Evaluation of a Roadside Survey Procedure for Dwarf Mistletoe on Ponderosa Pine in Colorado

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ABSTRACT

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A survey of dwarf mistletoe intensity on ponderosa pine (*Pinus ponderosa*) was conducted along roadsides and on adjacent plots in the Roosevelt, Pike, and San Juan national forests in Colorado. Presence of dwarf mistletoe (*Arceuthobium vaginatum* subsp. *cryptopodum*) was recorded along roads for each 0.1 km of a strip one chain (20 m) wide and 1.6 km long. Plots were then established at 100-m intervals 40 m from and parallel to the same surveyed portion of the road. Regression of plot data on roadside data was highly significant ($R^2 = 0.88$ for all national forests combined). The roadside survey procedure can be reliable for estimating the proportion of ponderosa pine stands with dwarf mistletoe if the road network provides a representative sample of the stands being surveyed.

Dwarf mistletoes (*Arceuthobium* spp.) are highly specialized, dicotyledonous pathogens that damage many North American conifers, including ponderosa pine (*Pinus ponderosa* Laws.). Southwestern dwarf mistletoe (*Arceuthobium vaginatum* (Willd.) Presl. subsp. *cryptopodum* (Engelm.) Hawksw. & Wiens) is distributed throughout the central Rocky Mountains and the Southwest (8). The pathogen causes extensive losses in ponderosa pine stands through growth reduction, mortality, tree deformity, and reduction in cone and seed crops (13). Dwarf mistletoe also weakens its host, increasing susceptibility to other pests (8). Information on dwarf mistletoe intensity and distribution and estimates of losses caused by dwarf mistletoes are needed to assist the land manager in making sound management decisions (2). Dwarf mistletoe surveys have routinely combined plot survey information, designed to estimate volume loss, with roadside reconnaissance surveys to determine incidence and severity of the parasite (1–5,7,10–12). In some instances, roadside and plot information has been compared with results obtained from more intensive surveys. Hawksworth (6) found that incidence estimated from a roadside survey of ponderosa pine on the Mescalero Apache Reservation (New Mexico) was within 5% of that estimated from an intensive plot survey (9). Data from an earlier roadside survey of lodgepole pine (*P. contorta* Dougl.) conducted by Hawksworth in 1958 (7) were compared with those from a 1977 roadside/plot survey conducted by Johnson et al (10) in the Medicine Bow National Forest in Wyoming. Estimates of incidence were 59% in 1958 and 60.5% in 1977. In addition, there was only 0.5% difference between the incidence observed from the roadside (60.5%) and that observed in plots (60%) in the 1977 survey. Although the roadside survey technique is reliable where the forest type is relatively continuous, the accuracy of this technique in discontinuous forest types (i.e., ponderosa pine) was unknown. Thus, this study was made to evaluate the accuracy of roadside surveys for estimating the incidence of dwarf mistletoe in ponderosa pine stands in Colorado.

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MATERIALS AND METHODS

The 1982 roadside/plot study areas were selected in the Roosevelt, Pike, and San Juan national forests in Colorado. Tentative study areas were randomly chosen on the basis of the amount of dwarf mistletoe infection observed. Presence or absence of dwarf mistletoe was recorded for each 0.1 km of a strip one chain (20 m) wide and 1.6 km long on the right side of the road in each study area. The study areas were grouped into incidence categories by visual estimation of the percentage of ponderosa pine infested with dwarf mistletoe: 1) none = no visible infection, 2) low = fewer than one-third of the trees infected, 3) medium = one-third to two-thirds of the trees infected, and 4) high = more than two-thirds of the trees infected.

Thirty-five study areas were established: three study areas in each dwarf mistletoe incidence category in each of the three national forests. (Only two study areas in the high-incidence category were established in the San Juan National Forest.) Within each study area, a row of plots (on the surveyed side of the road) was established at 100-m intervals 40 m from and parallel to the road. At each plot center, a fixed 0.004-ha circular plot and a variable plot (basal area factor 2.3 m^2/ha.) were established. Depending on the curvature of the road, 13–17 plots were located within each study area. A plot was considered infested if at least one infected tree was present. Linear regression analyses of the data were used to compare the incidence of dwarf mistletoe along the roadside with that found in the plots 40 m from the road. Data from each national forest were analyzed separately. Data were also grouped according to the dwarf mistletoe incidence categories originally assigned and were analyzed using a paired *t* test to determine if mean percentages of roadsides and plots with dwarf mistletoe were similar in each of the four categories.

Table 1. Linear regression equations relating the percentage of roadside infested (X) to the percentage of plots infested (Y) with dwarf mistletoe in three national forests in Colorado

National forest	Equation	Coefficient of determination (R^2)	Standard error of estimate
Roosevelt	$Y = 0.94X - 3.85$	0.85	11.86
Pike	$Y = 0.83X + 4.15$	0.96	7.00
San Juan	$Y = 0.88X - 0.67$	0.88	11.15
Pooled	$Y = 0.88X + 0.07$	0.88	9.84

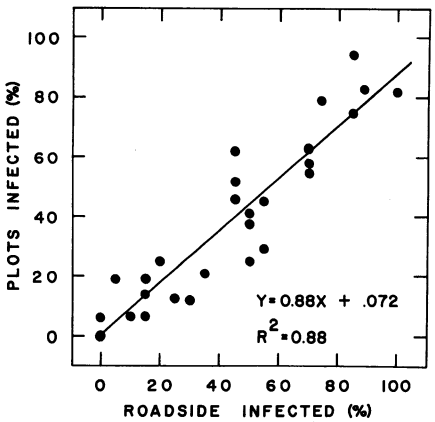

Fig. 1. Linear relationship between the percentage of roadside infested and the percentage of plots infested with ponderosa pine dwarf mistletoe in the Roosevelt, Pike, and San Juan national forests in Colorado.

RESULTS AND DISCUSSION

In each national forest sampled, the incidence of dwarf mistletoe observed from the road was similar to that found 40 m into the forest. Regression equations relating the percentage of roadside infested (X) to the percentage of plots infested (Y) and coefficient of determination (R^2) and standard error of estimate values for all 35 study areas are presented in Table 1. Results indicate a significant relationship between the percentages of roadside and plots infested with dwarf mistletoe in the Roosevelt, Pike, and San Juan national forests (R^2 = 0.85, 0.96, and 0.88, respectively). Regressions for the three national forests were not significantly different ($P = 0.05$), so the data were pooled. The pooled R^2 for all forests combined indicated that 88% of the observed variation in the percentage of plots infested (Y) could be explained by the percentage of roadside infested (X) (Fig. 1). Roadside and plot data were then grouped according to the dwarf mistletoe incidence categories originally assigned (none, low, medium, and high) to determine if mean percentages of roadside and plots infested were similar within incidence categories. Using a paired t test, no significant ($P = 0.05$) differences were found between roadside and plot means in any category (Table 2). Regardless of the amount of infection (absent, light, moderate, or heavy), the roadside survey accurately predicted the amount of dwarf mistletoe intensity occurring 40 m into the forest.

Table 2. Analysis of mean percentages of roadside and plots in each of four dwarf mistletoe incidence categories

Incidence category[a]	Mean percent roadside infestation[b]	Mean percent plot infestation[c]	Difference	95% Mean confidence interval
None	0.0	1.3	1.3 ns[d]	−3.1 to 0.7
Low	18.3	14.2	4.1 ns	−4.2 to 12.4
Medium	47.8	40.2	7.6 ns	−3.4 to 18.6
High	80.4	73.9	6.5 ns	−1.3 to 14.3

[a] Based on the percentage of ponderosa pine infected with dwarf mistletoe observed along 1.6 km of road: none = no visible infection, low = less than one-third of the trees infected, medium = one-third to two-thirds of the trees infected, and high = more than two-thirds of the trees infected.
[b] Derived from the average of the percentages of roadsides infested in that incidence category.
[c] Derived from the average of the percentages of plots infested in that incidence category.
[d] ns = Nonsignificant ($P = 0.05$).

Conclusions. A useful regression was found for predicting the incidence of dwarf mistletoe in ponderosa pine stands on the basis of roadside survey data. The roadside survey procedure gave data that were highly correlated to percentages of plots infested in all three national forests surveyed, without bias according to the dwarf mistletoe incidence categories assigned from roadside observations. The roadside survey procedure, therefore, can be reliable for estimating the incidence of dwarf mistletoe in ponderosa pine stands if the road network is sufficient to provide a representative sample of the stands being surveyed.

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