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Plot Survey of Dwarf Mistletoe and Comandra Blister Rust Diseases in Lodgepole Pine on the Bighorn National Forest: 2018

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Abstract

In 2018, a plot survey of dwarf mistletoe and comandra blister rust diseases was conducted in lodgepole pine stands on the Bighorn National Forest. Variable-radius plots (n=93) were installed at two-mile intervals along roads to evaluate lodgepole pine for these diseases. Plot survey results estimate 49% of lodgepole pine trees and 70% of the plots near roads were infected with dwarf mistletoe; 16% of the trees and 60% of the plots were infected with comandra blister rust; and 11% of the trees and 50% of the plots had both diseases. This survey and previous surveys of the forest indicate dwarf mistletoe incidence and severity are increasing. Comandra blister rust disease incidence also increased compared with the most recent survey in 2013, but decreased consistently from 1979 to 2013. Emphasis on suppression work for these two diseases will result in reductions in disease incidences and promote improved forest health.

Introduction

Lodgepole pine dwarf mistletoe (*Arceuthobium americanum*) is one of the most important diseases of lodgepole pine (*Pinus contorta*) in the region. It is a parasitic plant that requires water, mineral, and carbon nutrients from its hosts. This stresses host trees causing reductions in both growth and cone/seed production. Seeds are explosively-released and typically fly < 33 ft. Long-distance seed dispersal by birds can occur, but is uncommon. Infections of young host tissues result in stimulation of dormant host buds which causes abnormal-dense clumps of branches called “brooms” or “witches’ brooms.” Other symptoms include branch swellings, host dieback from the top down, and eventual tree mortality. Trees can survive infection for decades. However, in areas with extensive infection, tree mortality can be three to four times higher than in uninfected areas (Hawksworth and Wiens 1996).

Comandra blister rust (*Cronartium comandrae*) is also one of the more important diseases of lodgepole pine in the region. This rust disease requires two hosts to complete its life cycle. The incidence of disease is correlated with the presence of its alternate host; bastard toadflax. Long periods of high humidity in late summer or fall are required for infection of lodgepole pine. Therefore, rust epidemics often follow years with a long-moist late growing season. The disease causes stem deformities, growth reduction, and cankers that girdle branches and/or stems resulting in top-kill and tree mortality. Trees may survive several decades with spiked-tops. However, top-kill can cause reductions in both growth and cone/seed production. Heavy stand infections can result in high volume losses by affecting tree form, lumber quality, and growth rate.

Past plot surveys conducted on the Bighorn National Forest (NF) indicated an increasing incidence of dwarf mistletoe in lodgepole pine. In 1958, Hawksworth (1958) reported 60% of the plots and 31% of road sections of 146 miles of roads near lodgepole pine stands in the Bighorn NF were infected with dwarf mistletoe. Twenty years later, Johnson et al. (1979) duplicated the methodology used in the road-plot studies. The same roads were evaluated as in the Hawksworth survey, including newer roads built near lodgepole pine stands. Johnson et al. (1979) found 23% of the plots and 36% of road sections of 174 miles of roads were infected with dwarf mistletoe. After another 20 years (sampled in 1999) Harris (2003) found 57% of the plots and 79% of road sections of 147 miles of roads were infected with dwarf mistletoe. After another 10 years Blodgett (2015) found 65% of the plots and 75% of road sections of 133 miles of roads were infected with dwarf mistletoe. The data suggested a 4% decrease with road-side surveys and an 8% increase with plot surveys when comparing the same years.

An accuracy check for road-side surveys includes a comparison with plot surveys (Blodgett 2015, Harris 2003). Blodgett (2015) found dwarf mistletoe incidence measured via a road-side survey was high when compared to a plot survey. This discrepancy is not unusual for dwarf mistletoe road-plot survey (Harris 2003, Johnson et al. 1979) including those in other forests (Smith and Hoffman 1998). Lodgepole pines growing near roads or stand edges can have "stimulation brooms." Stimulation brooms are non-mistletoe brooms that can be confused with brooms induced by dwarf mistletoe and are common in lodgepole pine (Hawksworth 1961, Hawksworth and Johnson 1989). Thus, dwarf mistletoe incidence was likely overestimated during road-side surveys due to these non-mistletoe brooms. Plot dwarf mistletoe incidence values should be more accurate due to ground-level inspections.

Johnson et al. (1979) assessed growth loss and mortality caused by dwarf mistletoe on the Bighorn NF. Their findings were used to promote dwarf mistletoe suppression work on the forest. Dwarf mistletoe suppression work has occurred on the Bighorn NF (Johnson 1987) and other forests (Hawksworth and Johnson 1989).

The incidence of comandra blister rust disease was also evaluated during the previous surveys. However, Hawksworth (1958) did not note any comandra blister rust disease incidence. Johnson et al. (1979) found 62% of the plots and 71% of road sections contained comandra blister rust infected trees. Harris (2003) found this disease to be less common in 1999 with 43% of the plots and 62% of road sections containing comandra blister rust. This decreasing trend was also observed in 2013 with 37% of the plots and 44% of road sections containing comandra blister rust (Blodgett 2015). Results suggest comandra blister rust disease may also be overestimated using road-side surveys compared with plot surveys.

The objectives were to evaluate incidence and severity of dwarf mistletoe and comandra blister rust diseases on the Bighorn NF. Comparisons with previous years plot data were used to explore changes in these important diseases.

Methods

In 2018, traveling many of the same roads previously described (Blodgett 2015, Harris 2003, Hawksworth 1958, Johnson et al. 1979) a plot survey was conducted in the Bighorn NF. Due to road closures and new roads, some road sections were different from those previously surveyed. Plots were evaluated at two-mile intervals along roads near lodgepole pine stands. Only plots survey methods were used due to reported discrepancies between road-side and plot surveys (Blodgett 2015, Harris 2003).

Plot survey methods. Plots were installed 2 chains or more into stands perpendicular to roads every 2 miles. Variable-radius plots with 20 basal area factor were used to delineate trees as saplings (dbh < 4 in), poles (4 in ≥ dbh < 9 in), or mature trees (dbh ≥ 9 in). A 1/100 acre, fixed-radius plot at plot center was used to evaluate frequencies of seedlings by species (height ≤ 4.5 feet).

Data collected for live trees in plots included species, dbh, and disease rating. The six-level dwarf mistletoe disease rating system was used (Hawksworth 1977). Disease severity ratings for comandra blister rust were: 0 for no infection, 1 for a branch canker, 2 for a stem canker, 3 for a girdling stem canker causing top kill, and 4 for rust-caused mortality. Plot dwarf mistletoe incidences and plot comandra blister rust incidences were calculated as percent of plots with the diseases. Tree dwarf mistletoe incidences and tree comandra blister rust incidences were calculated as percent of trees within plots with the diseases. Frequencies of other damage agents were recorded.

Results and Discussion

Plot survey. We surveyed 93 lodgepole pine plots along 198 miles of roads. Plots contained 1,070 trees (all sizes); approximately 81% were lodgepole pine (**Table 1**); the average dbh of lodgepole pine in variable-radius plots was 10.7 inches. Lodgepole pine made up 97% of the mature and pole-sized trees; with 2% Engelmann spruce and <1% subalpine fir, limber pine, ponderosa pine, and Douglas-fir.

Table 1. Number of trees by species and size class in 93 variable-radius and fixed-radius plots in the Bighorn National Forest.

Size class[a]	Lodgepole pine	Other conifers	Aspen	Total
Seedlings	146	149	29	333
Saplings	9	0	0	
Pole trees	294	5	0	737
Mature trees	421	17	0	
Total	870	171	29	1,070

[a] Variable-radius plots with 20 basal area factor were used to delineate trees as saplings (dbh < 4 in), poles (4 in ≥ dbh < 9 in), or mature trees (dbh ≥ 9 in). A 1/100 acre, fixed-radius plot at plot center was used to evaluate seedlings (height ≤ 4.5 feet).

Overall regeneration was low (348 stems per acre; all seedling species). The low regeneration numbers were likely caused by the dense overstory in many of the stands. For seedlings, lodgepole pine made up 45% of the regeneration; with 35% subalpine fir, 11% Engelmann spruce, 9% aspen, and <1% limber pine and Douglas-fir. Lodgepole pine regeneration was observed in 38% of the plots. The large percentage of other conifer seedlings (46%) suggests forest successional changes are occurring on some sites. This could be hastened by reduced seed production due to high levels of dwarf mistletoe and/or comandra blister rust in some stands. The observed disease-caused top-kill can hindered lodgepole pine seed production and viability (Hawksworth and Johnson 1989).

In trees, the incidences of both dwarf mistletoe and comandra blister rust disease were high, as was the average disease severity ratings of infected trees (**Table 2, Fig. 1 and 2**). Other damage agents were infrequent in mature trees: 1.7% for western gall rust, 1.0% for pine engraver beetles (*Ips* sp.), and 0.4% for mountain pine beetle. Dwarf mistletoe was never observed in seedlings and comandra blister rust disease was observed in 5% of the lodgepole pine seedlings.

Table 2. Incidence and mean disease ratings for dwarf mistletoe and comandra blister rust in trees[a] in 93 variable-radius plots in the Bighorn National Forest.

Damage agent	Plot incidence	Tree incidence[a]	Mean tree severity rating[b]	Mean infected tree severity rating[b]
Dwarf mistletoe	70%	49%	1.4	3.1
Comandra blister rust	60%	16%	0.3	2.0

[a] Tree incidence is the percentage of infected lodgepole pine.

[b] The six level Hawksworth (1977) system was used to rate dwarf mistletoe infection. Comandra blister rust infections were rated by the most lethal canker on a tree: 1 = branch canker, 2 = stem canker, 3 = girdling stem canker causing top-kill, and 4 = rust-caused mortality; and 0 = no canker.

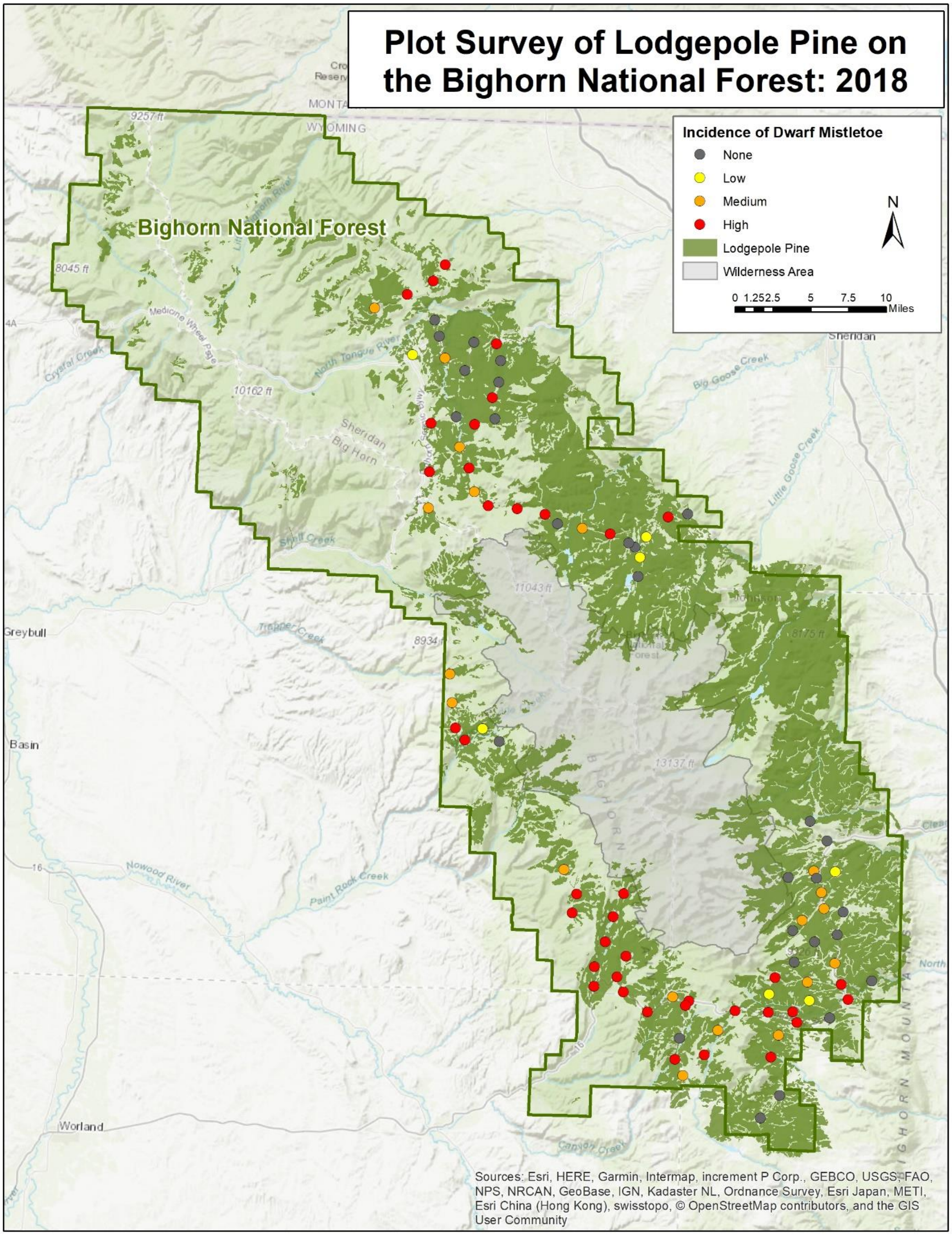

Figure 1. Incidence of dwarf mistletoe in lodgepole pine on the Bighorn National Forest. Plots were installed at 2-mile intervals along 198 miles of roads in 2018.

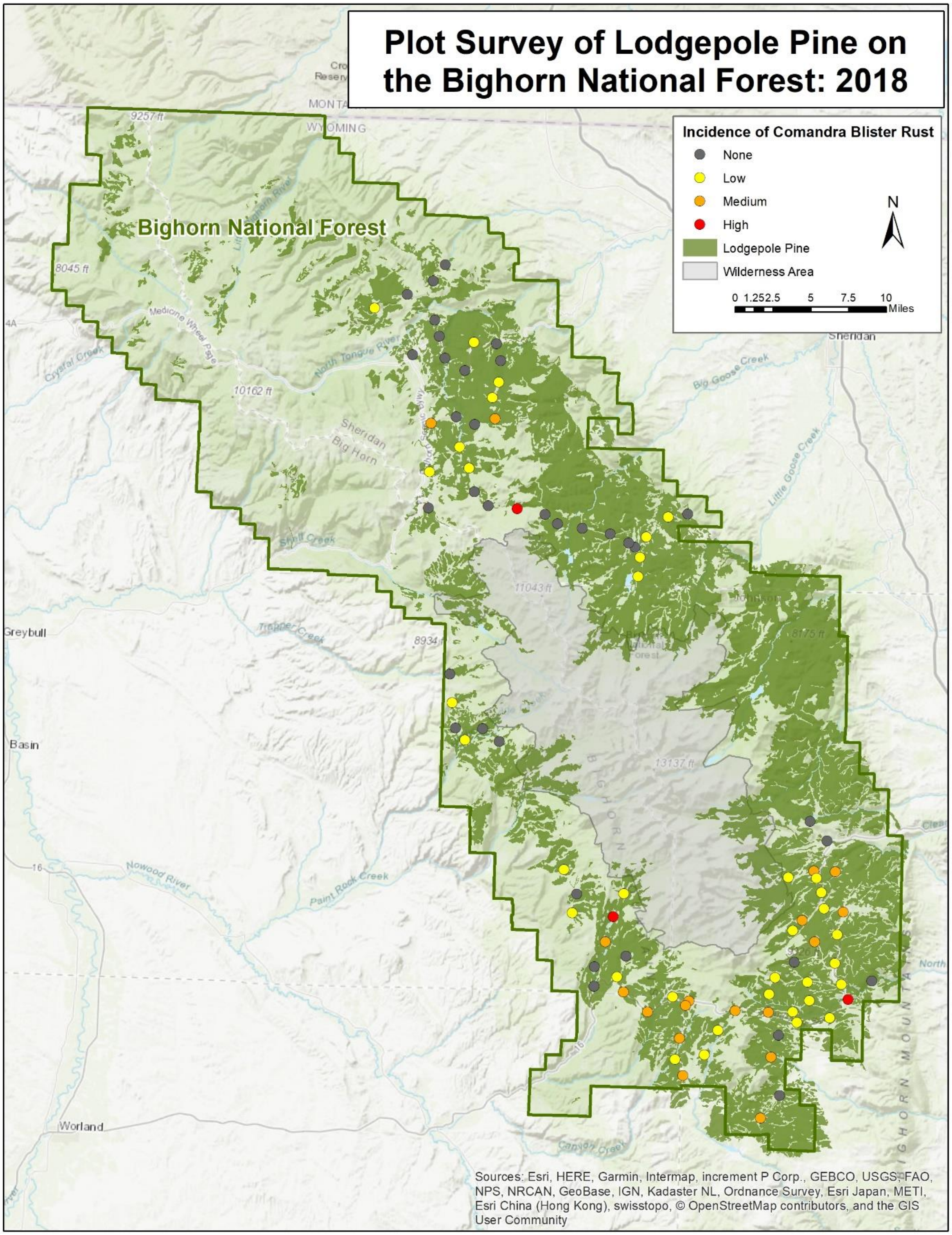

Figure 2. Incidence of comandra blister rust disease in lodgepole pine on the Bighorn National Forest. Plots were installed at 2-mile intervals along 198 miles of roads in 2018.

At least one of the two diseases occurred in 80% of the plots (**Fig. 3**). In lodgepole pine trees (variable-radius plots), 52% were infected with either dwarf mistletoe, comandra blister rust, or both diseases (**Fig. 3**). Twenty-four percent of the lodgepole pine trees had a high dwarf mistletoe infection rating (≥ 3 infection rating). Although not as high, 9% of the trees had comandra blister rust stem canker (≥ 2 infection rating); and 4% had a high infection ratings for both diseases.

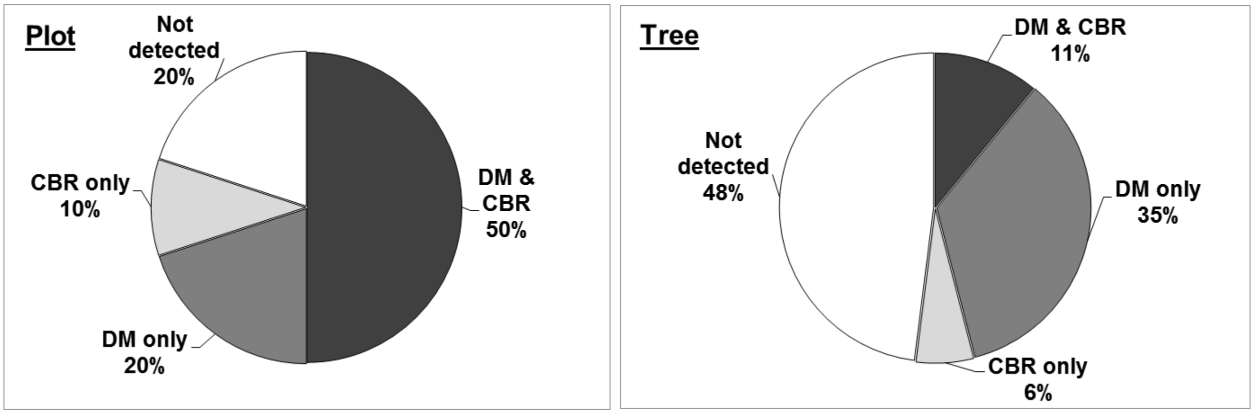

Figure 3. Frequencies of dwarf mistletoe (DM) and comandra blister rust (CBR) infection in plots and in lodgepole pine trees (sapling to mature trees) in 93 variable-radius plots along Bighorn National Forest roads in 2018.

Comparisons among study years. Survey results suggest an increase in dwarf mistletoe incidence from 1979 to 2018 (**Fig. 4**), though 1959 dwarf mistletoe incidence results do not fit this trend. Harris (2003) speculated the very high 1958 percentage for plot data were due to different method of traversing stand from the road. The 2018 survey results suggest a slight increase in dwarf mistletoe incidence compared to the 2013 survey. Different plot locations and more road segments were surveyed in 2013 and 2018, which could account for some of the differences among years.

The incidence of comandra blister rust decreased consistently from 1979 to 2013 (**Fig. 5**). This trend was likely due to mortality of rust infected lodgepole pine along with low infection rates. Harris (2003) speculated Hawksworth (1958) did not evaluate comandra blister rust disease in the Bighorn NF since levels were very low in 1950's. It is believed that weather conditions of the 1940's promoted *C. comandrae* infection, starting a disease outbreak of this rust in Wyoming during the 1950's (Krebill 1965). Symptoms of the disease may not have been apparent during the 1958 survey. The increase in comandra blister rust disease observed in 2018 suggests another weather condition favoring *C. comandrae* infection occurred between 2013 and 2015 (a rust "wave-year" event). It takes at least 3 years for symptoms to be apparent in tree crowns. Increased top and tree mortality should be expected in the future from this disease.

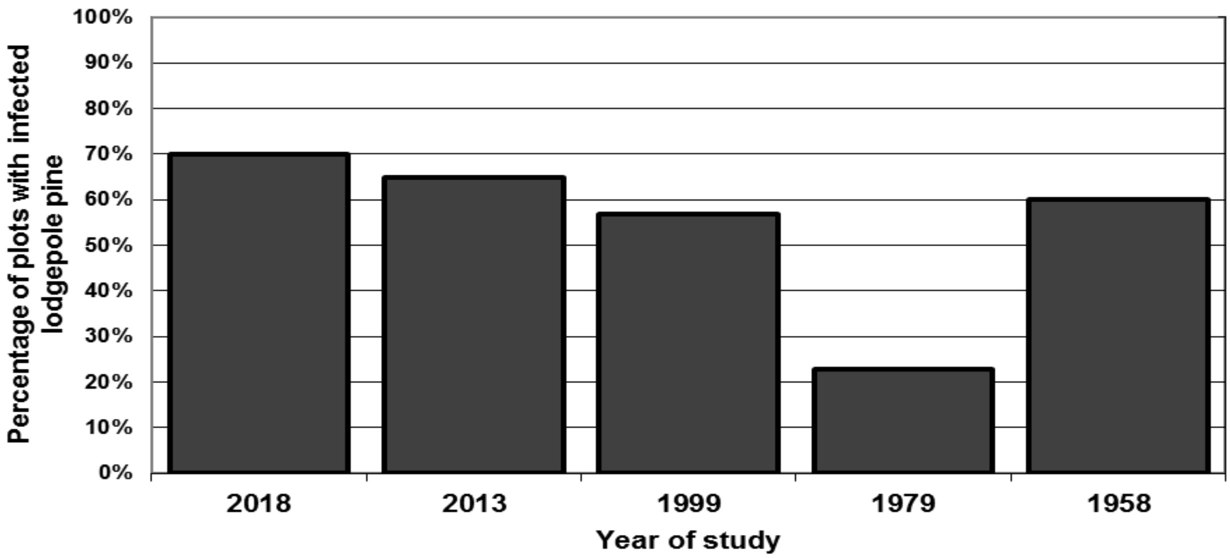

Figure 4. Dwarf mistletoe incidence in lodgepole pine plots on the Bighorn National Forest from 1958 to 2018. Hawksworth (1958) surveyed 146 miles of roads with 70 plots. Johnson et al. (1979) surveyed 174 miles of roads with 65 plots. Harris (2003) in 1999 surveyed 147 miles of roads with 44 plots. Blodgett (2015) in 2013 surveyed 161 miles with 91 plots. In 2018, 198 miles of roads were surveyed with 93 plots.

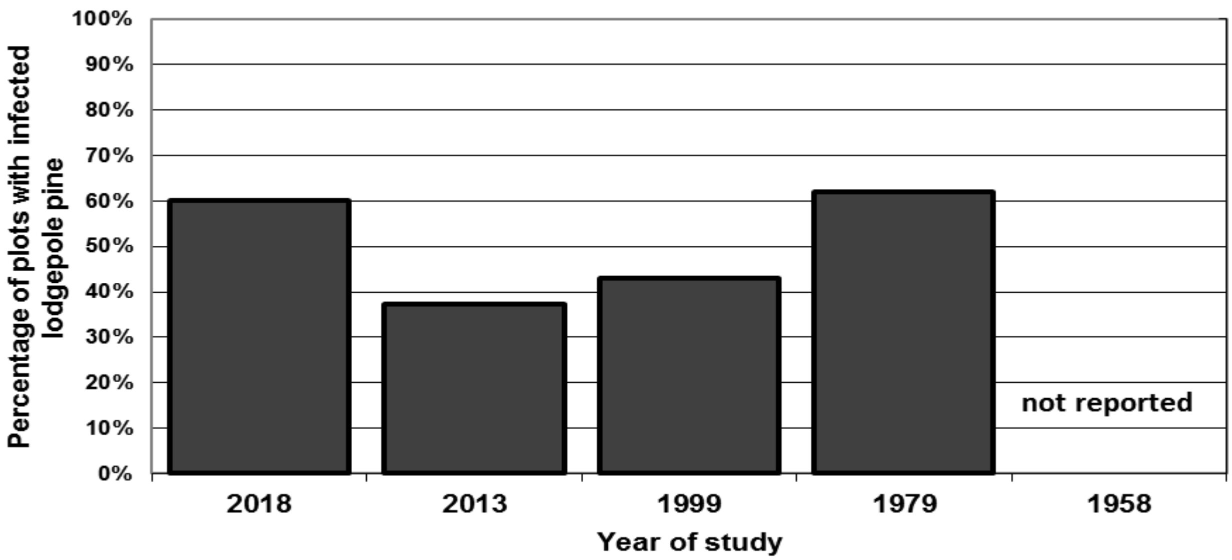

Figure 5. Comandra blister rust incidence in lodgepole pine plots on the Bighorn National Forest from 1958 to 2018. Hawksworth (1958) surveyed 146 miles of roads with 70 plots. Johnson et al. (1979) surveyed 174 miles of roads with 65 plots. Harris (2003) in 1999 surveyed 147 miles of roads with 44 plots. Blodgett (2015) in 2013 surveyed 161 miles with 91 plots. In 2018, 198 miles of roads were surveyed with 93 plots.

Summary and Recommendations

- Results suggest dwarf mistletoes levels are high and increasing in the forest. The more accurate plot dwarf mistletoe incidence suggests a consistent increase in dwarf mistletoes since 1979.

- Comandra blister rust levels are moderate in the forest. Results suggest a significant increase, likely as a result of a rust "wave-year" event between 2013 and 2015 (*i.e.*, weather condition favoring *C. comandrae* infection).

- Some lodgepole pine stands are shifting to subalpine fir and/or Engelmann spruce. This might be due to forest succession and/or reduced lodgepole pine seed production resulting from dwarf mistletoe and/or comandra blister rust.

- Seed tree cuts were observed during the survey where the residual overstory (seed trees) had dwarf mistletoe, infecting regeneration. These residual seed trees should be felled or girdled.

- Several stands are reaching levels where the only management option is stand replacement to improve forest health. These heavily infected mature stands have reduced vigor and volume growth. Stand replacement could result in healthier residual stands.

- Although mean per tree dwarf mistletoe and comandra blister rust disease severity ratings were low, plot incidences are high for these diseases. The mean tree severity ratings of infected trees are also high. This indicates several stands (not all) in the forest would benefit from disease management.

- Options for comandra blister rust management could include removal of infected trees during partial cuts and selecting disease-free trees as leave trees during seed cuts.

- Silvicultural controls to reduce incidence and severity of dwarf mistletoe include:
    - clear large areas during regeneration cuts or by fire, to reduce new infections from stand edges,
    - select disease-free trees as leave trees during seed cuts, and promptly remove or kill all infected seed-trees after regeneration is established,
    - use stand borders adjacent to treated areas that are dwarf mistletoe free,
    - establish buffer strips around infection centers or around sanitized patches, and promptly remove or kill infected trees along the edge (to create a 52 foot barrier) once regeneration is established,
    - remove or kill infected trees during partial cuts,
    - prune infected trees when possible (*e.g.*, in campgrounds, picnic areas, etc.),
    - favor or encourage non-host species that are adapted to the site,
    - monitor treatments to identify and remove infected trees that were missed or had latent infections.

- Dwarf mistletoe and comandra blister rust suppression work will promote healthier forest stands. Forest Health Protection staff can assist with planning and funding suppression projects for these diseases.

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