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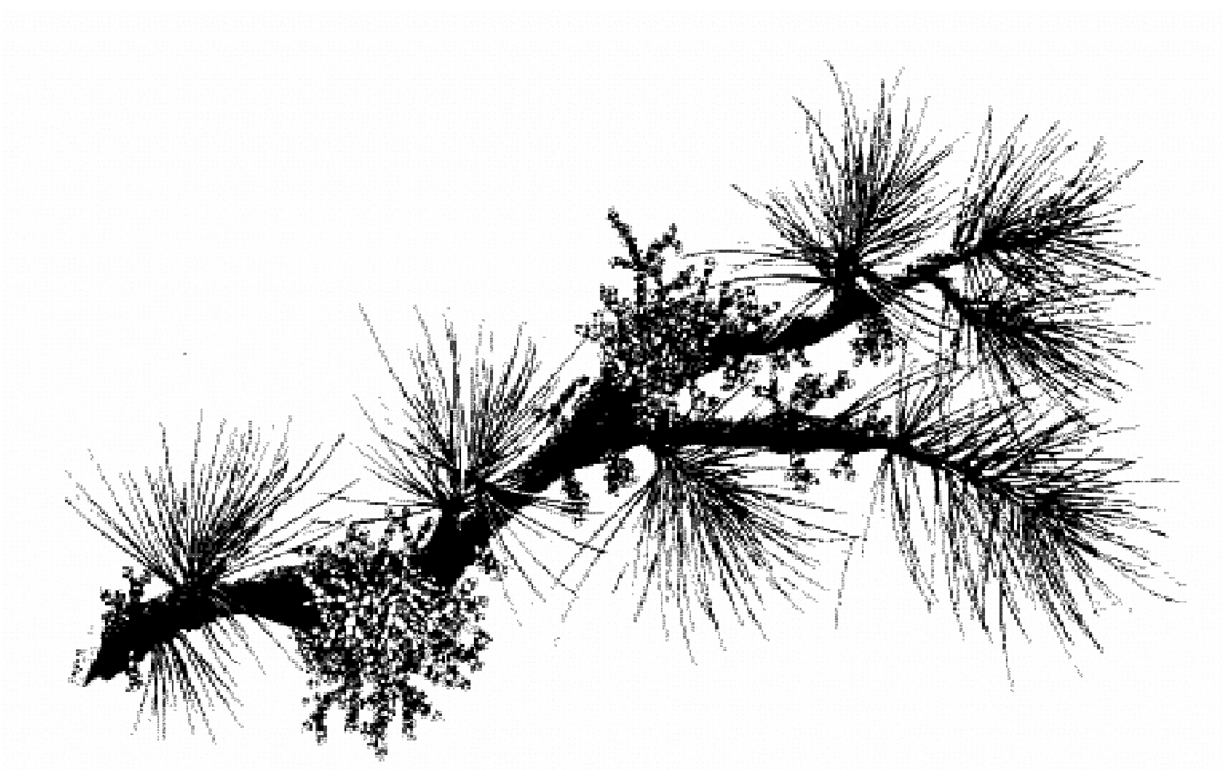

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Comparison of Dwarf Mistletoe Behavior and Stand Development in Treated and Untreated Areas: 10-Year Monitoring on Jarita Mesa

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Abstract

Monitoring plots containing a sample of 265 ponderosa pine were installed following a dwarf mistletoe sanitation-thinning treatment on the Carson National Forest in 1991. From 1992 to 2002, average dwarf mistletoe ratings (DMRs) increased from 1.20 to 2.12 (0.92) in the treated area, and from 2.20 to 2.44 (0.24) in an adjacent untreated area. The greater increase on the treated plot was a function of both a more rapid intensification of mistletoe on infected trees on that plot and the death of several heavily-infected trees on the untreated plot. Average diameter growth over the 10-year period was 2.2 inches on the treated plot and 1.0 inches on the untreated plot; growth was markedly reduced on both plots in the second five-year period because of drought. Tree mortality was four times higher on the untreated plot, and mortality was strongly correlated with dwarf mistletoe infection on this plot. Regeneration was healthier and more abundant on the treated plot. Management implications are discussed.

Introduction

Ten – year remeasurements were conducted during the summer of 2002 on two dwarf mistletoe monitoring plots on the El Rito Ranger District of the Carson National Forest. These plots were established in 1992 as part of a West-wide effort to better quantify dwarf mistletoe spread and intensification, and improve growth and yield models. This particular set of plots, located on Jarita Mesa, provides a comparison of dwarf mistletoe behavior and stand development in a treated (thinned) and an adjacent untreated stand.

Study Area

Jarita Mesa lies just east of the communities of Vallecitos and Canon Plaza, and is part of the Vallecitos Federal Sustained Yield Unit. The plots are in the Little Rock sale area, and are located approximately 200 yards apart on opposite sides of Forest Road 110 (T.27N., R.8E., sec.17). The stands are predominantly ponderosa pine, with minor amounts of young white fir and Douglas-fir. Site quality is good, with an estimated site index of 80 for ponderosa pine. Like much of Jarita Mesa, this area has a high incidence of pine dwarf mistletoe (*Arceuthobium vaginatum* subsp. *cryptopodum*) infestation.

The treated stand was harvested in 1989 under a seed-tree cut prescription, which retained (where possible) five to 10 mature, uninfected or lightly infected pine seed trees/acre. Because of the extensive mistletoe infestation, the prescription originally called for a “slashing” of the entire existing understory of small poles and saplings. However, because of visual and wildlife concerns raised following earlier treatments on Jarita Mesa, the slashing was changed to a “sanitation-thinning” prescription. The new prescription called for thinning overstocked groups of poles and saplings to an average 14 foot spacing. Lightly infected trees could be retained where they were the best available crop trees.

The untreated area was a fairly dense, multistoried stand of mature pine sawtimber, poles, and saplings. The most recent entry was around 1970, when a light selective harvest and pre-commercial thinning were conducted. Stand structure and infection levels were probably similar in both areas prior to the Little Rock sale and follow-up treatment in 1989/91.

Methods

The plots were set up in August 1992, approximately one year after the understory treatment. They were located in easily accessible areas that had relatively uniform stand structures. (Note that although structures were relatively uniform, at least compared to some portions of these stands, both plots did contain considerable heterogeneity because of multi-age cohorts and irregular stem distributions.) Square plots were established from a center point using a staff compass and tape. Dimensions were selected to provide a similar number of trees on each plot. All live trees over 4.5’ tall were tagged, measured for dbh, and rated for dwarf mistletoe infection using the standard 6-class system (Hawksworth 1977). A subsample of these trees was also measured for age, radial growth, and height; however, these attributes have not been used in the current analyses.

Remeasurements were made during the summers of 1997 and 2002, five and 10 years after plot establishment. During remeasurements, dead trees were examined to determine cause(s) of mortality. Ingrowth (i.e., untagged regeneration at least 4.5’ tall) was tagged, measured, and rated during the 10-year remeasurement in 2002. The plots were also re-visited in the summer of 2000 to assess mortality because of the severe drought that year; dwarf mistletoe ratings (DMRs) were again made at that time.

Only data from surviving trees were used in analyses of tree growth and dwarf mistletoe spread and intensification. Except where noted, ingrowth was also not included in these analyses. Plot dwarf mistletoe ratings (DMRs) were calculated as the average rating of all live ponderosa pine (including uninfected trees); the few trees of other species are excluded. In some analyses (as indicated), dwarf mistletoe information is based on trees greater than 4" dbh (in 1992) only, in order to factor out the inherent variability among the smaller trees.

Results and Discussion

Initial plot attributes are summarized in Table 1. All sample trees were ponderosa pine, except for seven white fir saplings and one Rocky Mt. juniper on the treated plot, and a single Douglas-fir sapling on the untreated plot.

Table 1. Plots at time of establishment, 1992.

Plot	Size (ac.)	# Live Trees	Trees/ Acre	BA (ft^2/ac.)	Avg. DBH	% Pine Infected	Plot DMR
Treated	1.250	139	111	33.5	6.7	44.3	1.04
Untreated	0.625	135	216	95.5	7.5	62.7	2.08

Figure 1 displays the distribution of trees by DMR class on each plot in 1992. The differences between treated and untreated areas provide some indication of the effectiveness of this particular treatment in reducing dwarf mistletoe severity. The presence of some moderately infected trees – even a few heavily infected ones – on the treated plot probably indicates some discrepancy between the written prescription and the actual implementation. On the other hand, some increase in visible infection would have been likely in the year following treatment, prior to plot establishment.

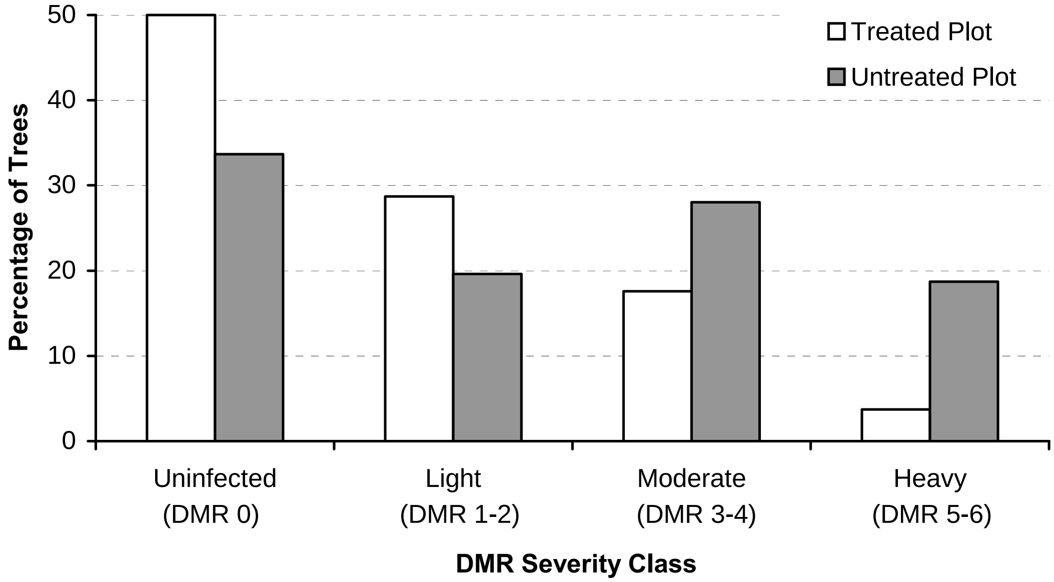

Figure 1. Distribution of trees by dwarf mistletoe severity class (DMR) in 1992 (Includes trees ≥ 4" DBH only).

Intensification of dwarf mistletoe on infected trees (Figure 2).

On both plots, the dwarf mistletoe ratings (DMRs) increased on the majority of infected trees over the 10-year period. However, the overall rate of intensification was considerably greater on the thinned plot. More than 40 percent of the infected trees on the thinned plot had increases of two or more, while less than 10 percent of those on the unthinned plot increased this much. Similarly, DMRs remained the same (or decreased) on more of the infected trees on the unthinned plot than on the thinned plot (about 30 percent vs. less than 10 percent).

The greater intensification of mistletoe on the thinned plot appeared to be mostly a result of a more rapid development of latent infections. Latent infections are more likely to develop as trees become more vigorous following thinning. An additional factor is that dwarf mistletoe generally intensifies more slowly on larger trees than on smaller ones (Hawksworth and Geils 1990). Although the average tree size was similar on the two plots (Table 1), the untreated plot had more large mature trees.

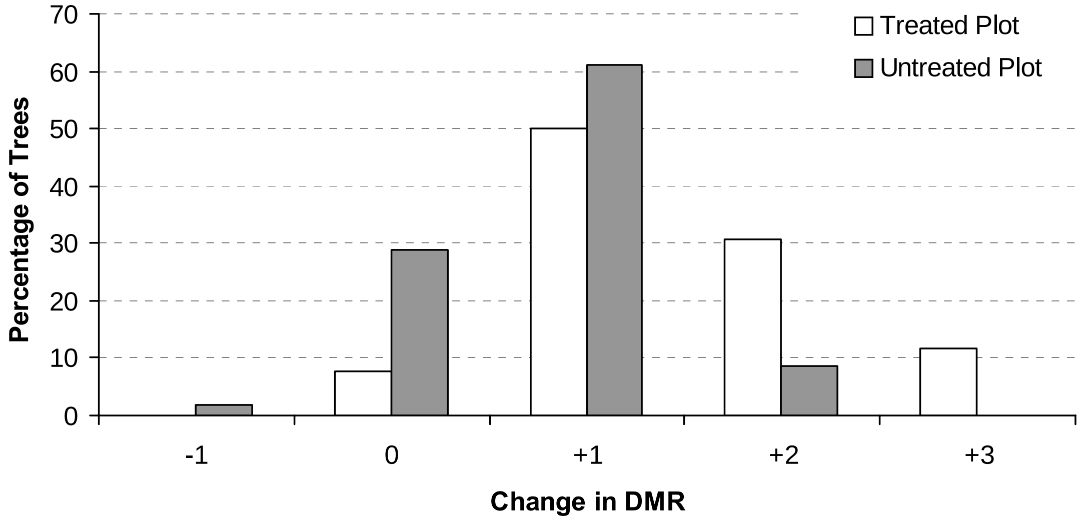

Figure 2. Changes in dwarf mistletoe ratings from 1992 to 2002 on infected trees (includes only trees ≥ 4" DBH with ratings of 1-5 in 1992).

Spread of dwarf mistletoe to uninfected trees

The proportion of the uninfected trees that became infected over the 10-year period was about the same on both plots: 39 percent vs. 37 percent for the treated and untreated areas, respectively. As might be expected, mistletoe spread more quickly into the smaller trees than the larger ones: overall, 62 percent of uninfected trees less than 4” dbh (in 1992) were infected by 2002, while only 30 percent of those greater than 4” became infected. Given the slow development of dwarf mistletoe infection, probably at least half the trees that became visibly infected between 1992 and 2002 actually had latent (established, but not yet visible) infection in 1992.

The percentage of all sample trees (excluding ingrowth) with visible infection increased from 44 to 66 percent on the treated plot, and from 63 to 72 percent on the untreated plot, over the 10-year period. The lower rate of increase on the untreated plot was mostly due to the death of several infected trees on that plot.

Tree mortality

The mortality rate over the 10-year period was about four times higher on the untreated plot than the treated plot (Table 2).

Table 2. Number of trees that died and percent mortality.

Plot	1992-1997	1997-2002	% Mortality 92-02
Treated	4	0	3.1%
Untreated	6	10	11.9%

Mortality on the untreated plot was strongly correlated with dwarf mistletoe infection; all 12 of the trees ≥ 4” dbh that died were heavily infected (DMR 5 or 6). Most of dead trees on this plot also had at least some sign of bark beetle (primarily *Ips* sp.) attack. Drought undoubtedly influenced mortality on this plot. Mortality on the treated plot was primarily associated with mechanical or abiotic factors: two trees had received serious damage from the harvest or thinning operation and the other two blew over. It is significant that no mortality occurred in the treated area during 1997-2002, one of the driest 5 year periods on record.

Changes in plot DMR’s

Plot DMR’s increased at a considerably higher rate on the treated plot than on the untreated plot (Figure 3). This was a function of both the greater intensification of mistletoe on infected trees on treated plot and the death of several heavily infected trees on the untreated plot. Mortality actually resulted in a slight decrease in DMR on the untreated plot between 2000 and 2002.

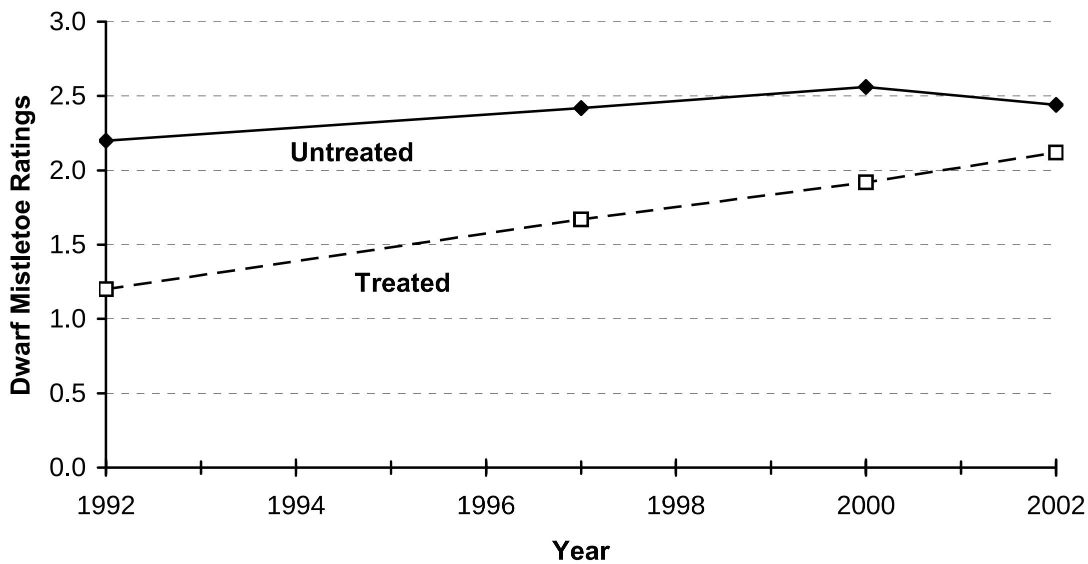

Figure 3. Changes in average dwarf mistletoe ratings (includes only trees ≥ 4" DBH in 1992).

For trees ≥ 4” dbh only, plot DMRs increased by 0.24 (from 2.20 to 2.44) on the untreated plot, and by 0.92 (from 1.20 to 2.12) on the treated plot (Figure 3). Somewhat greater increases result when the smaller trees are included in these calculations: 0.39 (from 2.08 to 2.47) on the untreated plot, and 0.97 (from 1.04 to 2.01) on the treated plot. This reflects a more rapid spread and intensification of mistletoe in the smaller trees, especially on the untreated plot.

Tree and stand growth

Diameter growth was much greater on the treated (thinned) plot than the untreated plot, over both five year periods (Figure 4). Growth on both plots was much reduced in the second five year period, undoubtedly a function of drought. This reduction was proportionally greater on the unthinned plot, where trees were under more competition. Average diameter growth over the entire 10-year period was 2.2 inches on the treated plot and 1.0 inch on the untreated plot.

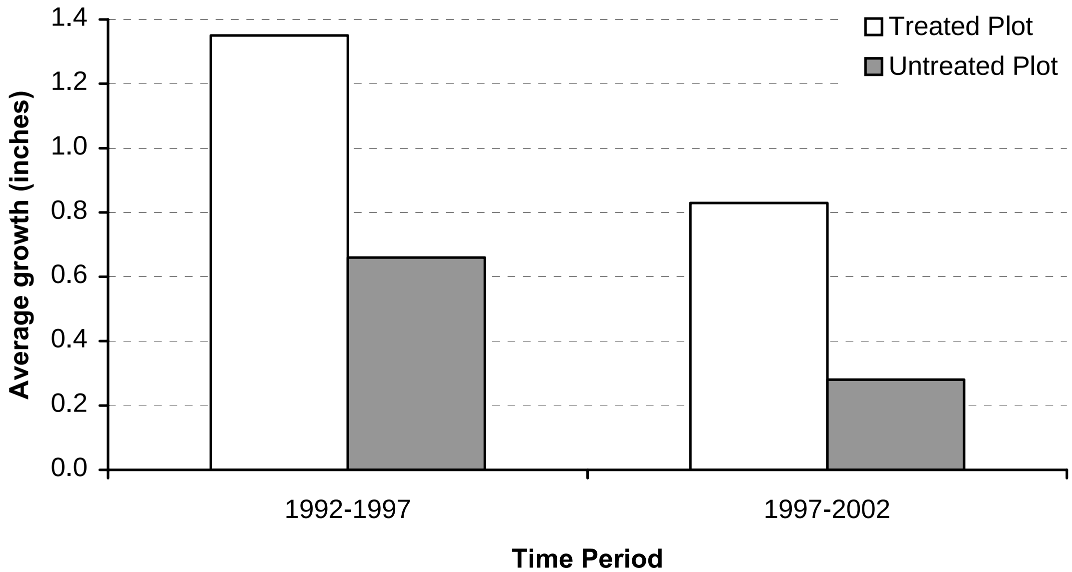

Figure 4. Average diameter growth, 1992 - 2002.

The average dbh increased from 6.7 to 8.9 inches (2.2 inches) on the treated plot, and from 7.5 to 8.8 inches (1.3 inches) on the untreated plot, over the 10-year period. (Note the increase in average dbh is greater than the average growth on the untreated plot because of mortality. The 16 trees that died on this plot were smaller on average (average 1992 dbh = 5.5 inches) than the surviving trees, resulting in a larger average size among surviving trees).

Basal area increased from 33.5 to 53.0 ft^2/acre on the treated plot and from 95.5 to 107.0 ft^2/acre on the untreated plot over the 10-year period.

The effects of dwarf mistletoe on tree growth are displayed in Figure 5, and are consistent with those reported previously (Korstian and Long 1922, Hawksworth 1961, Hawksworth and Wiens 1996, Geils et.al. 2002). Little or no reduction occurred for DMR classes 1 to 3, slight reduction for DMR class 4, and increasingly more reduction for DMR classes 5 and 6. These effects, previously well documented, are displayed here primarily to illustrate that density can have a greater influence on stand growth than dwarf mistletoe infection. Note that the few DMR 6 trees in this sample died before 2002 and that several of the DMR 5 trees had become 6’s by 2002.

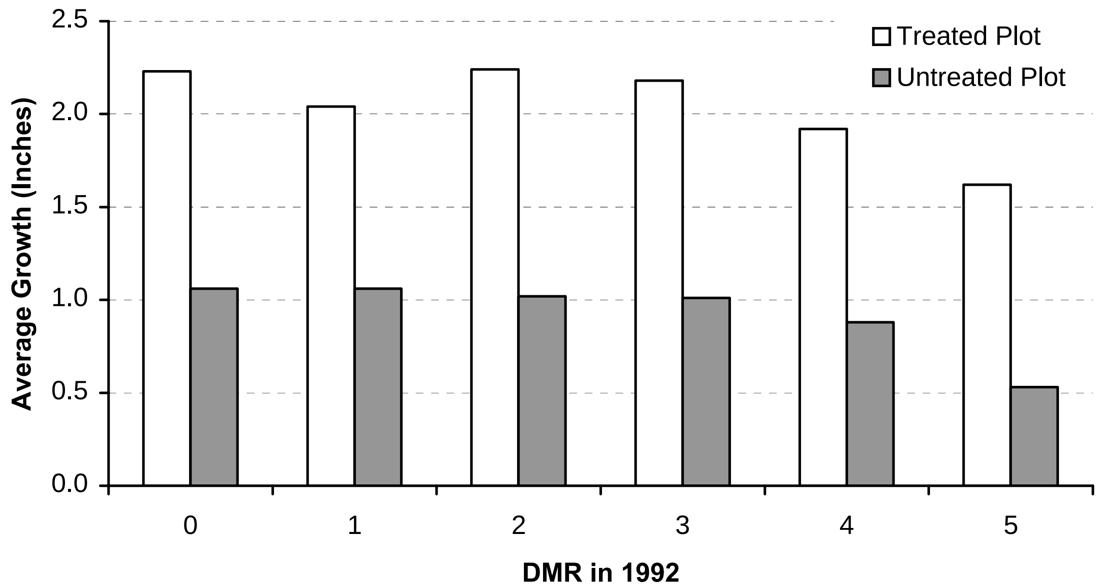

Figure 5. Average growth by DMR class, 1992 - 2002.

Ingrowth

Pine regeneration was more abundant and had much less infection on the treated plot than on the untreated plot (Table 3). Ingrowth also included one Douglas-fir and one white fir on the treated plot, and two white fir on the untreated plot.

Table 3. Ingrowth: additional trees ≥ 4.5' tall in 2002.

Plot	Size (acres)	# Ponderosa Pine	% Pine Infected
Treated	1.250	104	16.3
Untreated	0.625	25	56.0

Summary and Conclusions

Observations in the Southwest have long suggested that dwarf mistletoe can intensify more rapidly in thinned than in unthinned areas (Korstian and Long 1922, Hawksworth 1961), but relatively little quantitative information has been available on these differences. Although these plots on Jarita Mesa cannot provide a definitive measure of these differences – every stand is different – they provide a rough estimate of dwarf mistletoe behavior in these (and presumably similar) stands. Over this 10-year period, it appears that the disease has intensified more slowly in the untreated area, and somewhat more rapidly in the treated area, than current models would have predicted.

Was the treatment monitored here successful? Some argument could be made that it was not, because of the amount of dwarf mistletoe remaining, and its relatively rapid intensification. On the other hand, much higher growth rates and lower mortality rates are indications of success, especially in a timber emphasis area like Jarita Mesa.

Success in any sanitation-thinning depends on good marking/selection of crop trees. Other important factors are site quality and the level of infection prior to treatment (Hawksworth 1977). Treatments tend to be most successful (i.e. provide the greatest benefits) on good sites with relatively light dwarf mistletoe infection.

Results from these plots demonstrate some of the difficulties inherent in dwarf mistletoe control efforts, and support the idea that infested stands should not necessarily receive higher priority for treatment (i.e. thinning) than uninfested stands (Conklin 2000). On the other hand, they demonstrate that benefits that can be derived from prudent thinning of some infested stands. In addition to those measured, benefits would presumably include some reduction in fire hazard.

In evaluating the results of the sanitation-thinning treatment, comparisons are also needed with earlier seed-tree cuts on Jarita Mesa that involved "slashing" of existing understories. These earlier (1984 – 1988) treatments became very controversial; later, additional expense was incurred in replanting these areas. Surveys conducted in 1996 found that significant proportions (14 to 47 percent) of the seed trees in these stands were infected (USDA Forest Service, 1996). Infection rates in the young regeneration are still very low, but the disease will gradually spread and intensify as these stands develop. To date, final removal cuts have not been implemented in any of these stands.

From strictly a disease control standpoint, better results have probably been achieved in stands where the understories were slashed (even without final removal cuts). However, these results were achieved with a considerable sacrifice of accumulated growth, at least in many areas. The young regeneration (both planted and natural) in these stands will require 80 to 100 years before it can provide a commercial harvest. Stands where the understories were sanitation-thinned should be available for another commercial harvest within 20 to 40 years. From an economic standpoint, this is very significant, especially on a sustained-yield unit. In the long run, the use of both of these prescriptions in different stands will have resulted in more diverse forest conditions on Jarita Mesa.

Should efforts have been made to cut all infected trees during the treatment? This would have undoubtedly resulted in a lower post-treatment stand DMR, and probably also a somewhat lower rate of intensification. However it, too, would have involved a significant sacrifice of accumulated growth, and, because of latent infections, would have still retained a considerable amount of mistletoe. Within infested areas, lightly infected dominant and codominant trees are usually better choices for retention than intermediate or suppressed trees without visible infection (Even occasional moderately infected trees can serve as acceptable crop trees if they can be harvested within about 20 years).

Over time, the greatest impact of dwarf mistletoe is probably its effect on regeneration. Infected seedlings and saplings rarely become large trees. In an effort to prevent or delay infection of the young regeneration in the treated area, the El Rito District conducted a follow-up treatment in about 300 acres of the old Little Rock sale area in 1998 and 1999 (The plot itself and a one-chain buffer around it were excluded). This was primarily a "spot treatment" that removed scattered infected saplings and small poles located within 30 to 40 feet of groups of young regeneration. This treatment was relatively inexpensive, generated only minor amounts of slash, and maintained (and improved) the pleasing visual quality of these stands. This treatment is expected to increase long-term productivity and help insure sustainability in these areas.

We plan to maintain and monitor these plots on Jarita Mesa for at least 10 more years. These and other similar plots in New Mexico (and other parts of the West) will help us better understand and quantify dwarf mistletoe spread and intensification, which should ultimately lead to better management of this disease.

Acknowledgements

Appreciation is expressed to Len Scuffham, Carson National Forest Silviculturist, for his interest in and support of this monitoring effort. Thanks also to Ponciano Madrid, El Rito Ranger District, for insuring the integrity of the plots during recent thinning activities in these stands. Daniel Ryerson, Forest Heath Protection, is acknowledged for assistance with data analyses and graphics.

Literature Cited

Conklin, D.A. 2000. Dwarf mistletoe management and forest health in the Southwest. USDA Forest Service SW Region report. 30 p.

Geils, B.W.; Cibrian Tovar, J.; Moody, B., tech. coords. 2002. Mistletoes of North American conifers. USDA Forest Service Gen. Tech. Rep. RMRS-GTR-98. 123p.

Hawksworth, F.G. 1961. Dwarf mistletoe of ponderosa pine in the Southwest. USDA Forest Service Tech. Bul. No. 1246. 112 p.

Hawksworth, F.G. 1977. The 6-class dwarf mistletoe rating system. USDA Forest Service Gen. Tech. Rep. RM-48. 7 p.

Hawksworth, F.G. 1978. Intermediate cuttings in mistletoe-infested lodgepole pine and Southwestern ponderosa pine stands. In: Proceedings of the Symposium on dwarf mistletoe control through forest management, USDA Forest Service Gen. Tech. Rep. PSW-31, pp. 86-92.

Hawksworth , F.G; Geils, B.W. 1990. How long do mistletoe-infected ponderosa pines live? Western Journal of Applied Forestry 5(2): 47-48.

Hawksworth, F.G.; Wiens, D. 1996. Dwarf mistletoes: biology, pathology, and systematics. USDA Forest Service Ag. Handbook 709. 410 p.

Korstian, C.F.; Long, W.H. 1922. The western yellow pine dwarf mistletoe: effect on growth and suggestions for control. U.S. Dept. Agr. Bul. 1112, 35 p.

USDA Forest Service, 1996. Monitoring in the Benji timber sale area, Jarita Mesa. FPM 3420 letter to Carson National Forest Supervisor, August 21, 1996, 3 p.