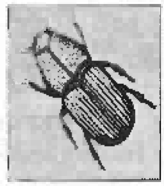
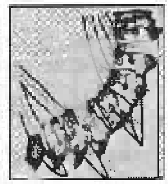
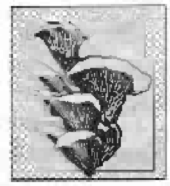
SD 144 .M9 A3 no.97-5
SD
144
.M9
A3
no.97-5

[redacted]

ection


Report 97-5 **December 1997**

PERMANENT PLOTS FOR STUDYING THE SPREAD AND INTENSIFICATION OF LARCH DWARF MISTLETOE AND THE EFFECTS OF THE PARASITE ON GROWTH OF INFECTED WESTERN LARCH ON THE FLATHEAD INDIAN RESERVATION, MONTANA

JUN 2002
Government Depository
Library-Documents
Oregon State
University

Results from the 5-year Re-Measurement

Jane E. Taylor[1], Michael A. Marsden[2]

INTRODUCTION

In 1991, a study was initiated on the Flathead Indian Reservation (IR) in northwestern Montana with the following objectives: (1) to quantify the spread and intensification of larch dwarf mistletoe (*Arceuthobium laricis* (Piper) St. John) in western larch (*Larix occidentalis* Nutt.) with and without overstory removal and with and without precommercial thinning, (2) to quantify the growth effects due to dwarf mistletoe in western larch with and without overstory removal and with and without precommercial thinning, (3) to provide a visual demonstration of the treatment effects on stand growth and development, and (4) to provide data for the validation of the dwarf mistletoe spread and impact model extension of the Forest Vegetation Simulator (Hawksworth et al. 1995). The complete study plan, including a description of sample design, site treatment, plot establishment, and a summary of the baseline data taken at plot establishment, can be found in a previous report (Taylor et al. 1993). The purpose of this report is to detail the results from the measurement of the study plots in 1996, with an emphasis on the increase in dwarf mistletoe infection and the growth of the host trees in the first 5 years of the study.

METHODS

The study site is located in the North Valley Creek Area on the southern end of the Flathead IR in northwestern Montana. The site had been selectively harvested in 1972 and the site preparation following harvest encouraged prolific natural regeneration. Before our study treatments were carried out, the tree component on the site consisted of a mature, predominantly western larch overstory with a heavily stocked understory of western larch, alpine fir, Douglas-fir, lodgepole pine, grand fir, Engelmann spruce, and ponderosa pine saplings (listed in descending order of occurrence). The western larch overstory trees were heavily infected with dwarf mistletoe with most trees showing extensive brooming and receiving a Hawksworth dwarf mistletoe rating (DMR) of 5 or 6 (Hawksworth 1977). There were an average of 37 infected larch overstory trees per acre in the entire study area prior to treatment. The average DMR of all overstory larch was 4.78 (sd=.80) and the average DMR of the infected overstory larch (DMI) was 4.92 (sd=.66).

The study was set up as a split plot design with four replications of two plots, each receiving one of two

[1]*Jane E. Taylor, USDA Forest Service, Forest Health Protection, Northern Region, Missoula, MT 59807*
[2]*Michael A. Marsden, Management Assistance Corp. of America, Coeur d'Alene, ID 83814*

overstory treatments (*(1)* overstory removal, *(2)* no overstory removal). Each plot was divided into two 1/4-acre square subplots, each receiving one of two thinning treatments (*(1)* thinned to a 12- by 12-foot spacing, *(2)* no thinning). Subplots that were neither logged nor thinned were designated as controls.

In 1991, numbered metal tags were attached to understory trees identified as crop trees on all subplots. On the thinned subplots, the crop trees were the residuals following thinning. On the unthinned subplots, crop trees were designated using the same criteria used to select trees on the thinned subplots and they were tagged on a 12- by 12-foot spacing. By tagging similar trees on both the thinned and unthinned subplots, comparable data sets were created for use in future data analysis.

In the 1996 measurement, the following data items were collected for all live understory crop trees: diameter at breast height (d.b.h.), tree height, height to bottom of the live crown (used later to compute live crown ratio), DMR for each crown third (lower, middle, upper), crown class, and the three most damaging agents on the tree (in addition to dwarf mistletoe). Records were noted for trees that had died, and attempts were made to determine cause of death; however, measurements were not taken on dead trees for use in any data analyses of growth and yield or dwarf mistletoe spread and intensification. The overstory trees on the unlogged plots were examined for mortality, but no other data were taken.

All statistical analyses were performed using the statistical program SPSS, version 6.1 (SPSS INC, 1994).

RESULTS AND DISCUSSION

Out of the 1,237 understory trees originally tagged in 1991, 1,186 were re-measured in 1996. Fifty-one trees were recorded as dead or missing. Twenty-eight were subalpine fir, Douglas-fir, and grand fir that had been cut for Christmas trees. Five larch, three Douglas-fir and one ponderosa pine had been killed by *Armillaria ostoyae* (Romagn.) Herink. One larch was dead from suppression effects, seven larch and one spruce were never located, and five larch were dead from unidentified causes. Only four larch were found to have been killed by dwarf mistletoe; in each case the mortality resulted from a girdling stem infection and each killed tree had a DMR=1. No mortality had occurred in the overstory trees.

Analysis of Treatment Effects. ANOVA was used to compare the variables of DMR, DMI, height, and diameter between (*a*) the overall plot treatment of overstory removal *vs.* no overstory removal, and (*b*) the interaction of thinning and overstory treatments. Results indicated that there were no significant differences between any of the treatments for any of the analyzed variables (P=0.05). Plots receiving the unlogged with thinning treatment appear to have a much higher percentage of larch infected than the other three treatments (Table 1). However, ANOVA results indicated that the difference was not statistically significant (P=0.05). Although the above measured variables were not significantly different between treatments, field observations found the dwarf mistletoe plants to be larger and more robust in the overstory removal with thinning treatment. The plants may be responding directly to the greater availability of sunlight, or perhaps they are responding to a tree response that was great enough to benefit the plants while not great enough to significantly effect tree growth.

Dwarf Mistletoe Spread and Intensification 1991-1996. A comparison of infection data between 1991 and 1996 (Table 1) indicates that both incidence and severity of dwarf mistletoe infection increased slightly in the 5-year period. Based on the unweighted means,the percentage of all trees infected increased from 57 to 63 percent, and the percentage of larch infected increased from 73 to 77 percent. The average DMR increased from 0.8 (sd=0.3) to 1.1 (sd=1.1), and the average DMI increased from 1.3 (sd=0.2) to 1.8 (sd=0.9).

OREGON STATE UNIVERSITY, CORVALLIS

SD
144
.M9
A3
no.97-5

Table 1. Number of live trees, percent larch, percent total trees infected, percent larch infected, average dwarf mistletoe rating (DMR), average dwarf mistletoe rating of only infected trees (DMI), average tree height, and average diameter at breast height (d.b.h.) for understory crop trees on each subplot in 1991 and 1996, grouped by treatment.

Treatment	# Trees	% Larch	% Total Infec.	% Larch Infect.	Avg. DMR	Avg. DMI	Avg. Hgt (ft)	Avg. d.b.h. (in)
Logged & Thinned								
1991	352	80	62	78	0.8	1.3	10.3	1.0
1996	331	83	68	79	1.1	1.7	15.7	2.0
Logged & Unthinned								
1991	322	82	57	69	0.8	1.3	11.5	1.1
1996	304	85	58	67	1.0	1.6	15.9	2.5
Unlogged & Thinned								
1991	279	79	60	77	0.9	1.4	12.2	1.1
1996	274	79	71	90	1.4	2.0	16.9	1.9
Unlogged & Unthinned								
1991	284	77	50	67	0.8	1.4	11.9	1.2
1996	277	77	56	70	1.0	1.6	17.5	1.9
Totals								
1991	1,237							
1996	1,186							
Total Means								
1991		80	57	73	0.8	1.3	11.5	1.1
1996		81	63	77	1.1	1.8	16.5	2.1

Infection data were broken down by the number of trees in each DMR class and by the number of trees with infections in each crown-third (lower, middle, upper) (Table 2). This breakdown shows that the majority of infected trees had an infection rating of one or two (as reflected in the low average DMR). However, the percentage of trees in the higher DMR classes has increased slightly in the 5-year period. The two trees receiving a rating of six in 1996 had both lost their tops to a girdling dwarf mistletoe bole infection. Therefore, the high ratings reflected the loss of total crown area, not an intensification of the dwarf mistletoe into the upper crown third. Throughout the study area, infections were still concentrated in the bottom crown-third, but the percentage of trees with infections in the middle-third of the crown almost doubled in the 5-year period, and the percentage with infections in the upper-third increased more than tenfold.

Although the numbers indicate a slight increase in dwarf mistletoe infection in the study area, this information needs to be interpreted with some caution. The general increase in incidence and severity does not simply point out an increase in dwarf mistletoe infection. Some trees did become infected for the first time during the 5-year period, but there are other factors reflected in these calculations: 1) several trees died or were removed over the 5-year period (i.e., calculations were done using 1,237 trees in 1991 and 1,186 trees in 1996), 2) some infections died, resulting in once infected trees becoming "clean," 3) many of the now visible infections could have been latent, meaning the actual infection was there during the 1991 measurement, but symptoms were not visible, and 4) some infections that were recorded in 1996, may have been missed in 1991.

Table 2. Number of infected trees in each dwarf mistletoe rating (DMR) class, and the number of trees with dwarf mistletoe infections in each crown-third, grouped by treatment and summarized to compare 1991 and 1996 results.

	Number of Infected Trees by DMR						# of Trees with Infections in Each Crown-Third		
	1	2	3	4	5	6	Low	Mid	Up
Logged & Thinned (1996)	118	60	41	2	1	0	218	98	4
Logged & Unthinned (1996)	92	48	26	1	1	2	168	77	4
Unlogged & Thinned (1996)	78	61	43	11	0	0	187	117	19
Unlogged & Unthinned (1996)	65	54	16	4	1	0	138	78	5
Total (1996)	353	223	126	18	3	2	711	370	32
Total (1991)	479	169	44	1	0	0	680	198	2
% of Total Number of Infected Trees (1996)	49	31	17	3	0.4	0.3	98	51	4
% of Total Number of Infected Trees (1991)	69	24	6	0.1	0	0	98	29	0.3

Tree Growth 1991-1996. A comparison of average tree height and diameter between 1991 and 1996 showed that the trees grew an average of 5 feet in height and 1 inch in diameter in the 5-year period (Table 3). Mean height and d.b.h. were computed for infected and uninfected trees in 1991 and 1996 (Table 3). The average height and diameter growth rates were similar for infected and uninfected trees, so it appears that dwarf mistletoe is not causing any growth effects at this time. In both years, the infected trees were taller and bigger in diameter than the uninfected trees. Students t-tests (SPSS 1996) showed that the height difference between infected and uninfected trees was statistically significant ($P<0.001$), but the diameter difference was not ($P=.05$). These results may indicate that the taller trees have a greater probability of becoming infected because they are bigger targets for the reception of dwarf mistletoe seeds.

Table 3. Comparison of the average height and d.b.h. for all trees, uninfected trees, and infected trees for 1991 and 1996.

Year	Avg. Hgt. (ft) (all trees)	Avg. Hgt. (ft) (uninfected)	Avg. Hgt. (ft) (infected)	Avg. d.b.h. (in) (all trees)	Avg. d.b.h. (in) (uninfected)	Avg. d.b.h. (in) (infected
1991	11.5	8.7	13.1	1.1	0.8	1.2
1996	16.5	13.1	18.2	2.1	1.7	2.2

We gratefully acknowledge the Confederated Salish and Kootenai tribes for allowing us to use a portion of their land for this study site. We would like to thank the following folks for their assistance in project management, field data collection, and data compilation: Tom Corse, Ken Gibson, Blakey Lockman, Tim McConnell, Terry Reedy, and Dennis Vander Meer. We acknowledge John Schwandt for his review of this paper, and Forest Health Techonology Enterprise Team in Fort Collins, CO for M. Marsden's financial support.

REFERENCES

Hawksworth, F.G. 1977. The 6-class dwarf mistletoe rating system. USDA For. Serv. Gen. Tech. Rept. RM-48. Rocky Mountain Forest and Range Experiment Station. 7p.

Hawksworth, F.G., J.C. Williams-Cipriani, B.B. Eav, B.W. Geils, R.R. Johnson, M.A. Marsden, J.S. Beatty, G.D. Shubert, and D.C.E. Robinson. 1995. Dwarf mistletoe impacty model ing system. User's guide and reference manual. USDA For. Serv. Rept. MAG-95-2. Methods Application Group. Ft. Collins, CO. 120p.

SPSS Inc. 1994. SPSS Professional Statistics 6.1. Chicago. Il.

Taylor, J.E., T. Reedy, and T. Corse. 1993. Permanent plots for studying the spread and intensification of larch dwarf mistletoe and the effects of the parasite on growth of infected western larch on the Flathead Indian Reservation, Montana. USDA For. Ser. Rpt. FPM-93-2. Forest Health Protection, Northern Region, Missoula, MT. 13p.