

Yield Loss of Lodgepole Pine Stands to Dwarf Mistletoe in Colorado and Wyoming National Forests

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ABSTRACT

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From 1977 to 1979, a road and plot survey was conducted for *Arceuthobium americanum* in lodgepole pine (*Pinus contorta*) stands on nine national forests in Colorado and Wyoming. Infestation levels ranged from 0 to 64.0% and averaged 50.6% for all forests surveyed. Estimates of annual merchantable loss to dwarf mistletoe by forest ranged from 880 to 101,930 m³ (0.40-1.36 m³/ha). The annual loss for these forests is estimated at 270,750 m³ (average, 0.76 m³/ha). This loss is equivalent to the annual harvest of lodgepole pine sawtimber for these national forests or at least 25% of the annual growth.

Dwarf mistletoes (*Arceuthobium* spp.) are regarded as the most damaging disease agents of conifers in the western United States. Annual combined growth loss and mortality from these pests has been estimated at more than 3.2 billion board feet (about 18 million m³) (9).

Lodgepole pine (*Pinus contorta* Dougl. ex Loud.) is an important component of commercial forestland in the West, particularly in the Rocky Mountains where it is estimated to cover 4 million ha (10). In Colorado and Wyoming national forests, 27% of the annual harvest is lodgepole pine sawtimber. Lodgepole pine dwarf mistletoe (*Arceuthobium americanum* Nutt. ex Engelm.) is estimated to infest more than half of the lodgepole pine in these states (4). This dwarf mistletoe occurs throughout the range of lodgepole pine in Colorado and Wyoming except in the extreme southern limits of the tree in the Sangre de Cristo Range in southern Colorado. Since 1977, the U.S. Forest Service has been involved in the assessment of volume losses of lodgepole pine to *A. americanum* on national forests in Colorado and Wyoming (6-8).

The objective of this study was to provide current estimates of forest resource losses to *A. americanum*. These data are needed to respond to inquiries on forest disease losses, to provide a basis for establishing priorities for action and research programs, and to provide more accurate data for resource planning. These data also demonstrate to forest resource managers the need for prevention and suppression of major pests influencing management goals and decision making.

METHODS

Survey techniques. Each forest was surveyed in two stages; the first was a roadside reconnaissance (to determine the general incidence of dwarf mistletoe), and the second located a series of variable radius plots at predetermined intervals along roads through lodgepole pine. The survey was similar to those of Andrews and Daniels (1) and Hawksworth (3).

Crews drove most passable roads at speeds less than 16 km/hr. Trees were observed to 20 m into the forest parallel to the right side of the road. Mileage was recorded to the nearest 0.16 km whenever a change was noted in timber type, size class, or dwarf mistletoe infection intensity.

Data gathered by roadside reconnaissance were location and extent of lodgepole pine (where more than 50% of

the trees in the stand were lodgepole pine), timber size class, and dwarf mistletoe intensity. The timber size classification was based on estimated average diameter of trees in the stand, as follows: seedling-sapling = less than 13 cm dbh (diameter at breast height), pole = 13-23 cm dbh, and mature = greater than 23 cm dbh. Dwarf mistletoe intensity was estimated on a scale of 0 = no infection, 1 = less than one-third of the trees infected, 2 = one-third to two-thirds of the trees infected, and 3 = more than two-thirds of the trees infected.

Variable radius plots (basal area factor, 10) were established 40 m into the stand every 4.8 km on the right side of and perpendicular to the road. If an intended location was not a plot of lodgepole pine, then the left side of the road was examined. If neither location was a lodgepole plot, the plot was discarded without replacement, and another 4.8 km was traveled. Height, dbh, and dwarf mistletoe rating (DMR) (5) were recorded for all lodgepole pines greater than 13 cm dbh. The age of one representative tree on or near each plot was estimated from an increment core and was used in calculating site index and for producing yield tables.

Data analysis. Roadside reconnaissance data were used to estimate the

Table 1. Incidence of *Arceuthobium americanum* on lodgepole pine in Colorado and Wyoming national forests (1977-1979)

National forest	Roadside (km)	
	Surveyed	Infested (%)
Colorado		
Arapaho and Roosevelt	557	48
Grand Mesa, Uncompahgre, and Gunnison	124	52
Pike and San Isabel	180	43
Rio Grande	11	0
Routt	225	52
White River	130	36
Subtotal	1,227	47
Wyoming		
Bighorn	280	36
Medicine Bow	709	60
Shoshone	126	64
Subtotal	1,115	55
Total	2,342	51

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Table 2. Yield reduction of lodgepole pine stands attributed to *Arceuthobium americanum*

National forest	Area of commercial lodgepole pine (×1,000 ha) ^a	Area of type infested (×1,000 ha)	Annual merchantable volume loss	
			(m ³ /ha) ^b	Total (×1,000 m ³) ^c
Colorado				
Arapaho and Roosevelt	185.6	89.4	0.76	67.93
Grand Mesa, Uncompahgre, and Gunnison	59.8	31.3	0.42	13.00
Pike and San Isabel	71.7	31.0	0.60	18.59
Rio Grande	2.5	0.0	0.00	0.00
Routt	70.1	36.7	0.82	29.95
White River	59.5	21.1	0.04	0.88
Subtotal	449.2	209.5	...	130.35
Wyoming				
Bighorn	100.6	36.5	0.55	20.24
Medicine Bow	123.6	74.7	1.36	101.93
Shoshone	54.8	35.1	0.52	18.23
Subtotal	279.0	146.3	...	140.40
Total	728.2	355.8	...	270.75

^a From timber management plans, includes stands of pole and sawtimber size only.

^b Volume loss/ha infested.

^c From Rocky Mountain Yield calculations.

proportion of lodgepole pine type with dwarf mistletoe by determining the ratio of the number of kilometers traveled adjacent to infested stands to the total miles traveled adjacent to the host type.

The computer program for simulating forest stand yields including the effects of dwarf mistletoe in infested stands, Rocky Mountain Yield (2), was used to estimate merchantable cubic-meter volume loss of lodgepole to dwarf mistletoe. The average DMR for each plot was used to make this estimate. Because mistletoe infestations in the seedling-sapling size class do not affect present yield, only data from plots of trees of pole and sawtimber size were used in the analysis.

Loss estimates were derived by making two consecutive computer runs of the program; the first used the current DMR for each plot, and in the second, the plot DMR was converted to zero to represent uninfested stands. The former, which estimated yield with dwarf mistletoe present, was subtracted from the latter, which simulated growth for all stands during the next decade as if no dwarf mistletoe were present. Resulting values were divided by 10 to obtain an estimate of annual loss. This gives a conservative estimate of dwarf mistletoe loss because it does not account for cumulative loss before the 10-yr analysis.

Estimates of the number of hectares of commercial lodgepole pine for each national forest were obtained from the most recent timber management plans.

Again, only plots of trees of pole and sawtimber size were used since dwarf mistletoe causes no current merchantable volume loss in stands of the seed-sapling class. Future loss of volume to dwarf mistletoe in these stands was not considered in this assessment.

RESULTS AND DISCUSSION

Estimates of the incidence of *A. americanum* in lodgepole pine stands for each national forest are summarized in Table 1. The road survey showed that 51% of the 2,342 km traversed were adjacent to mistletoe infested stands and that 37% of the 473 plots contained infected trees. Among forests where the pathogen was found, the incidence of the disease was greatest on the Shoshone National Forest, Wyoming (64%), and least on the White River National Forest, Colorado (36%). We do not feel that the estimate for the White River National Forest represents the true loss since very few plots were found with mistletoe ratings above 1.0. It seems unreasonable that the road survey estimate of 36% accurately reflects the loss. No infested stands were encountered on the Rio Grande National Forest, Colorado, but the area of lodgepole pine in this forest is small (Table 1).

Three of these national forests were surveyed in 1953-1955 (3), and comparisons with our assessment indicate little change in dwarf mistletoe status. For instance, in the early survey, the

incidences on the Bighorn, Medicine Bow, and Roosevelt national forests were 31, 59, and 52%, respectively, compared with our estimates of 36, 60, and 48%. The 48% for the Roosevelt includes data for the now combined Arapaho and Roosevelt national forests.

Estimates of annual merchantable volume loss for infested forests ranged from 880 m³ (0.04 m³/ha) for the White River National Forest to 101,930 m³ (1.36 m³/ha) for the Medicine Bow National Forest, Wyoming (Table 2).

The total annual loss for all of the forests we surveyed is estimated at 270,750 m³ (average 0.76 m³/ha) (Table 2), and the loss in potential income from timber sales is estimated at \$1.5 million, based on 1978 average stumpage prices for lodgepole pine. This loss is equivalent to the annual harvest of lodgepole pine sawtimber for these forests or at least 25% of the annual growth.

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