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Needle Diseases in Oregon Coast Range Conifers

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Contents

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This publication discusses the environmental requirements of needle diseases, their potential impact on tree vigor, when disease levels signal a problem, and what you can do to minimize damage. For specific disease identification and treatment options, see the references on the back page.

Why be concerned about needle diseases?

Fungi cause needle diseases, and environmental conditions along the Oregon Coast Range are ideal for fungi reproduction and spread. Abundant conifers plus moist, cool spring weather and mild winters increase the level of needle disease. Although needle-disease-causing fungi are some of the most common pathogens (disease-causing organisms) found in this region, not all needle fungi damage trees. Some are actually beneficial.

Conifer tree species along the Oregon coast have evolved in an environment favoring needle fungi. Therefore, under “normal” conditions they have developed significant tolerance. The most severe needle disease outbreaks are during unusually wet weather and among trees poorly adapted to the site. In some parts of the Coast Range, planting Douglas-fir from outside the region or poorly adapted species such as ponderosa pine or interior lodgepole pine has been largely unsuccessful due to needle disease attacks.

With the exception of a recent outbreak of Swiss needle cast on Douglas-fir, most needle diseases of Coast Range conifers do not seriously affect forest health or management objectives on a large scale. However, localized outbreaks of needle diseases can be significant, so it is important to understand why they occur and what you can do to limit their impact. The current outbreak of Swiss needle cast in Coast Range forests shows the damage potential of widespread disease-causing fungi. The outbreak is an example of the interaction of environmental conditions and management practices.

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Why do moist environments favor fungi?

Needle fungi reproduce through spores and mycelium that spread and infect healthy needles. Spores are similar to plant "seeds," spreading the fungus through the air to needles on the same tree or on other trees. Mycelium are like plant "roots," growing to infect the same needle or adjacent needles on the same twig. In some cases, such as Swiss needle cast, life cycles are simple. One spore stage infects only Douglas-fir needles, primarily in the spring and early summer. In other cases, such as hemlock–blueberry rust, life cycles are complex. Several spore stages infect hemlock and blueberry alternately at different times throughout the year.

Wind or rain carries spores to the foliage of susceptible hosts. With moisture from rain, dew, or fog, spores germinate and infect the foliage either directly through the needle cuticle or through small openings (stomata). Therefore, the key factor for spore germination usually is moisture. Without adequate moisture, spores either do not germinate at all, or if they do germinate, infection does not result because spore germ tubes dry out. During years with above-normal rainfall, conifers are more likely to experience outbreaks of needle diseases.

Ecological role of needle fungi

Needle fungi live on both living and dead needles. On dead needles, fungi enhance decay rates and recycle needed nutrients to the soil and tree. Dozens of fungi colonize living needles both on the surface and internally. A single conifer needle may contain several dozen different fungal species. Many of these fungi are not harmful and can actually benefit the tree by breaking down nutrients, producing compounds toxic to insects, and preventing colonization by more harmful species.

Needle disease's impact on the tree

To better understand how needle diseases cause damage, we first need to look more closely at the primary site of infection and colonization: the needle. Needles are the tree's primary site of food production (photosynthesis). Elements required for photosynthesis—carbon dioxide, water, and nutrients—are imported to the needle from other locations. Carbon dioxide from the atmosphere enters the leaf through small pores (stomata) often on the underside of the needle. Sapwood (xylem) transports water and nutrients to the needles where

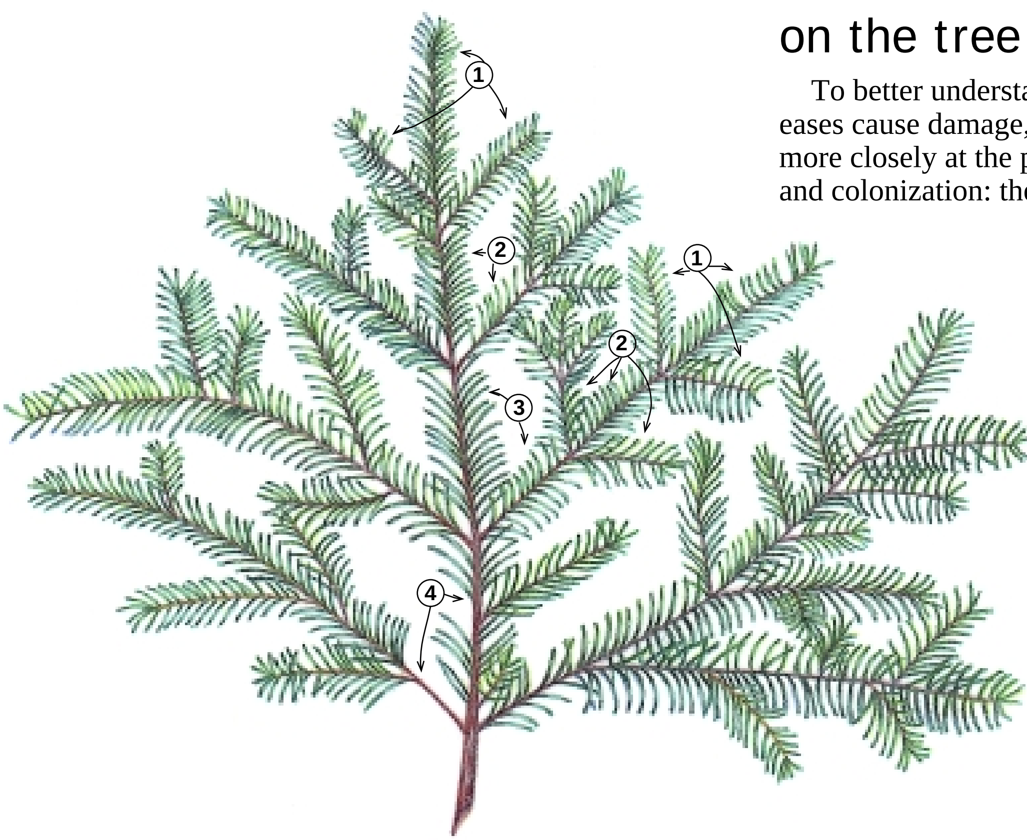

Figure 1.—Determining needle age. The numerals in circles indicate the needles' age in years.

they are combined with carbon dioxide and energy from sunlight to produce food for the entire tree.

Combining carbon dioxide, water, and nutrients into food requires energy. An important part of the needle, called chlorophyll, gets this required energy from the sun. When chlorophyll is abundant and healthy, it gives leaves their green color. When disease-causing fungi infect needles, functions such as transport and the capture of energy—and therefore photosynthesis—are disrupted. This disruption often leads to varying levels of damage and, as a consequence, reduces the amount of chlorophyll in the needle. Chlorophyll loss causes the needle to turn yellow and eventually brown if the needle dies. A needle that has turned yellow is called chlorotic (lacking in chlorophyll); a brown needle is called necrotic (dead). Some needle diseases colonize only limited areas on the needle, resulting in sharply defined chlorotic or necrotic areas. In many cases, needle yellowing leads to the incorrect conclusion that the tree has a nutrient deficiency. Aside from their abnormal appearance, heavily infected trees grow less, lose vigor, and possibly die prematurely.

Figure 2.—At top, older needles have been prematurely shed, due to Swiss needle cast. Healthy branches (lower photo) retain older needles.

Determining disease impact on tree growth and survival

The three most important indicators of potential damage from needle fungi are:

- Extent of disease in the tree crown
- Number of consecutive years in which damage has been significant
- Age class of the needles with symptoms

Other factors may include tree age, genetic tolerance or resistance, tree species, tree health before the disease struck, current growing conditions, and presence of other tree-weakening organisms.

Healthy conifers retain their needles for several years. In the Oregon Coast Range, a needle may stay on a branch from 3 to 7 years depending on tree age, needle location within the crown, and tree species. As illustrated in Figure 1, usually it's easy to determine needle age. Determining the age of the infected needle is important because a needle contributes less to tree growth and vigor as it ages. Therefore, a disease-causing fungus that infects only needles older than 3 years may have little consequence for tree growth and survival. Conversely, needle fungi that infect new growth in the spring and needles in their first growing season can have a direct impact on a tree's growth and survival, particularly if the damage is in consecutive years.

The extent of foliage disease and the number of consecutive years of damage can be measured by estimating the number of years of needle retention. Examine the lateral branches in the middle to upper parts of the tree crown. For Swiss needle cast in coastal Douglas-fir, which normally has 3 to 4 years of needles, high disease severity would be 1.5 years or less of needles; medium severity would be 1.6 to 2.5 years of needles; and low severity would be 2.6 to 3.5 years of needles (Filip et al. 2000). The same technique could be used for other, similar needle diseases.

"The dose makes the poison" is a saying that is very applicable to fungi that cause needle diseases. If fungi numbers are moderate, the host plant may be relatively tolerant of infection. As the infection level increases, usually because of more favorable (wetter) weather and host availability, the overwhelmed tree no longer can produce enough food to maintain vigor.

Figure 3.—Fruiting bodies of the Swiss needle cast fungus on the underside of an infected Douglas-fir needle (magnified 20 times).

Common identifying characteristics of conifer needle diseases

Symptoms are the reactions of the host tree to a pathogen, such as premature needle loss or needle yellowing. *Signs* are the parts of the fungus on the needle. The only visible signs of many needle fungi are fruiting bodies (reproductive structures) that usually appear as small black specks or dots on the foliage (Figure 3).

Due to their characteristic symptoms, fungi that cause needle diseases often are grouped as "needle casts," "needle blights," or "needle rusts." Needle casts and blights are associated with fungi that often cause loss of older needles and that infect newly emerging needles. Rust fungi can infect several age classes of needles but usually are limited to current-age needles. Foliar rusts are recognized by distinct fruiting bodies produced in the spring or fall. Needles infected with rust fungi develop prominent white blisters filled with orange spores; the surrounding area of the needle is yellow (Figure 4). Needle rusts need an alternate host such as a fern or shrub to complete their life cycles.

Determining the cause of foliar damage from symptoms alone is challenging. Often it takes a microscope to find and identify fruiting bodies. Initial symptoms are uniform or partial discoloration of the needle from green to yellow or brown. Often, during certain times of year, small fruiting bodies (black specks or blotches) are on the needle. As the disease progresses, the damaged needles may be shed prematurely (Figure 2, upper) or may die and remain attached. Eventually, the tree crown begins to have a transparent, brown-gray, or yellow-red appearance. Initially, needle diseases often affect individual trees, ones that are especially susceptible local specimens or off-site (from another geographic area) species or individuals. However, symptoms seen throughout a forest stand indicate a major outbreak.

Not all defoliation or discoloration is a result of needle fungi. Chewed, clipped, punctured, bent, or mined (hollow) needles indicate insect feeding. If only the oldest interior needles are being shed, it may be periodic needle drop normal in conifers (Figure 6, page 6). Other frequent and confusing causal agents include weather injury—such as cold, hail, heat, or wind—and nutrient imbalances.

How to manage needle diseases

Current science does not allow us to predict the extent of damage a needle pathogen will cause, but there are guidelines for minimizing the likelihood of an outbreak and for minimizing the damage level in an outbreak. As with any disease, a successful outbreak requires a susceptible host, a disease-causing organism, and an environment favorable to infection (Figure 5, page 6). Knowing this, we can adapt management actions to minimize extent and level of damage. The principal guidelines are as follows.

1. Do not manage for a single species.

Because needle fungi are usually host specific—that is, they attack only a single tree genus such as pine, hemlock, or fir—a good strategy is to plant several species on a site, thereby limiting spread and loss if one species is affected.

2. Do not plant trees or seed from trees that are not native to the area.

It is very important to plant seedlings grown from local-seed sources and to plant them on suitable sites. Bringing nonnative (exotic) species or seed sources into this region not only will result in damage to those trees but may allow a buildup of spores that can harm native trees.

3. Understand the role environment plays in favoring infection.

Weather conditions cannot be controlled; however, good air circulation and sun exposure within a stand, as a result of thinning or pruning, may limit outbreaks of certain needle diseases.

Figure 4.—Fruiting bodies of the fir–blueberry rust fungus on an infected white fir needle.

Table 1.—Common needle diseases of Oregon Coast Range conifers.

	Major tree species in the Oregon Coast Range					
Needle disease	Douglas-fir	Shore pine	Western redcedar	Sitka spruce	True fir	Western hemlock
Needle casts						
Swiss needle cast	X					
Rhabdocline needle cast	X					
Lophodermella needle casts		X				
Lophodermium needle casts		X	X	X	X	
Rhizosphaera needle cast	X			X	X	X
Lirula needle cast				X	X	
Needle rusts						
Fir–broom rust					X	
Fir–bracken fern rust					X	
Fir–blueberry rust					X	
Fir–fireweed rust					X	
Hemlock–blueberry rust						X
Hemlock–willow rust						X
Spruce needle rust				X		
Melampsora needle rust	X	X		X	X	X
Needle blights						
Red-band needle blight		X				
Botrytis blight	X	X		X	X	X
Cedar leaf blight			X			
Snow blight					X	
Brown felt blight	X	X		X	X	X

4. Maintain forest health.

Stand management activities such as precommercial and commercial thinning may reduce the impact of some needle diseases by improving tree vigor and favoring resistant trees or nonhost tree species. However, once disease is severe, thinning may actually be harmful except when it removes an infected species. The stress of thinning stands that are already damaged by foliage disease, such as Swiss needle cast, may further stress the residual trees. In local areas, removing alternate-host plants adjacent to susceptible tree species may reduce the severity of rust diseases.

5. Limit chemical treatment.

Applying fungicides in forests has *not* been cost effective. A thorough spray is required, and repeated applications following each rain often are not possible. In general, fungicides are effective only in Christmas tree plantations or on single trees in urban landscapes where appearance is important.

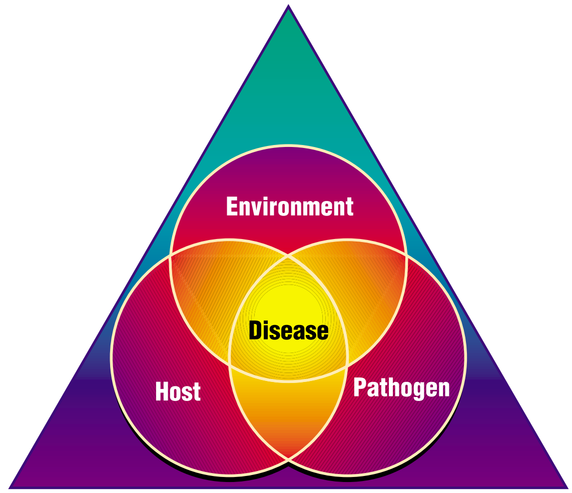

Figure 5.—The disease triangle.

Summary

We know that needle fungi populations fluctuate greatly from year to year, depending on weather conditions, host susceptibility, and spore production, release, and germination. Using this knowledge in making management decisions will go a long way to minimize damage when the inevitable outbreak does occur.

Figure 6.—Normal, periodic needle drop of the oldest interior needles.

Table 2.—Descriptions of fruiting bodies and symptoms for common needle diseases of Oregon Coast Range conifers.

	Signs or fruiting body description						
Needle diseases	Black or brown dots	Black lines	Brown or red spots	Yellow tubes or spots	Dark to tan spots	Spores on stalks*	Most common symptoms
Needle casts							
Swiss needle cast	X						Yellow to brown needles, defoliation
Rhabdocline needle cast			X				Necrotic spots, defoliation
Lophodermella needle casts					X		Older needles turn brown
Lophodermium needle casts	X						Dead needles persist on twig
Rhizosphaera needle cast	X						Yellow or gray-green spots, defoliation
Lirula needle cast		X					Brown needles
Needle rusts							
Fir-broom rust				X			Witches'-brooms
Fir–bracken fern rust				X			Yellow needles, defoliation
Fir–blueberry rust				X			Yellow needles, defoliation
Fir–fireweed rust				X			Yellow needles, defoliation
Hemlock–blueberry rust				X			Yellow needles, defoliation
Hemlock–willow rust				X			Yellow needles, defoliation
Spruce needle rust				X			Yellow needles, defoliation
Melampsora needle rust				X			Yellow needles, defoliation
Needle blights							
Red-band needle blight	X						Yellow to tan spots or bands on needles
Botrytis blight						X	Watersoaked, dark, discolored spots
Cedar leaf blight	X						Brown foliage as if scorched
Snow blight	X						Brown needles
Brown felt blight	X						Brown crust on needles

* Stalk is like a stem (technically, a conidiophore) that supports the spore or spores.

For further information

Needle fungi identification

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