DWARF MISTLETOES

State Forester Forum

Introduction

Dwarf mistletoes are parasitic plants that cause a widespread, serious disease of conifers in western North America. There are numerous species of dwarf mistletoe (*Arceuthobium* spp.), each specializing on one or two conifer species, but not all dwarf mistletoe species are found across the entire range of their respective hosts. The species of mistletoe is named according to the host it affects, such as Douglas-fir dwarf mistletoe, lodgepole pine dwarf mistletoe, etc.

Five dwarf mistletoe species occur (Table 1) to varying degrees in stands of western larch, Douglas-fir and lodgepole pine across the state. Ponderosa pine dwarf mistletoe is found only in certain areas along the western edge of Idaho. Limber pine dwarf mistletoe is known from only a handful of sites in southern Idaho.

Dwarf mistletoes parasitize their host by robbing it of water, nutrients and sugars that would otherwise be available for tree growth and function. Chronic effects on the host include growth reduction, gradual top-kill, reduced cone and seed production, susceptibility to drought and insect attack, and eventually death. At the stand level, severe infection can greatly reduce growth and yield.

***Arceuthobium* spp.**	**Principal host**	**Secondary host**	**Rare host**	**Range in Idaho**
A. americanum	lodgepole pine	(none)	ponderosa, white-bark, & limber pines; Engelmann spruce	Range of lodgepole pine
A. campylopodum	ponderosa pine	(none)	lodgepole pine	Various areas along on west-ern border
A. cyanocarpum	limber pine	whitebark pine	western white pine	In south - rare
A. douglasii	Douglas-fir	(none)	grand & subalpine fir; Engelmann spruce	Range of Douglas-fir
A. laricis	western larch	lodgepole pine, subalpine fir	Engelmann spruce; whitebark & pon-derosa pines	Northern and west-central

Table 1. *Dwarf mistletoes species, conifer hosts, and distribution in Idaho.*

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Biology

Dwarf mistletoe species belong to the plant family Viscaceae. Another type of mistletoe, the leafy mistletoes of the genus *Phoradendron*, belongs to the same family. Leafy mistletoes infect mainly hardwoods although there are leafy mistletoes on conifers such as juniper. The leafy mistletoes are well known for their use during the Christmas season.

Dwarf mistletoes are small, perennial, seed-bearing higher plants with shoots ranging from only a few tenths of an inch to several inches in height (Figures 1-2).

Figure 1. *Female, seed-bearing plant of A. laricis on western larch. (Photo by USFS, Region 1.)*

Figure 2. *Dwarf mistletoe plants (A. douglasii) growing from a Douglas-fir. Note size of the mature mistletoe plants compared to the length of needles. (Photo by USFS, Region1)*

The jointed stems have opposite pairs of small, scale-like leaves. Male and female dwarf mistletoe plants grow separately and can live for several years. New plants can grow from the same infection site. A small cup-like structure called a basal cup remains when dwarf mistletoe shoots fall off a branch (Figure 3).

Figure 3. *Basal cups, plants, and spindle-shaped swelling on branch of lodgepole pine. (Photo by USFS, Region 1)*

Each species of dwarf mistletoe specializes on one or two conifer hosts termed the principal or primary hosts. Secondary hosts are those conifers that can be readily infected and damaged when growing in association with infected principal hosts (Table 1). Rare or occasional hosts are species on which infections can occur when growing in association with the infected principal host, but are usually not significantly damaged. For the purposes of disease management, it is the primary and secondary hosts that should most concern foresters.

There are several key features of dwarf mistletoe biology that foresters should keep in mind. First is that mistletoes are obligate parasites, meaning they cannot live except when growing on a living branch. If the limb or host tree dies then the dwarf mistletoe plant dies along with it. Dwarf mistletoes do manufacture a small portion of their carbohydrates through photosynthesis but the majority is derived from the host. The physiology of

infected branches is altered so that they become resource sinks, and thus water and nutrients are drawn to the site of infection.

A second key feature is that seeds are explosively discharged from mature berries due to water pressure that builds up in the seed-bearing capsule as it matures. Seeds are generally discharged 15-20 feet, or further if the mistletoe plants are high in a tree's crown or if the seeds are discharged down slope. However, ~90% of the seed falls within 33 feet of the source plant. Seeds are coated with a sticky substance, called viscin, which allows the seed to stick to whatever it contacts. Most seeds make contact non-host plants or the ground, but seeds that stick to needles of susceptible species can initiate infections. The viscin coating of a mistletoe seed swells with humidity or rain and the seed slides down to the fascicle or twig. Once there, the coating hardens and the seed overwinters.

Mistletoe seeds germinate in the spring and penetrate host tissues to begin forming a network of absorbing strands, known as an endophytic system, which is embedded in host tissues. It is similar to a plant's root system as it absorbs water and nutrients from the host. After the formation of an endophytic system a spindle-shaped swelling in the branch may begin to form, but aerial shoots do not grow for several more years. This early stage of infection that lacks visual evidence is known as a latent infection.

A third key feature of dwarf mistletoe biology is a life cycle of 4-6 years from the time of infection until a female plant produces seed. One important implication of this is that dwarf mistletoes spread relatively slowly through the forest, *on average only several feet per year*. Another is that the latent infection period shows little or no visual evidence because branch swellings have not formed and mistletoe plants have not appeared.

Two terms that are used in regards to dwarf mistletoe are spread and intensification. Spread is when mistletoe on one tree causes infections on adjacent trees; intensification is when existing mistletoe within the crown of a tree causes more infections within the same tree. Intensification will increase damage to the host because much of the food produced by the tree is absorbed by the mistletoe. Long-distance, passive transport of mistletoe seeds via birds or mammals into uninfected stands almost certainly occurs but is considered relatively rare.

Recognition

Descriptions and images of dwarf mistletoe can be found in "A Field Guide to Diseases & Insect Pests of Northern and Central Rocky Mountain Conifers" (Hagle et al. 2003). Idaho foresters and landowners should always have this field guide on hand when attempting to diagnose forest insect and disease problems.

Most dwarf mistletoe plants are difficult to observe in a tree's crown due to their small size and coloration. Over time, however, plants cause readily-visible symptoms in the host. The first obvious symptom of infection is most often a localized, spindle-shaped swelling on a branch (Figure 4).

Figure 4. *Spindle-shaped branch swelling and dwarf mistletoe plants on western larch. (Photo by USFS, Region 1).*

Infections near or within the bole often cause deformities or stem cankers (Figure 5), and a mistletoe plant could be seen growing directly from it.

The most obvious symptom of dwarf mistletoe infection is a witches' broom; a clumping of branches and needles. These form over time due to altered host physiology in an infected branch

Figure 5. *Bole canker of ponderosa pine caused by dwarf mistletoe stem infection. (Photo by USFS, Region 1)*

(Figures 6-8). Large brooms commonly form in the lower portion of a tree's crown where plants have existed for the longest time. Large brooms can also cause a branch to become greatly thickened close to the bole. If a broom is accessible from the ground, check it closely for dwarf mistletoe plants or basal cups. If brooms are inaccessible, look for any that have fallen around the base of the tree and examine them for basal cups or fragments of dead mistletoe plants.

Size and density of witches' brooms vary greatly by host and time since infection. Brooms on Douglas-fir can be small and inconspicuous to massive and dense (Figure 7), while those on western larch are dense, and small-to-medium in size.

Figure 6. *Witches' brooms in crowns of infected western larch. Tree on left has a DMR of 4-5, while tree on right has a DMR of 5-6. (Photo by USFS, Region 1)*

Due to the parasitic nature of dwarf mistletoe, physiological changes within infected branches, plants located low on a tree's bole can live decades beyond the point at which they would normally self-prune. This is often seen in infected stands of ponderosa pine and Douglas-fir. Although diseases, such as broom rusts and Elytroderma needle cast, cause witches' brooms, only those produced by dwarf mistletoe will have plants or basal cups on the branches of the broom. Mistletoe brooms do not shed their needles in the winter or have off-color foliage in the summer like broom rusts, nor do they accumulate dead needles as with brooms of *Elytroderma* needle cast in ponderosa pine. Mature trees in stands that have undergone thinning can sometimes form what are

called stimulation brooms in response to the exposure of their boles to light (Figure 9). These can appear similar to dwarf mistletoe brooms, but careful examination will not reveal evidence of dwarf mistletoe plants.

Figure 7. *Large, dense witches' brooms in Douglas-fir. (Photo by USFS, Region 1)*

Damage

Little damage may occur when trees or stands are lightly infected by dwarf mistletoes. However, dwarf mistletoes can spread and intensify over the life of a stand due to seed dispersal, so the potential impact must be considered over a stand rotation and beyond. Selective harvest practices that leave an infected overstory and/or promote development of a susceptible (same species) understory can greatly increase the impacts of this parasite.

Figure 8. *Severe infections in Douglas-fir. (Photo by USFS, Region 1)*

Figure 9. *Stimulation brooms in thinned Douglas-fir. (Photo by USFS, Region 1)*

Due to the host specificity of dwarf mistletoe, and the fact that an infected overstory will rain down mistletoe seeds on the understory, the worst case scenario for spread and subsequent damage is in a two-storied stand of the same host species.

Even in a situation where clearcutting is employed,

such as a heavily dwarf mistletoe-infected lodgepole pine stand, dwarf mistletoe can remain a problem if infected, regeneration is left alive. The most severely impacted stands can be thought of as growing mistletoe, not timber. Large growth reductions begin to occur after approximately half of a tree's crown is infected. Trees are weakened and killed, attacked by insects such as wood borers, or succumb to the effects of sustained drought.

Management

Implementing well designed silviculture prescriptions can reduce or eliminate dwarf mistletoe from the stand. Failure to account for dwarf mistletoe in management plans can worsen the impact and reduce options for disease management in subsequent rotations. Fortunately, dwarf mistletoe does not need to be eliminated from a stand in order to meet most management objectives. The most appropriate management options for dwarf mistletoe will depend on, and must take into account, factors such as stand structure, composition, age, site potential, and current dwarf mistletoe infection.

The following steps describe the development of a dwarf mistletoe management prescription.

Describe the extent of the problem: The dwarf mistletoe rating (DMR) (Hawksworth 1977) allows for quick visual estimates of mistletoe intensity in individual trees based on the number of infected branches in each third of their live crown (Figure 10). Infection is categorized as light (DMR = 0-2), moderate (DMR = 3-4), and severe (DMR 5-6). Growth loss in individual trees becomes significant when DMR exceeds 3; growth of trees with DMR = 5-6 is substantially reduced, or virtually non-existent, compared to non-infected trees.

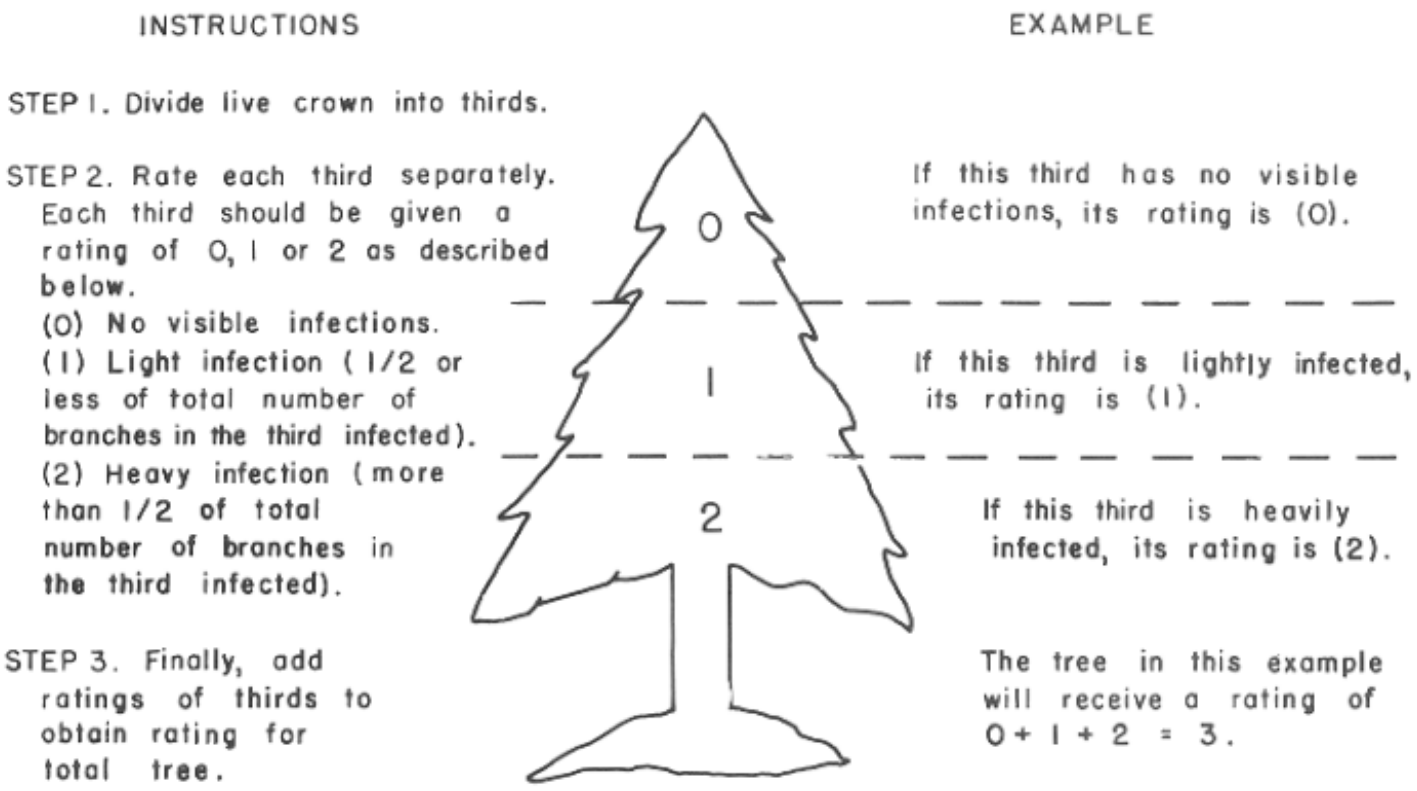

Figure 10. *Estimating the dwarf mistletoe rating (DMR). (Figure from Hawksworth, 1977)*

If DMR's are estimated for each tree species on random plots within a stand as part of normal forest inventory, you can then calculate a stand-level DMR for each tree species by averaging the DMR's of all individuals, both infected and non-infected.

***Incorporating dwarf mistletoe management into a silvicultural prescription*:**

Stand regeneration: The earlier that trees are infected with dwarf mistletoe the worse will be the impact, and minimizing infection in regenerating stands is crucial. Use of an infected overstory as a seed source for natural regeneration is still possible, however, if care is taken in selecting seed trees and planning for their timely removal. Selection of infected seed trees needs to be a compromise between tree form, vigor, and DMR. Obviously, the lower a seed tree's DMR the better. Fortunately, regeneration that is less than three feet tall and less than 7-10-years of age has a good chance of escaping parasitism, thus leaving a window of opportunity for successful natural regeneration to become established before removing or girdling the infected overstory becomes critical.

Young stands: In pre-commercial-aged stands, remove obviously infected trees as part of pre-commercial thinning to reduce the current and future impacts of dwarf mistletoe in the stand and fill plant with non-susceptible tree species if infection rates are too high to maintain stocking levels.

Commercial stands: Stands should be surveyed for the level of dwarf mistletoe infestation before treatment is prescribed. If timber production is not the primary objective, or if infection is light in the preferred timber species, it is possible that control measures will not be warranted. During sale preparation select trees for removal that have a DMR >3. Trees with DMRs of 3 or less, especially those with infections limited to the lower 1/3 of the crown, will probably not experience major growth loss; growth of the thinned trees should exceed the dwarf mistletoe impacts. It is also important to consider the time of harvest and site quality. If time until harvest is short, or if the site is good, leave trees with moderate levels of dwarf mistletoe infection to maintain stocking.

The above management recommendations should be considered generic. Silvicultural prescriptions for dwarf mistletoe are best considered on a site-by-site basis, taking many factors into account. Consult a forest pest specialist for assistance when developing long-term management plans for stands where dwarf mistletoe is a concern.

Control of dwarf mistletoes in recreation areas and around homes:

Dwarf mistletoe-infected, high value trees, such as those around homes or in recreation areas, can be treated by pruning branches to gradually improve tree vigor and reduce or halt mistletoe spread and intensification. The vigor and appearance of trees with off-color, thinning crowns due to mistletoe infections can be greatly improved with this treatment, although obvious results will take several years to develop.

Utilize the following guidelines for pruning of dwarf mistletoe:

- The best candidates are those trees with infections confined to the lower half of their crown.
- Prune large witches' brooms first because they are causing the most damage to the tree, but prune all infected branches if possible.
- If possible prune a few more branches above the highest, visibly-infected branches; these branches are likely to have latent infections.
- Do ***not*** prune more than half of the ***live crown***, bottom to top, from a tree.
- If pruning larger-diameter, high-value Douglas-fir, be aware that risk of Douglas-fir beetle attack may be increased on pruned trees. Application of MCH bubble caps to pruned trees may be warranted, particularly as they provide a relatively cheap insurance policy against beetle attack. See: http://www.fs.fed.us/foresthealth/technology/pdfs/

MCH_online.pdf

- Re-examine pruned trees in 3-5 years, particularly the lower whorls, and remove any additional infected branches.

References:

Hagle, S.K., K.E. Gibson, and S.T. Tunnock. 2003. A field guide to diseases and insect pests of northern and central Rocky Mountain conifers. USDA Forest Service State and Private Forestry. Northern Region. Report No. R1-03-08. 197 p.

Hawksworth, F.G. 1977. The 6-class dwarf mistletoe rating system. General Technical Report RM-48. Fort Collins, CO: U.S.D.A. Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.

Useful Links

Forest Insect and Disease Leaflet

USFS Region 1 Field Guide

USFS Region 1 Management Guide

Acknowledgements

Photos courtesy of USDA Forest Service, Region One, Forest Health Protection.

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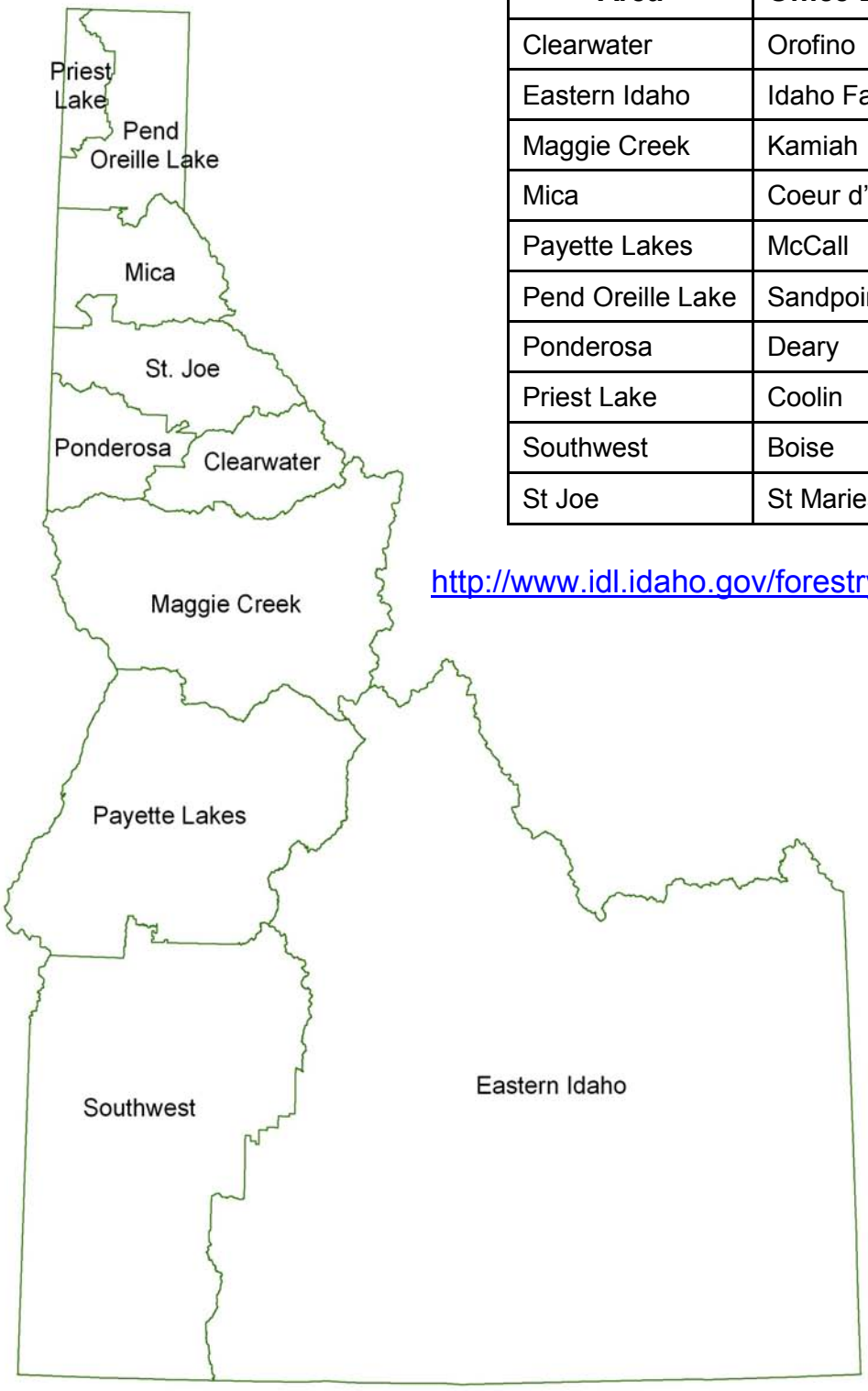

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Maggie Creek	Kamiah	(208) 935-2141
Mica	Coeur d'Alene	(208) 769-1577
Payette Lakes	McCall	(208) 634-7125
Pend Oreille Lake	Sandpoint	(208) 263-5104
Ponderosa	Deary	(208) 877-1121
Priest Lake	Coolin	(208) 443-2516
Southwest	Boise	(208) 334-3488
St Joe	St Maries	(208) 245-4551

http://www.idl.idaho.gov/forestry/forest-health/index.html