Mortality and growth of dwarf mistletoe-infected true fir in the Sierra Nevada and the efficacy of thinning for reducing associated losses, 1981 to 2006

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In the Western United States, dwarf mistletoes (*Arceuthobium* spp.) are damaging pathogens of coniferous trees. In managed forests dominated by fir (*Abies* spp.), stands are often re-stocked using understory trees retained during timber harvest, making the effects of dwarf mistletoe infection on small, developing true firs an area of concern. This study examined the effects of dwarf mistletoe on small red (*A. magnifica*) and white (*A. concolor*) firs and the efficacy of thinning for reducing mortality and increasing radial growth. The influences of thinning on dwarf mistletoe infection dynamics over time were also examined. Plots were located in six forests in the Sierra Nevada Mountains: Klamath, Lassen, Stanislaus, Sequoia, and Tahoe National Forests, and the LaTour Demonstration Forest (Fig. 1, Table 1). Tree growth and mistletoe infection intensity were monitored from 1981 to 2001, and mortality from 1981 to 2006. Thinning significantly increased the survival (Figure 2) and radial growth (not shown) of white firs, but not red firs. Over the course of the study, increases in the intensity of dwarf mistletoe infections and spread to initially uninfected trees were greater under thinned than unthinned conditions for both fir species.

Figure 1. Distribution of field plots

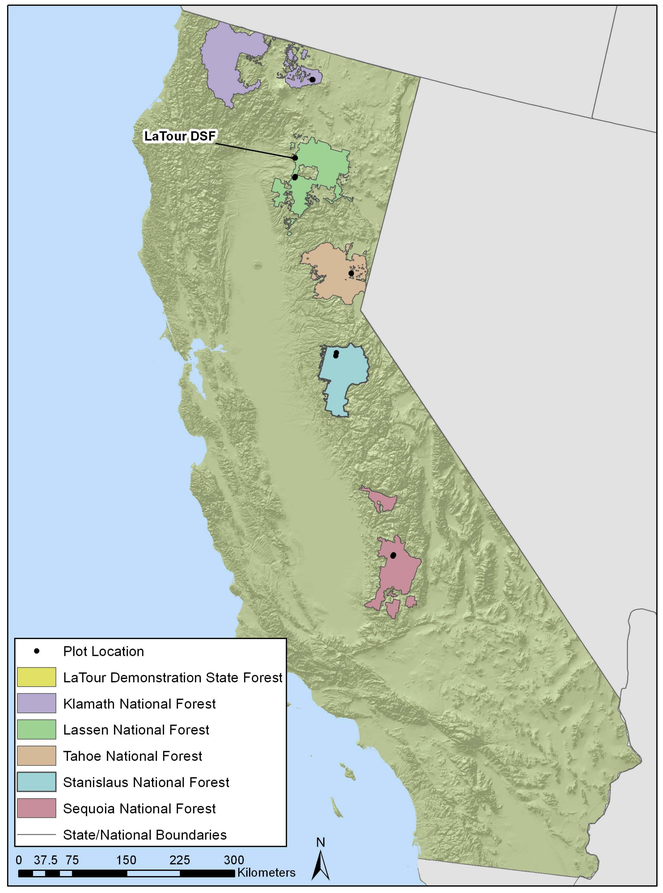


Table 1. Attributes of 5.1-30.5cm dbh fir trees in study strips at the start of the study (1981) and the end of the study by thinned and unthinned treatments, within forests. Forests are divided based on the dominant fir species present . All values are calculated from data on the specified fir species only. Values for the Hawksworth dwarf mistletoe rating (dmr), live crown ratio (lcr), and dbh are mean values across plots, by forest and treatment, including both infected and uninfected trees. Standard errors are reported in parentheses.

			1981				2001				2006
	Forest	Plots	N trees	dmr	lcr	dbh	N trees	dmr	lcr	dbh	% Mortality
White fir	Klamath	9	1274	1.3 (0.3)	4.6 (0.3)	16.5 (1.0)	914	1.8 (0.3)	5.1 (0.2)	26.2 (1.3)	25.7 (2.3)
		3*	342	1.7 (0.5)	4.7 (0.8)	13.7 (0.3)	165	1.8 (0.5)	3.9 (0.1)	21.6 (0.5)	39 (11.7)
Red fir	Lassen NF	3	1078	1.8 (0.9)	5.6 (0)	15.2 (2.0)	833	2.1 (1.1)	5.4 (0.5)	24.3 (1.3)	14.5 (5.1)
		2*	339	2.1 (2.1)	5.4 (1.2)	15.7 (3.3)	222	1.6 (1.3)	4.7 (0.2)	24.6 (0.6)	13 (2.3)
	LaTour	4	319	1.8 (1)	4.7 (0.4)	16.5 (1.5)	213	1.7 (1.1)	4.7 (0.6)	26.7 (0.3)	25.2 (10.9)
		2*	205	4 (0.3)	4.2 (0.3)	13.2 (0.8)	101	3.2	4.6	21.1	31.1 (24.2)
	Sequoia	3	269	1.8 (0.6)	6.1 (0.1)	13.0 (0.8)	218	2.1 (0.1)	6.1 (0.2)	24.1 (1.8)	18.5 (9.2)
	Stanislaus	1	252	2.5	6.6	14.5	155	2.9	7.0	29.5	38.1
		1*	49	4.0	4.7	15.2	27	2.4	4.9	25.9	44.9
	Tahoe	3	386	1.4 (0.8)	4.3 (0.3)	16.5 (0.3)	288	2.2 (0.7)	5.2 (0.3)	25.4 (1.3)	25.7 (5.9)
		1*	152	0.7	4.9	17.5	120	1.1	4.6	23.1	21.1
White fir	Klamath	9	1274	1.3 (0.3)	4.6 (0.3)	16.5 (1.0)	914	1.8 (0.3)	5.1 (0.2)	26.2 (1.3)	25.7 (2.3)
		3*	342	1.7 (0.5)	4.7 (0.8)	13.7 (0.3)	165	1.8 (0.5)	3.9 (0.1)	21.6 (0.5)	39 (11.7)

*Unthinned plots

Figure 2. Survival probability curves over the course of the study (1981-2006)

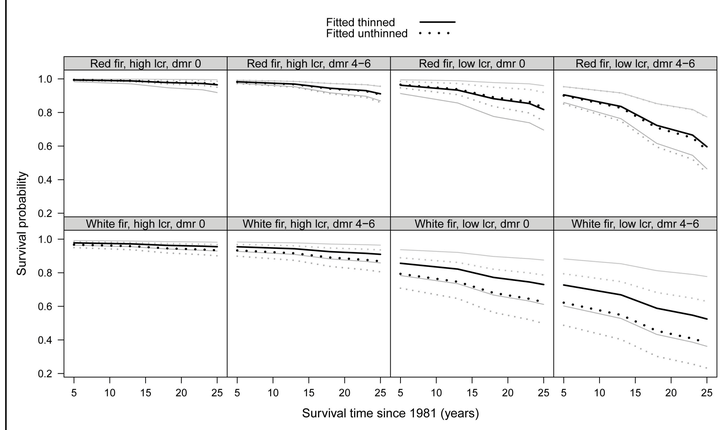
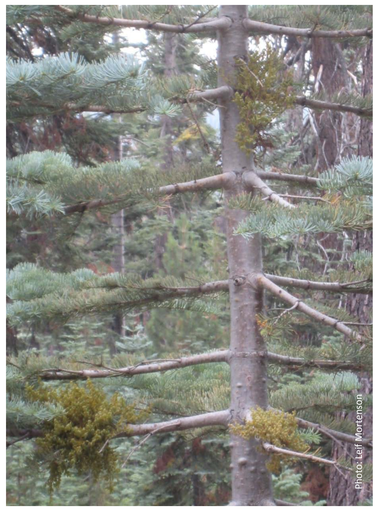


Figure 2. Survival probability curves over the course of the study (1981-2006) estimated from Cox Proportional Hazard survival models for white and red fir. Based on exploratory analyses, dwarf mistletoe infection ratings were grouped into three classes: no infection (dmr 0), low infection (dmr 1 to 3), and high infection (dmr 4 to 6) in 1981. Changes in predicted survival probability are shown for trees with high (lcr = 9) and low (lcr = 2) 1981 live crown ratios, growing under thinned and unthinned treatments. All survival probabilities were calculated based on an initially large dbh (30.48cm) in 1981. Grey solid and dashed lines represent the upper and lower 95% confidence boundaries under thinned and unthinned treatments, respectively.

Conclusion:

This study shows that pre-commercial thinning has only minor and mixed benefits for tree survival and growth in dwarf mistletoe-infected fir stands, and indicates that losses associated with dwarf mistletoe infection may be minor over harvesting intervals frequently applied to managed stands, and so may not warrant expensive control measures.



PTIPS Data Analysis Project

Background and objectives

Between 1990 and 2006, Forest Health Protection (FHP) invested $6.19 million in the Pest Trend Impact Plots Project (PTIPS). A series of 135 permanent plot sets were established nationwide to provide data for validation, calibration and development of pest models, improvement of pest damage estimates, and provide information for forest health monitoring.

The purpose of this project is to collect, organize, make available, analyze and publish Pest Trend and Impact Plot data in order to communicate pest trends in the USA to all interested parties. A website, data repository, data summaries and more are under development.

The challenges of working with older data sets.

While working on this dwarf mistletoe analysis we encountered many of the difficulties of working with old datasets. The project was set up in the late 1970s, since then the taxonomy of mistletoes changed and we needed to consider white fir dwarf mistletoe and red fir dwarf mistletoe separately yet the original project design assumed one species. The dataset did not include measurements on overstory trees and other aspects of stand structure and composition. Some of the data was lost so parts of the experiment could not be analyzed.

Call for data

We have obtained 23 out of 135 PTIPS datasets. We are still actively seeking data from pest trend plots and welcome continued contributions to this project. All future materials will be incorporated into the project database and website to both preserve and make accessible the findings of this extensive research. If you have materials to contribute, please contact Dave Rizzo (dmrizzo@ucdavis.edu) or Susan Frankel (sfrankel@fs.fed.us).

FY 2012 Presentations and Publications:

Frankel, S.J.; Rizzo, D.M.; Mehl, H.K. 2011. Communicating Forest-Pest Impact Trends 2011 Western International Forest Disease Work Conference. October 11, Leavenworth, WA.

Mehl, H. K.; Frankel, S. J.; Mori, S.; Rizzo, D. M. The influence of dwarf mistletoe infection on mortality and growth of red (*Abies magnifica*, var. *magnifica*) and white (*A. concolor*) firs in Sierra Nevada forests and the efficacy of thinning for reducing parasite-associated losses. Forest Pathology (in review)

Acknowledgements:

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