True Fir Dwarf Mistletoe in the Sierras: Long-Term Growth and Mortality Trends

Heather Mehl[1], Sylvia Mori[2], Susan Frankel[2] & David Rizzo[1]

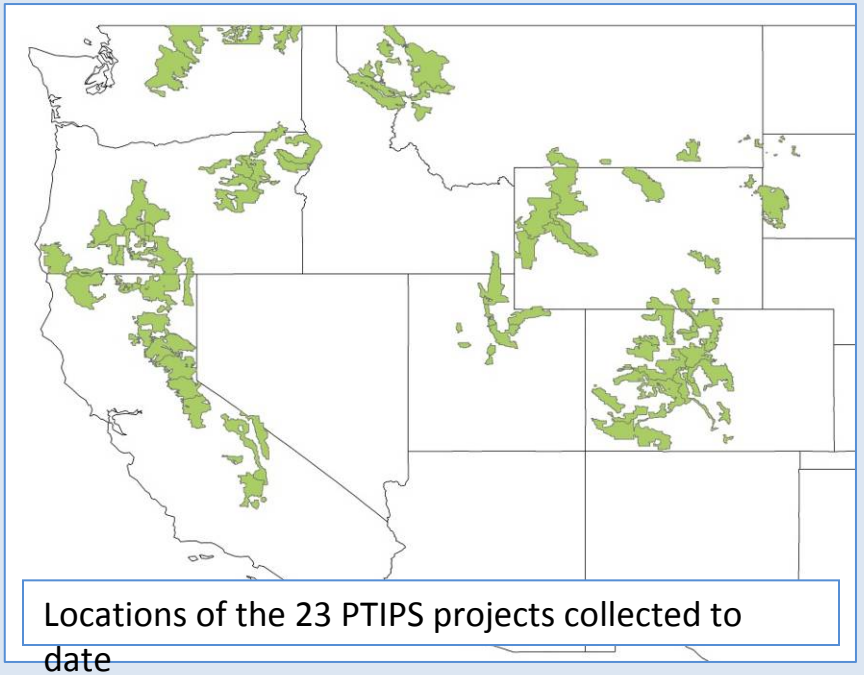
[1] Department of Plant Pathology, University of California, Davis, CA

[2] USDA Forest Service, Pacific Southwest Research Station, Albany, CA

Photo: Terry W. Henkel

Pest Trend Impact Plots (PTIPS)

- Forest Health Protection invested $6.19 million between 1990-2006
- 135 plot networks nationwide
- Project to collect, organize and analyze PTIPS data
  - Create and maintain a data repository
  - Analyze and repot basic pest trend summaries
  - In-depth analysis and publication



Locations of the 23 PTIPS projects collected to date

- Data from 23 projects have been compiled to date

- The study I am presenting today is the first detailed analysis of a PTIPS dataset recovered as a part of this project

“The control of dwarf mistletoe-caused losses young true fir stands by thinning- A demonstration control project”

Objective:

- “To demonstrate the efficacy of standard pre-commercial thinning and the consequent release of young red and white firs to reduce dwarf-mistletoe caused losses.”

Motivation:

- Advanced fir regeneration used for stand restocking
- Regeneration frequently infected with dwarf mistletoe

Can thinning mitigate the negative impacts of dwarf mistletoe infection?

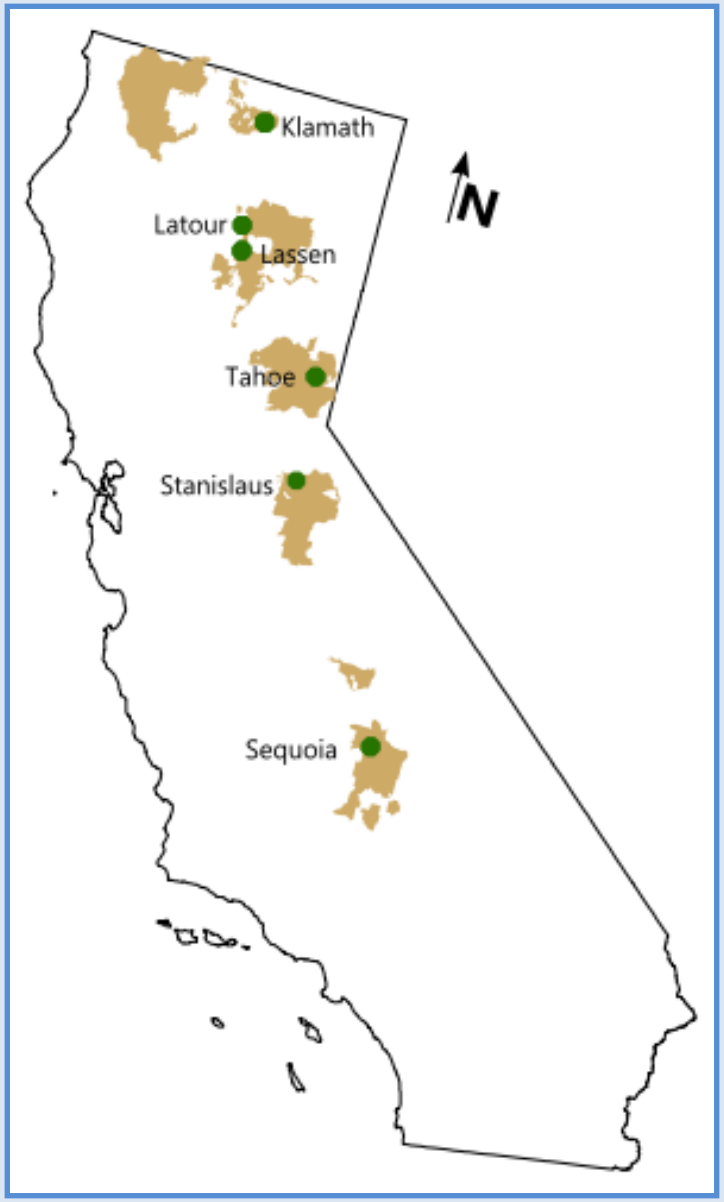
Previous research :

- Young fir with full crowns respond well to release even when infected (Scharpf, 1979)
- Vertical growth can reduce infection severity (Parmeter & Scharpf, 1976)

Stand selection 1978-1979

- Stand criteria
  - 50% red or white fir
  - Fir dwarf mistletoe present
  - Over-stocked (in need of thinning)
  - No residual overstory trees

- Plots established in six forests
  - Klamath National Forest
  - Latour Demonstration Forest
  - Lassen National Forest
  - Tahoe National Forest
  - Stanislaus National Forest
  - Sequoia National Forest



Thinning treatments 1979-1980

- Thinned from below
- Average spacing of 12 feet (3.7m)
- Left all conifers greater than 8 inches DBH (20.3cm)
- Infected trees were selected first for removal

- Surveyor notes indicated that residual overstory trees were present on many of the plots

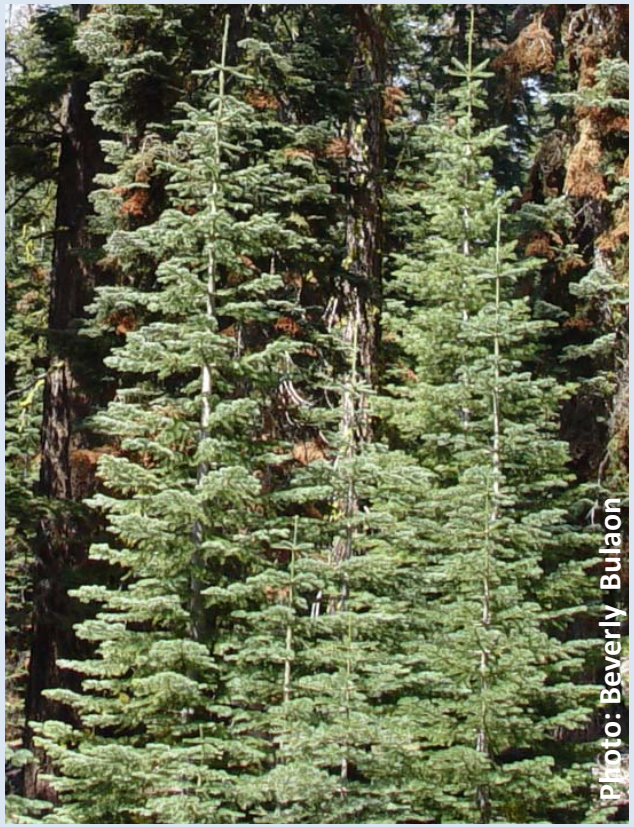
23 thinned and 9 unthinned plots across all forests

Data collection: 1981, 1990, 1995, 2001, 2004 & 2006

- Data only recorded for red and white firs with a DBH of 2-12” (5.1-30.5cm) in 1981

- 20 years (1981-2001)
  - Growth (DBH)
  - Hawksworth dwarf mistletoe rating (DMR)
  - Live crown ratio (LCR)

- 25 years (1981-2006)
  - Mortality



Questions addressed:

Mortality:

- How do dwarf mistletoe infection and tree health impact tree survival?
- Does thinning increase tree survival?

Radial growth:

- How do dwarf mistletoe infection and tree health impact radial growth?
- Does thinning increase radial growth?

Dwarf mistletoe dynamics:

- Does thinning affect changes in infection frequency and/or severity in a stand over time?

Mortality: analysis

- Objective:

  Predict the probability of mortality based on:

  - Dwarf mistletoe rating (DMR)
  - Live crown ratio (LCR)
  - Tree size (DBH)
  - Treatment (thinned or unthinned)

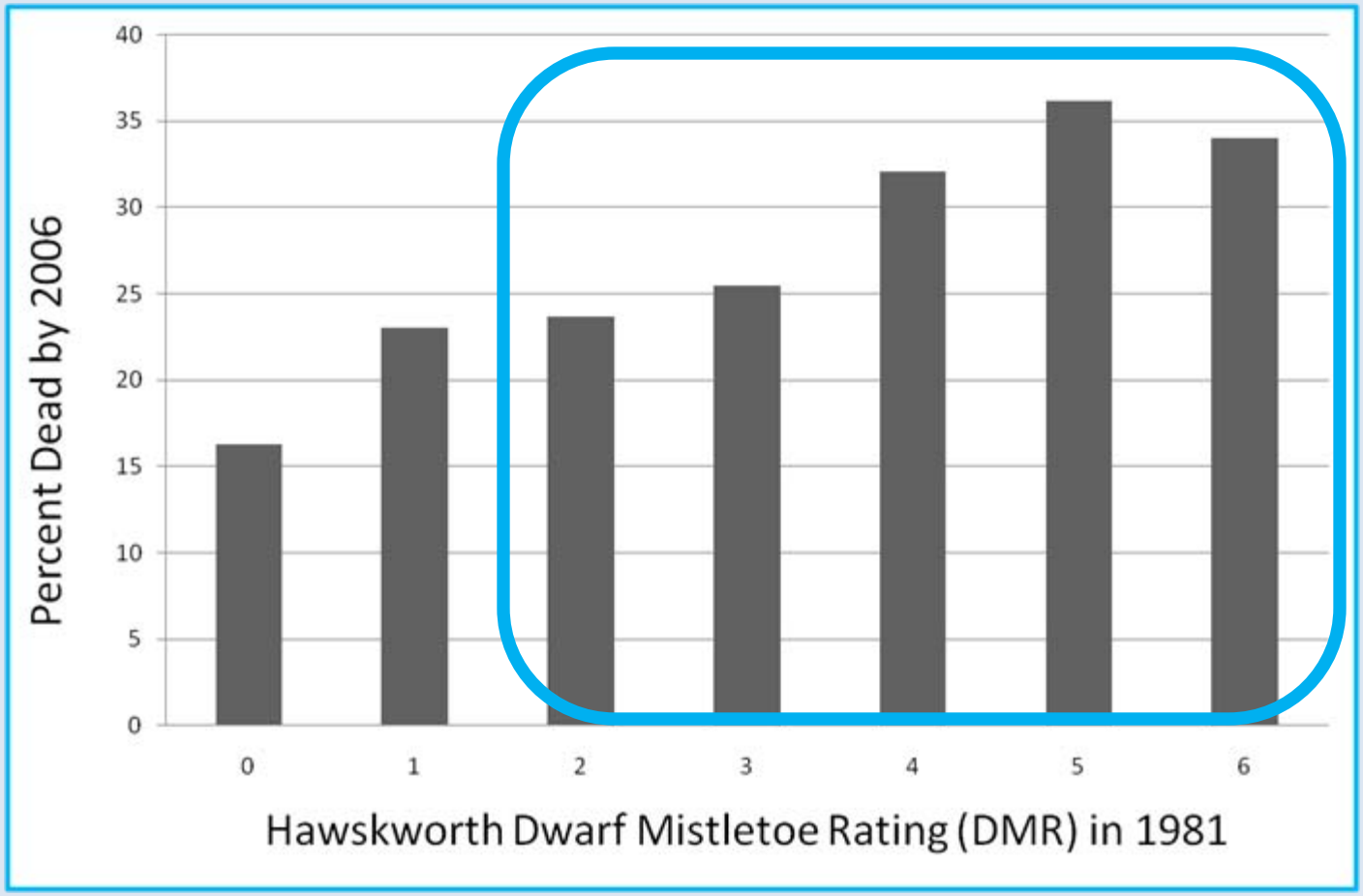
- Regression model: Survival analysis

  Cox proportional hazard semi-parametric model

  - Determines the contribution of multiple tree health characteristics to mortality risk
  - Requires detailed long-term survival data

Mortality: results

Of the 5,111 trees alive in 1981, 1,158 (22.7%) died by 2006



Infected: 28.4%

Uninfected: 16.3%

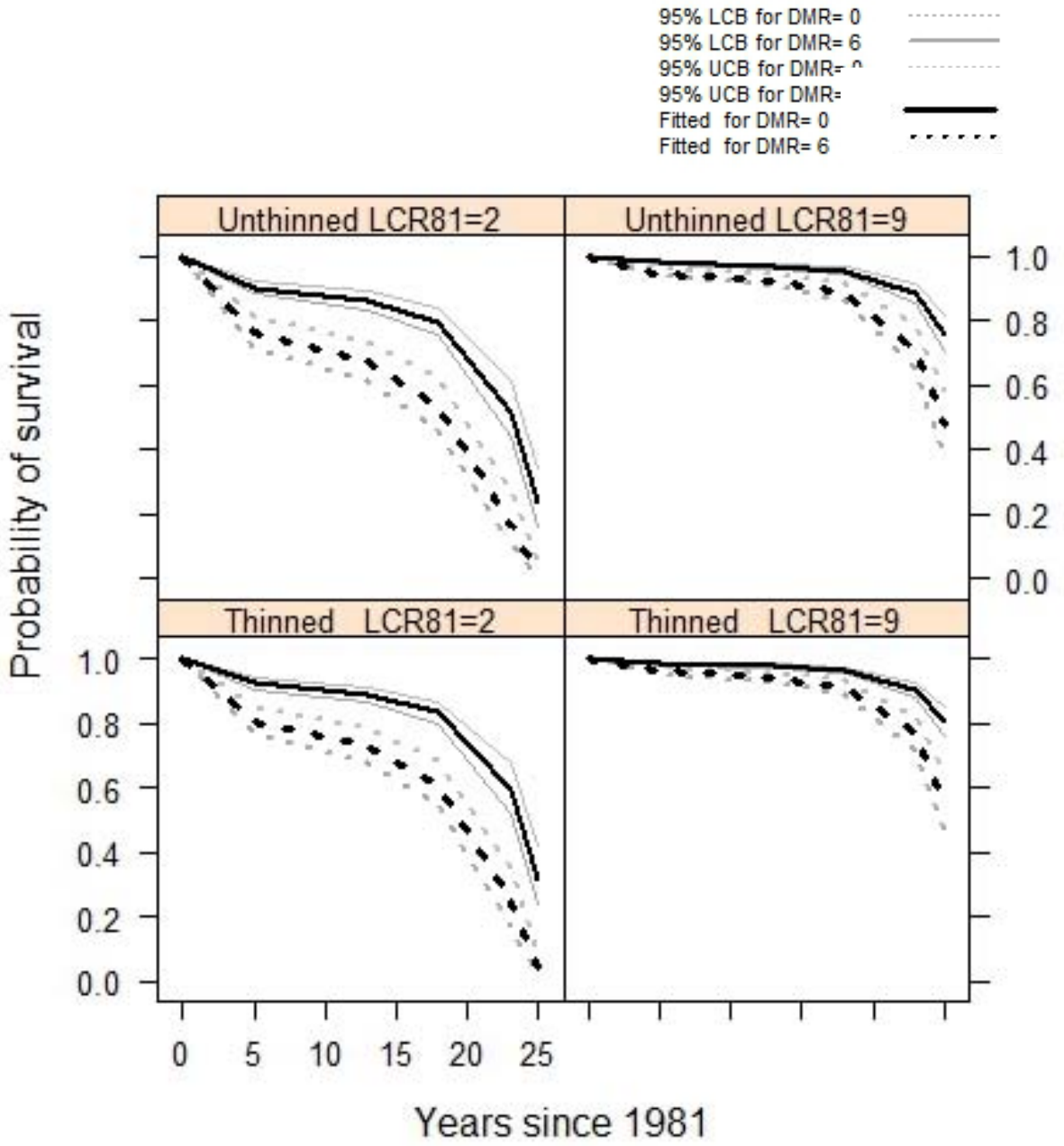
Trees with initial dwarf mistletoe infection ratings of 2 or greater were significantly more likely to die than initially uninfected trees

Survival analysis results

All tree health characteristics examined significantly influenced the probability of survival

Dwarf mistletoe:

- Decreasing survival with increasing infection



For a tree with an initial DBH of 30 cm (11.8 in)

Survival analysis results

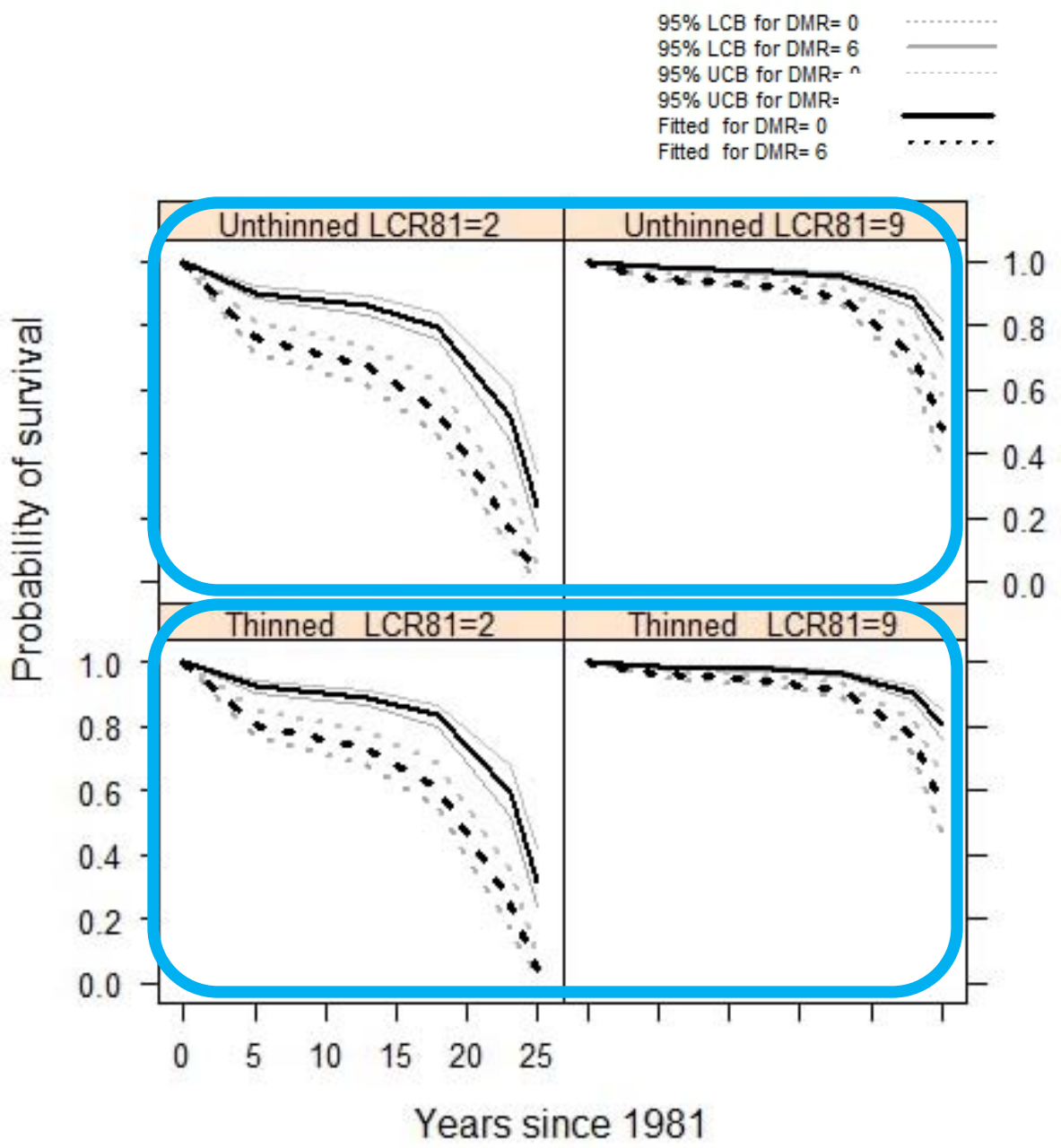
All tree health characteristics examined significantly influenced the probability of survival

Live crown ratio:

Increasing survival with greater living crown

Initial DBH:

Increasing survival with greater size



For a tree with an initial DBH of 30 cm (11.8 in)

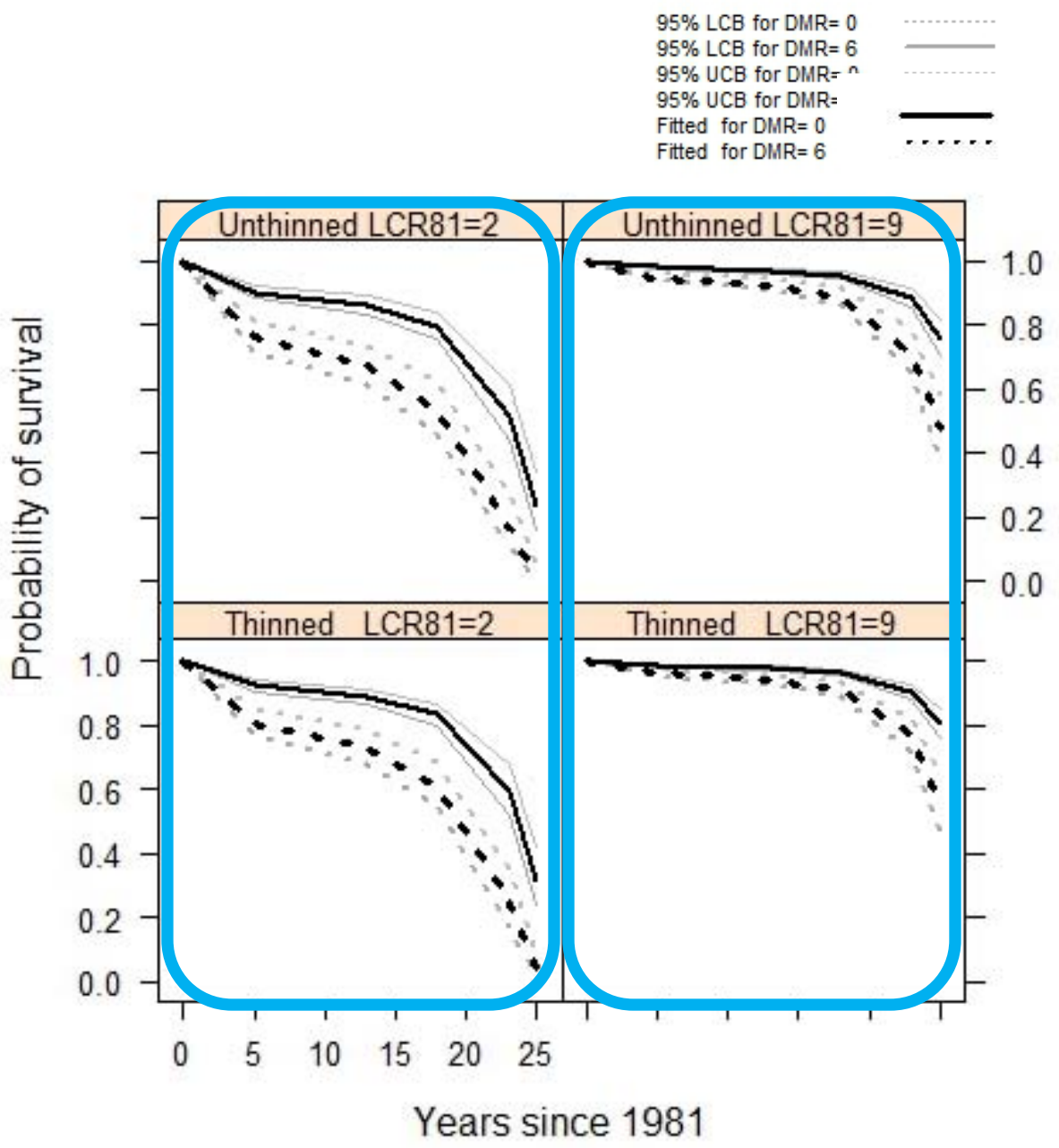
Survival analysis results

All tree health characteristics examined significantly influenced the probability of survival

Thinning:

Increasing survival with thinning in the overall analysis

No effect on survival at the individual forest level



For a tree with an initial DBH of 30 cm (11.8 in)

Radial growth: analysis

- Objective:

  Estimate radial growth rate based on:

  - Dwarf mistletoe rating (DMR)
  - Live crown ratio (LCR)
  - Tree size (DBH)
  - Treatment (thinned or unthinned)

- Regression model: Mixed general linear model

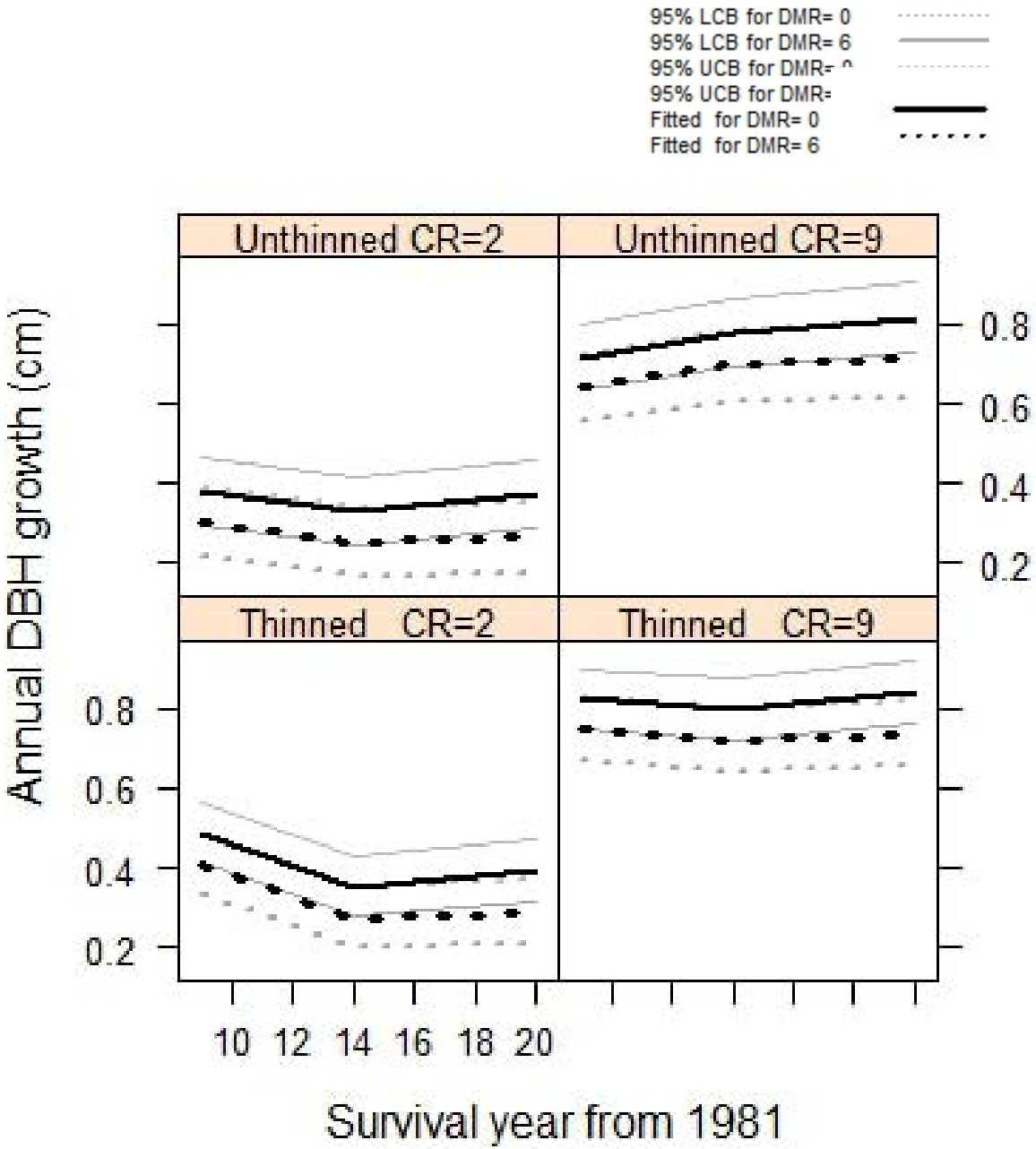
- Response: Annual Growth Rate $(DBH_t - DBH_{t-1})/ (Year_t - Year_{t-1})$

Radial growth:
Model results

All tree health characteristics examined significantly influenced the radial growth rate

Dwarf mistletoe:

- Decreasing growth rate with increasing infection



For a tree with an initial DBH of 30 cm (11.8 in)

Radial growth:
Model results

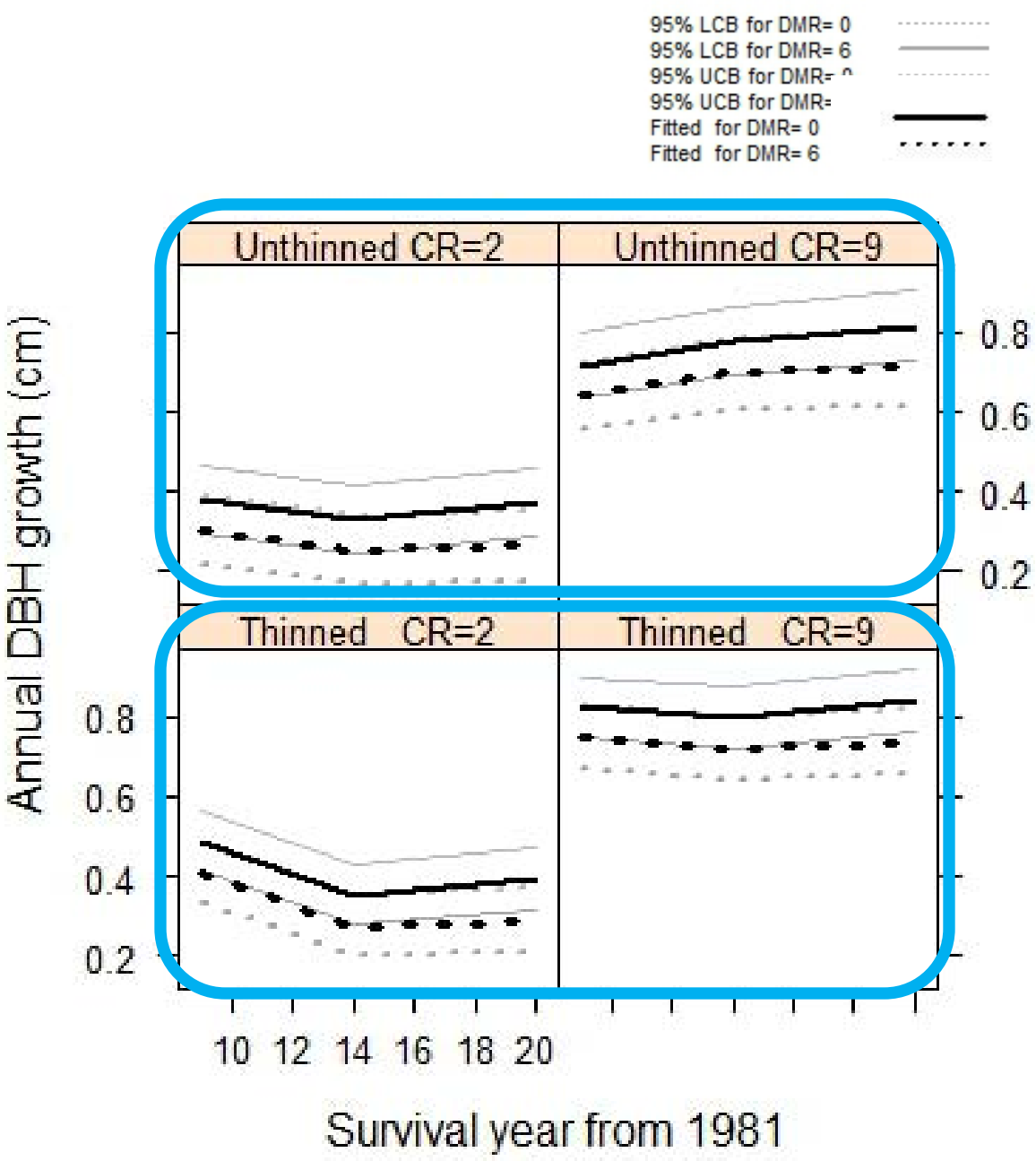
All tree health characteristics examined significantly influenced the radial growth rate

Live crown ratio:

Increasing growth rate with greater living crown

Initial DBH:

Increasing growth rate with greater size



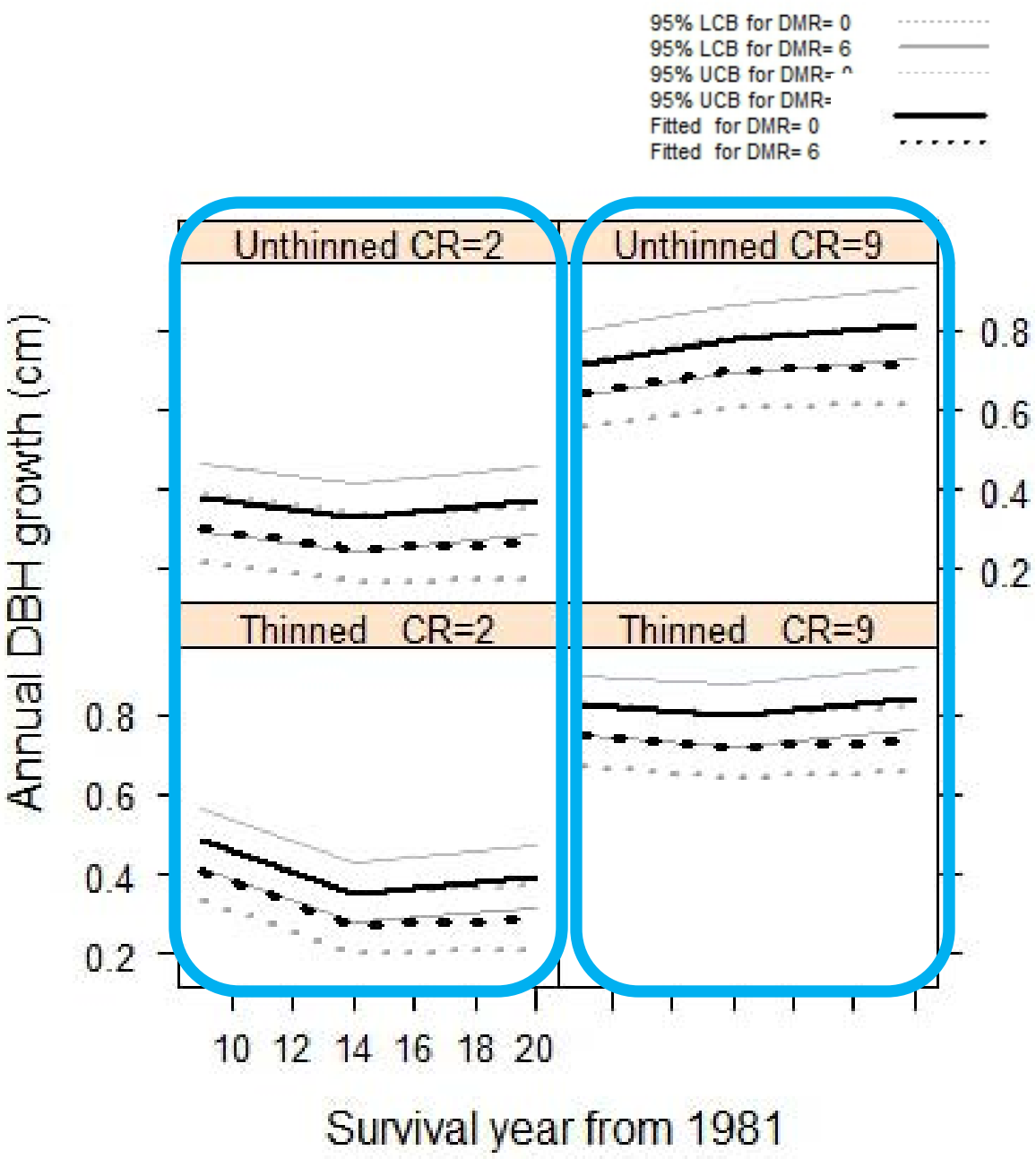
For a tree with an initial DBH of 30 cm (11.8 in)

Radial growth:
Model results

All tree health characteristics examined significantly influenced the radial growth rate

Thinning:

Increased growth rate in thinned plots



For a tree with an initial DBH of 30 cm (11.8 in)

Dwarf mistletoe dynamics: analysis

- Objective:

  Infection frequency:

  – Determine if changes in dwarf mistletoe occurrence differed in thinned versus unthinned plots

  Infection severity:

  – Determine if changes in mistletoe infection severity (DMR) differed for trees in thinned versus unthinned plots

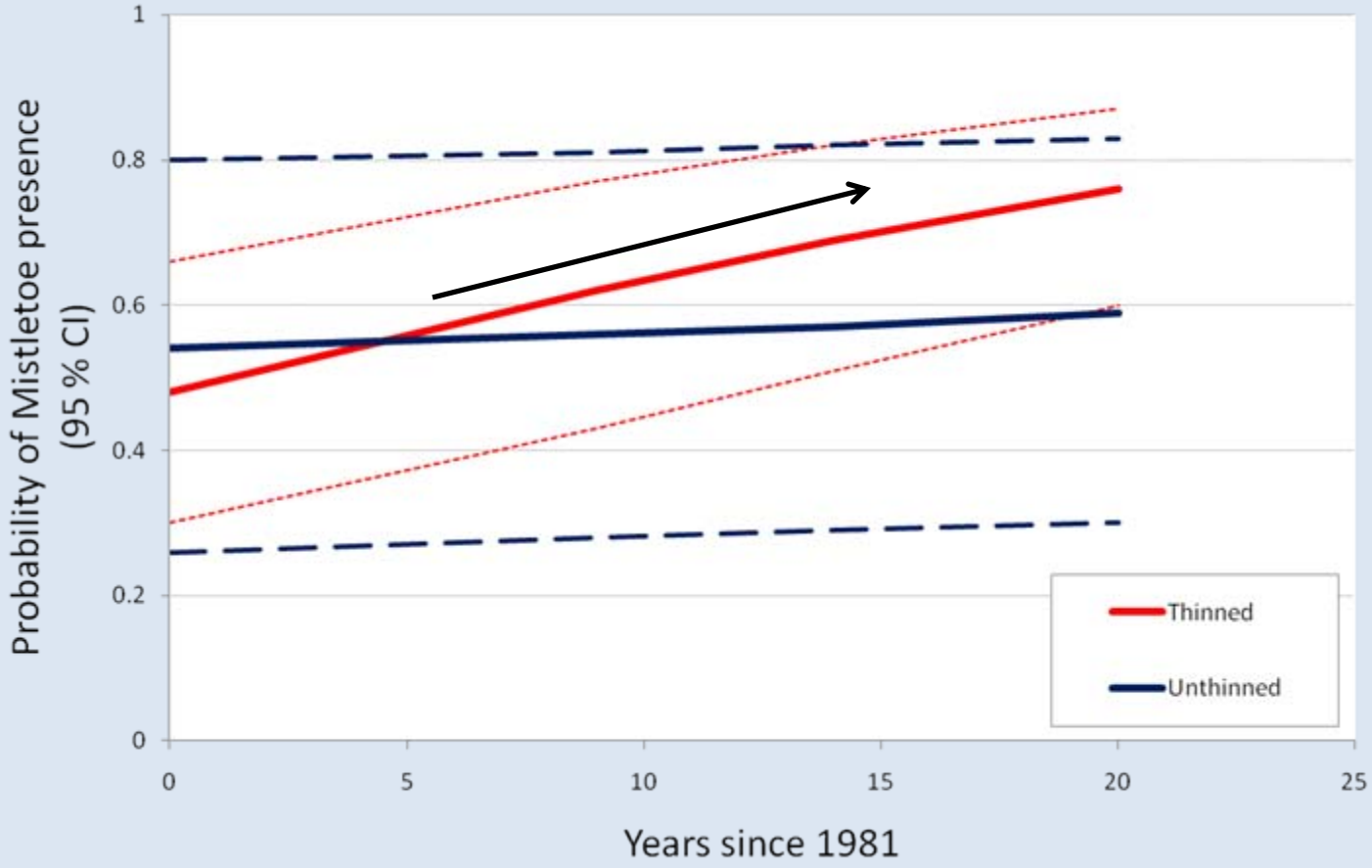
  Based on:

  - Treatment (thinned/unthinned)
  - Time (years since 1981)

- Regression models: Mixed general linear model

Infection frequency: model results

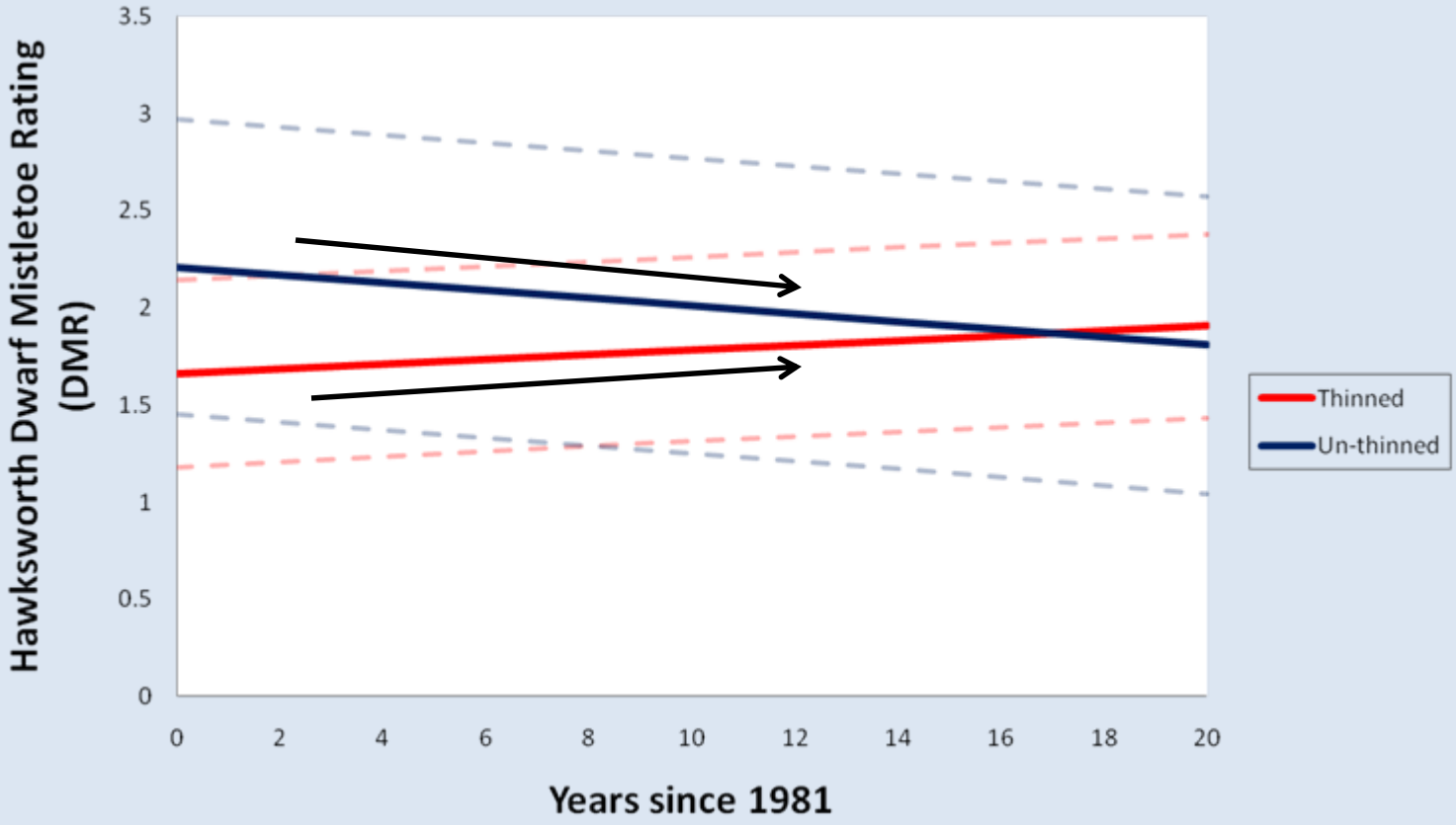
Changes in mistletoe infection frequency differed between treatments



Infection occurrence increased significantly in thinned plots, but not in unthinned plots

Infection severity: model results

Changes in mistletoe infection severity differed between treatments



Increased in thinned plots

Decreased in unthinned plots

Summary

Mortality:

- Dwarf mistletoe infected trees are more likely to die
- Trees with larger live crown ratio and DBH are less likely to die
- Thinning reduces mortality

Radial growth:

- Dwarf mistletoe infected trees have decreased radial growth
- Trees with larger live crown ratio and DBH have increased radial growth
- Thinning increases radial growth

Dwarf mistletoe dynamics:

- Thinning increases both infection frequency and severity in a stand over time

Conclusions

- Does thinning reduce dwarf mistletoe caused losses in regenerating true-fir?
  - Reduced mortality and increased radial growth
  - Increasing dwarf mistletoe frequency and severity

A very special thanks to Robert Scharpf, Gary Fiddler, Don Triplat, and everyone involved in establishing and maintaining this study over the decades

Thanks also to: Margaret Metz, Richard Cobb, Beverly M. Bulaon, and Leif Mortenson

Support for this project was provided by:

Analysis: USDA Forest Service, Forest Health Protection, Forest Health Monitoring

Data collection: USDA Forest Service, Pacific Southwest Region, Forest Health Protection and the Pacific Southwest Research Station

Literature Cited

Hawksworth, F. G., & Wiens, D. (1996). Dwarf Mistletoes: Biology, Pathology, and Systematics. USDA Forest Service, Agriculture Handbook 709.

Geils, Brian W.; Cibrián Tovar, Jose; Moody, Benjamin, tech. coords. 2002. Mistletoes of North American Conifers. Gen. Tech. Rep. RMRS–GTR–98. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 123 p.

Parmeter, J.R. Jr. and R.F. Scharpf. 1963. Dwarf mistletoe on red fir and white fir in California. Journal of Forestry 61:371-374.

Scharpf, Robert F., 1979. Dwarf mistletoe-infected red fir: growth after release. Research Paper, PSW-RP-143. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 9 p.

Scharpf, Robert F., and John R. Parmeter, Jr. 1976. Population buildup and vertical spread of dwarf mistletoe on young red and white firs in California. USDA Forest Serv. Res. Paper PSW-122, 9 p., illus. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.