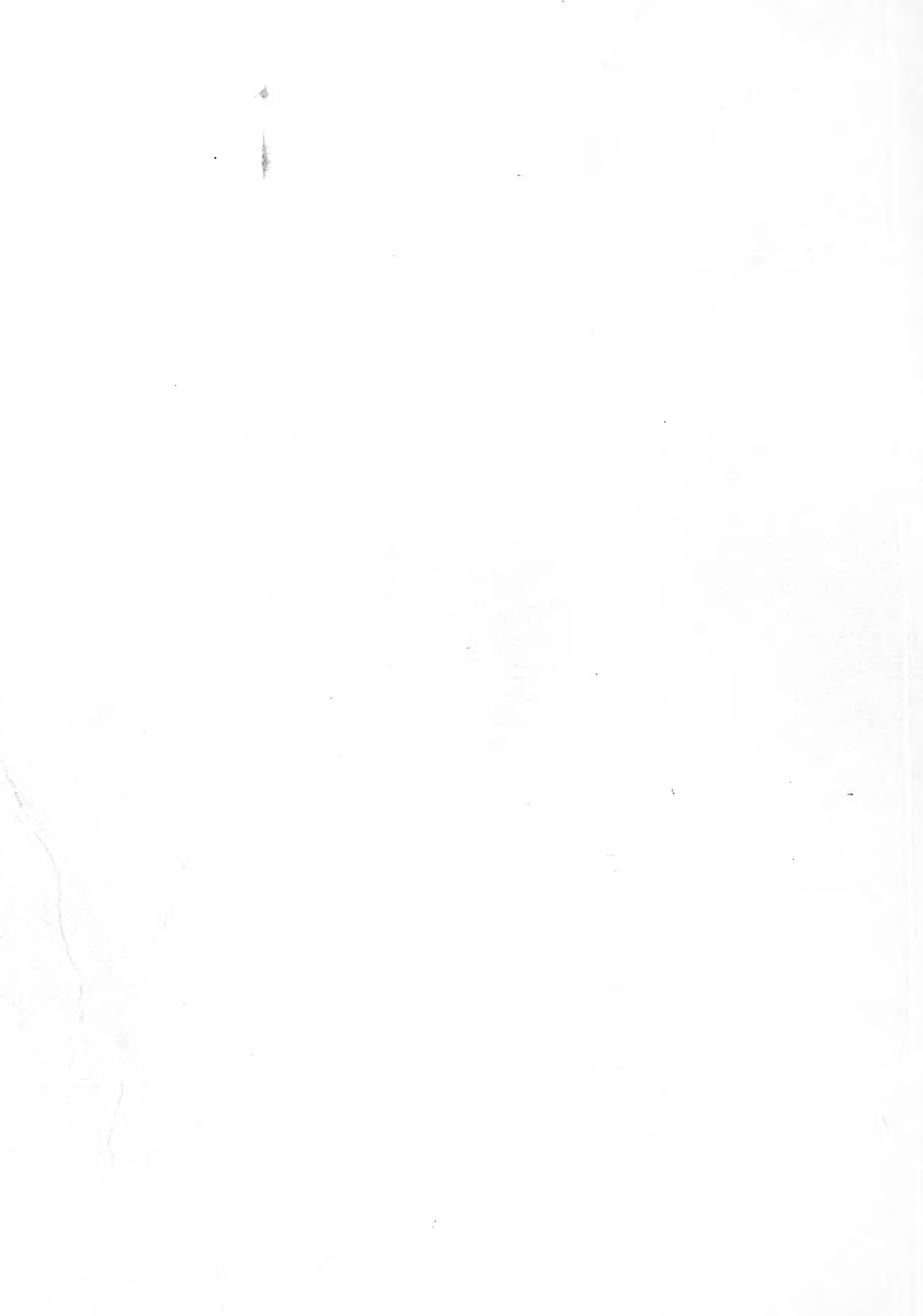


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Estimates of the Occurrence of Dwarf Mistletoe on the Deschutes National Forest

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Reference Abstract

The proportion of forest area infested and of trees infected were calculated for the Deschutes National Forest using 10-point plot inventory data. The proportion of commercial forest acres infested with dwarf mistletoe is 0.476, and the proportion of trees infected on these acres is 0.308. //

KEYWORDS: Dwarf mistletoe, diseases (plant), Oregon (Deschutes National Forest).

Metric Equivalents

1 mile = 1.61 kilometers

1 acre = 0.405 hectare

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Introduction

Although dwarf mistletoes² have long been recognized as a problem in the forests of eastern Oregon and Washington (Weir 1916), few attempts have been made to quantify the extent of the infestations. A review of the literature revealed only a research note by Roth (1953), two unpublished reports³ that evaluated the magnitude of the problem for small areas in the Deschutes National Forest of central Oregon, and an article by Shea and Orr (1963) that evaluated the problem for the Antelope Unit of Weyerhaeuser Company, Klamath Falls tree farm, Oregon.

In 1968, it was proposed that the dwarf mistletoe six-class rating system devised by Hawksworth and Lusher (1956) be used to rate trees sampled on inventory plots of the Pacific Northwest Region of the USDA Forest Service. The purpose was to obtain dwarf mistletoe data that could be used for impact estimates.

Dwarf mistletoe impact can be expressed in various ways; probably the most meaningful is the loss of annual wood growth of a stand (or forest) expressed in cubic-foot units. At present, this cannot be estimated because dwarf mistletoe's effect on volume growth has not been quantified.

Even though dwarf mistletoe's impact on volume growth cannot as yet be calculated, an indication of the extent of the dwarf mistletoe problem on a National Forest can be obtained by calculating the proportion of land area infested and proportion of trees infected on the infested area. These are less meaningful estimates when compared to the volume measure of dwarf mistletoe impact; however, they can indicate to forest managers that a problem may exist and that additional investigation is needed to calculate the extent of the problem.

So far, the National Forests inventoried since the six-class dwarf mistletoe rating system was adopted are the Deschutes, the Mount Hood, and the Gifford Pinchot. Of the above, only the Deschutes and the Gifford Pinchot were ready for processing. For this paper, the Deschutes National Forest was selected for analysis because its dwarf mistletoe problem is more serious than that of the Gifford Pinchot.

²Arceuthobium campylopodum on ponderosa pine; Arceuthobium americanum Nutt. on lodgepole pine; Arceuthobium tsugensis Rosend. on hemlocks.

³Childs, T. W., and Greene, W. B. 1959. Dwarf mistletoe surveys on the Deschutes National Forest 1958. 34 p. Unpublished report on file at the Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Roth, L. F. 1952. Observations of pine dwarf mistletoe, Pringle Falls Experimental Forest July 7 to August 8, 1952. Unpublished report on file at the Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

In 1972, a total of 704 10-point plots⁴ were established on the commercial forest land of the Deschutes National Forest with field plot locations determined by a 1.7-mile grid superimposed on the Forest. A plot's grid location on a species type-map of the commercial forest land was used to classify the plot into one of four strata: (1) ponderosa pine, (2) lodgepole pine, (3) hemlock, and (4) pine-associated marginal (i.e., marginal timber land on which pine occurs).

Each field plot consisted of 10 points systematically distributed over an area approximately 1 acre in size.⁵ At each point, sample trees with a d.b.h. (diameter breast height) of 5.0 inches or larger were selected by using a 40 basal area factor prism and variable radius plot methods. For trees 1.0- to 4.9-inch d.b.h., a fixed plot of one-three-hundredth of an acre was established at each point, and all trees within the above diameter range were selected as sample trees.

All sample trees were measured for d.b.h. and rated for dwarf mistletoe using the six-class system (Hawksworth and Lusher 1956). Other inventory information (not used in this analysis) was also observed and recorded for the sample trees and for the plot.

⁴Inventory procedures are described in the 1969 manual titled "Field Instructions for Integrated Forest Survey and Timber Management Inventories in Oregon, Washington, and California." The manual was prepared by the Forest Survey Research Work Unit of the Pacific Northwest Forest and Range Experiment Station, Divisions of Timber Management for the Pacific Northwest and Pacific Southwest Regions of the USDA Forest Service.

⁵The actual size of the plot depends on the basal area factor of the prism and the size of the trees in the stand being measured.

Estimation Procedure

Plot location on a species type-map of the National Forest was used to sort the survey plots into groups. Estimates of the proportion of area infested and trees infected were calculated for all the plots pooled and for each plot group determined from the type map. The pooled plots were used to calculate forest estimates; no effort was made to derive forest estimates by weighting and combining the group estimates. Estimates were made using the fixed plot trees only (representing understory), the variable plot trees only (representing overstory), and the fixed and variable plot trees combined.

To estimate the proportion of area infested, a tally of infested and noninfested plots was made for each data group. Plots were classified as infested if one or more trees sampled on the plot were infected (having a dwarf mistletoe rating of 1 or more). From this tally, proportion of area infested was calculated as the ratio of number of infested plots to total number of plots. In mathematical form:

$$P = \frac{n}{N}$$

where p = proportion of area infested.
 n = number of infested plots, and
 N = total number of plots

The standard error of this proportion is

$$S.E. \text{ of } p = \sqrt{pq/(N-1)}$$

where

$$q = 1.0 - p$$

The ratio of trees infected on the infested area was calculated by dividing the total number of infected trees per acre by the total number of trees per acre on the infested plots.

In mathematical form:

$$\hat{R} = \frac{\sum_{i=1}^n y_i}{\sum_{i=1}^n x_i}$$

where

y_i = number of infected trees per acre on plot "i",
 x_i = total number of trees per acre on plot "i".

The standard error of this estimated ratio was calculated as follows:

$$S.E. \text{ of } \hat{R} = \sqrt{\frac{\sum y_i^2 + \hat{R} \sum x_i^2 - 2\hat{R} \sum y_i x_i}{n(n-1)\bar{x}^2}}$$

where

\bar{x} = mean number of trees per acre on the infested area.

Results and Discussion

Tables 1, 2, and 3 present some statistics on the Deschutes National Forest and the estimates of the occurrence of dwarf mistletoe for the total Forest and for each stratum. Estimates in table 1 were derived from variable and fixed plot data combined; estimates in table 2 were derived from variable plot data only; and estimates in table 3 were derived from fixed plot data only. Most of the estimates in the tables are easy to interpret; however, the estimates of proportion of area infested derived from variable plots need further explanation. For example, the 0.476 ratio given for the total Forest in table 1 does not mean that that proportion of land is totally covered

Table 1--Estimates of occurrence of dwarf mistletoe by all sample trees combined, Deschutes National Forest, Oregon

Item	Total commercial	Stratum			
		Ponderosa pine	Lodgepole pine	Hemlock ¹	Pine-associated marginal
Area:					
Total acreage as determined from the type-map	1,264,507	786,368	363,334	83,116	31,689
Number of plots	704	437	202	43	22
Proportion of area infested ²	0.476	0.449	0.619	0.279	0.091
Standard error	.0188	.0238	.0343	.0692	.0627
95-percent confidence limits					
Lower limit	.439	.402	.552	.139	.000
Upper limit	.513	.496	.686	.419	.222
Trees:					
Mean number of trees per acre on infested area	1,220	1,121	1,416	1,055	476
Ratio of trees infected on infested area ²	.308	.248	.392	.204	.010
Standard error	.0172	.0204	.0286	.0622	.0085
95-percent confidence limits					
Lower limit	.274	.208	.336	.078	.000
Upper limit	.342	.288	.448	.330	.028

¹Primarily mountain hemlock.

²To change to percent, multiply by 100.

Table 2--Estimates of occurrence of dwarf mistletoe by variable plot trees,¹/ Deschutes National Forest, Oregon

Item	Total commercial forest	Stratum			
		Ponderosa pine	Lodgepole pine	Hemlock ²	Pine-associated marginal
Area:					
Total acreage as determined from the type-map	1,264,507	786,368	363,334	83,116	31,689
Number of plots	704	437	202	43	22
Proportion of area infested ³	0.453	0.423	0.594	0.279	0.091
Standard error	.0188	.0237	.0346	.0692	.0627
95-percent confidence limits					
Lower limit	.416	.377	.526	.139	.000
Upper limit	.490	.470	.662	.419	.222
Trees:					
Mean number of trees per acre on infested area	184	152	232	222	42
Ratio of trees infested on infested area ³	.495	.390	.6117	.394	.120
Standard error	.0211	.0235	.0340	.0835	.0039
95-percent confidence limits					
Lower limit	.454	.344	.545	.230	.113
Upper limit	.537	.436	.678	.557	.128

¹Tree diameter 5.0 inches or larger, representing overstory trees.

²Primarily mountain hemlock.

³To change to percent, multiply by 100.

with infested trees. The correct interpretation is this: if the commercial forest area were divided into 1-acre components and every acre was sampled, approximately 0.476 of the 1-acre components can be expected to have at least one infested tree.

This interpretation can be modified when the proportion of trees infested in the infested area is known. The modified statement would read: "The proportion of commercial forest land area infested with dwarf mistletoe is 0.476 and the proportion of trees infested in this infested area is 0.308."

Relating the two estimates in the above statement gives the forest manager an idea of how widespread dwarf mistletoe is on the Forest and its severity within the infested area. The manager is still faced with locating infested areas and planning their treatment. It may be more efficient to locate infested areas by concentrating efforts in the species type having the highest incidence of dwarf mistletoe.

Table 3--Estimates of occurrence of dwarf mistletoe by fixed plot trees,^{1/} Deschutes National Forest, Oregon

Item	Total commercial forest	Stratum			
		Ponderosa pine	Lodgepole pine	Hemlock ²	Pine-associated marginal
Area:					
Total acreage as determined from the type-map	1,264,507	786,368	363,334	83,116	31,689
Number of plots	704	437	202	43	22
Proportion of area infested ³	0.379	0.341	0.545	0.186	0
Standard error	.0183	.0227	.0351	.0600	--
95-percent confidence limits					
Lower limit	.343	.296	.476	.068	--
Upper limit	.415	.386	.614	.304	--
Trees:					
Mean number of trees per acre on infested area	1,104	1,030	1,217	941	--
Ratio of trees infected on infested area ³	.330	.282	.391	.203	--
Standard error	.0188	.0238	.0294	.0862	--
95-percent confidence limits					
Lower limit	.293	.235	.334	.034	--
Upper limit	.366	.329	.449	.373	--

¹Tree diameter less than 5.0 inches, representing understory trees.

²Primarily mountain hemlock.

³To change to percent, multiply by 100.

Table 2 gives results of the variable plot tree analysis; table 3 gives results of the fixed plot tree analysis. For variable plot trees (assumed to represent overstory trees), the proportion of commercial forest land area infested with dwarf mistletoe is 0.453, and the proportion of variable plot trees infested in this infested area is 0.495. For fixed plot trees (assumed to represent understory trees), the proportion of commercial forest land area infested with dwarf mistletoe is 0.379 and the proportion of fixed plot trees infested in this infested area is 0.330.

It should be noted that the estimates from the fixed plot trees are probably very conservative. According to one research forester,⁶ "the Pringle Falls study indicates that many trees, visibly free of infection, while under an overstory and unthinned, suddenly produce visible infection after overstory removal and thinning. This latent infection phenomenon should be recognized."

⁶Correspondence in author's file from James W. Barrett, Silvicultural Laboratory, Pacific Northwest Forest and Range Experiment Station, Bend, Oregon.

The results shown in the tables indicate that the Deschutes National Forest has a dwarf mistletoe problem in both the overstory and the understory. Forest managers should be aware of the problem when they develop their management plans. Managers can use thinnings and harvest cuts to control the spread of dwarf mistletoe and to reduce loss of volume growth caused by dwarf mistletoe.

Summary

At this time, the impact of dwarf mistletoe on volume growth cannot be calculated for a National Forest, but other measures can be used to estimate its magnitude. The proportion of land area infested and the proportion of trees infected can be calculated using inventory data that has dwarf mistletoe information recorded for each sample tree.

Estimates were derived for the Deschutes National Forest using 10-point plot data. Proportion of land area infested was 0.476 and the proportion of trees infected on the infested area was 0.308. The forest was type-mapped with four strata resulting and similar estimates were calculated for each stratum. Other management considerations being equal, priorities for locating dwarf mistletoe infested areas may be established by comparing stratum results.

Separate analyses of fixed plot trees and variable plot trees revealed that the Deschutes National Forest has a serious dwarf mistletoe problem in the understory as well as the overstory.

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