture. While the disease disfigures ornamental trees, growth is mostly unaffected. Therefore, chemical control is rarely warranted. If fungicide application is desired, it should occur at bud break and continue until conditions become dry or leaves are fully elongated.	Mancozeb Thiophanate-methyl
	<i>Rhytisma</i> (tar spot) (66-67)	Maple (<i>Acer</i>)	Spores disseminated from fallen leaves initiate new infections in the spring, with symptoms developing four to eight weeks after infection. Very conspicuous circular, black spots develop on the foliage in early to mid-summer. Leaf spots are considerably larger on Norway maple. When trees are heavily shaded, especially in forest understories, numerous spots can form and coalesce. Rarely is the disease of concern in landscape settings. Remove fallen leaves to reduce inoculum at site; chemical management is not warranted.	Chemical management not warranted
	<i>Marssonina</i> (82-83)	Birch (<i>Betula</i>), aspen/cottonwood/poplar (<i>Populus</i>) and willow (<i>Salix</i>)	Infections are initiated from overwintering inoculum in fallen leaves and in small twig cankers. Symptoms develop approximately two weeks after infection and appear as small, irregularly-shaped, brown spots and blotches. If wet conditions persist beyond spring and early summer, infections can be severe. Remove fallen leaves to reduce inoculum at site; chemical management is not warranted in most cases.	Mancozeb
	<i>Entomosporium</i> (78-79)	Hawthorn (<i>Crataegus</i>), and occasionally on serviceberry (<i>Amelanchier</i>), cotoneaster (<i>Cotoneaster</i>), apple/crabapple (<i>Malus</i>), pear (<i>Pyrus</i>) and mountain-ash (<i>Sorbus</i>)	New infections initiate in the spring, but symptoms are not usually present until mid-summer. Symptoms appear as small, dark leaf spots. In wet years, or for trees residing in deep shade, numerous spots coalesce to cause a complete foliar blight. Typically, the pathogen does little damage, but can cause early leaf drop. Remove fallen leaves to reduce inoculum at site. In rare cases, fungicide applications during wet periods in the spring may be warranted for severe infections. Note that azoxystrobin is phytotoxic on certain apple cultivars.	Azoxystrobin Copper Hydroxide Copper Salts of Fatty and/or Rosin Acids Copper Sulfate Mancozeb Myclobutanil Thiophanate-methyl Triadimefon Triadimefon+Trifloxystrobin

Table 1. Common diseases of woody ornamentals in Massachusetts, host plants, and associated management options.

DISEASE	PATHOGEN*	HOSTS	SYMPTOMS & MANAGEMENT	ACTIVE INGREDIENT(S)
Leaf Spots, Blights & Powdery Mildew (continued)	<i>Pseudocercospora</i> and <i>Passalora</i> (previously known as <i>Cercospora</i>) (30-35)	(1) <i>Pseudocercospora kalmiae</i> : mountain laurel (<i>Kalmia</i>); (2) <i>P. handelii</i> : rhododendron/azalea (<i>Rhododendron</i>); (3) <i>P. juniperi</i> : juniper (<i>Juniperus</i>); and (4) <i>Passalora sequoiae</i> : cypress (<i>Cupressus</i>)	Symptoms appear as circular leaf spots with purple centers and grey margins or browning needles on juniper, beginning on the lower branches and spreading upward. Numerous leaf spots may coalesce to cause a foliar blight. If possible, transplant shrubs from deep shade to sunnier areas; prune dead branches to increase air-flow and remove fallen leaves to reduce inoculum at site. Chemical management is only warranted in extreme cases.	Azoxystrobin Copper Hydroxide Copper Hydroxide+Mancozeb Mancozeb Myclobutanil Propiconazole Thiophanate-methyl Triadimefon
	<i>Macrophoma</i> (N/A)	Boxwood (<i>Buxus</i>)	Infection usually requires a predisposing stress, such as root or stem cankering disease or drought. Symptoms appear as leaf spots and general dieback of the foliage. <i>Macrophoma</i> produces black, circular fruiting bodies on the underside of the foliage and can be seen with the naked eye. Management should focus on pruning dead branches and raking up fallen foliage. Address other predisposing factors causing stress such as drought, root disease, <i>Volutella</i> and <i>Calonectria</i> (boxwood blight).	Chemical management not warranted
	<i>Tubakia</i> (44-45)	Oak (<i>Quercus</i>) and numerous secondary hosts.	Infections are likely initiated in late spring to early summer, with symptoms appearing in mid-summer as large, circular leaf spots. Often, the spots coalesce to create large patches of necrotic tissue. Later in the season, the spots can be very large as the pathogen continues to expand on the surface of the leaf. As a result, the disease is most often reported in July and August. Rake up and remove fallen leaves to reduce inoculum at the site. Chemical management is not usually necessary.	Copper Hydroxide Copper Hydroxide+Mancozeb Copper Salts of Fatty and/or Rosin Acids Mancozeb Mancozeb+Thiophanate-methyl Propiconazole Thiophanate-methyl
<i>Diplocarpon</i> (black spot) (80-81)	Rose (<i>Rosa</i> ; yellow- and gold-flowering varieties are more susceptible)	The pathogen overwinters on fallen leaves and infected canes and though new infections can initiate throughout the growing season, most occur in the spring. Several resistant rose varieties exist, but they are not immune to the disease. Black spots develop on leaves and canes of susceptible plants. Spots are mostly circular and surrounding tissue may become yellow. Newly expanding leaves, 6-14 days old, are most susceptible to infection. Remove and destroy fallen leaves, prune out dead canes and avoid overhead watering.	Chlorothalonil (R) Chlorothalonil+Thiophanate-methyl (R) Copper Hydroxide Copper Sulfate Kresoxim-methyl (R) Mancozeb Myclobutanil Propiconazole Sulfur Triadimefon+Trifloxystrobin Trifloxystrobin Thiophanate-methyl	
<i>Septoria</i> (24-25)	Aspen/cottonwood/poplar (<i>Populus</i>), birch (<i>Betula</i>), dogwood (<i>Cornus</i>), rhododendron/azalea (<i>Rhododendron</i>) and other hardwoods	Symptoms of infection include small, dark, circular to angular leaf spots and blotches. Often, the lesions are limited in size by the leaf veins. Severe infections lead to coalescing spots that can cause a complete foliar blight under optimal conditions. Most foliar infections are inconsequential to the health of the plant. In addition, <i>Septoria</i> can cause a damaging branch and trunk canker on <i>Populus</i> . Cankers often appear as sunken lesions and over time have rough margins with various stages of callus tissue.	Chlorothalonil (R) Mancozeb Thiophanate-methyl	
<i>Taphrina</i> (peach leaf curl) (4-5)	Peach and nectarine (<i>Prunus persica</i>), almond (<i>P. dulcis</i>) and apricot (<i>P. armeniaca</i>)	New infections occur in the spring on leaves, flowers and fruit of susceptible trees. Spores are disseminated in late spring to early summer and the fungus goes dormant until the following spring. Newly forming foliage and succulent shoots become curled, twisted and deformed. Leaves turn from green to yellow, finally becoming reddish when the disease is fully developed. Early leaf drop can occur after severe infections. Signs of the pathogen include a white, powdery appearance on deformed plant parts. This is the spore mass produced by <i>Taphrina</i> and extreme care should be taken when handling plants at this stage to avoid spreading the pathogen. Rake up and destroy fallen leaves to reduce inoculum at the site. Apply fungicides in the spring prior to bud break.	Mancozeb	

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DISEASE	PATHOGEN*	HOSTS	SYMPTOMS & MANAGEMENT	ACTIVE INGREDIENT(S)
Leaf Spots, Blights & Powdery Mildew (continued)	<i>Erysiphe</i> , <i>Phyllactinia</i> , <i>Podosphaera</i> (powdery mildew) (8-13)	Numerous angiosperms, especially hydrangea (<i>Hydrangea</i>), lilac (<i>Syringa</i>) and oak (<i>Quercus</i>); gymnosperms are not hosts	Symptoms appear as white to grey powder or dust on leaf surfaces and undersides. Powdery mildew fungi only invade the epidermis and most have evolved to infect a single host genus or family. Many powdery mildew fungi are inhibited by the presence of free water on plant surfaces, while others can tolerate wet leaf surfaces. High humidity often drives powdery mildew outbreaks. Spore production can take as little as four to six hours and fungi can rapidly colonize plant surfaces under optimal conditions. In greenhouse settings, powdery mildew fungi can reproduce all year. In our region, disease severity usually corresponds with high humidity and a lack of rainfall (August).	Azoxystrobin Chlorothalonil (R) Chlorothalonil+Propiconazole (R) Copper Hydroxide Copper Salts of Fatty and/or Rosin Acids Copper Sulfate Fenarimol Mineral Oil Myclobutanil Neem Oil Phosphorous Acid Potassium Bicarbonate Propiconazole Sulfur Tebuconazole+Trifloxystrobin Trifloxystrobin Thiophanate-methyl Triadimefon
Rusts: Characterized by their orange-brown rust-colored spores. Symptoms are highly variable by host.	<i>Gymnosporangium juniperi-virginianae</i> (cedar-apple rust) (260-262)	Juniper (<i>Juniperus</i> ; especially <i>J. virginiana</i>) and apple/crabapple (<i>Malus</i>)	On juniper, symptoms appear as small, woody galls on fine twigs and stems. Some galls may become quite large (e.g. the size of a golf ball), but most are small and can be hard to find. During wet periods in the spring, orange, jelly-like masses will extrude from the galls. On rosaceous hosts, the primary symptom of infection are leaf spots. On apple and crabapple, the fungus produces large reddish-orange, circular lesions that are very conspicuous. Over the summer, cream-colored tendrils develop on the underside of the lesion. In many cases, the disease is cosmetic and does little damage to landscape trees. Fungicide application prevents infection of apple foliage in the spring from the spores produced on juniper. Conversely, the spores produced on apple leaves infect juniper in the late summer and autumn.	Chlorothalonil+Propiconazole (R) Chlorothalonil+Thiophanate-methyl (R) Copper Salts of Fatty and/or Rosin Acids Copper Sulfate Kresoxim-methyl (R) Mancozeb Propiconazole Sulfur Tebuconazole Tebuconazole+Trifloxystrobin Triadimefon Triadimefon+Trifloxystrobin Trifloxystrobin Triflumizole
	<i>Gymnosporangium claviceps</i> (cedar-quince rust) (264-266)	Juniper (<i>Juniperus</i> ; especially <i>J. virginiana</i>) and rosaceous hosts: apple/crabapple (<i>Malus</i>), quince (<i>Cydonia</i>), flowering quince (<i>Chaenomeles</i>), serviceberry (<i>Amelanchier</i>), mountain-ash (<i>Sorbus</i>) and hawthorn (<i>Crataegus</i>)	On juniper, symptoms appear as small, woody galls on fine twigs and stems. Some galls may become quite large (e.g. the size of a golf ball), but most are small and can be hard to find. During wet periods in the spring, orange, jelly-like masses will extrude from the galls. On rosaceous hosts, the primary symptom of infection are leaf spots, fruit lesions and stem galls. Serviceberry suffers the most damage, as the pathogen produces galls that become perennial and, over time, can girdle the stems. This can lead to significant lower crown dieback, especially on plants that are heavily shaded. On hawthorn and quince, the fruit is often infected and conspicuous, pinkish-colored tendrils develop in mid-summer. Damage varies by host, condition and environmental factors.	Chlorothalonil+Thiophanate-methyl (R) Copper Salts of Fatty and/or Rosin Acids Copper Sulfate Kresoxim-methyl (R) Mancozeb Propiconazole Sulfur Tebuconazole Tebuconazole+Trifloxystrobin Triadimefon Triadimefon+Trifloxystrobin Trifloxystrobin Triflumizole
	<i>Chrysomyxa weirii</i> (spruce needle rust; Weir's cushion rust) (288-289)	Spruce (<i>Picea</i>); especially blue (<i>P. pungens</i>)	On spruce, symptoms appear as orange-red lesions surrounded by chlorotic tissue, scattered across the needles. These lesions are actually blisters that swell in late spring and rupture to release spores. Early needle drop can occur but the damage is generally not severe on established trees. The disease is often concurrent with needle cast from <i>Rhizosphaera</i> , which is a more serious threat to long-term health. Management should focus on protecting new needles prior to spore dispersal from nearby, infected needles. Fungicide application should occur just prior to budbreak and reapplications can be made on 7-10 day intervals until approximately one month after budbreak.	Chlorothalonil (R)

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DISEASE	PATHOGEN*	HOSTS	SYMPTOMS & MANAGEMENT	ACTIVE INGREDIENT(S)
Rusts (continued)	<i>Cronartium ribicola</i> (white pine blister rust) (292-295)	Pine (<i>Pinus</i> : five-needle species) and gooseberry/currant (<i>Ribes</i> ; especially <i>R. nigrum</i>)	Infection of pine needles occurs from mid-summer to autumn and initiates a long life cycle that can take three to six years to complete. The fungus spreads from the needles to the twigs the same year or by the following summer, then grows in living bark to larger branches and/or the main stem. Disseminated spores then infect <i>Ribes</i> species, a required host for completion of the life cycle. Symptoms appear as needle blight, premature needle loss, twig and branch dieback and stem cankers with oozing blisters. The blisters may produce copious volumes of resin, while the fungal fruiting bodies rupture through the bark and appear as gelatinous masses. Pruning and destruction of the infected twigs/branches before the fungus reaches the main stem, can help to control the pathogen. Lower branches where moisture and humidity levels are higher are often infected first.	Copper Hydroxide Copper Hydroxide+Mancozeb Mancozeb Myclobutanil Triadimefon
Vascular Wilts: Prominent symptoms include wilting, browning and early shedding of foliage along with staining of vascular tissue (olive-green to dark brown). These diseases target the water-conducting tissues and symptoms typically first appear in upper-canopy branches.	<i>Verticillium albo-atrum</i> & <i>V. dahliae</i> (242-245)	Numerous hardwoods, especially: maple (<i>Acer</i>), smoke-tree (<i>Cotinus</i>), elm (<i>Ulmus</i>) and lilac (<i>Syringa</i>)	Many hardwoods are resistant and all gymnosperms are immune. Confusion is rampant because some plant genera have both resistant and susceptible species. Symptoms appear as flagging of upper canopy branches, wilt and dieback. Vascular staining appears green to olive-green to brown and penetrates several millimeters into the sapwood. Water-soaked, stem lesions may also be present, especially on hosts that produce abundant sap (e.g. <i>Liquidambar</i> and <i>Acer</i>). Maintain vigor by watering during extended dry periods; replace infected plants with resistant species such as pine, dogwood, hawthorn, apple, walnut, willow, oak and pear. <i>Verticillium</i> will persist in the soil for many years after infected plants are removed. Soil fumigation is not effective nor is it recommended for landscape settings.	Debacarb+Carbendazim
	<i>Ophiostoma ulmi</i> & <i>O. novo-ulmi</i> (Dutch elm disease) (240-241)	American elm (<i>Ulmus americana</i>); numerous resistant hybrids of American elm exist	Symptoms appear as flagging of upper canopy branches, wilt and yellowing of leaves and general crown dieback. Vascular staining appears brown to dark brown within the sapwood. Management includes regular scouting and pruning of branches exhibiting symptoms. Prune approximately five (or more) feet below the infected area to ensure removal. Remove and destroy nearby elm logs, as they may harbor the elm bark beetle and <i>Ophiostoma</i> . Apply insecticides during dormant periods to kill overwintering beetles; apply fungicides using trunk injections (macro- or micro-injections). Several resistant varieties are available for planting, but <u>none are immune to the disease.</u>	Debacarb+Carbendazim Imidacloprid+Debacarb Propiconazole Tebuconazole Thiabendazole Hypophosphite
	<i>Ceratocystis fagacearum</i> (oak wilt) (238-239)	Oak (<i>Quercus</i> ; especially the red oak group)	Not currently known to occur in New England, but the oak wilt pathogen has been steadily spreading eastward and was confirmed in eastern New York in '06. It is vectored by sap-feeding beetles and also spreads through root grafts. Symptoms appear in spring and early summer as foliar wilt, chlorosis and branch dieback. Signs of the pathogen include grey pads of fungal tissue underneath the bark. The pads rupture the bark, but may not be immediately visible; remove the bark and investigate the sapwood for the presence of the fungal pads on dead trees. Oaks can die in as little as six weeks to one year after infection. Trenching to sever root grafts can limit the spread of oak wilt to nearby trees.	Debacarb+Carbendazim Imidacloprid+Debacarb Propiconazole
Root & Lower Trunk Rot: The most cryptic and difficult group of pathogens to identify and manage. The most important root rot pathogens live as parasites of living hosts and as saprophytes on dead organic matter.	<i>Phytophthora</i> spp. (354-367)	Numerous hardwoods and conifers, especially ericaceous shrubs (<i>Rhododendron</i>) and oak (<i>Quercus</i>)	Symptoms appear as crown dieback, stunted growth, yellowing and shriveling of foliage, early leaf drop and resin/sap flow near the base of the trunk. Infected roots often appear brown to black, water-soaked and soft. <i>Phytophthora</i> produces no visible signs, making field diagnosis tenuous. Plants growing at sites with standing water or where seasonal flooding occurs are more susceptible, as <i>Phytophthora</i> produces a swimming asexual spore. Dry sites with sandy soils often do not support the pathogen. Remove and discard infected plants, keeping in mind that <i>Phytophthora</i> can survive for many years in the soil. Fungicides applied to the soil often fail to reach their target or leach away prior to contact with roots.	Copper Salts of Fatty and/or Rosin Acids Etridiazole Etridiazole+Thiophanate-methyl Fosetyl-Aluminum Mefenoxam/Metalaxyl Phosphorous acid
	<i>Pythium</i> spp. (N/A)	Numerous hardwoods and conifers in seedling stage of development	<i>Pythium</i> is not considered a pathogen of established forest and landscape trees and shrubs. However, the pathogen does readily kill seedlings growing in soil-less media when other microorganisms are absent. Symptoms include stunted growth, wilting (damping off), and crown lesions. Fine roots are often absent while main roots are brown to black with little integrity.	Azoxystrobin Copper Salts of Fatty and/or Rosin Acids Etridiazole Etridiazole+Thiophanate-methyl Mancozeb Mefenoxam Phosphorous acid Thiophanate-methyl

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DISEASE	PATHOGEN*	HOSTS	SYMPTOMS & MANAGEMENT	ACTIVE INGREDIENT(S)
Root & Lower Trunk Rot (continued):	<i>Armillaria</i> spp. (honey fungus, shoestring root rot) (326-331)	Nearly all woody plants, especially maple (<i>Acer</i>) and oak (<i>Quercus</i>)	New infections can develop at almost anytime during the growing season. Symptoms appear as wilting and yellowing of foliage, canopy dieback, undersized or stunted foliage, excessive cone production, basal sap/resin flow, basal swelling and open wounds at the base of infected plants. Signs of the pathogen include rhizomorphs (black, root-like structures attached to roots and the lower bole underneath the soil line), mycelial fans (white pads of fungal tissue beneath the bark) and mushrooms (produced sporadically for very short periods of time in the fall).	Chemical management not warranted
	<i>Phaeolus schweinitzii</i> (velvet top fungus; brown cubical rot) (340-341)	Pine (especially white pine; <i>P. strobus</i>), spruce (<i>Picea</i>), fir (<i>Abies</i>), larch (<i>Larix</i>) and Douglas-fir (<i>Pseudotsuga</i>)	Symptoms of infection are often not present on infected trees. Generally speaking, symptoms of root and lower trunk rot on conifers include: crown dieback, stunted and chlorotic needles, basal resinosis, and a stress cone crop. Typically, the only indication of infection are the conks, produced most often from infected roots close to the lower bole. The annual conks are tan to yellow and have a soft texture when fresh, only to become brown with age. Trees suffering stem failure have decaying wood that appears brown and separates easily into cubical pieces.	Chemical management not warranted
	Several fungi: (1) <i>Laetiporus</i> spp. (310-311); (2) <i>Grifola frondosa</i> (N/A); (3) <i>Inonotus dryadeus</i> ; 344-345; (4) <i>Bondarzewia berkleyii</i> (N/A)	Numerous hardwoods, especially oak (<i>Quercus</i>)	Numerous fungal pathogens cause root and lower trunk rot of oaks of all ages. However, older trees can be more susceptible to stem failure, creating a threat to people and property. Symptoms are very general and can include: basal seams and cavities, basal swelling, sap flow, crown dieback, undersized foliage, scorch and early leaf drop, among others. In many cases, the fruiting body (conk/mushroom) is the only indication the tree is infected. Internal decay that does not affect the outer sapwood may cause little physiological damage, but structurally the tree may be unsound.	Chemical management not warranted
Trunk Rots: Wood-decaying fungi that often go unnoticed until an annual or perennial conk (mushroom) appears on branches or the main trunk.	<i>Phellinus</i> (white trunk rot of hardwoods) (306-309)	Maple (<i>Acer</i>) Birch (<i>Betula</i>) Beech (<i>Fagus</i>) Aspen (<i>Populus</i>) Numerous other hardwoods	Infections often initiate on branch and trunk wounds from windborne spores (often branch stubs) and the fungus then attacks the sapwood and also colonizes the heartwood. Widely regarded as the most important trunk rot pathogen of northern hardwoods, the pathogen can be very aggressive. Conks are usually the only indicator of infection and have a dark blue, cracked pileus (cap) and a concave to convex, brown to dark brown hymenium (underside). The existence of a conk on the main trunk indicates that severe decay is present.	Chemical management not warranted
	<i>Ganoderma applanatum</i> (artist's conk) (350-351)	Cottonwood (<i>Populus deltoides</i>) Sugar maple (<i>Acer saccharum</i>) Numerous other hardwoods	The fungus invades susceptible trees through the roots and wounds on the lower and upper trunk. The pathogen has a wide host range but in our region it is found most often on cottonwood, maple, beech and oak. While often described as a saprophyte, the fungus can cause severe root and trunk rot. The presence of a conk on a living tree indicates extensive decay is present in the surrounding area. Trees with conks present in residential and commercial settings should be considered a hazard. The perennial conks have a tan to brown pileus (cap) and a brilliant white hymenium (underside) and can be quite large.	Chemical management not warranted
	<i>Climacodon septentrionalis</i> (northern tooth fungus) (308-309)	Sugar maple (<i>Acer saccharum</i>) Hickory (<i>Carya</i>)	The fungus often colonizes trunk wounds and less often gains entry through branch stubs. A spongy, white trunk rot ensues and the presence of the annual conk indicates extensive decay. The fungus produces cream-colored to pale yellow, overlapping shelves of fleshy conks, with a hymenium (underside) composed of numerous slender spines or 'teeth'. The conks are usually very conspicuous and begin to appear in late summer.	Chemical management not warranted
	<i>Fomes fomentarius</i> (308-309)	Birch (<i>Betula</i>) Beech (<i>Fagus</i>)	Secondary white rot pathogen of hardwoods, targeting wounds in the sapwood for colonization. Trees in serious decline or recently killed often have multiple conks from the pathogen. They are generally small with a grey-blue to tan colored pileus (cap) and a cream-colored, concave hymenium (underside).	Chemical management not warranted

*Numbers in parenthesis refer to page numbers in Sinclair and Lyon (2005): Diseases of Trees and Shrubs. (R) denotes chemical has restricted use status in Massachusetts.