1999 Road-Plot Survey of Dwarf Mistletoe and Comandra Blister Rust Diseases of Lodgepole Pine on the Bighorn National Forest

Biological Evaluation R2-03-07

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Abstract:

In 1999, a road-plot survey of dwarf mistletoe and comandra blister rust diseases was conducted in lodgepole pine stands on the Bighorn National Forest. An increase in dwarf mistletoe disease incidence and a reduction of comandra blister rust disease incidence were found during this study. Reports from previous road-plot surveys reported dwarf mistletoe incidence in this area as 31% (Hawksworth 1958) and 36% (Johnson *et al.* 1979). Survey data from this 1999 study indicated a conservative estimate of 44% of lodgepole pines near the roads was infected with dwarf mistletoe. Variable-radius plots were installed at three-mile intervals along the roads to evaluate the lodgepole pine for dwarf mistletoe and comandra blister rust diseases. Dwarf mistletoe and/or comandra blister rust infect over 86% of the lodgepole pines along the roads of the Bighorn National Forest. Greater emphasis on suppression work for these two diseases on the Bighorn National Forest would reduce these disease incidences and promote improved forest health.

Introduction

Past road-plot surveys conducted on the Bighorn National Forest (Hawksworth 1958, Johnson *et al.* 1979) indicated an increasing incidence of dwarf mistletoe (*Arceuthobium americanum*) in lodgepole pine (*Pinus contorta*). Hawksworth reported in 1958 that 31% of 146 miles through lodgepole pine stands of the Bighorn National Forest were infected with dwarf mistletoe. Twenty years later, Johnson *et al.* (1979) duplicated the methodology used in the road plot studies and evaluated the same roads used in the Hawksworth survey, including newer roads built through lodgepole pine stands. Johnson *et al.* (1979) found 36.3% of 174 miles through lodgepole pine forest types near roads were infected with dwarf mistletoe. They assessed growth loss and mortality caused by dwarf mistletoe on the Bighorn National Forest; subsequently, their findings were often used to promote dwarf mistletoe suppression work on the forest. Some dwarf mistletoe suppression work has occurred on the Bighorn National Forest in the last 30 years (Drummond and Johnson 1986, Johnson 1987) but the disease appears to have increased in incidence and severity since the Johnson survey in 1978.

The incidence of Comandra blister rust disease, caused by the fungus, *Cronartium comandrae,* was also evaluated during the Johnson *et al.* (1979) survey. They found that almost 72% of the lodgepole pine stands along the Bighorn National Forest roads contained comandra blister rust infected trees, however, the severities of those infections were not evaluated in the 1979 study. In the 1958 survey, Hawksworth did not record any comandra blister rust disease incidence perhaps due to minimal, visible damage by this fungus during the 1950's.

Rocky Mountain Region - Forest Health Management (FHM) crews conducted a similar road-plot survey in 1999. Crews from the Rapid City Service Center, a FHM unit, traveled many of the same roads (Figure 1) used in the Hawksworth 1958 and Johnson *et al.* 1979 surveys. We evaluated the current incidence and severity of dwarf mistletoe and comandra blister rust diseases on the Bighorn National Forest. The incidences and severities found by FHM in 1999 were compared to previous estimates of Hawksworth (1958) and Johnson *et al.* (1979).

Methods

In 1999, field crews traveled the same roads and used the same survey methods as described in the Hawksworth 1958 and Johnson *et al.*1979 studies. Some of the roads surveyed by Johnson *et al.* 1979 were under construction, closed, or obliterated in 1999. Plots were evaluated at three-mile intervals throughout the road-plot survey. Incidences and infection severities of dwarf mistletoe and comandra blister rust diseases were recorded during the road-plot survey.

Road Survey Methods

Forest roads through stands with lodgepole pine were traversed by FHM driving at 10 – 15 miles per hour. This slow speed allowed surveyors to observe and record general stand conditions and dwarf mistletoe infection of lodgepole pine along the right side of the road about 1 chain (66 feet) deep into the stand. At every tenth of a mile, field crews evaluated the amount of infected lodgepole pines observed in that road segment. An intensity rating was given to each road segment as follows:

0 = no dwarf mistletoe observed,
1 = dwarf mistletoe observed on 1/3 or less of the lodgepole pines,
2 = dwarf mistletoe observed on 2/3 or less of the lodgepole pines, and
3 = dwarf mistletoe observed on more than 2/3 of the lodgepole pines.

Other data recorded for each 0.1-mile segment were comandra blister rust incidence, non-disease disturbances, forest vegetation types, and major tree size. For each road segment, occurrences of topkilled lodgepole pines with distinct, yellowing cankers caused by comandra blister rust infection were noted. Easily observed disturbances such as cutting (thinning or harvesting) and fire (prescribed or wildfire) were recorded. Areas with no disturbances were also recorded. Forest vegetation types were categorized as pure lodgepole pine, mixed conifer, or aspen/lodgepole pine mix. Tree size for the majority of the trees in the road segment was determined as mature (dbh>9”), pole (4”<dbh<9”), or sapling (dbh <4”).

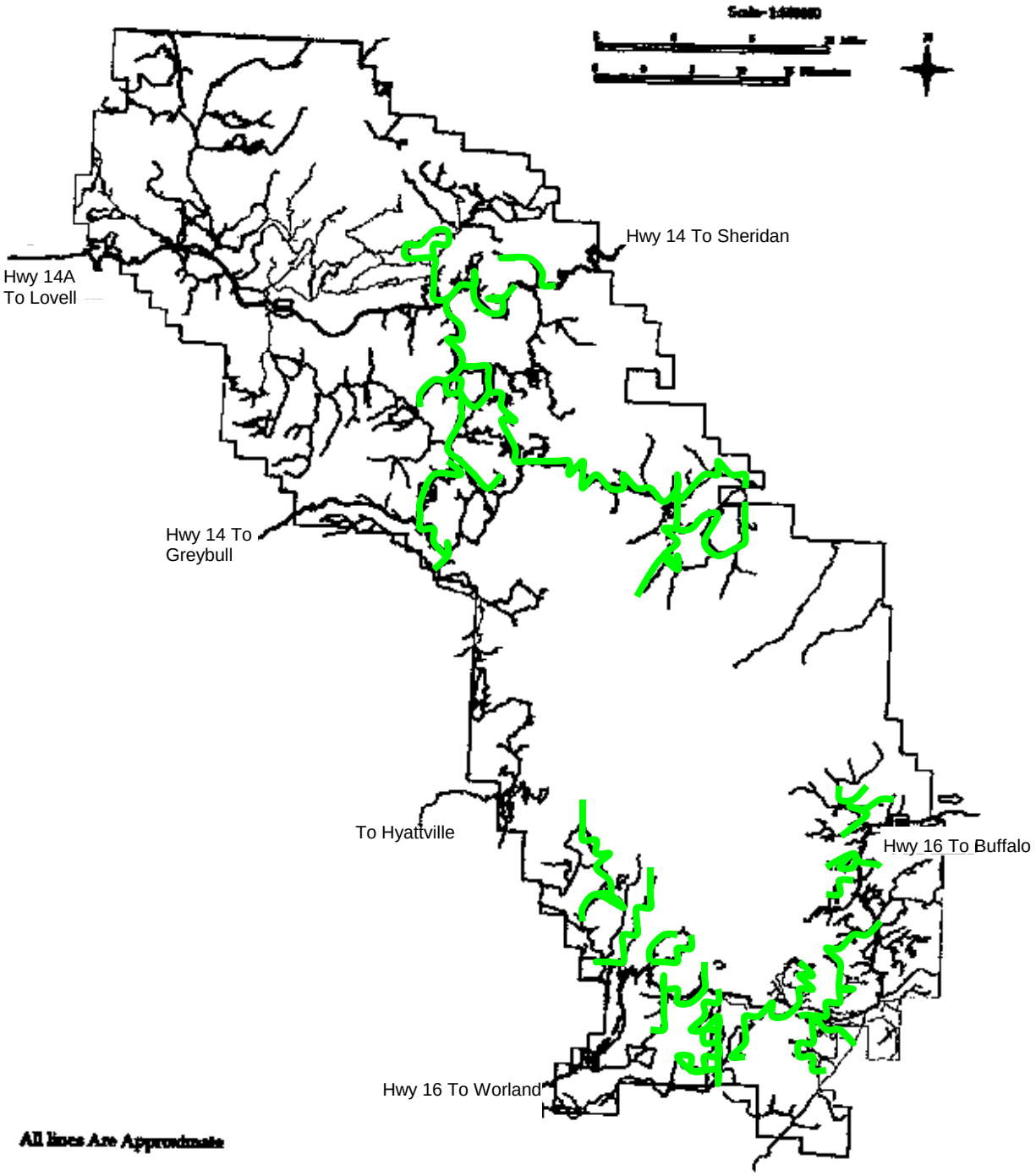

Figure 1. High-lighted roads of the Bighorn National Forest traveled through lodgepole pine stands during a road-plot, disease survey. Forty-four plots were installed at 3-mile intervals along the 146.5 miles surveyed for dwarf mistletoe and comandra blister rust diseases. Many of these same roads were used in similar road-plot surveys of 1958 and 1979.

Plot Survey Methods

Every three miles along the roads of the survey, plots were installed two chains into the stand and perpendicular to the road. We used variable-radius plots with a 20 Basal Area Factor to delineate plot trees that were sapling size (dbh < 4“), pole size (4“ ≤ dbh < 9”), and mature size (dbh ≥ 9“). A 1/100 acre, fixed-radius plot at plot center was used for evaluating seedlings (tree height ≤ 4.5 feet).

Data collected on live trees in the variable-radius plots included species, dbh, health status, and disease ratings. Health status was defined as:

1= uninfected
2= declining (one disease with disease ratings of 2 or less), and
3= dying (disease ratings ≥ 3 or more than one disease).

Disease ratings were performed for dwarf mistletoe and comandra blister rust infections. The Hawksworth dwarf mistletoe rating system (Hawksworth 1977) was used to evaluate plot trees for the severity of dwarf mistletoe infection. Severity of comandra blister rust infections were rated according to the severity of the most lethal canker on the tree as:

1 = a branch canker,
2 = a stem canker,
3 = a girdling stem canker causing topkill, and
4 = rust-caused mortality.

Counts were made of seedlings by species in the fixed-area plots. This provided information on tree species regeneration and forest succession trends within the plots. Generally, pine seedlings are too small to be infected with dwarf mistletoe, so no health status data were recorded in the seedling subplots.

Results and Discussion

We surveyed 146.5 miles of roads in forested areas containing lodgepole pines. Approximately 103 miles were recorded as pure lodgepole pine stands; 39.5 miles were mixed conifer forests and 4 miles were aspen/lodgepole pine stands. We also surveyed 44 plots at 3-mile intervals along the roads. These variable-radius plots contained 653 trees; approximately 97% of these plot trees were lodgepole pine.

Dwarf mistletoe incidence (DMI) was calculated as the percent of road segments or plots with dwarf mistletoe infection. A good check for accuracy of the road survey is to compare road DMI with plot DMI. In our survey, the DMI of the road

segments was 79% and seemed too high when compared to the DMI for the plots of 56.8%. However, this discrepancy was not unusual for a dwarf mistletoe road-plot survey; similar differences occurred between the DMI's of road segments and plots of previous road-plot surveys (Johnson *et al.*1979, Smith and Hoffman 1998) for dwarf mistletoe in lodgepole pine (Figure 2).

Road Survey

We diverged from past survey methods by using four surveyors in two-person crews to conduct the survey in less time. The two member crews rotated with each other throughout the survey so that all four crew members worked with each other and each crew member evaluated lodgepole pines for dwarf mistletoe incidence. The surveyors were familiar with lodgepole pine growth and development, and had surveyed for *A. americanum* in several other forest health studies.

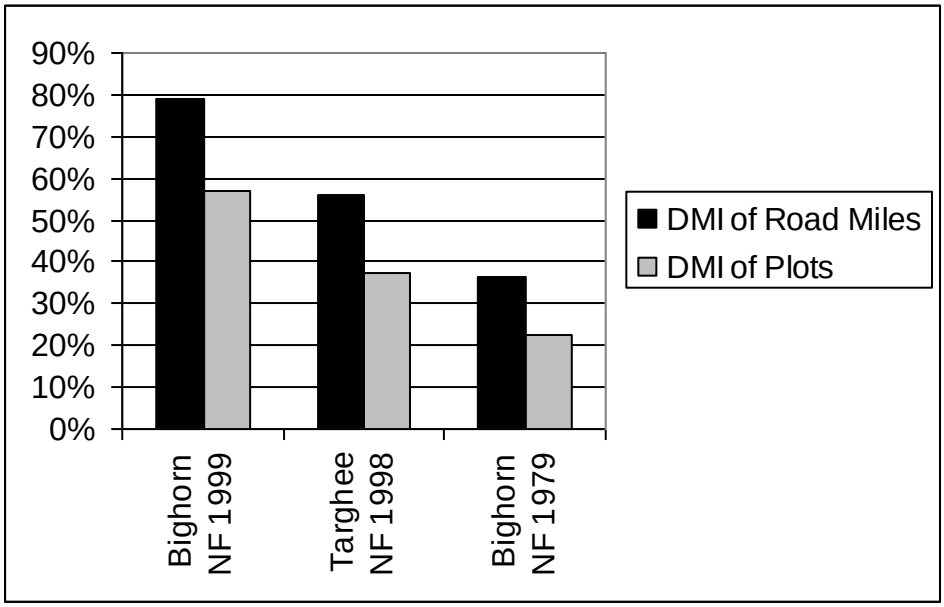

Figure 2. Dwarf mistletoe incidence (DMI) of three road-plot surveys on national forests (NF). DMI was calculated as a percent of road segments or plots with dwarf mistletoe incidence compared to the total number of road segments or plots.

Other forest pathologists familiar with this type of survey cautioned us to take time to “train our eyes” to accurately evaluate dwarf mistletoe incidence from the road. These pathologists said that the tendency to overrate the dwarf mistletoe incidence was high due to the stimulation branching nature of lodgepole pines growing near roads. Stimulated branches are often confused with the excessive branching nature of witches-brooms caused by dwarf mistletoe infection (Hawksworth and Johnson 1989).

We spent several hours during the start of the survey with each crew member practicing roadside rating of dwarf mistletoe occurrence. Throughout the survey, we compared our recent road data with recent plot data to check for accuracy of road segment data. The plot data should be more accurate due to “ground-level” inspections for dwarf mistletoe incidence. If the two sets of data were similar in dwarf mistletoe occurrence, then we felt that the road-plot data could be considered correct.

Intensity Levels 2 and 3 were easy to distinguish and surveyors were confident that these road segments were evaluated accurately for dwarf mistletoe intensity. However, intensity level 1 may have been overestimated; perhaps some of those road segments should have been classified as level 0. So instead of a 79% DMI of the road segments on the Bighorn National Forest infected with dwarf mistletoe, we determined a more conservative estimate of 44%, the total DMI of Intensity Levels 2 and 3 (Table 1). This 44% incidence of dwarf mistletoe infection was still a significant increase from 36.3% incidence found in 1979 (Johnson et al.1979).

Interesting relationships were observed when comparing tree size, disturbance categories, with occurrences of both mistletoe and rust diseases (Table 1). Stands with mature size trees had the greatest amount of dwarf mistletoe and comandra blister rust diseases. This is likely due to the longer time of exposure to these pathogens and further development of the diseases in the trees (Hawksworth and Johnson 1989).

There was little evidence of recent fire in these areas with lodgepole pine. Fire sanitizes forested areas from dwarf mistletoe (Hawksworth and Johnson 1989); since burned areas were not observed frequently during the survey this might account for increasing dwarf mistletoe incidence over the last four decades.

TABLE 1	Miles Surveyed	DMI of Surveyed Miles
Miles with Intensity Level 0 – no dwarf mistletoe	30.3	21%
Miles with Intensity Level 1	51.4	35%
Miles with Intensity Level 2	42.3	29%
Miles with Intensity Level 3	22.5	15%
Miles of Saplings	13.1	2.3%
Miles of Poles	57.7	14.7%
Miles of Mature	75.7	27%
Miles with No Disturbance	77.5	19.5%
Miles with Cutting	67.8	24.3%
Miles with Fire	1.2	0.2%
Miles with Comandra Blister Rust Disease	90.4	54.7%

Table 1. Characteristics of road-side lodgepole pine stands and various dwarf mistletoe incidences (DMI). Intensity levels were an evaluation of the amount of infected lodgepole pines in each road segment. Perhaps, the DMI of the road segments of intensity levels 1, 2, and 3 totaling 79% was overestimated for Intensity Level 1; a more conservative estimate of 44% was found using the total DMI of only intensity levels 2 and 3.

Cutting was observed along 67.8 miles of the road-plot survey and dwarf mistletoe was found in 54.8 of these miles. Some of these road segments were seed tree cuts with large, residual trees left for seed production to restock the site. However, these residual, seed trees were infected with dwarf mistletoe and were not destroyed when the regenerating pine seedlings were small (about 5 years old). As a result, the seed trees are now currently releasing dwarf mistletoe seed and infecting the regeneration; many of these young pines in these sites were severely infected with dwarf mistletoe. These situations of infected seed tree cuts were recorded for 3.8 miles during the survey.

Dwarf mistletoe and comandra blister rust occurred in 80.1 miles (54.6%) of the survey. Road segments with only dwarf mistletoe disease totaled 36.1 miles (24.6%). Comandra blister rust also occurred alone in another 10.3 miles (7%) lodgepole pine stands. These two diseases infected an estimated 86% of the lodgepole pines along the roads of the Bighorn National forest (Figure 3). This is an increase from 71.4% of road segments infected with these two diseases in the 1979 survey (Johnson per. com.). Essentially in 1979, there were 29% of the lodgepole pine stands uninfected with either of these diseases; by 1999, the amount of disease-free lodgepole pine stands had significantly decreased to only 14%.

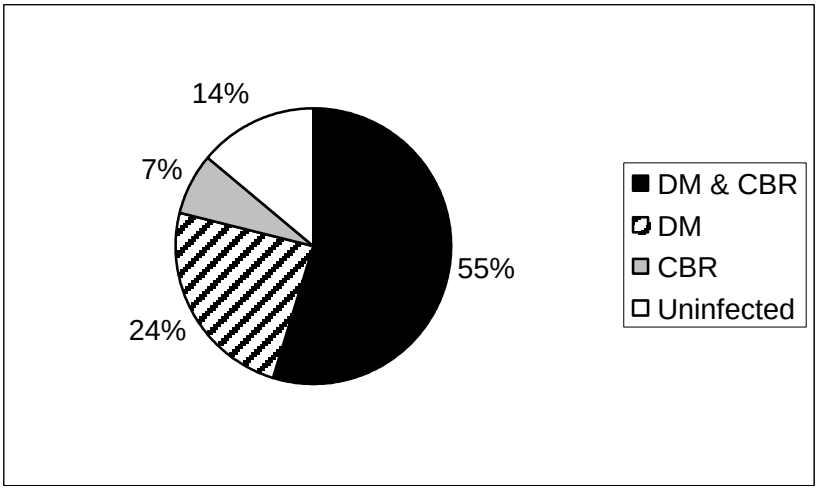

Figure 3. The percentages of diseased lodgepole pines along Bighorn National Forest roads in 1999. Roads were used as transects to evaluate the amounts of dwarf mistletoe (DM) and Comandra blister rust (CBR) infection in stands with lodgepole pine.

Plot Survey

Forty-four plots with a total of 653 living trees were evaluated in this survey (Table 2). We used a 20 Basal Area Factor to delineate variable-radius plot trees. A 10 Basal Area Factor would have delineated more trees for the survey and may have resulted in a more accurate assessment of the plots.

The large number of spruce and fir seedlings indicated a change in forest succession on these sites (Hawksworth and Johnson 1989). The low number of lodgepole pine seedlings may be caused by a reduction in seed production by the older lodgepole pines due to the high incidences of dwarf mistletoe and comandra blister rust diseases (Table 3). The average ratings for both of these diseases were high enough to show that some disease-caused topkill was happening with these trees. Since many of the pine cones are produced in the tree tops, this topkill hindered lodgepole pine seed production and viability (Hawksworth and Johnson 1959).

Of all the lodgepole pines in the plots, over 43% were infected with either dwarf mistletoe, comandra blister rust, or both diseases. Most of these infected trees had one or both diseases and several were close to mortality. While many of the plots trees were categorized as "healthy/uninfected", the high incidence and rating numbers of the infected trees indicate that these trees have advanced damages caused by the diseases.

Table 2	# Lodgepole pine	# Subalpine fir and Englemann spruce	TOTALS
Seedlings	59	139	298
Saplings	93	7	
Poles	174	0	355
Mature	174	7	
TOTALS	500	143	653

Table 2. Number of trees by species and tree size in the 44 variable-radius plots. A 1/100 acre, fixed-radius plot was used to evaluate seedlings and saplings. A 20 basal area factor prism was used to sample 355 older trees in the 1999 plot survey.

Table 3	Incidence	Average Rating
Dwarf Mistletoe	56.8%	3.05
Comandra Blister Rust	43%	2.95

Table 3. Incidence and average disease ratings of dwarf mistletoe and comandra blister rust in the plots. Incidence was calculated as the percentage of all infected lodgepole pines. The 6 level Hawksworth 1977 system was used to rate dwarf mistletoe infection for each tree. The comandra blister rust infections were rated according to the most lethal canker on the tree as: 1 = a branch canker, 2 = a stem canker, 3 = a girdling stem canker causing topkill, and 4 = rust-caused mortality.

Comparisons in disease incidences from 1958 to 1999 are interesting to note the changes (Fig.4). The dwarf mistletoe incidences (DMI) of the road surveys show an increase during the 40 years. The DMI between 1979 and 1999 also increased, but the 1958 percentage was very high. This is probably due to a slightly different method of traversing the stand from the road and installing several more plots in the lodgepole pine stands. Comandra blister rust incidences (CBRI) have declined from 1979 to 1999. Perhaps several lodgepole pines observed in 1979 have died from the disease in the last 20 years and the disease incidence and infection rates have been reduced.

There is a possible reason why the Hawksworth 1958 study did not evaluate the comandra blister rust disease along the Bighorn National Forest roads. It is believed that the weather conditions of the 1940's promoted the increase of *C. comandrae* fungus and started the large outbreaks of the rust disease in Wyoming during the 1950's (Krebill 1965). Perhaps visible canker symptoms of the disease were not very apparent in the 1950's or this disease was not much of a management concern at that time, so evaluation of this disease was not done in the 1959 survey (Hawksworth 1958).

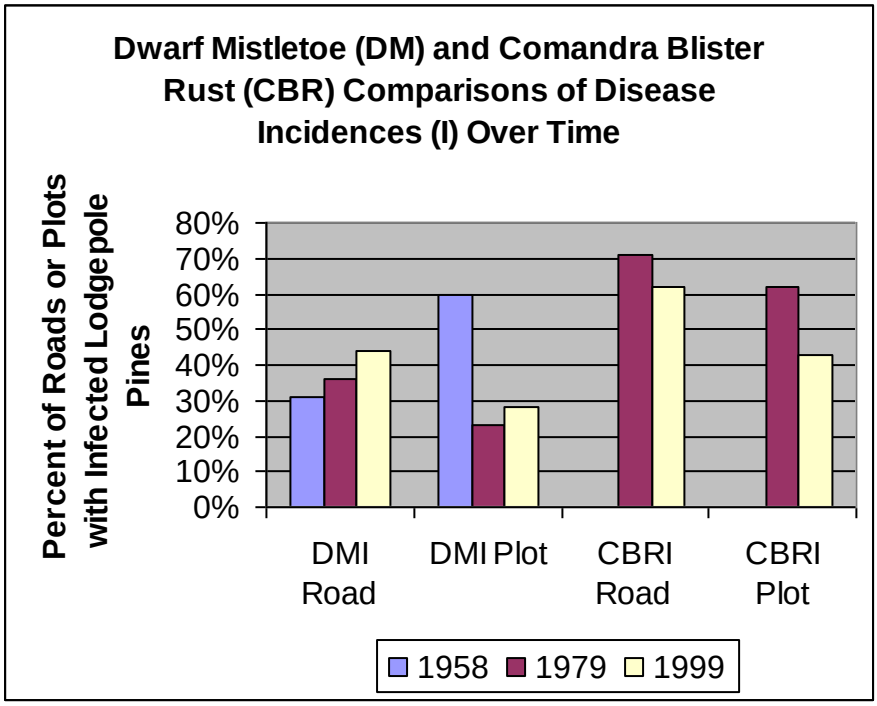

Figure 4. Comparisons of incidences of dwarf mistletoe and comandra blister rust diseases in lodgepole pine stands along roads of the Bighorn National Forest from 1958 to 1999. Hawksworth (1958) surveyed 146 miles of road and installed 70 plots. Johnson et al. (1979) evaluated 174 miles of forest roads and 65 plots. In the 1999 study, we surveyed 147 miles and established 44 plots.

Summary and Recommendations

- Dwarf mistletoe incidence (DMI) in lodgepole pine increased since 1958 from 31% (Hawksworth 1958) to a conservative estimate of 44% 1999; the DMI might be as high as 79% in the 1999 survey. Some lodgepole pine stands may be reaching levels where the only management option will be to replace the stand to improve forest health.

- Dwarf mistletoe and/or comandra blister rust infect over 86% of the lodgepole pines along the roads of the Bighorn National Forest. Dwarf mistletoe and comandra blister rust suppression work will promote healthier forest stands. FHM staff can assist with planning and funding suppression projects for these two diseases.

- Low lodgepole pine seedling counts in the predominantly lodgepole pine survey plots indicate forest succession and/or reduced pine seed production and regeneration due to the effects of dwarf mistletoe and/or comandra blister rust. The average disease ratings of both diseases were high enough to indicate that topkill was affecting many of the seed-bearing trees.

- Seed tree cuts were observed in 3.8 miles of the road survey. The residual overstory, seed trees have dwarf mistletoe and are infecting lodgepole pine regeneration. If these residual seed trees are not felled or girdled soon, the regenerating lodgepole pine stands will have a greater, increased incidence and severity of dwarf mistletoe infection. This negates any previous suppression efforts and creates worse forest health conditions than previously seen.

- Greater emphasis on dwarf mistletoe suppression work on the Bighorn National Forest could reduce this disease incidence in stands with lodgepole pines. Assessments of the dwarf mistletoe infection in the regeneration will help forest managers determine which sites would benefit from dwarf mistletoe suppression efforts.

- Survey road segments where the majority of mature lodgepole pines trees have the greatest amount of DMI. These heavily infected mature trees have reduced vigor and volume growth; these sites might be harvested and healthier lodgepole pine stands promoted.

Acknowledgments

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