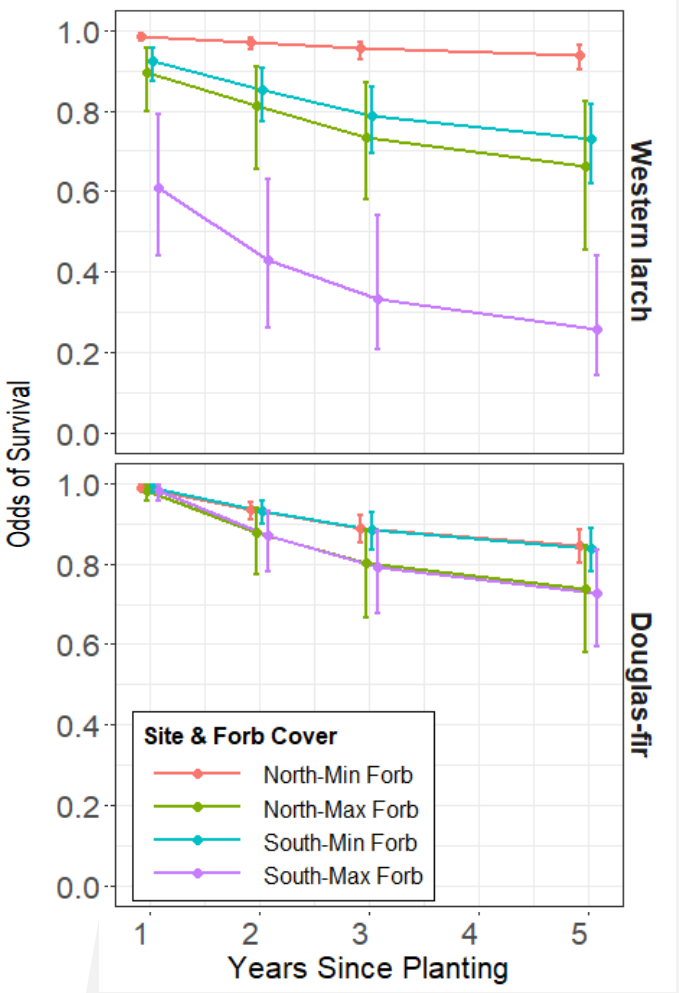
University of Idaho
College of Natural Resources

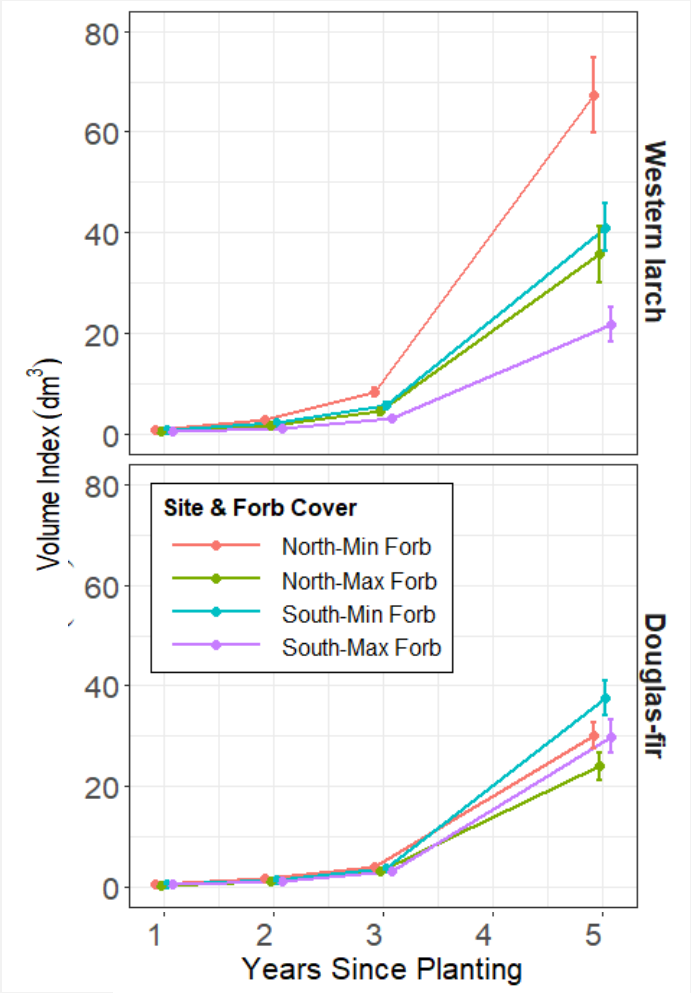
CONIFER SEEDLING RESPONSE THRESHOLDS

ANDREW S. NELSON
CENTER FOR FOREST NURSERY & SEEDLING RESEARCH
UNIVERSITY OF IDAHO

IMPORTANCE OF COMPETITION CONTROL

EFFECTS OF FORB COMPETITION DURING ESTABLISHMENT

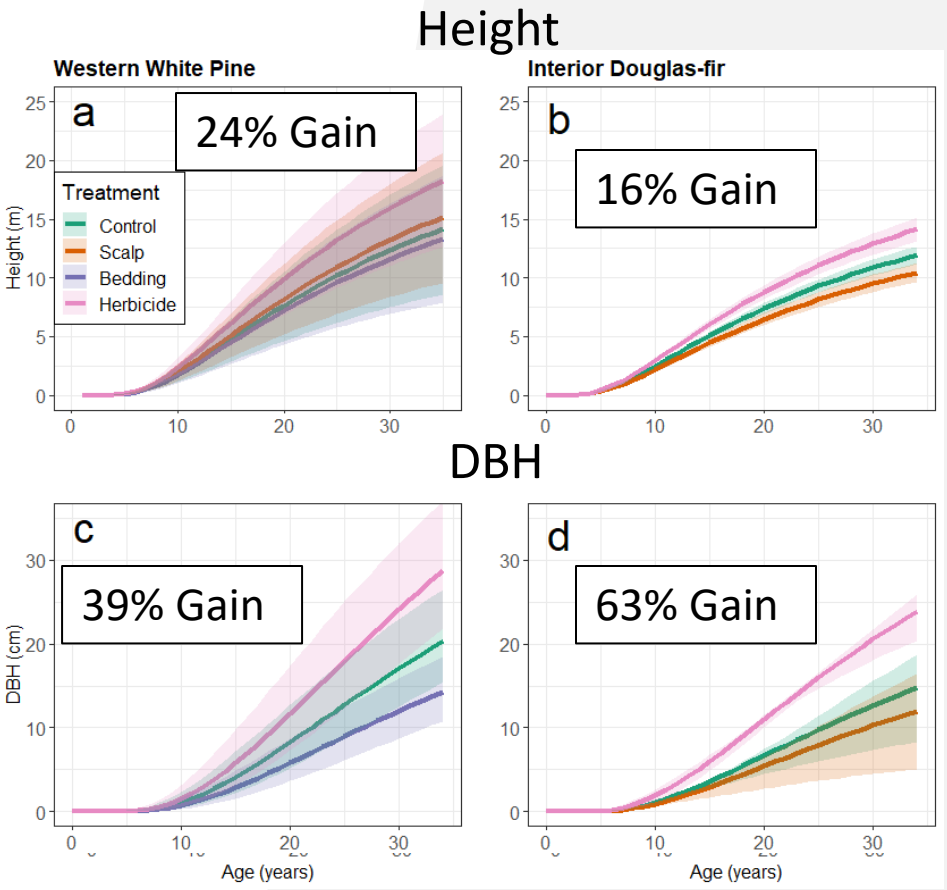


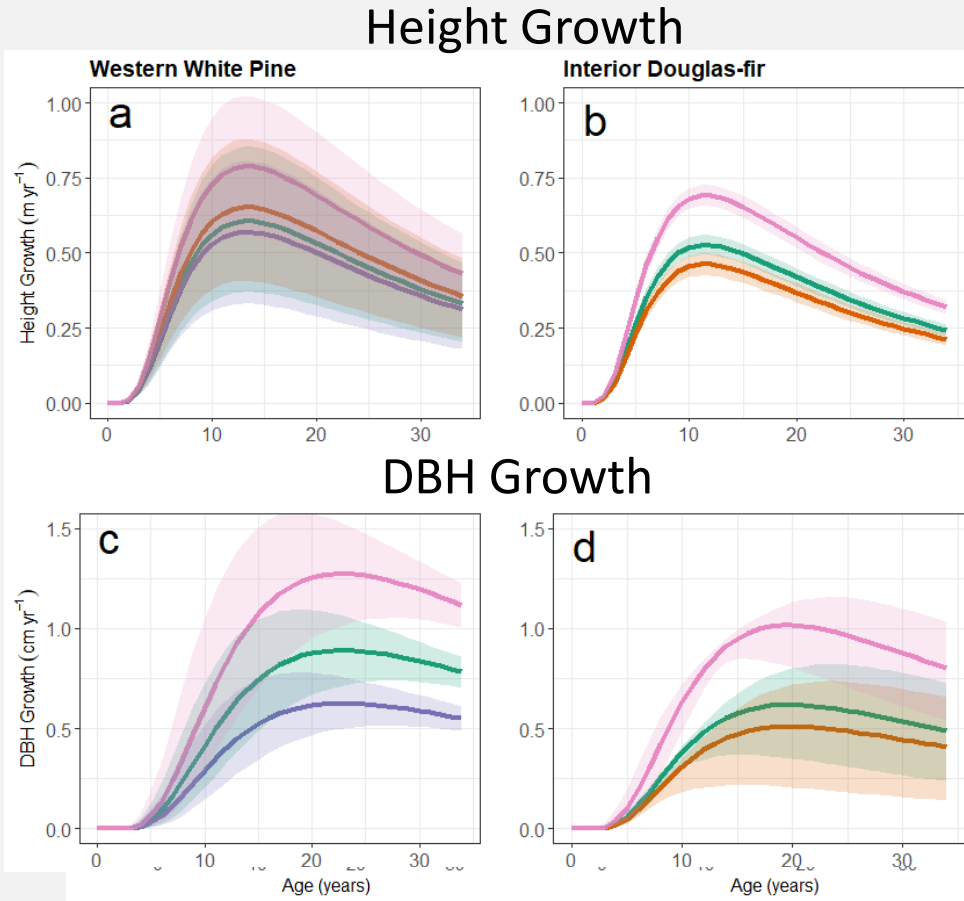


Reely et al. *In Preparation*

IMPORTANCE OF COMPETITION CONTROL

SUSTAINED GAINS IN GROWTH & YIELD 32 YEARS AFTER SITE PREPARATION

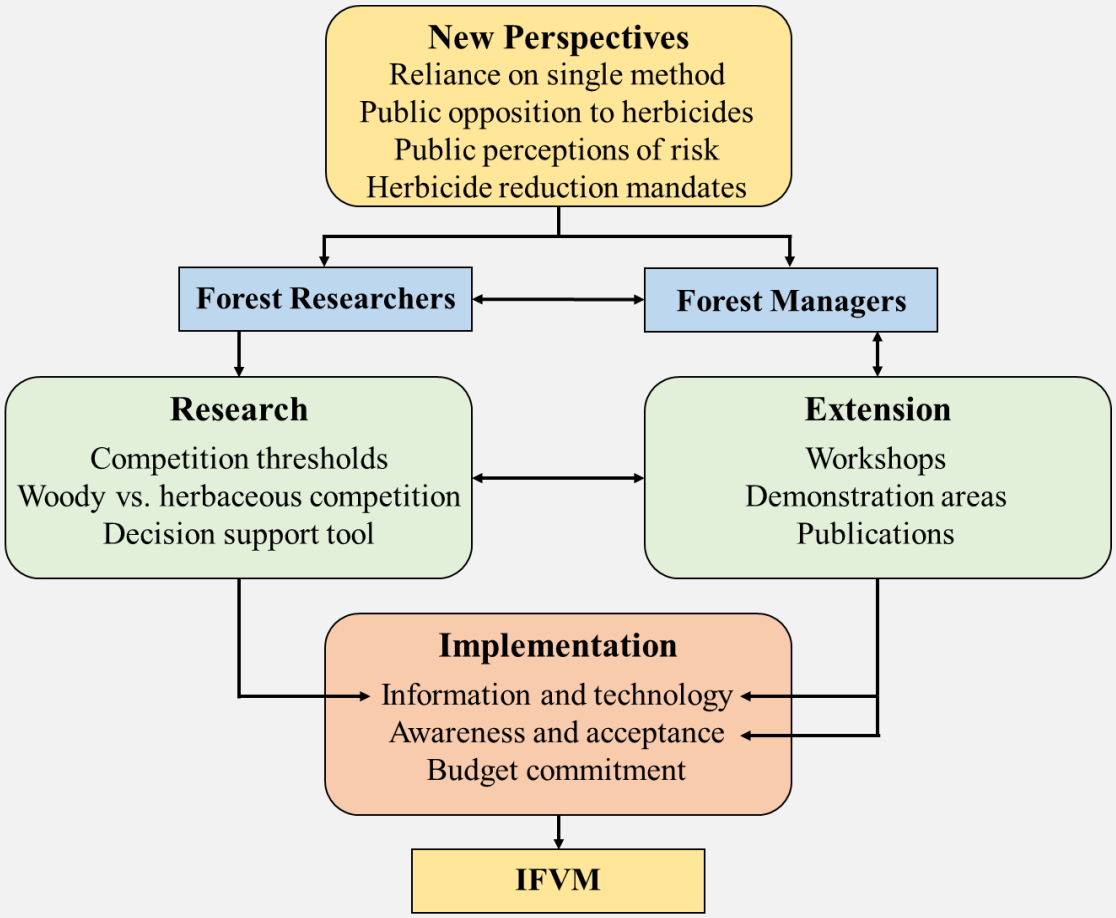




Cherico et al. 2020. Forests 11: 509

INTEGRATED FOREST VEGETATION MANAGEMENT

"Managing the course and rate of forest vegetation succession to achieve silvicultural objectives by integrating knowledge of plant ecology with a wide variety of complimentary methods that are ecosystem-based, economical, and socially acceptable"



Wagner. 1994. Journal of Forestry 92(11): 26-30

VEGETATION MANAGEMENT THRESHOLDS

- **Threshold:** The intensity below which a stimulus cannot be perceived or no longer produces a response
- **Forest Vegetation Management Threshold:** Weed density at which a vegetation control treatment should be applied to prevent unacceptable losses in the survival and/or growth of desired tree species
- Central to integrated pest/forest vegetation management (IPM/IFVM)

TYPES OF VEGETATION MANAGEMENT THRESHOLDS

- Economic
- Economic Optimum
- Statistical
- Predictive
- Safety
- Visual
- Critical period
- Competition
- Ecological

TYPES OF VEGETATION MANAGEMENT THRESHOLDS

- Economic
- Economic Optimum
- Statistical
- Predictive
- Safety
- Visual
- Critical period
- Competition
- Ecological

COMPETITION THRESHOLD

- **Focused on spatial factors (vegetation density or competitor size)**
- "Weed density at which yield loss begins to occur" (Cousens 1987)
- "Level of vegetation abundance where there is an abrupt increase or decrease in the rate-of-change in tree growth or survival" (Wagner et al. 1989)

DO SEEDLINGS NEED (NEARLY) BAREGROUND FOR OPTIMAL PERFORMANCE?

IS THIS TOO MUCH COMPETITION FOR OPTIMAL SEEDLING PERFORMANCE?

WHAT ABOUT THE INTENSITY OF COMPETITION HERE?

SURVIVAL AND VOLUME GROWTH THRESHOLDS

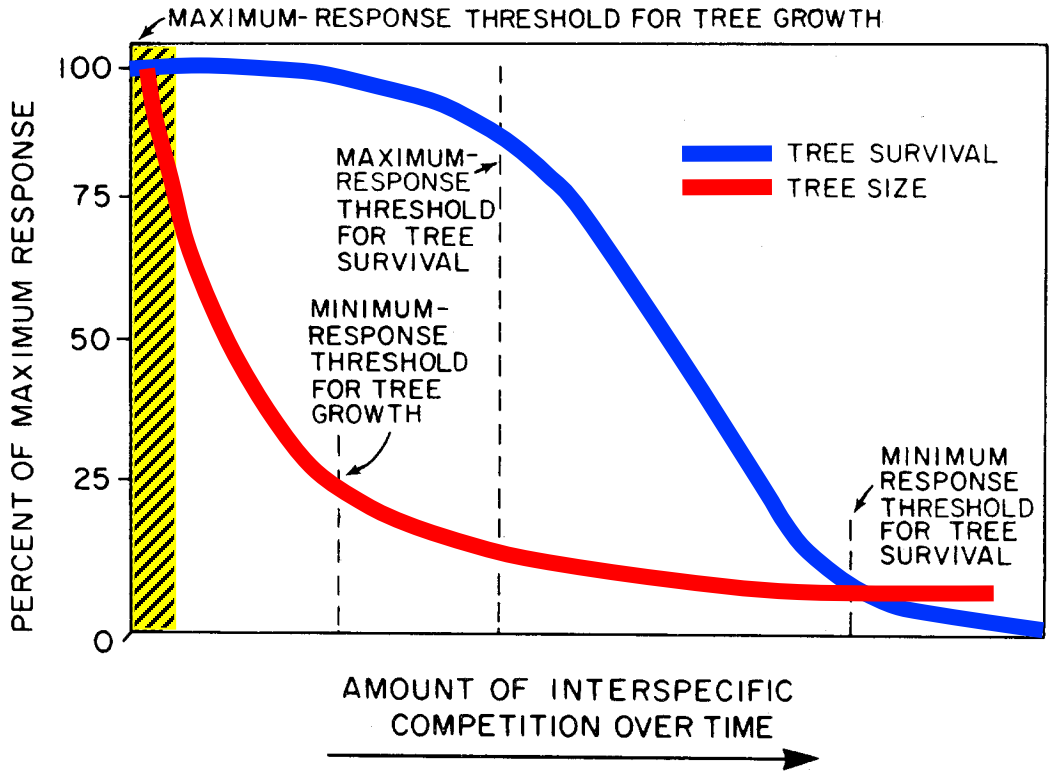
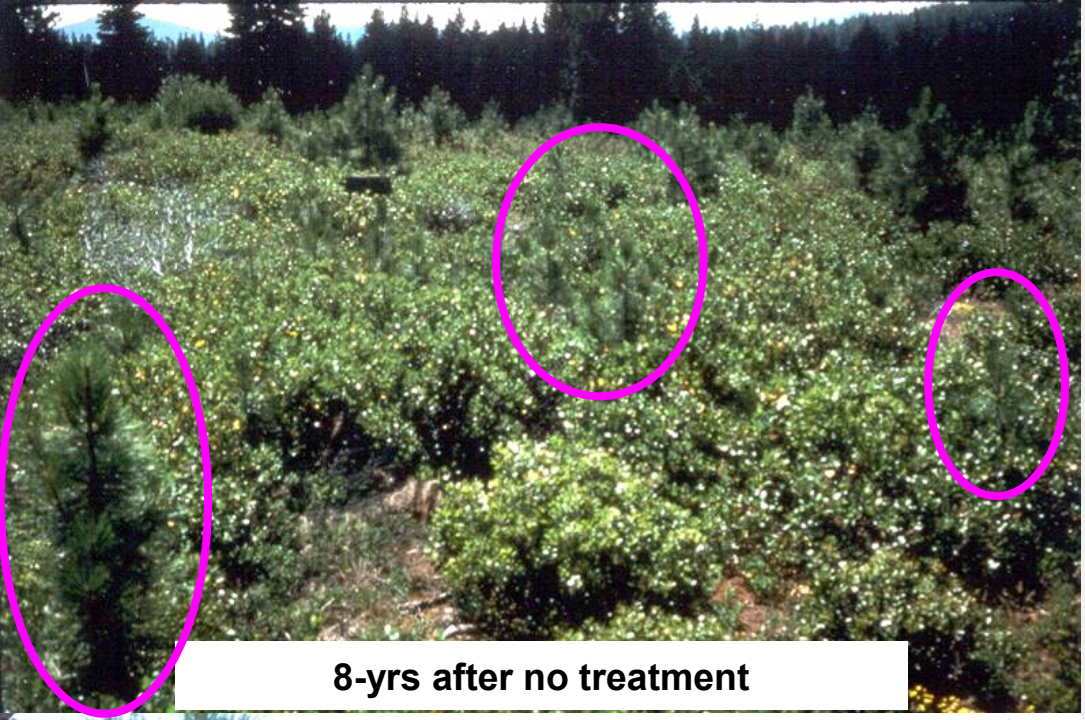


Fig. 3. Hypothetical relationship between interspecific competition, and tree survival and growth. The maximum- and minimum-response thresholds for tree survival and growth occur at different levels of interspecific competition. The maximum-response threshold for tree growth occurs in the shaded region under nearly vegetation-free conditions.

Wagner et al. 1989. New For. 3: 151-170.

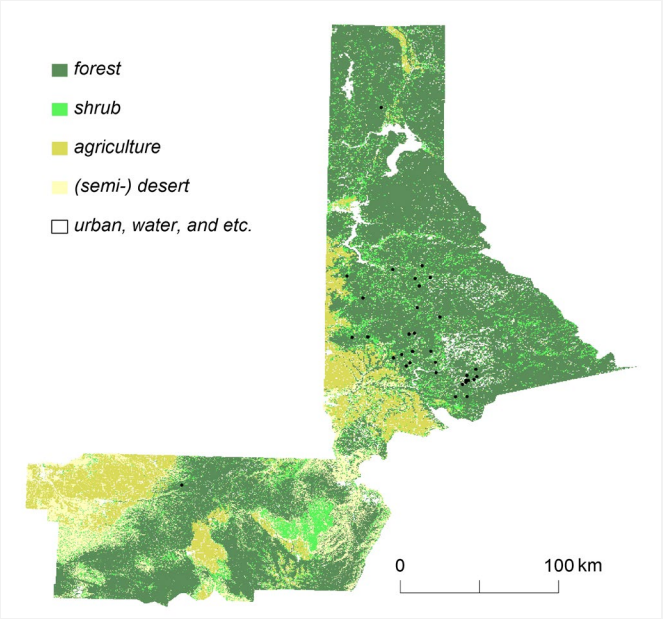


EFFECT OF WOODY VEGETATION ON PONDEROSA PINE IN SOUTHWEST OREGON

Study site: Ross et al. 1986. CJFR.

INLAND NORTHWEST SURVIVAL AND GROWTH COMPETITION THRESHOLDS

- Interior Douglas-fir and western larch—two of the most widely planted tree species in plantations
- Plots across northern Idaho and northeastern Oregon, primarily on moderate to high productivity sites
- Various stocktypes: 309A, 315B, 411B, 412A, 415B, 415C, 415D, 512A, 515A
- Annual plot installation & measurements: 2016, 2017, 2018, 2019, 2020
- Seedling quality from nursery measured by root growth potential (RGP) available for most seedlings

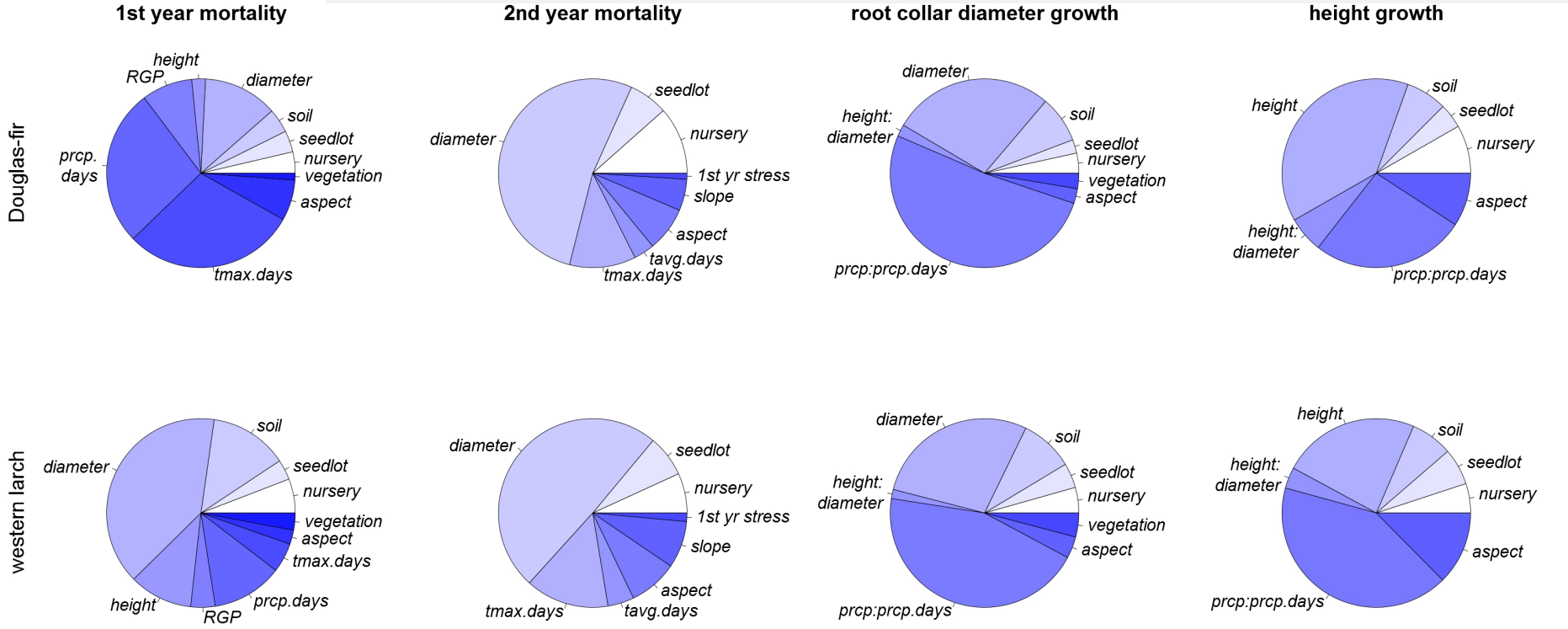


ONE NORTH IDAHO SITE (END OF 2ND YEAR)

ROOT GROWTH POTENTIAL

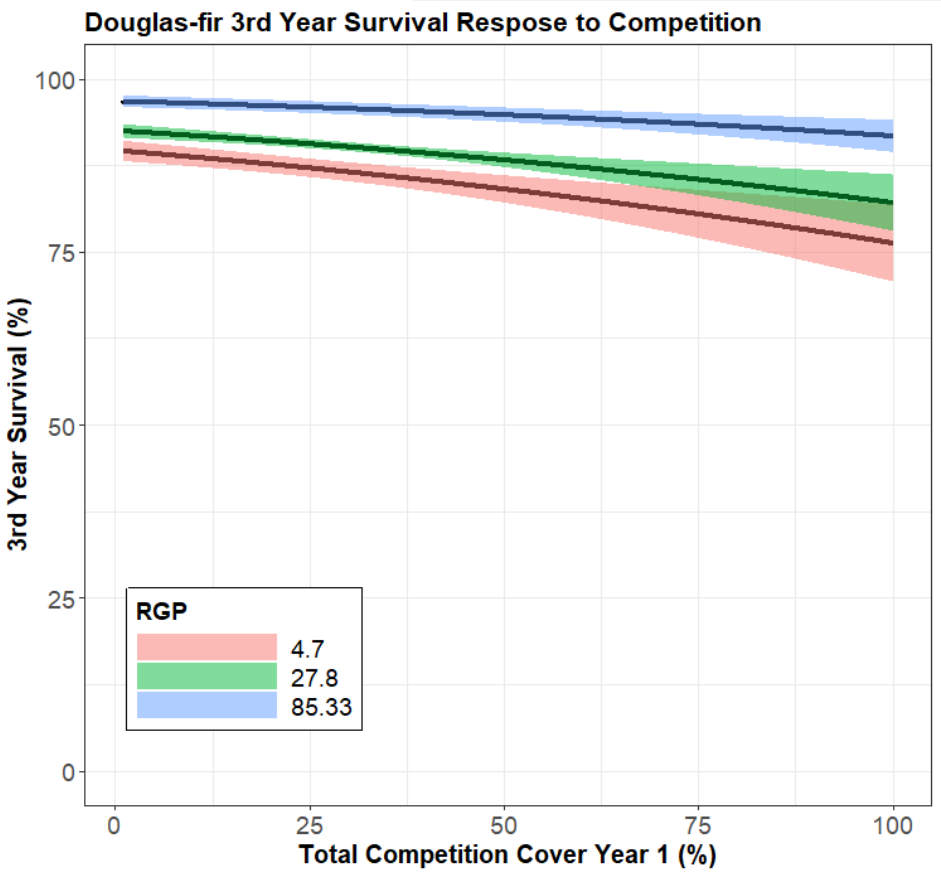
"…defined as a seedling's ability to grow roots when placed into an environment which is highly favorable for root growth (i.e., warm, moist, well-lighted) (Ritchie and Tanaka 1990)

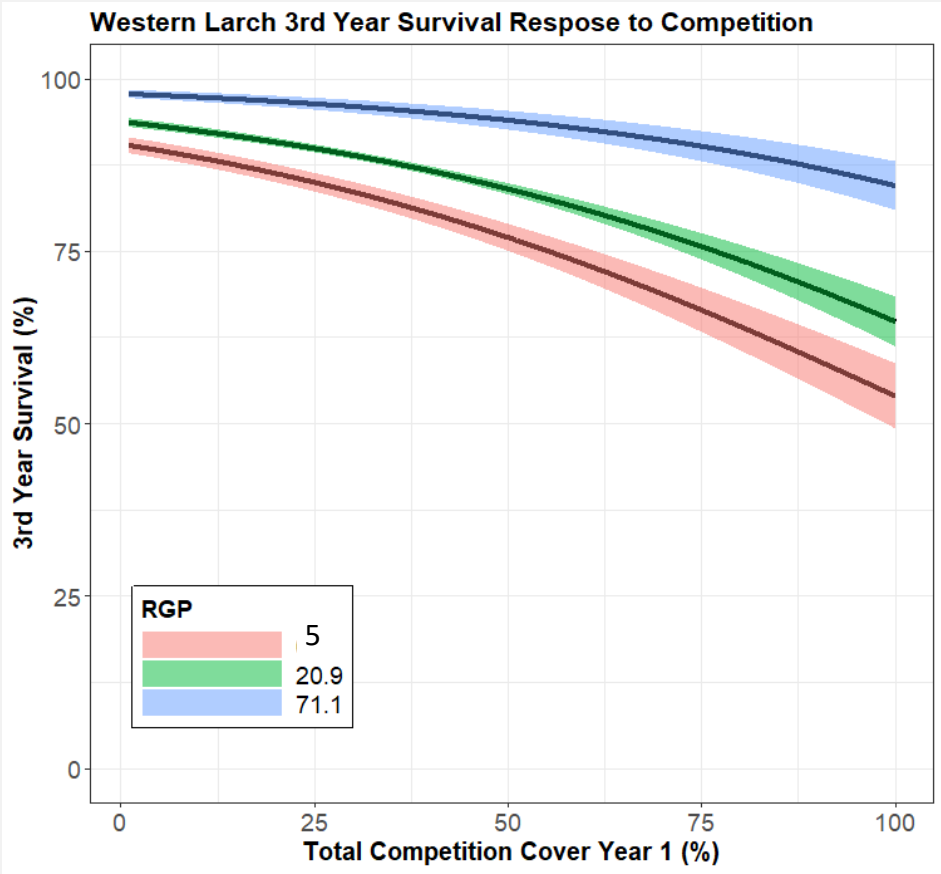
VARIOUS SITE, WEATHER, NURSERY, & SEEDLING SIZE FACTORS INFLUENCE SEEDLING SURVIVAL & GROWTH



Chen & Nelson. 2020. Forest Ecology & Management 474: 118386

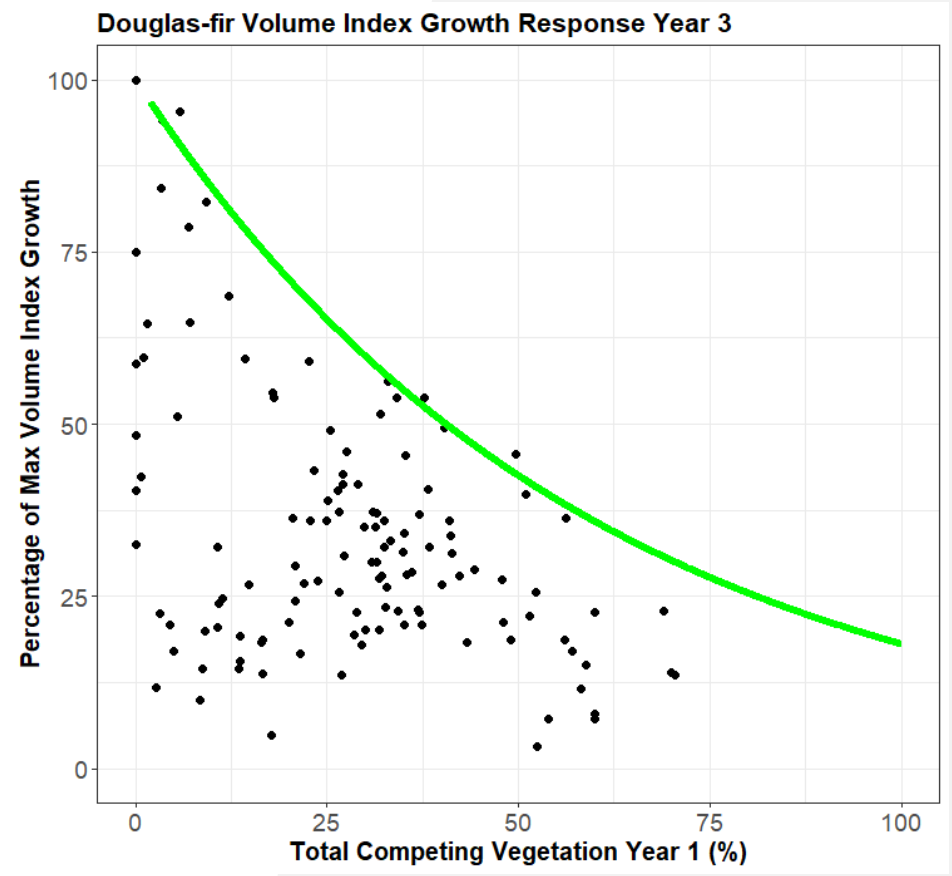
3RD YEAR SURVIVAL ACCOUNTING FOR SEEDLING QUALITY

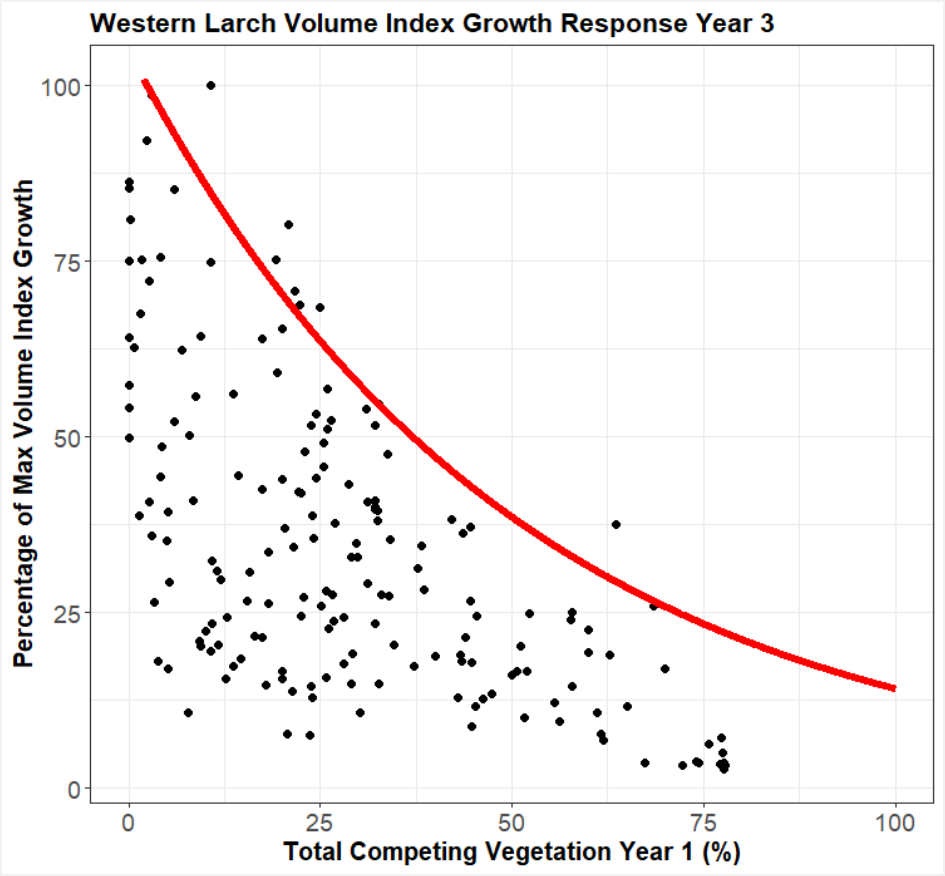




RGP is the count of new root production in mist chambers. Metric of seedling quality from the nursery.
Based on 155 remeasured DF plots and 208 remeasured WL plots, each with 15-49 seedlings

3RD YEAR GROWTH IN RELATION TO COMPETITION

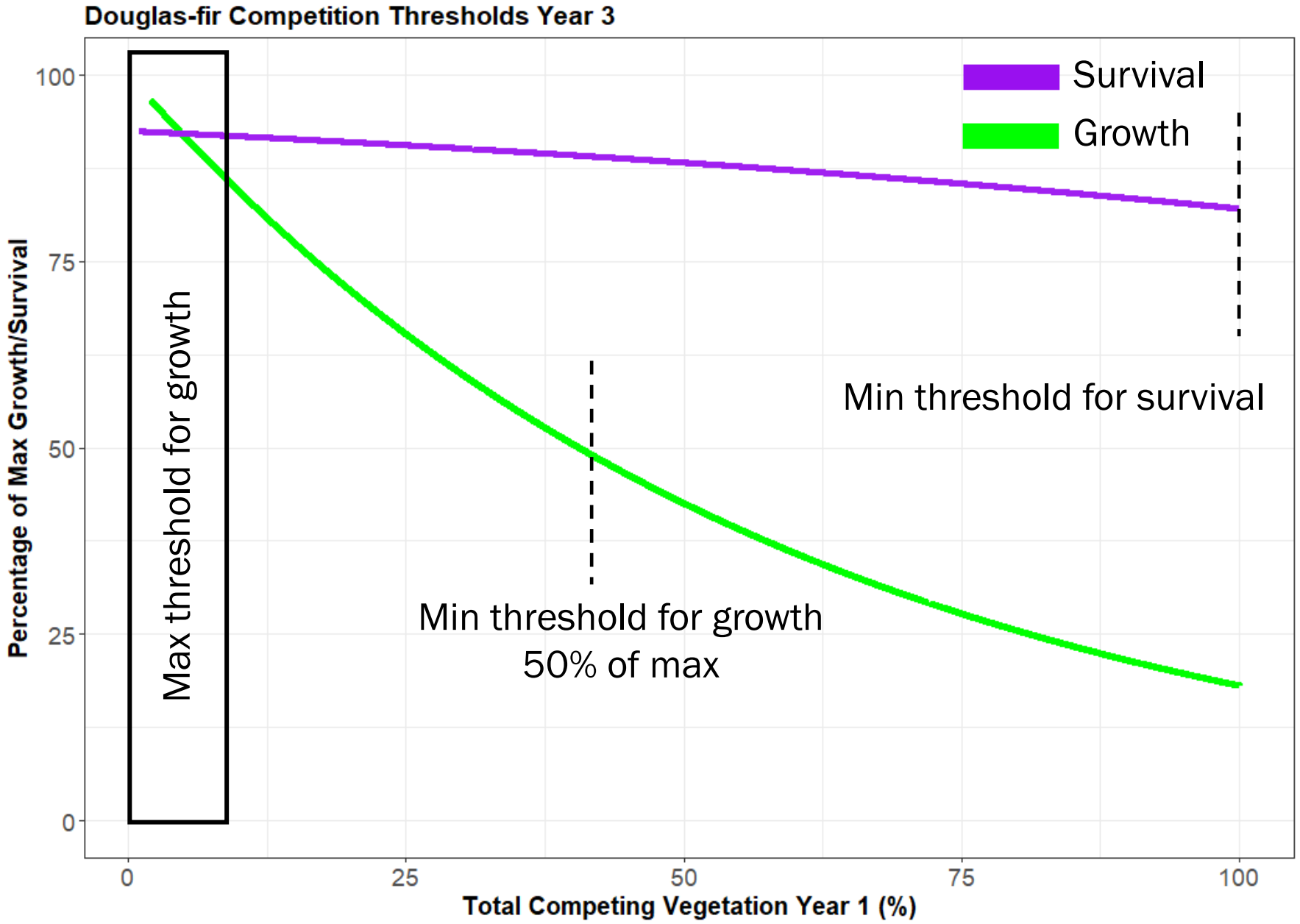




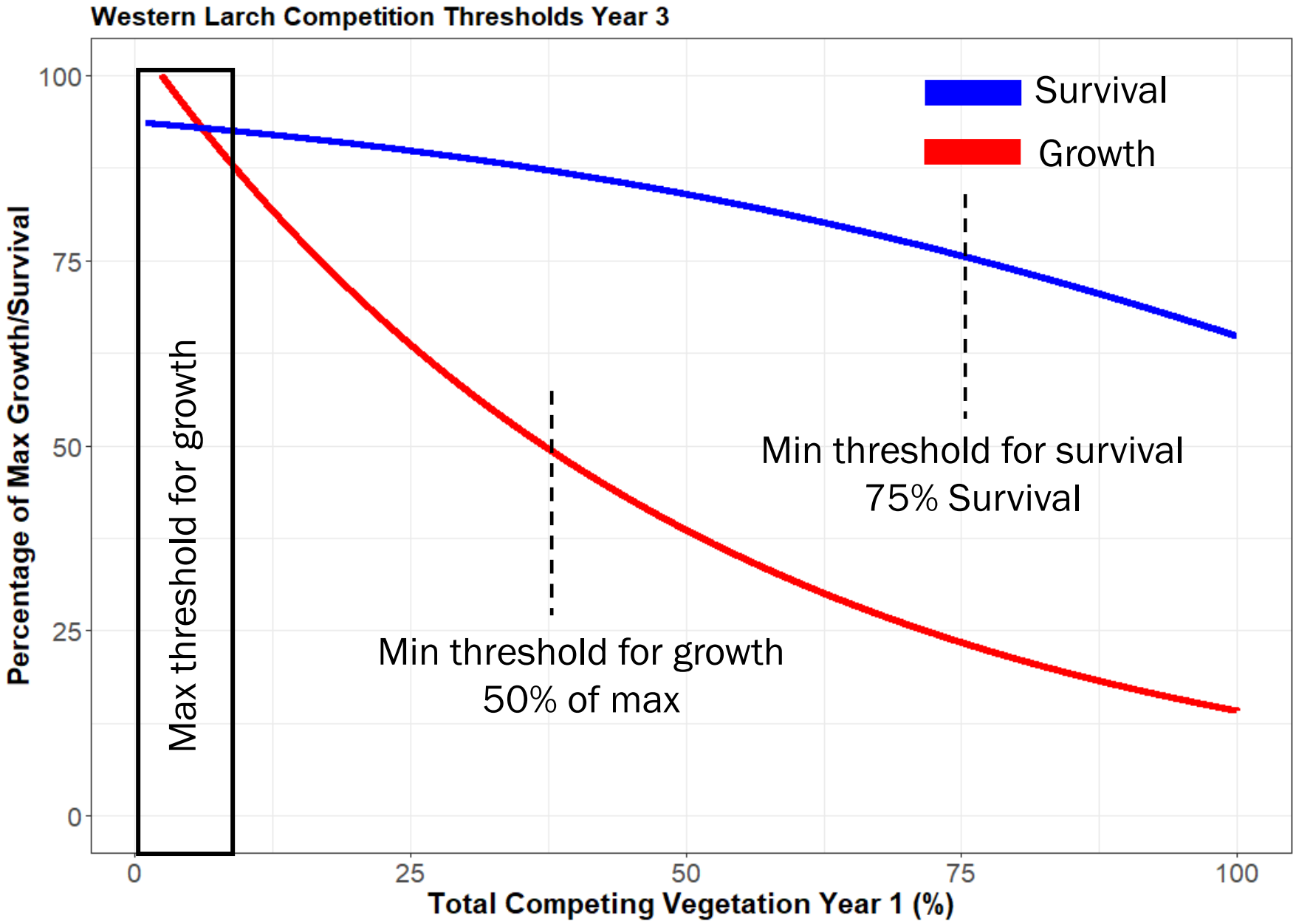
Fit with quantile nonlinear regression at 95th percentile ($\tau = 0.95$)

Growth = $b_0 e^{b1 * \text{total vegetation}}$

DOUGLAS-FIR 3RD YEAR COMPETITION THRESHOLDS



WESTERN LARCH 3RD YEAR COMPETITION THRESHOLDS



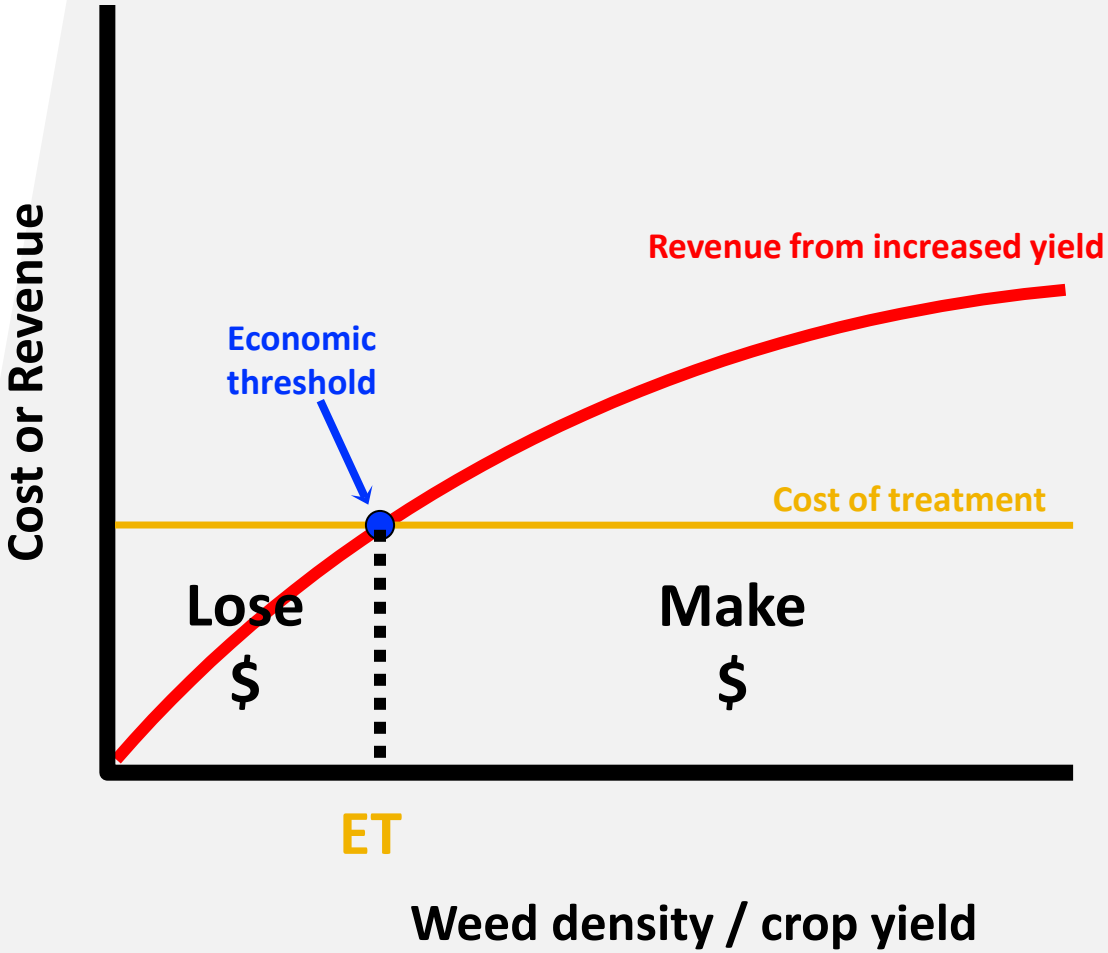
TYPES OF VEGETATION MANAGEMENT THRESHOLDS

- Economic
- Economic Optimum
- Statistical
- Predictive
- Safety
- Visual
- Critical period
- Competition
- Ecological

ECONOMIC THRESHOLD

- **Economic threshold:** weed density at which the cost of control equals the increased value of yield that would result
  - Equal to the economic-injury level in IPM
  - Refers to a single year only

ECONOMIC THRESHOLD

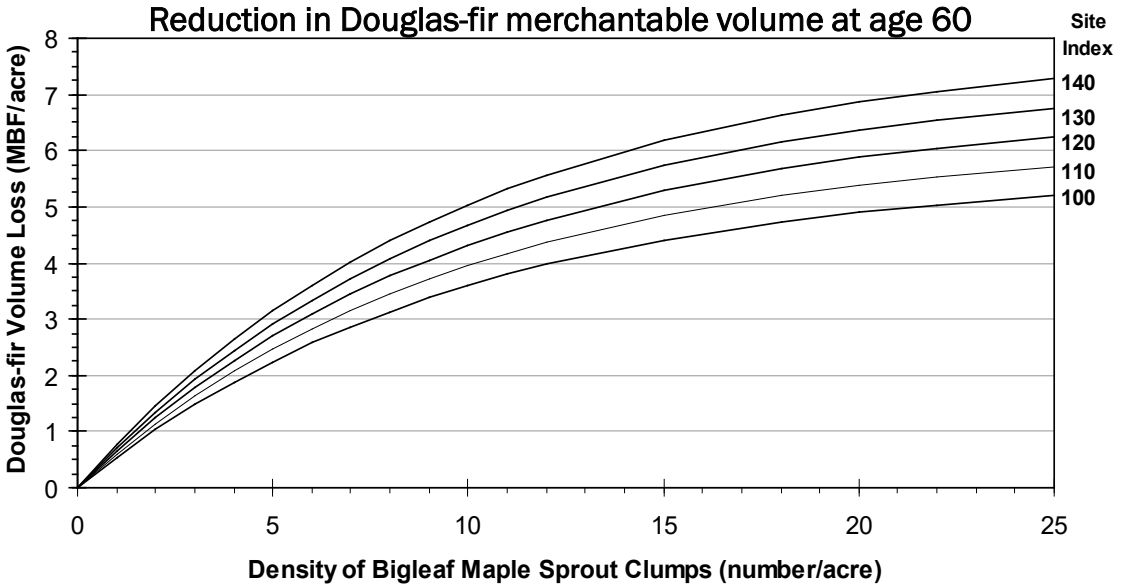


- If the increased revenue from control is **less than** the cost of control, you **lose money**
- If the increased revenue from control is **greater than** the cost of control, you **make money**

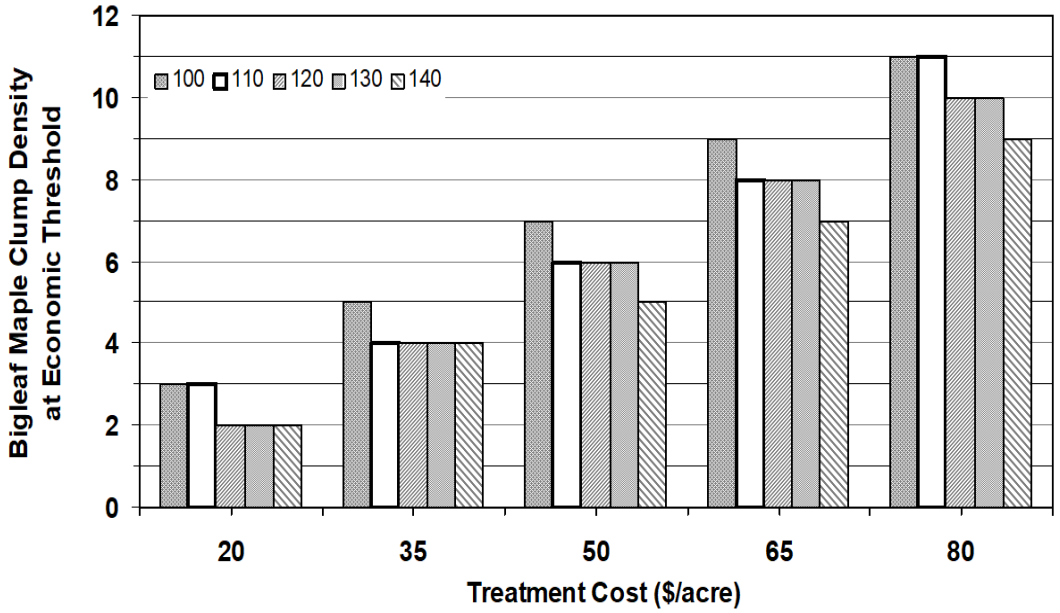
ECONOMIC OPTIMUM THRESHOLD

- **Economic optimum threshold:** weed density above which weeds should be controlled to optimize financial returns over the long term
  - Assumes weed control treatments influence future weed problems
  - Applies to long-term stand dynamics

ECONOMIC OPTIMUM THRESHOLD FOR BIGLEAF MAPLE CLUMPS



Economic threshold density of bigleaf maple sprout clumps at various treatment costs and site indices. *Assumptions: interest rate = 7%; Douglas-fir stumpage value = $500/MBF; and bigleaf maple stumpage value = $3.50/ft³*



Source: Knowe et al.

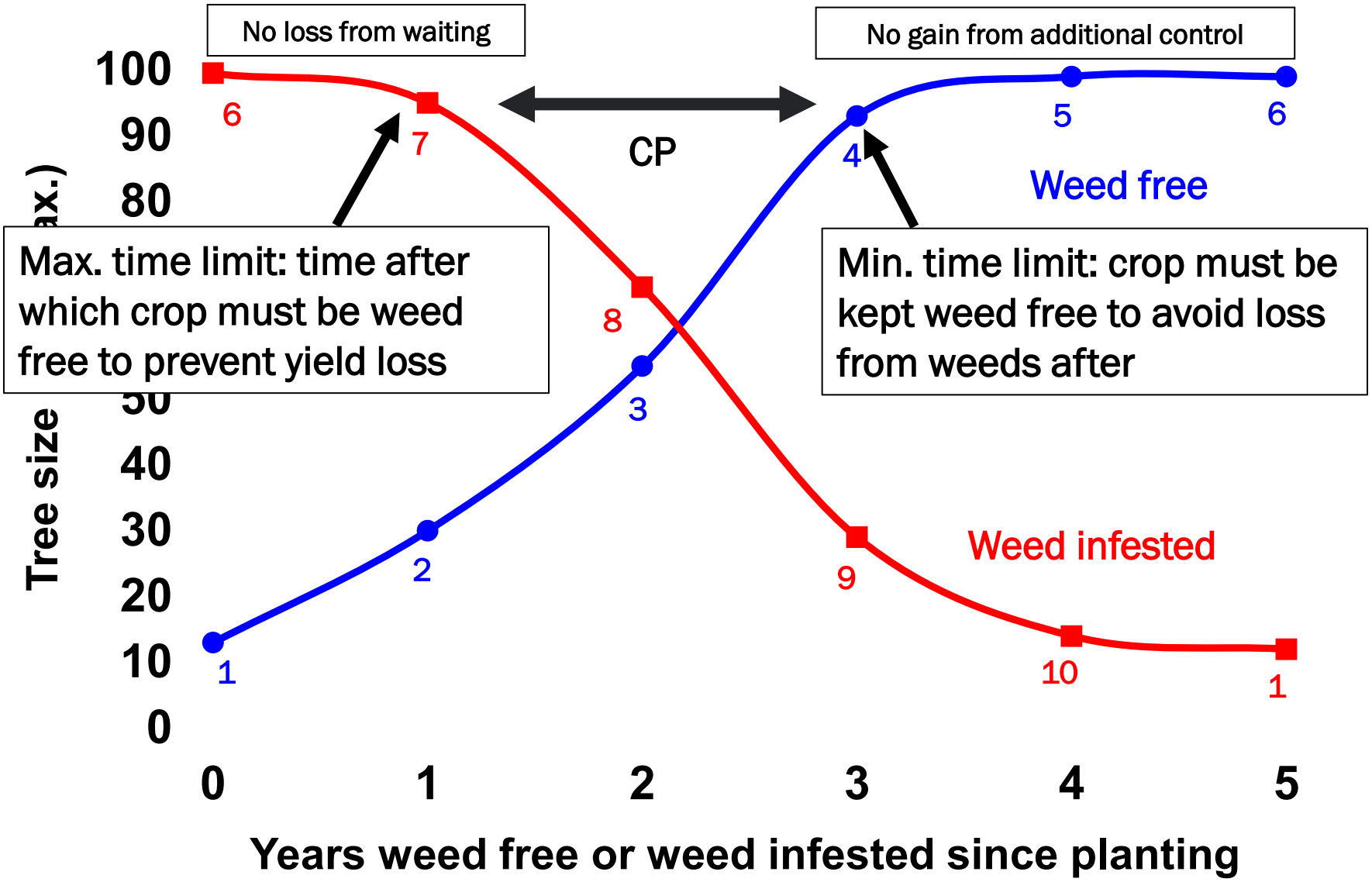
TYPES OF VEGETATION MANAGEMENT THRESHOLDS

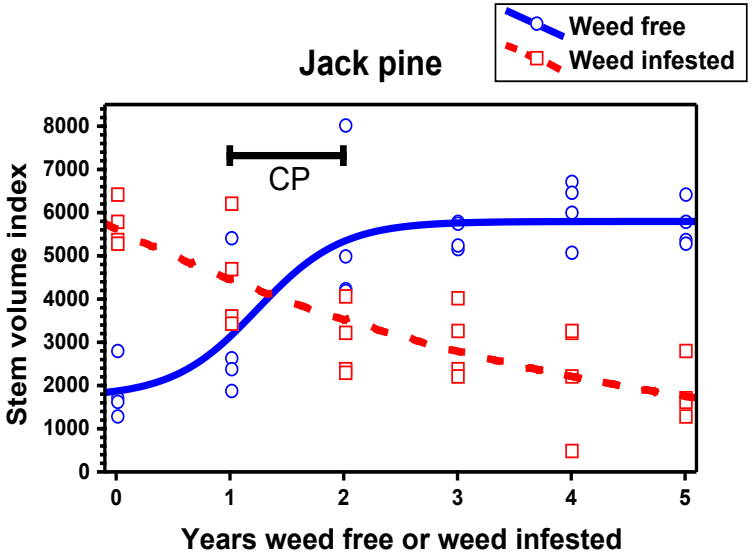
- Economic
- Economic Optimum
- Statistical
- Predictive
- Safety
- Visual
- Critical period (time)
- Competition
- Ecological

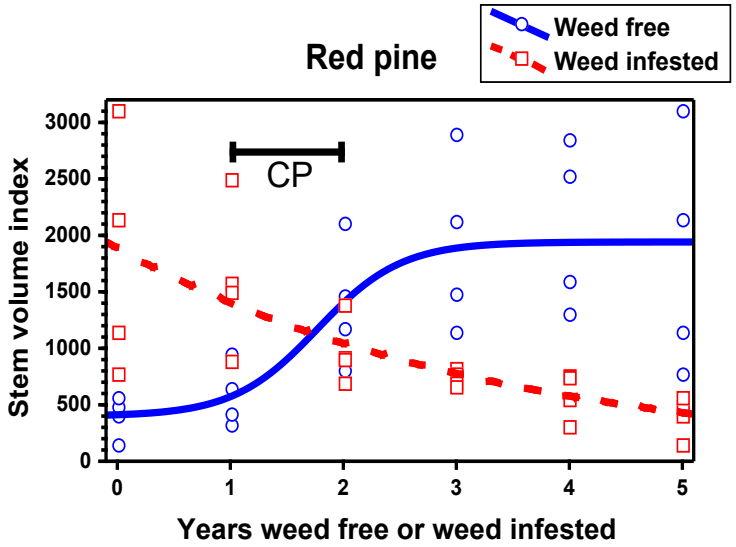
CRITICAL PERIOD THRESHOLD

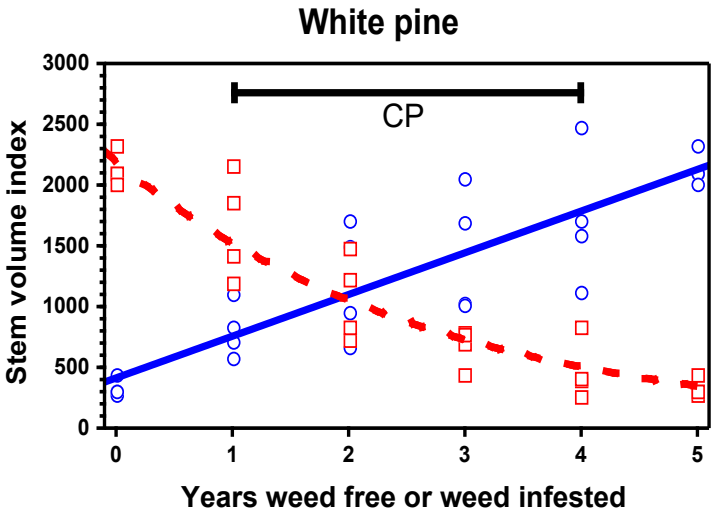
- Defines the time period during crop development when interspecific competition occurs between weeds and crop plants
- Focus on **temporal** factors (**timing** of competitive interactions or **when** treatments should be applied)
- Developed for a wide range of annual agricultural crops
- Only 2 studies in forest systems in North America (Douglas-fir in Oregon, Various Conifers in Ontario)

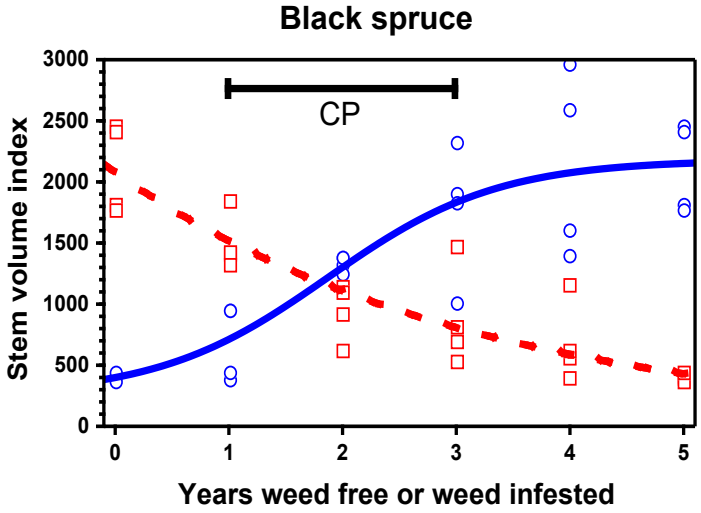
CRITICAL-PERIOD COMPONENTS











From: Wagner, R.G., et al. 1999. Can. J. For. Res. 29: 890–897.

ONTARIO CRITICAL PERIOD STUDY (YEAR 10)

ACKNOWLEDGEMENTS

- PotlatchDeltic Corp.
- Hancock Forest Management
- UI Experimental Forest
- USDA NIFA
- USDA Forest Service
- National Science Foundation
- Bob Wagner, Purdue U.
- Mike Newton, OSU
- Jim Miller, USFS
- Chance Brumley, PotlatchDeltic Corp.
- Florian Deisenhofer, HFM


QUESTIONS