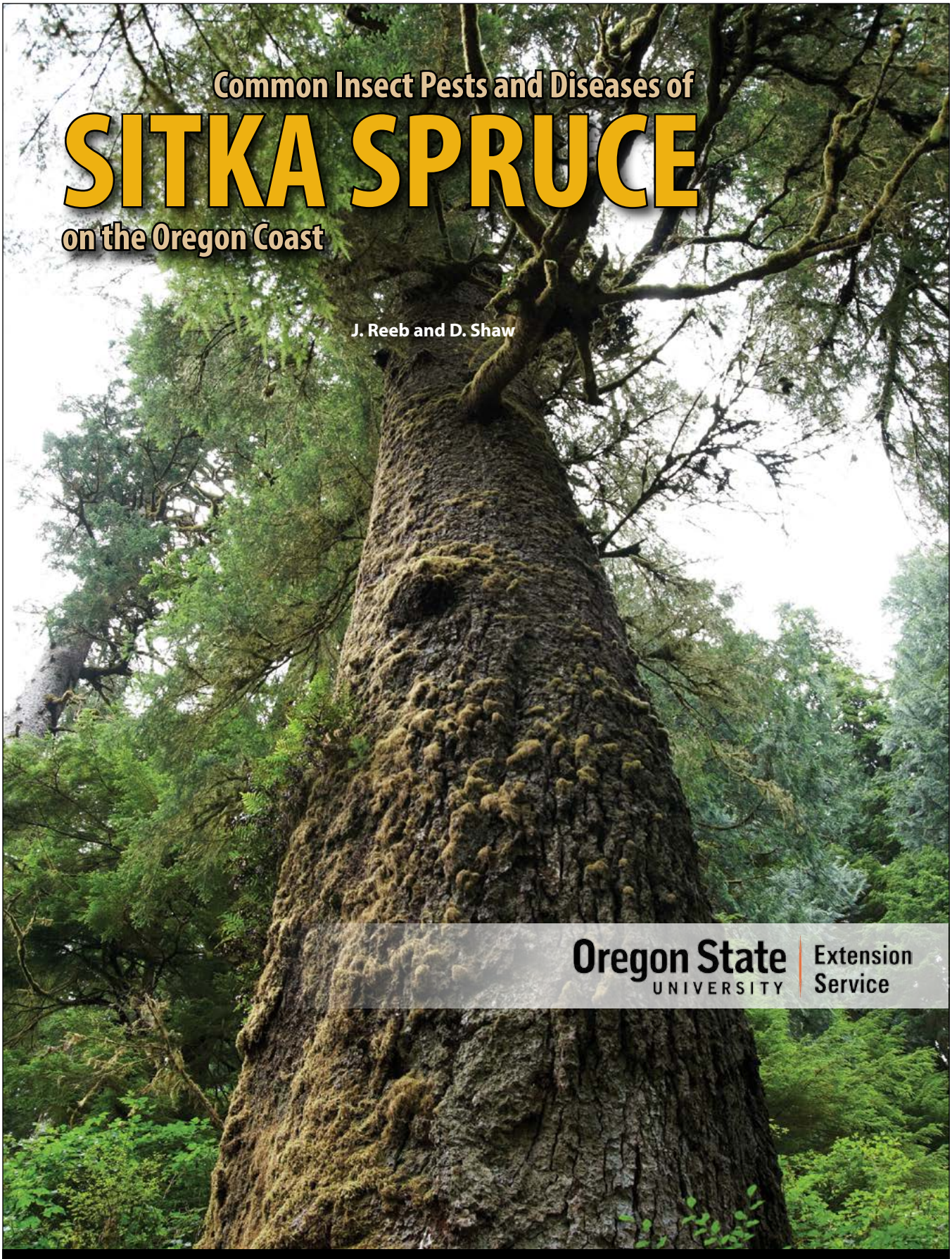

Common Insect Pests and Diseases of SITKA SPRUCE on the Oregon Coast

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Oregon State University | Extension Service

EM 9105 JANUARY 2015

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EM 9105 • January 2015

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Sitka spruce *(Picea sitchensis)* (Figure 1) is one of the most prominent trees along the Pacific Northwest coast of North America. This species' range extends from northern California to Alaska. The Oregon coast is at the southern limit of the range of Sitka spruce, and the tree there has many problems that are distinct from the ones it faces in British Columbia and Alaska.

Background on Sitka Spruce

Sitka spruce is also known as tidewater spruce, coast spruce, and yellow spruce. It is found near the Pacific Coast, where mild winters, moist maritime air, and cool summer fog maintain the humid conditions that are necessary for its growth (Figure 2, page 3). It is most often associated with western hemlock (*Tsuga heterophylla*) in dense stands where growth rates are among the highest in North America. Along Oregon's central and north coasts, it can be found with western red cedar (*Thuja plicata*), Douglas-fir (*Pseudotsuga menziesii*), Pacific silver fir (*Abies amabilis*), grand fir (*Abies grandis)*, red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), and black cottonwood (*Populus trichocarpa*). On the southern Oregon coast, it associates with coast redwood (*Sequoia sempervirens*) and Port Orford cedar (*Chamaecyparis lawsoniana*).

Sitka spruce is more tolerant of salt spray than associated tree species, and often occupies a prominent position on exposed headlands and beaches along the Oregon coast. It often follows shore pine (*Pinus contorta*) in succession on coastal sand dunes as they become stabilized by vegetation. On highly disturbed sites, it frequently becomes established with red alder or Sitka alder (*A. sinuata*), gradually overtopping the alder. Sitka spruce grows best on deep, moist, and well-aerated soils with high amounts of calcium, magnesium, and phosphorus. Growth is poor in poorly drained, swampy areas. Sitka spruce is shade tolerant, although not as shade tolerant as its most common associate, western hemlock.

Figure 1. Sitka spruce in coastal Oregon. Note the drooping branchlets and the associated maximization of foliage display.

Sitka spruce is among the world's fastest growing trees. It is the largest of the world's spruces. It commonly reaches heights of 180 feet (55 meters), with diameters of 5 feet (1.5 meters). The largest known Sitka spruce in the country grew in Klootchy Park southeast of Seaside, Oregon. Before a 2006 windstorm, the Seaside spruce stood 216 feet (65.8 meters) tall and over 18 feet (5.5 meters) in diameter. The windstorm caused a large amount of rotted wood to break free from the tree at the site of an old lightning scar. One year later, a second windstorm snapped the trunk about 80 feet from the ground. In February 2011, the Oregon Parks and Recreation Department removed 40 feet of the

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Figure 2. Range of Sitka spruce in the Pacific Northwest of North America. Note the very narrow range along the Oregon coast, at the southern limit of the tree species.

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remaining snag due to concerns about decaying wood falling and putting visitors at risk. Sitka spruce and western hemlock are nearly equal in height growth during the period of most rapid growth, but spruce grows more rapidly in diameter. Spruce continues to maintain height growth longer than western hemlock, and it lives longer. Few western hemlock live more than 500 years, but Sitka spruce can live to 800 years. Eventually, old spruces assume a dominant position in old-growth, hemlock-spruce stands.

Most Sitka spruce trees do not begin cone bearing until after 20 years. Sitka spruce is monoecious; that is, it has both male and female flowers on the same tree. Female cones are usually found at the ends of primary branches near tops of trees, and male strobili are usually found at the ends of secondary branches lower in trees. Sometimes, both are found on the same branch. Cones are 1 to 4 inches (2.5 to 10 centimeters) in length, hang down from branches, and have very thin scales with jagged edges. Needles are about 1-inch long (2.5 centimeters), often flat in cross-section, yellow-green in color, stiff, and usually very sharp.

Throughout much of its range, Sitka spruce is a commercial timber species used for lumber, pulp, and many special uses. Compared with other woods, its strength-to-weight ratio is very high, and consequently it is used for ladders, aircraft shells, racing shells, garage doors, boat oars, sailboat masts and spars, planking, folding bleachers, and other uses where light but strong wood is needed. It is especially known for its outstanding resonant qualities in pianos, organs, and violins. Sitka spruce's long wood fibers make it ideal for making paper.

Abiotic and Human-Caused Problems of Sitka Spruce

Abiotic means nonliving or nonbiological. Abiotic problems often look like insect or disease damage, or one might find a biotic agent on a tree because it is stressed by abiotic factors. Most insects and biotic diseases affect a particular host tree species or group of tree species. Abiotic problems will often affect all or many of the trees, shrubs, and herbaceous species growing near each other. However, different species of trees, and trees of the same species but of different ages and vigor, often vary in their susceptibility to this type of damage. It is not always easy distinguishing abiotic causes of stress from biological causes (Figure 3).

The 2005 Oregon Coast defoliation and Shoot-Blight Event

In the late spring and early summer of 2005, Sitka spruce along the entire coast of Oregon had

Figure 3. These Sitka spruce trees in a picnic area established on "nurse logs" of the rainforest. The logs have since rotted away, and surrounding forest vegetation has been cleared. The compaction and root disturbance associated with heavy human use may eventually compromise the health of these trees.

an unusual defoliation event, especially noticeable along roadways. No biotic agents were found to be directly linked to the event. Oregon Department of Forestry forest entomologists and pathologists investigated the problem, which included current-year foliage dying and then some apparent older-foliage dying with subsequent small-twig dying. This was most intense in the lower crowns, but appeared to progress upwards. Scientists theorized that an extreme weather event of very high daytime temperatures exceeding 90° F in late May set the stage for the foliage loss. They also thought that spruce aphids (*Elatobium abietinum*) may have exacerbated the situation by injecting toxins into needles, although this was not proven. The following year, there were no indications of a similar problem,

Figure 4. The abiotic needle loss on these trees is associated with 2005 weather events.

leading scientists to conclude that the extreme weather event led to the defoliation (Figure 4).

Salt Damage

Salt spray can damage and kill a wide variety of plants along the Oregon coast. Sitka spruce is able to withstand salt winds and harsh conditions along the central Oregon coast better than other associated conifers, such as western hemlock and shore pine. Sitka spruce normally grows in mixed stands, but because of its high tolerance of salt, it can be found in pure stands in tidewater areas. Salt damage is very uncommon for this species.

Shade and Epicormic Branching

Figure 5. The epicormic branching of these Sitka spruce is associated with exposure to sunlight when the adjacent stand was harvested.

Sitka spruce's tolerance for shade lies somewhere between that of Douglas-fir, a shade-intolerant species, and western hemlock, a shade-tolerant species. It can grow in the shade but does better in sunlight. Sitka spruce is one of the few conifers that develop epicormic branches (Figure 5). Epicormic branches are shoots arising spontaneously from an adventitious or dormant bud on the stem of a woody plant. Epicormic branching is related to light intensity, and occurs when the tree's trunk is newly exposed to sunlight. Thinning, windthrow, and road building can lead to more sunlight reaching the trunk. Epicormic branching can decrease the quality of the logs for such high-value products as molding, siding, or musical instruments. However, little to no value is lost if the logs are destined for pulp production or for structural lumber.

An abiotic agent might be suspected when the lower limbs in Sitka spruce die. However, in deep shade, it is natural for the lower limbs to die, decay, and break off. Small, often resinous, branch stubs can remain on the trunk for many years. Occasionally, large dead branches are shed under live trees as a normal part of shade pruning.

As with salt spray, shade isn't typically a major cause of stress for Sitka spruce.

Trenching and Construction Damage

The architecture of a given tree is a balance between the crown and the roots. The size of the crown is related to the size of the root system. Each individual leaf has a direct connection to certain roots due to small capillary water streams. Although trees have some ability to compensate when a major portion of the root system is severed, the entire

crown cannot be sustained, and a portion of the leaves and branches are shed (die). Butt wounding and root damage, especially roots severed by trenching, can cause a tree to die or to lose some portion of its crown. This is the same stress caused by drought (lack of water to the foliage), and may appear as drought damage. Wounding also allows root diseases and wood rot to access the tree, and encourages insects and pathogens that can further weaken the tree. Consequently, trenching and construction can cause major damage to Sitka spruce in landscape and housing areas. Expect damaged trees to have a wide range of health problems.

Off-Site Planting

Trees that are not genetically suited to an area are called off-site. As with other tree species having large ranges, a tree grown from stock originating a long distance from the planting site has less chance of survival than a locally grown seedling. Off-site plantings are often more susceptible to insect attack.

Windthrow

Windthrow of Sitka spruce can occur during violent windstorms, which often strike the Oregon coast. A recent example is the November 2007 storm along the north coast. Although this is not often confused with insect damage, heavily broken trees are often attacked by insect pests that can later infest standing trees.

To differentiate between windthrow and root disease, look for a central area that has the longest-dead trees. Think of this as the mortality center. Look for trees that are showing fewer symptoms of disease, or have been dead a shorter period of time, as you move away from the mortality center.

This is how root disease progresses. Centers of mortality from bark beetles, lightning, and windthrow won't look like this. If the fallen trees are aligned in the same direction, then the likely culprit was windthrow (Figure 6). If the trees are lying in all different directions, then the cause is likely to be a root disease. If the tree broke off rather than being uprooted, check the characteristics of the break. Wood that was nondiseased when it broke has jagged, splintery breaks, whereas wood that was decayed when it broke has "brash" breaks, where failure is across the grain and less splintery.

Figure 6. Windthrow of coastal forest exposed by clear-cut near Newport.

Insects

Beetles: Weevils, Bark Beetles, Ambrosia Beetles, and Wood Borers

Weevils, bark beetles, and ambrosia beetles are in the same family of beetles (*Curculionidae*). The typical weevils have a distinct snout-shaped face and feed on a variety of plant parts. Bark and ambrosia beetles refer to specific group of beetles (subfamily *Scolytinae*) that feed in the bark and wood of trees. The term "wood borer" refers to a broad range of potential insects that bore into wood. The term often refers to two families of beetles—long-horned wood borers or round-headed wood borers (*Cerambycidae*), and flat-headed or metallic wood borers (*Buprestidae*). Bark beetles and ambrosia beetles are related to each other but differ significantly in their life history. Bark beetles are the only group that can cause significant mortality of mature trees.

White Pine Weevil (Sitka Spruce Weevil)

The white pine weevil (*Pissodes strobi*) (Coleoptera: *Curculionidae*), also locally known as the Sitka spruce tip weevil, is the most important insect pest of Sitka spruce in forest plantations. The weevil repeatedly infests and kills the leader of the tree and therefore slows growth and produces severe stem deformations. The tree usually survives attacks by this weevil, but with repeated attacks, growth is reduced and the tree becomes crooked or bushy as one or more lateral shoots try to replace the killed, terminal growth. Sitka spruce located in the heavy fog zone within 2 miles of the coast are less influenced by the white pine weevil than trees located farther inland.

The adult weevil is about 0.18 of an inch (5 mm) long, dark colored with splotches of light-colored scales, and has a pronounced snout typical of weevils. In spring, it makes feeding puncture wounds on the previous years' leader below the bud. The female lays eggs just below the terminal leader bud, and these puncture wounds may have resin flowing from them. When the eggs hatch, the grubs bore into the inner bark and descend along the previous years' growth. The grubs feed on the inner bark until constructing a cocoon of chips by August, within which the grub pupates into an adult beetle. The adults emerge in autumn, chewing an exit hole visible to the eye, and overwinter in forest litter. The leader that did develop in spring above this activity dies midway through the summer, often forming a J-shaped "shepherd's crook" (Figure 7).

The beetles specialize in attacking leaders of exposed, open-growing, vigorous trees from about

Figure 7. Effect of Sitka spruce (white pine) weevil on the terminal leader of Sitka spruce.

3 feet tall (1 meter) to about 60 feet tall (18 meters). The plantation size-class considered most susceptible to heavy damage is from about 5 to 30 feet tall and at low density. Two primary plantation-management ideas have been put forward. One is to plant Sitka spruce at high density and delay precommercial thinning until age 25 or so. This changes the microclimate around the leaders, crowds the crowns so that secondary leaders can easily take over from killed primary leaders, increases height growth, and improves the chances that not every leader will be attacked. Then, at age 25 or so, the stand can be thinned, removing lower-quality trees. The second option is to grow Sitka spruce intermixed with red alder. The canopy of alder has a general effect on the light environment (shade, speckling) and lowers the probability of weevil attack. This is a silviculturally challenging strategy, but some may find it practical and economical.

Some Sitka spruce trees in British Columbia are resistant to white pine weevil damage. This indicates that resistant mechanisms exist in this host-insect system. In the future, the use of weevil-resistant planting stock may again make Sitka spruce a viable and important commercial species along Oregon's coast.

In a western Oregon landscape setting, Sitka spruce is likely to be attacked. Alternatives may include ornamental varieties of white and black spruces, which are reported to be rarely infested with the white pine weevil. On landscape trees, it may be desirable to prune and burn the infested terminal leaders in August to lower weevil population numbers. Pruning all the lateral shoots but one in the whorl just below the infested terminal may improve stem form, allowing a secondary branch to take over.

Contact insecticide sprays (bifenthrin, esfenvalerate) are effective only on adult pests; all other life stages occur under the bark. Apply to the leader and upper branches in spring as adults begin to feed and lay eggs. Systemic insecticides (abamectin, imidacloprid) can also be used to kill larvae feeding within the leader. Consult the current year edition of the Pacific Northwest Insect Management Handbook (available at http://insect.pnwhandbooks.org/ or http://extension.oregonstate.edu/catalog/) for specific recommendations. Always consult and follow labels.

Ambrosia Beetles

Ambrosia beetles (Coleoptera: *Curculionidae*: *Scolytinae* and *Platypodinae*) are relatives of bark beetles, but they bore into sapwood directly. They inoculate the sapwood with an ambrosia fungus, which they carry into the tree on specialized body structures called mycangia (Figure 8). The larvae eat the growing fungus that lines the larval cavity. The beetles do not kill trees but attack freshly dead or strongly declining trees. They are the first invaders of a dead tree! White dust may appear at the entrance hole as the adults bore into the sapwood. This is in contrast to bark beetles, which bore into the inner bark and create a reddish boring dust.

Figure 8. Pinhole borer (ambrosia beetle) galleries in sapwood. Some holes are stained with ambrosia fungi.

Along the Pacific coast of Oregon, ambrosia beetles can be significant pests of Sitka spruce logs that are left in place, or stored on landings or mill yards with the bark still on. The pinholes created by the beetles cause a defect in the lumber. Logs are particularly susceptible in spring and summer. *Trypodendron lineatum*

and *Gnathotrichus spp*. are considered the most important ambrosia beetles in coastal-log storage. Quick movement of logs out of the forest and into the mill is the best strategy for tree growers to reduce damage by these insects.

Spruce Beetle

Throughout the West, the spruce beetle (*Dendroctonus rufipennis*) (Coleoptera: *Curculionidae*: *Scolytinae*) is capable of large-scale mortality of mature and older trees, including Sitka spruce in British Columbia and Alaska. Although the beetle is present in Oregon, it is not considered a threat to the Sitka spruce forests in the state. The beetles appear to focus on very weak trees, or recently dead and down large trees, after winter storms. In other regions of the West, spruce beetle epidemics usually occur after a large-scale, windthrow event. The beetles colonize the downed wood in the late spring or early summer following the windthrow, and populations build to a degree that allows them to mass attack nearby healthy spruce in the following years. Again, this behavior has not been observed along the Oregon coast.

Depending on location, the spruce beetle can have a life cycle of one to three or more years. In Oregon, the beetle is reported to have a two-year life cycle. The beetle is dark brown to black and very small—4 to 7 millimeters (1/4 inch) long (Figure 9). Wing covers are reddish, and the beetles have hair-like projections. A recently attacked tree will have boring dust around the base of the tree from excavation of the bark by the beetles. This will look like reddish-brown sawdust, which can also collect in bark fissures. The beetles attack the tree by directly boring into the bark, where females lay eggs in a distinctly patterned gallery near the wood-bark interface. The galleries are visible on the inside of the bark after removing it from the tree. Larvae excavate away from the main vertical egg gallery and mine the inner bark, eventually crisscrossing each other and melding together into large communal feeding areas. Larvae pupate in the inner bark and adult emergence is likely in spring or early summer of the year following the initial attack. Distinctive woodpecker feeding on large trees attacked by beetles appears from the flaking activity of the birds that are harvesting grubs out of the bark, not the wood.

Figure 9. Spruce beetle.

Photo from OSU Integrated Plant Protection Center.

Aphids, Adelgids, Scale Insects, and Mites

Aphids, adelgids, and scale insects are small insects with piercing-sucking mouth parts. There are numerous types, although aphids are usually naked, while adelgids and scales often have some type of covering or form a gall. The spruce aphid is the most important and influential of these insects for Sitka spruce along the Oregon coast. Mites are an unrelated group of arthropods, not insects. They have eight legs, are very small, and are an incredibly diverse group. Only one, the spruce spider mite, is widely known to cause problems in spruce.

Cooley Spruce Gall Adelgid

The Cooley spruce gall adelgid (*Adelges cooleyi*, Homoptera: *Adelgidae*) is a fascinating insect that may cycle between two host trees: Douglas-fir and Sitka spruce. On Sitka spruce, the insect creates a swollen, cone-shaped gall on the new growth of spruce twigs (Figure 10, page 9). When these dry, they look much like brown cones on the terminals of the branches. Adelgids feed on succulent new growth at the base of developing needles. This stimulates the development of the gall. On close inspection of the maturing gall when fresh (not dried), the adelgids can be found inside chambers created by the gall. On Douglas-fir, the insect settles singly on new needles and covers itself with waxy excretion that looks like a cottony tuft. Feeding

Figure 10. Branchlet tips deformed by Cooley spruce gall adelgid.

damage is usually slight on young Douglas-fir, causing needle spotting or loss. However, this insect can reduce visual quality of Christmas trees, and growers concerned about Cooley spruce gall adelgid should not have any spruce species growing mixed with Douglas-fir. The adelgid is common on all spruce tree species throughout the West but is rarely considered a major problem.

Spruce Aphid

The spruce aphid (*Elatobium abietinum*) (Homoptera: *Aphididae*) causes foliage loss and crown thinning on trees of all ages and sizes (Figure 11). Continued infestations can cause tree death. It is common on Sitka spruce and ornamental spruces (especially blue spruce, *Picea pungens*) on the Oregon coast. The spruce aphid is thought to be a nonnative invasive from Europe and is a problem across North America on several spruce species. In North America, the insect is parthenogenetic (can reproduce without mating) and consists of females only.

On Sitka spruce, the insect is present year-round but rarely found in the drier seasons. It is most easily seen during late fall through early spring, when it can be very abundant. To find the insect, tap or beat the branches while holding a white sheet of paper under the branch. If the green (or olive-green) aphids are common, they will fall on the paper and be easily observed, despite their small size (1/16-inch or 1.5 mm long). Winged individuals are rare.

The spruce aphid sucks sap primarily on the undersides of older needles, rarely affecting the newer needles. The insect populations, which are gregarious, usually peak during late winter, and the needles that were fed on may be lost during the following growing season as new foliage emerges. The lower and inner crowns are typically most seriously affected. A tree crown in summer may have unaffected new needles and the remainder of the crown may be thin and lack needle retention.

The spruce aphid is thought to be influenced primarily by weather, with mild winters favoring the insect. Populations can flare up into epidemics, but these typically last only a few years. Mortality events in Sitka spruce are often associated with spruce aphid, but it is thought to be only one of a complex of factors observed.

Control of spruce aphid is mostly influenced by weather. Ornamental spruce may be treated with insecticides if the landowner is very concerned. Sprays must be applied in late March or early April

Figure 11. Symptoms of spruce aphid include foliage decline and loss of the lower and inner crown on Sitka spruce.

Figure 12. Spruce spider mites. Note webbing.

to be effective. Formulations that are registered for use on ornamental spruce include insecticidal soap, bifenthrin, acephate, and imidacloprid. Follow all directions and cautions when applying pesticides.

Spruce Spider Mite

The spruce spider mite (*Oligonychus ununguis*) (Acari: *Tetranychidae*) is an 8-legged arthropod not related to insects. It is a common conifer pest on Christmas tree farms and intensive nursery production areas. The spruce spider mite prefers spruce, but can be found on most conifers (Figure 12). Sometimes, the mite populations can erupt in forest settings. Spruce spider mites feed on plant juices and can cause a stippled or bronzing appearance on foliage, which may eventually turn yellowish to brown and fall off. Webbing is often present among the foliage and around the twigs. The general appearance is one of off-color gray, and the tree may have poor foliage retention. Spruce spider mites are very small and may require magnification to see. Tapping branches while holding a white sheet of paper will cause the mites to drop out, and one can observe the tiny creatures.

Leaf-Eating Defoliators

Defoliating insects that eat spruce needles and can cause significant loss of foliage in the entire crown are not particularly common on Sitka spruce. The damage is done by the moth caterpillars, or perhaps by sawfly larvae, which are actually related to bees and wasps. There are many insects that can feed on Sitka spruce needles; some are specialized to spruce, while others are generalists that may eat a number of different conifers. Table 2 (pages 17-20) lists many of the leaf-eating insects known on Sitka spruce, but defoliation of Sitka spruce by leaf-feeding insects is reasonably rare. The spruce bud moth,

Figure 13. Silver spotted tiger moth caterpillars on Sitka spruce.
Photo by Bryan Black

Zeiraphera spp. (Lepidoptera: *Tortricidae*), may kill developing buds. But perhaps the most recognizable defoliator is the silver spotted tiger moth.

Silver Spotted Tiger Moth

The silver spotted tiger moth (*Lophocampa argentata*, Lepidoptera: *Arctiidae*) feeds primarily on Douglas-fir but also is found on Sitka spruce (Figure 13), western hemlock, and grand fir along the coast. The adults fly in the fall, when the female lays eggs on the sunny side of the tree crown. Eggs hatch in fall, and the caterpillars feed together in social groups. The caterpillars form a loose tent and may spend time in it, though they are not restricted to the tent. The caterpillars are active all winter, aggregating to bask in sunshine (thermoregulate). The caterpillars feed socially until mid-spring, at which time they disperse throughout the crown. The social feeding creates patches of defoliation on a tree crown, but rarely is the entire crown defoliated. Initially, the caterpillars are dark colored and have a few hairs, but as they grow, they develop hairy tufts. Handling these insects can cause skin reactions. The patchy defoliation caused by these insects is most noticeable in late-winter to mid-spring, unlike most other tent caterpillars that develop after spring arrives.

Diseases Caused by Fungi

Disease is a broad term that refers to abnormal plant growth and development. This can be caused by abiotic agents, such as weather, soil nutrients, and herbicides (Table 1, page 17) or biotic agents, such as fungi, bacteria, viruses, and parasitic plants. In coastal Oregon Sitka spruce, fungi are the primary disease agents of concern (Table 3, pages 21-24).

Root, Butt, and Stem Rots

Root, butt, and stem rot diseases are caused by wood decay fungi that colonize and decay the wood of live trees. They can cause significant losses in timber production, especially in older, multi-entry stands of Sitka spruce and western hemlock. The fungus can enter the tree wood via root, butt, and

Figure 14. Conks indicating Heterobasidion root and butt rot is present in the stand.

stem wounds; root-to-root contacts; grafts between infected and noninfected trees; dead branches; and small, dead branch twigs.

Heterobasidion (*Annosus*) Root and Butt Rot

Heterobasidion root and butt rot, caused by the fungus *Heterobasidion occidentale*, is an issue in management of western hemlock and Sitka spruce along the coast of Oregon (Figures 14 and 15). The fungus is a prolific spore producer that can colonize roots and butts (even the stem) of wounded trees. It also can grow from one tree to another across root grafts and contacts. Heterobasidion is known for its ability to colonize freshly cut stump surfaces. It can grow down through the stump and infect nearby trees that have roots in contact with the stump roots. However, this is most important in drier habitats, such as white fir forests of California and grand fir forests in the Oregon Cascades. Along the coast, this does not appear to be a major form of tree infection

Figure 15. This windthrow is associated with butt rot caused by *Heterobasidion occidentale*. Note the white rot. This picture is of western hemlock, but decay in Sitka spruce will look very similar.

in thinned stands of western hemlock. Our knowledge of Sitka spruce is limited by the lack of any plantation management.

Heterobasidion root and butt rot is most important in landscapes around people, cars, and houses, and recreational areas along the coast, where heavily decayed, large trees may pose a hazard. Butt-scarred trees are likely infected with the fungus, and the white rot, with occasional black specks, can be extensive. The spores emanate from a bracket-shaped conk that is found in protected sites, underneath the butt of downed trees, or inside the heavily decayed heart or butt of the tree. The conks may form inside hollow stumps. The conk is dark above and creamy below, with a thin, sterile margin. Conks on the outside of a tree indicate significant internal decay.

Figure 16. Armillaria mushrooms grow out of a recently dead red alder tree. There are numerous species of Armillaria that are difficult to tell apart. However, when fruiting from the base on the lower bole of a tree, it is likely the fungus played a part in tree death.

Armillaria Root Rot

Armillaria root rot is caused by a number of Armillaria species. Any given site may have several Armillaria species, but only one will likely be pathogenic. Although Armillaria will produce mushrooms (the honey mushroom) often in clusters around infected trees, it does not appear to colonize trees with spores (Figure 16). It is a below-ground fungus that grows from tree to tree across root contacts.

Armillaria is also known as the shoe-string root rot because it also can grow through the soil with a structure called a rhizomorph. A black shell surrounds the thin core of mycelium in a rhizomorph, and these grow through the soil from a decaying root to new roots, where it branches and attempts to colonize the new substrate.

Figure 17. This sporophore (conk) of *Phaeolus schweinitzii*, cause of Schweinitzii root and butt rot, is emerging from an infected root underground.
Photo Glenn Ahrens

Typically, Armillaria species that causes root rot in Sitka spruce forests will be opportunistic pathogens that kill weakened and stressed trees by colonizing roots and killing the inner bark up to the root crown. If the root crown is completely girdled, the tree will die.

Armillaria fungi grow through the inner bark at the wood surface in distinct, fan-shaped mycelia that appear like white, alluvial fans. The tree reacts with resin production, and the surface of the bark at the tree base may have copious resin flow. Chopping under the bark and examining the inner bark will reveal the mycelial fans.

Occasionally, a very aggressive Armillaria clone will create a patch of mortality called a root disease center. These are characterized by dead and dying trees in the center, and dying trees around the opening. This differs from bark beetle mortality in that trees are in all conditions of decline and snag deterioration, while bark beetles kill all the trees at the same time. Along the Oregon coast, Armillaria root rot centers do occur, and within these centers, one should avoid planting Sitka spruce and western hemlock if doing reforestation. Maintaining tree vigor is the best defense against Armillaria.

Schweinitzii Root and Butt Rot

Schweinitzii root and butt rot, caused by *Phaeolus schweinitzii,* is a major root and butt rot of old-growth Sitka spruce. It is associated with butt-snap-type failure of large trees. Investigating the broken stump will reveal extensive brown cubical rot. The actual colonization and root infection biology is poorly known in Sitka spruce forests, but the fungus is quite common, and is also known throughout the northern hemisphere as a conifer butt rot. In Oregon, it is also very important in old-growth Douglas-fir.

The sporophore of *P. schweinitzii* is typically stalked and emerges from a buried root below ground, although they may also occur on the trunk up to 10 feet (3 meters) high or more. Fruiting occurs in the fall, when the upper surface will appear quite distinctively hairy and brown with yellow colors (Figure 17). The undersurface has pores, not gills. The sporophore persists for months as a brown "cow-pie" on the forest floor. Typically, older infected trees have pronounced butt swell.

Red Belt Fungus

The red belt fungus (*Fomitopsis pinicola*) causes a brown, cubical rot of dead conifer trees throughout Oregon, where it is considered a decomposer organism, not a pathogen. However, in the Sitka spruce forests of Alaska and Engelmann spruce forests of Oregon and Washington, the red belt fungus can decay wood on a living tree. In coastal Oregon, the red belt fungus usually behaves as it does in Alaska, and it is often observed on the pronounced stem wounds of large trees. The conk indicates significant decay inside the tree or snag Figure 18).

Red-Ring Rot

Red-ring rot (*Porodaedalia (Phellinus) pini*) is a heart rot of live trees that may occur on Sitka spruce. The heart rot is most abundant on older trees. Wounds are not required for the decay fungus to enter the tree; dead branches provide the primary entrance court.

Figure 18. Red belt fungus (*Fomitopsis pinicola*) on wounded living Sitka spruce.

Needle Diseases

Several needle fungi are reported on Sitka spruce (Table 3, pages 21-24), but they rarely cause broad-scale tree damage. Disease-causing fungi on foliage are closely linked to climate, especially leaf wetness during spore dispersal and leaf colonization usually tied to conditions in the spring. They also respond to mild winter and summer temperatures, and spring and summer rainfall in consecutive seasons. Therefore, when a flare-up occurs in a tree or stand, it is likely linked to seasonal patterns of weather. The spruce needle rust, caused by *Chrysomyxa ledicola*, has recently been reported to be extensive along a portion of coastal Oregon. The fungus requires two host species—spruce and Labrador tea. On spruce, the needles will have distinctive, spore-producing fungal structures that are light colored and hang down from the needles, after which the needles drop, and the crown of the tree can seem especially thin. On Labrador tea, the disease is inconspicuous, and causes general discoloration of foliage.

Canker Diseases

Cankers are areas of localized dead or dying bark on living twigs, branches, and stems of trees. These can be caused by a variety of organisms and can be perennial or annual. Fungi cause most cankers. Perennial cankers persist for many years and can form a target shape on the stem, with dead wood exposed in the center and the fungus in the bark at the edge. Annual cankers often attack young bark. They don't persist in the bark for a long time but cause areas of sunken, necrotic bark that kill the branch distal to the infection. Although cankers are routinely reported in plantations of Sitka spruce in Alaska, the importance in Oregon of cankers seems limited. Cankers may cause individual twig and branch death but rarely cause extensive damage in Oregon. Botryosphaeria canker, caused by *Botryopsphaeria piceae*, is reported on Sitka spruce, but its importance is unknown.

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Table 1. Nonbiological (abiotic) and human-related problems that can impact Sitka spruce and be confused with insects and disease

Cause	Symptoms and description
Salt damage	Reddish foliage, often on one side of the tree. The canopy can have a burned look. Trees often recover. Associated with winter storms that blow salty water onto land.
Shade	Lower limbs on shaded parts of the tree die, decay, and break off. Small, often resinous, branch stubs remain on the trunk for many years. Occasionally, large, dead branches are shed under live trees as a normal part of shade pruning.
Trenching or construction damage	Tree declines and may die. Trenching can damage major roots, thus weakening tree vigor and possibly allowing entrance courts for root and butt rots. All roots serve the crown of the tree, and the size of the below-ground, water- and nutrient-uptake apparatus is related to the size of the crown. When roots are severed, the remaining roots may be unable to service the entire crown as before.
Off-site planting	Tree declines and dies. Foliage disease causes foliage loss. Tree seems weak and never vigorous. Ask about the genetics of the tree before purchasing. (What is the seed source of this tree?). Use native seedlings or a local nursery that can tell you where their seedlings originated.

Table 2. Common Insect Pests of Sitka Spruce on the Oregon Coast

A. Terminal and Branch Insects			
Insects	**Notes**	**Symptom**	**Signs**
Sitka spruce weevil (white pine weevil) *Pissodes strobi*	The Sitka spruce weevil is the most important insect pest of Sitka spruce, limiting the use of spruce in forest plantations.	The terminal leader curves and dies, forming a "shepherds crook." Continual infestation causes reduced height growth and flattened tops.	Eggs are laid at the base of the terminal bud. Grubs hatch and mine the inner bark downward. Chip cocoons are made under the bark when the grubs stop feeding to pupate.
Cooley Spruce Gall Adelgid *Adelges cooleyi*	Although an adelgid, (see Table 2B, page 18) this insect causes branch tips to swell and eventually die. Common, but not considered too damaging. Insect alternates onto Douglas-fir, where it is observed as white, cottony tufts on new needles, new shoots, and developing cones.	Current year infestation: swollen branch tips, shortened needles. Cut into swollen area and find chambers with insects inside in summer. Branch tip dies and looks almost like a seed cone on the tips of branches.	Cut inside current-year, swollen area and find small aphid-like insects covered with white, waxy coating inside the chambers.
Pitch nodule moths *Petrova spp*.	Girdles and kills branch tips and terminal shoots—seldom kills trees but predisposes young plantation trees to breakage. Uncommon.	Pitch mass usually occurs at branch junctions and branchlet nodes.	Small, round, dirty lump of pitch and frass. Creamy-white to orange-brown larvae are 5/8". Head capsule is reddish brown.

B. Aphids, Adelgids Scale Insects, and Mites			
Insects	**Notes**	**Symptom**	**Signs**
Aphids and adelgids (Many spp. for both) Family *Aphididae*	Aphids attack hardwoods and conifers. Adelgids feed only on conifers (see Cooley spruce gall adelgid in section A, page 17).	Deformed needles or branch tips, curled up needles, yellow spots on leaves. General thin look to branches.	Small aphids, may be winged or not. Scales are an insect with an external covering.
Spruce Aphid *Elatobium abietinum*	Non-native, introduced aphid; can cause major damage to crowns; is very responsive to winter weather, with very cold temperatures reducing populations. Warm, mild, and wet winters create favorable conditions for population increases.	Current-year flush of needles are not affected in spring. Only older needles will be affected, especially from winter feeding.	Small, green aphids are present year-round, but most abundant in February-March. Shake branch over white paper and look for aphids.
Spruce spider mite *Oligonychus ununguis*	Can kill seedlings and small trees. Suck fluid from needles, causing needle stippling, discoloration and shedding.	Foliage appears faded or has a dusty-grayish appearance. Stippling and bronzing often near base of needles—ultimately changes from dingy-yellow to rusty-brown, and drops.	Fine webbing among needles and around twig. Webbing has a dirty appearance. Mites are difficult to see with naked eye.

C. Leaf-Eating Defoliators			
Insects	**Notes**	**Symptom**	**Signs**
Silver spotted tiger moth *Lophocampa argentata*	Most common on conifers such as Douglas-fir; occasionally found on Sitka spruce.	Localized defoliation patches develop from February to April. May have tent-like structures on branches. Frass and debris accumulate in the tent.	A loose tent caterpillar. Small, dark caterpillars are present in colonies all winter; as they grow in spring, they develop rusty and yellowish hair tufts, and consume more foliage. By late spring, they disperse singly until they pupate in brownish cocoons on the tree or in debris.
Spruce bud moth *Zeiraphera spp.*	Can cause growth reduction and crown distortion.	Current year foliage is chewed, discolored, or both. Damaged buds with webbing and frass.	Larvae have tan heads and pale brown bodies.
Loopers *Melanolophia imitate* *Nepytia phantasmaria* *Lambdina fiscellaria lugubrosa* (Western hemlock looper)	W. hemlock looper infestation can cause complete defoliation and death within one year. Mostly in stands more than 80 years old.	"Wasteful" feeding —dead needles mixed with live needles. Chewed foliage is yellowish red then brown in one season.	W. hemlock looper mature larvae are 1 $^{3}/_{16}$" (30 mm), green to brown with 4 dark dots on top of abdominal segments. Buff-colored moths fly in the fall.
Western blackheaded budworm *Acleris gloverana*	Cause top kill and mortality. Trees have reddish-brown, scorched look.	"Wasteful" feeders — they rarely consume entire needles. Clipped needles & web shelters.	Mature larvae 1/2 - 5/8" (12–16 mm) with brown head and green body. Gray moths 3/4" (19 mm) long with mottled coloration.

D. Bark beetles and wood borers			
Insects	**Notes**	**Symptom**	**Signs**
Ambrosia beetles *Gnathotrichus spp.* *Trypodendron lineatum*	Attacks recently dead trees and recently cut logs. Does not cause mortality. Will damage logs in storage.	Fine, white boring dust, pinholes straight into the bole—often black fungal stains around pinholes.	Shiny brown to black beetles 1/16″ – 1/4″ (1.5–6 mm) long. Some spp. have yellow stripes or yellow legs.
Spruce beetle *Dendroctonus rufipennis*	Causes mortality—worse east of the Cascades. Usually trees > 12″ diameter at breast height (4.5 feet)	Red-brown boring dust in bark crevices and at tree base.	Dark brown to black with reddish elytra (hardened forewings). Adults about 1/4″ (6 mm) long.
Oregon fir sawyer *Monochamus scutellatus*	Attacks dead and dying trees. Does not cause mortality. Will damage logs in storage.	Long, meandering galleries that can extend into the sapwood and heartwood.	Shiny black beetles 3/4″–1 1/4″ (19–32 mm) with white spot between wing covers. May have scattered white on the elytra.

Table 3. Major Diseases of Sitka Spruce on the Oregon Coast

A. Root, Butt, and Stem Rots (Wood Decays)			
Species	**Notes**	**Symptom**	**Signs**
Heterobasidion (*Annosus, Fomes*) root and butt rot *Heterobasidion occidentale*	An important root and butt rot of old and wounded Sitka spruce trees. Prolific spore disperser that colonizes wounds and stumps. Increases in importance with tree and stand age. Common on western hemlock also.	May be no obvious external symptoms. Infection highly likely if tree has large basal wound. The fungus is common heartrot of the roots and butt of the tree. It's also a wound colonizer and kills some roots.	White rot with occasional black flecks. Conk usually produced in protected place under stump or inside hollow heartrot column. Conk is bracket shaped, with dark top and whitish underside. A thin sterile margin surrounds the pores of the underside.
Armillaria root disease *Armillaria* species	An opportunistic root rot that often attacks stressed and low-vigor trees. Strictly below-ground infection (spores are not important). Occasionally creates root disease infection centers when a virulent clone becomes active.	General decline of the tree, including thinning crown, reduced leader growth, stress cone crop, yellowing crown. Eventual death. May see resin flow from bark at base of tree or under duff. Chop under bleeding bark to find mycelial fans, a distinctive sign.	Mushroom known as the honey mushroom and is edible. White spores and tan mushroom with distinct ring, often fruits in clusters at the base of infected trees. Mycelial fans are shaped like alluvial fans and form under the bark at the wood surface, where the fungus grows and colonizes the tree. These are white and very distinctive.
Schweinitzii root and butt rot *Phaeolus schweinitzii*	Perhaps the most important root and butt rot of old-growth Sitka spruce. Whenever an old tree breaks at the butt and has a dark brown cubical decay, this is likely *P. schwienitzii*.	There may be no external symptoms. Hollow large roots and butt up to 8 or more feet above ground. Carpenter ants often associated with decay columns.	Distinctive stalked mushroom-like conk. Usually fruits in fall, and, when fresh, it is brown, golden, tan, and hairy. When dried, it becomes brown like a cow pie. Hence, it is also known as cow pie fungus.
Ganoderma root and butt rot *Ganoderma applanatum*	A common decay of very old trees or large logs. Not considered highly pathogenic in Sitka spruce.	A white rot of large logs and old trees. External indications not obvious.	The "artists conk," a classic, potentially large conk with a dark, smooth upper surface and a distinct white undersurface that can be drawn on.
Conk rot, red ring rot. *Phellinus (Porodaedalia) pini*	Common heartrot of live trees.	Heartrot	Brown conk with cinnamon-colored pores associated with branches.

Red belt fungus *Fomitopsis pinicola*	The most common wood decay of dead conifers. In Sitka spruce, may occur as a wound colonizer and heartrot.	External symptoms rare, but may be associated with large wounds. A brown, cubical rot invades mostly dead trees.	Brown cubical rot, sometimes with white mycelial sheets in the shrinkage cracks of the decay. A distinctive conk with smooth, dark upper surface and cream undersurface, and a red band around the edge of the conk. A wide sterile margin on the undersurface.
Sapwood rots: wound colonizing, wood decay fungi. *Trichaptum abietinum* *Cryptoporus volvatus* *Gleophylum sepiarium*	These fungi are dead wood decayers, but can be found on living trees where bark has been wounded or sun scalded.	Usually there is a wound associated with these fungi, or the tree has had bark beetle or wood borer attack. These are either brown rots or white rots, but white is more common.	Each species has distinctive sporocarps and wood decay characteristics.

B. Needle Diseases			
Species	**Notes**	**Symptom**	**Signs**
Lirula needle cast *Lirula macrospora*	Not particularly important, but may be locally common or arise quickly.	Brown needles. Crown may thin.	Short black lines along length of needle (the spore producing structure).
Lophodermium needle casts *Lophodermium* species	Most common on older needles, interior crown.	Dead needles on twigs.	Black or brown dots on needle.
Rhizosphaera needle cast *Rhizosphaera kalkhoffii*	A common needle disease of blue spruce and other spruces, especially in the east and northeast of North America. Not particularly important in Sitka spruce, but may be locally common, especially on yard trees near blue spruce.	Thin crown, loss of interior foliage, foliage may be spotted yellow or gray-green.	Black dots emerging from air pores (stomates) on needle.
Spruce needle rust *Chrysomyxa ledicola*	Occasionally becomes abundant along portions of the Oregon coast. Linked to wet spring and summer weather.	Yellowing of needles, loss of current years' foliage. Requires alternate host (Labrador tea).	Yellow tubes hang down from underside of needles in summer. Very distinctive.

C. Canker Diseases			
Species	**Notes**	**Symptom**	**Signs**
Botryosphaeria Canker *Botryopsphaeria piceae*	Not known as a particular problem, but not well studied.	Small branch and twig death. Red foliage on dead twig. Tip dieback. Sunken dead patch of bark (canker) at base of dead twig. Seedlings to mature trees.	Small black fruiting bodies cover the canker.

Cover photo of Sitka spruce at Cape Perpetua, Oregon, by Brian Aydemir

Use pesticides safely!

- Wear protective clothing and safety devices as recommended on the label. Bathe or shower after each use.
- Read the pesticide label—even if you've used the pesticide before. Follow closely the instructions on the label (and any other directions you have).
- Be cautious when you apply pesticides. Know your legal responsibility as a pesticide applicator. You may be liable for injury or damage resulting from pesticide use.

Published January 2015.