

Establishment of the Paired-Plot Density Management network: 2013-2018

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Mark Kimsey



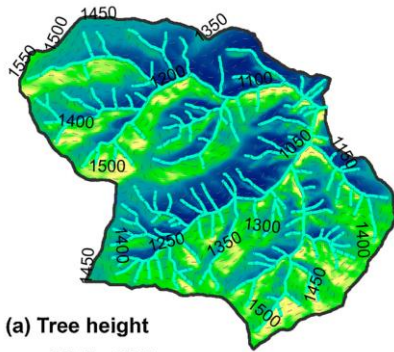
IFC Goal & Membership

Goal: Improving vigor and adding value to managed forests of the diverse Inland Northwest landscape.

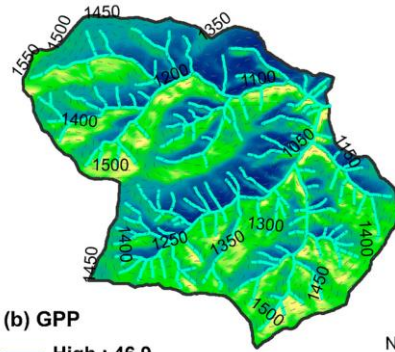


University of Idaho
Intermountain Forestry Cooperative

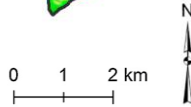
Obvious need to test site-specific silvicultural options in the INW



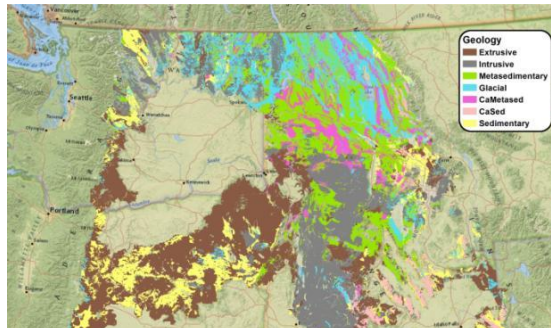
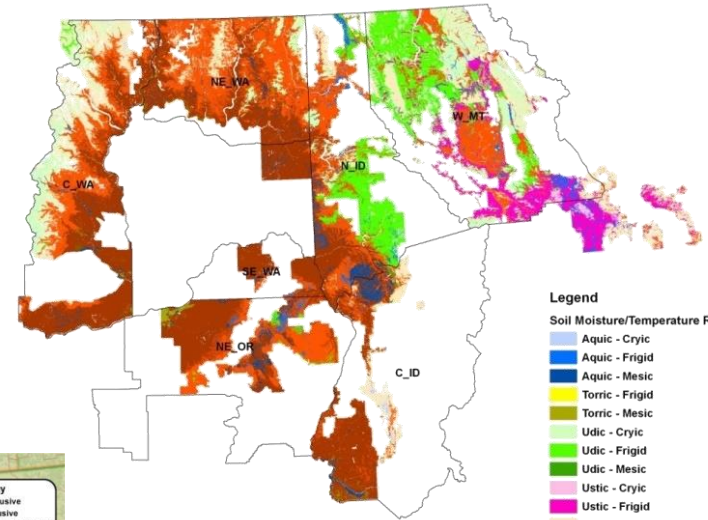
(a) Tree height
High : 36.3
Low : 29.5



(b) GPP
High : 46.9
Low : 25.7



Wie et al 2018



Categorize forest site quality throughout the Inland Northwest

- Define tree and stand responses to treatments across the range of forest site conditions
- First focused on site factors that define maximum stand density
- Density management creates lasting improvements to stand condition



Utility of Density Management

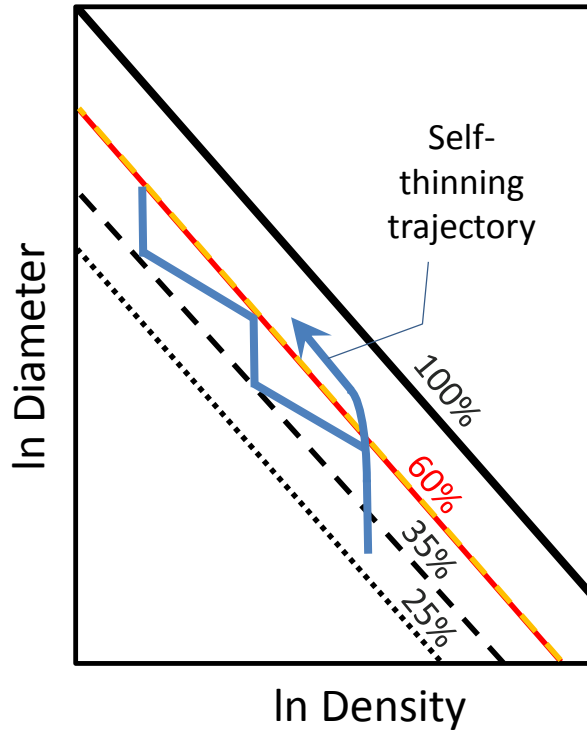
- Improves stand structure and development through density management
- Enhances resistance to fire, drought, pests & disease

Forgone or delayed thinning :

- Growth opportunity loss
- Extends rotation
- Increases mortality risk



Stand density relative to normal stands *defines thinning prescriptions for highest stand vigor*



- 100% - Normal
- 60% - Eminent mortality
- 35% - Lower Management Zone
- 25% - Crown closure



Density Management Research

1. Carrying capacity analysis

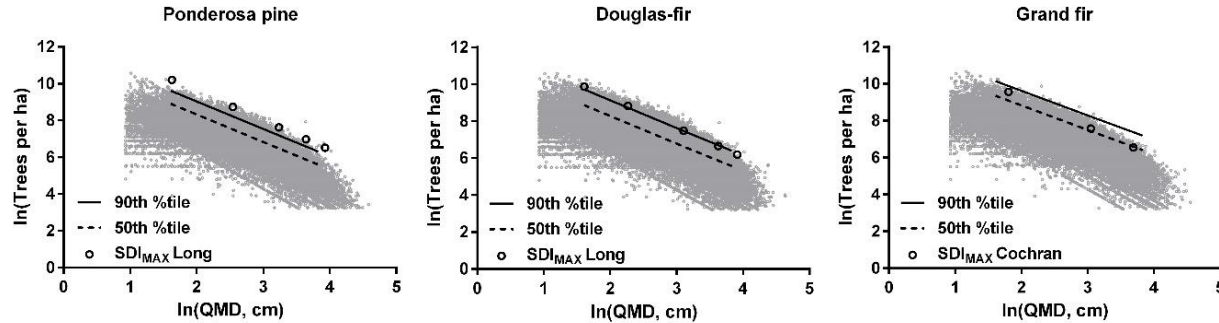
- Characterize maximum density across the INW
- Species specific

2. Spacing Trials

- Validate maximum density models
- Compare growth response to thinning among site classes
- Determine how stand development affects thinning response



Maximum density frontier models

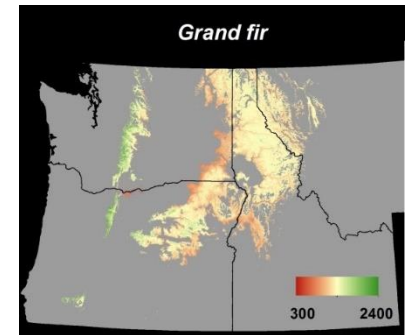
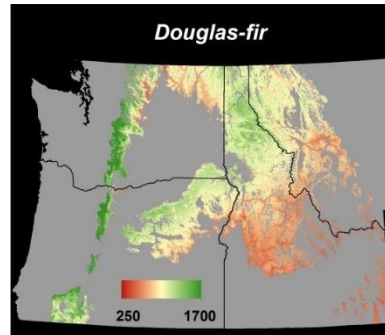
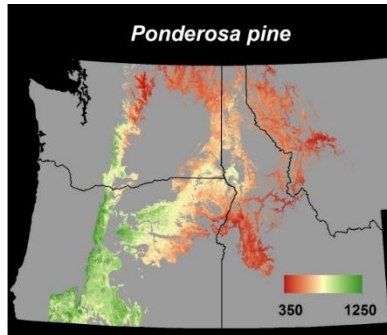


*Density x Diameter
depends on:*

*Topography
Geography
Climate
Soil*

Kimsey et al 2019

Geospatial representation of maximum Stand Density Index



Spacing Trials

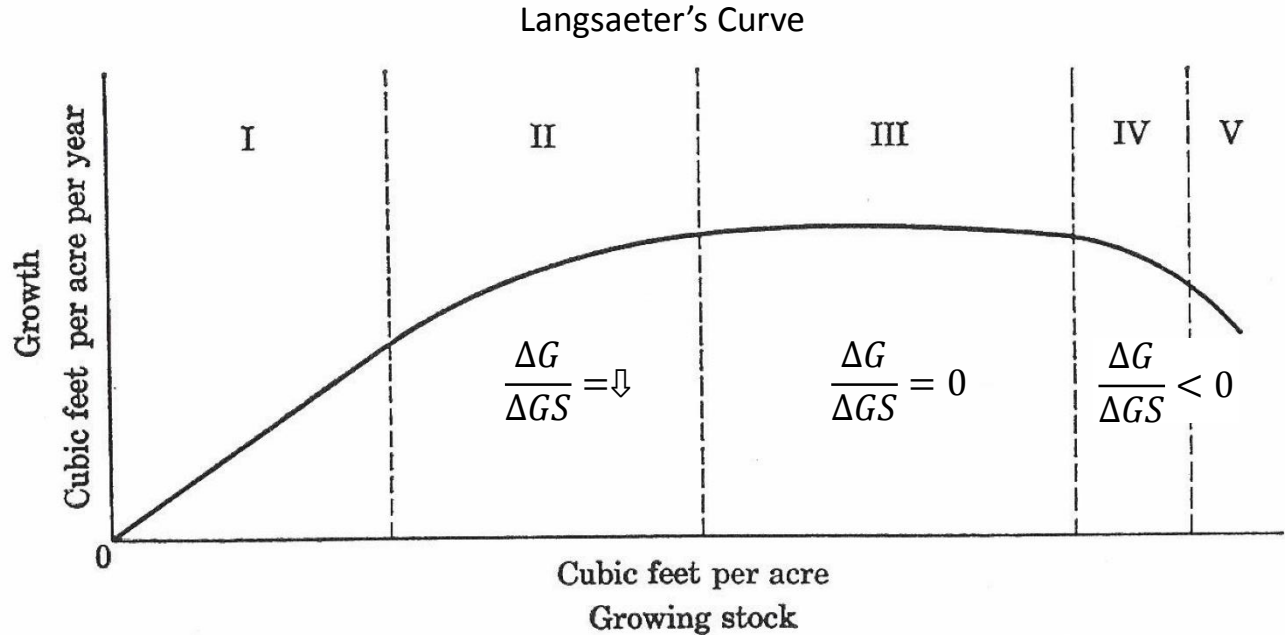
- Identify how stage of stand development affects thinning response
- Measure thinning response across site productivity classes
- Compare among dominant species



Total stand productivity should reach a broad optimum following canopy closure

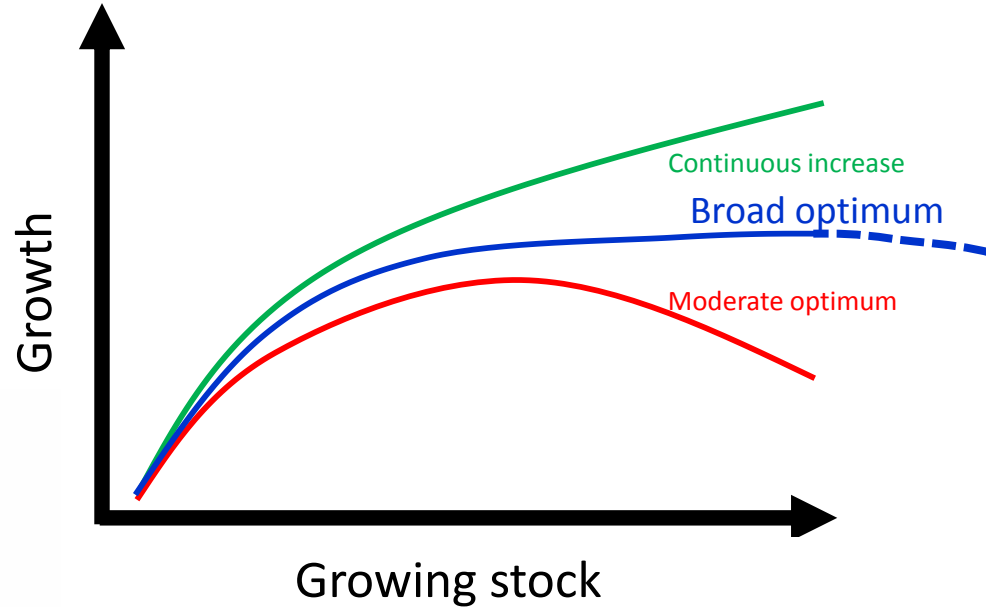
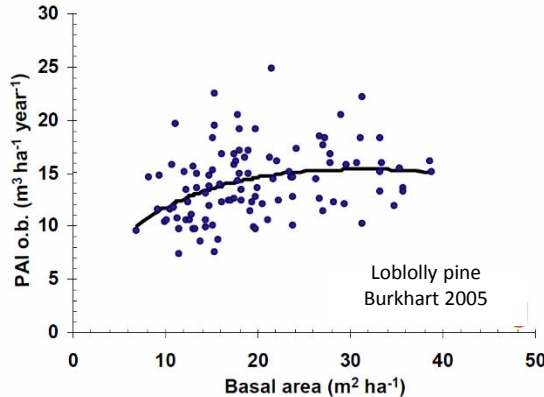
Growth phases:

- I. No competition
- II. Growth decline
- III. Constant wide optimum
- IV. Competition-caused decline



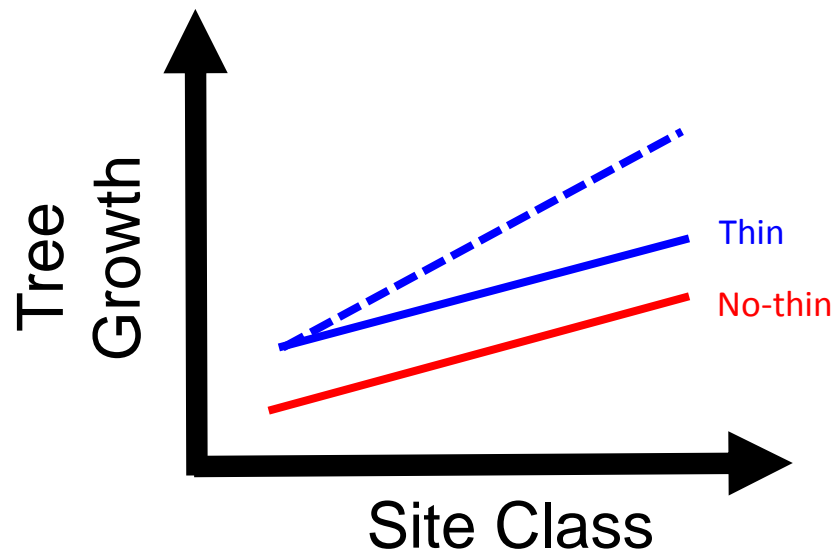
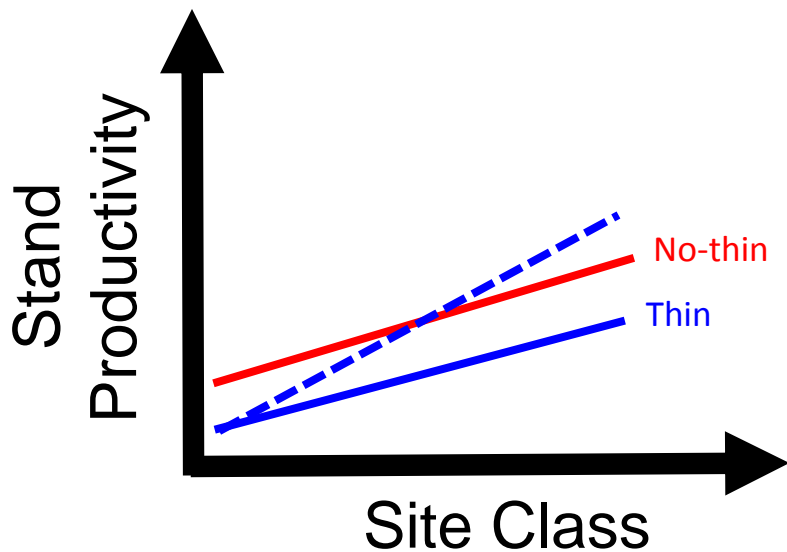
To plateau or not to plateau

- Uncertain width of plateau
- Uncertain effect of site quality
- Gross vs Net production
- Typically noisy data causes uncertainty



Site class vs. growth

- Stand growth of thinned stands may exceed that of no-thin on high sites
- Growth of thinned trees will always exceed no-thin trees; difference may be greatest on high sites



Paired Plot Density Management (PPDM) Objectives

1. Describe growth-density function shape
2. Identify optimal time of thinning for small diameter stands
3. Evaluate site effects on thinning response
4. Thinning effects on light, water, and nutrients



101 PPDM study locations

Thinning operations throughout the Inland Northwest

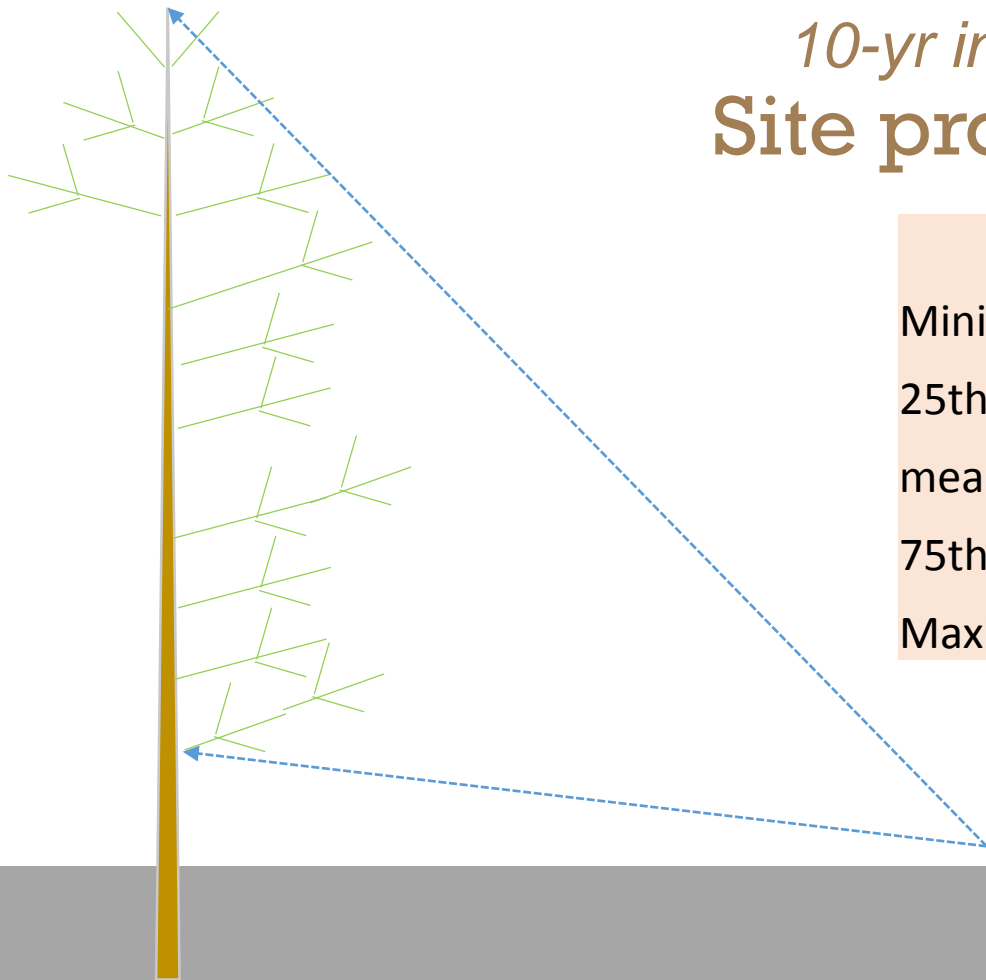
- 4 site classes x 3 density classes
- Divided among three forest types

Density	Site Productivity Class			
	1	2	3	4
I	1	13	13	8
II	10	15	16	4
III	2	8	9	2



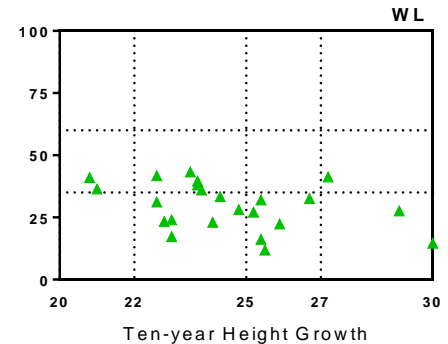
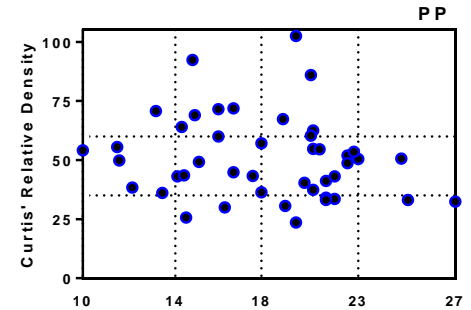
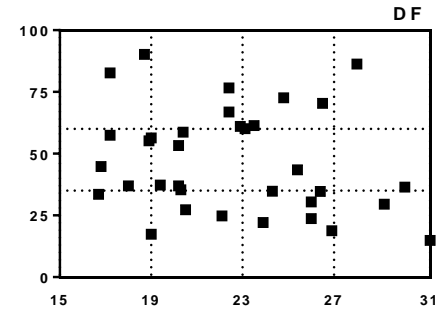
10-yr increment estimates Site productivity

	DF	PP	WL
Minimum	15	10	20
25th	19	14	22
mean	23	18	25
75th	26	23	27
Maximum	31	27	30



Matrix grid evenly classified site conditions

- Corners were hard to fill
- High density larch not available
- Represents range of forest stand conditions



PPDM within site plot Design

- 3-4 plots at each location
- No-thin
- Operational thin
- Alternative thin

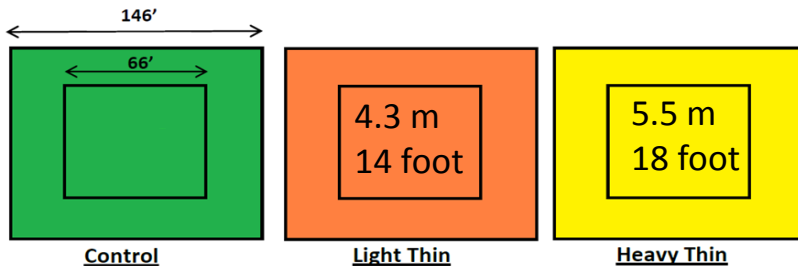
No thin,
Control



Light to moderate thin,
10-14 foot



Moderate to heavy thin,
16-18 foot

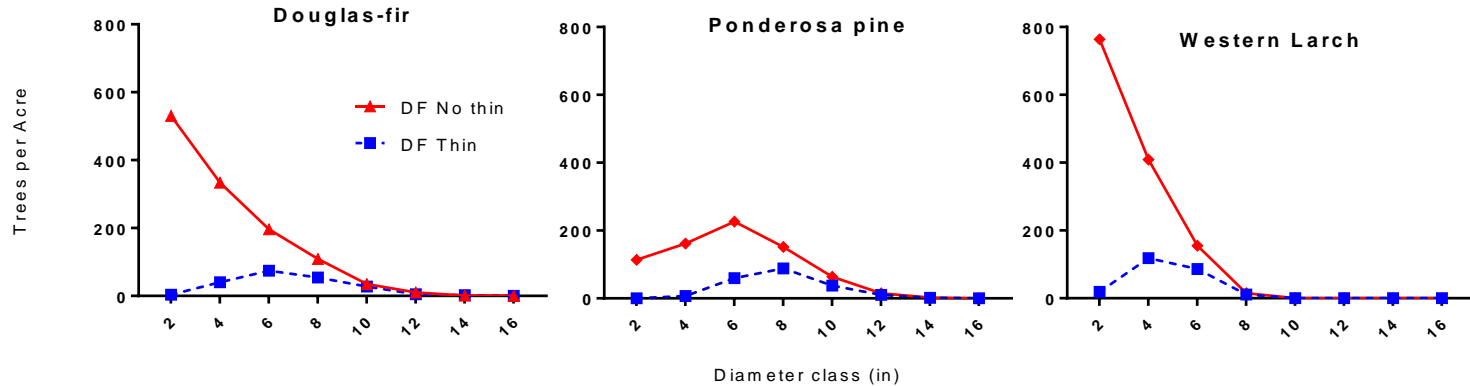


Establishment results

- Stand structure
- Density distribution
- Dependent site factors



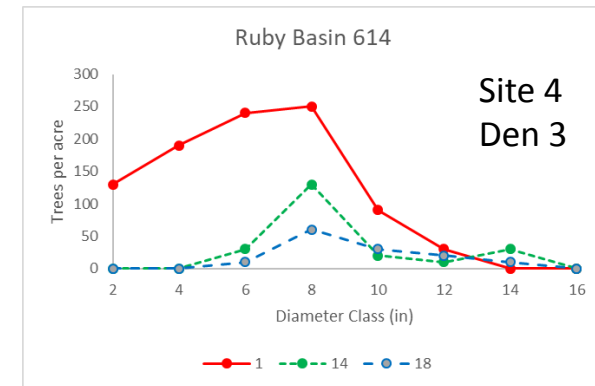
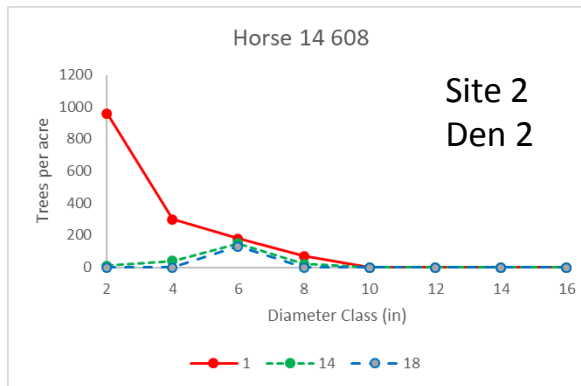
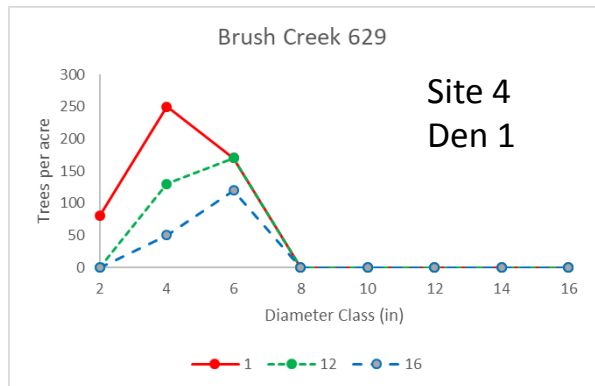
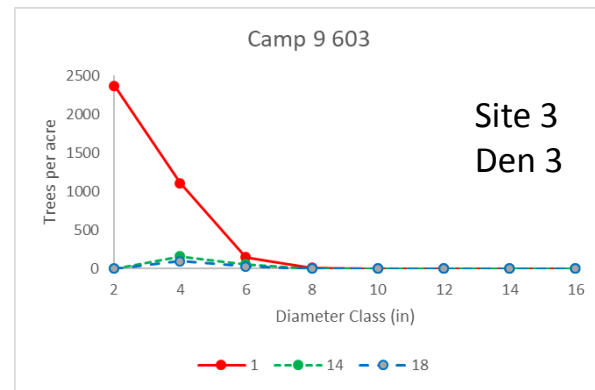
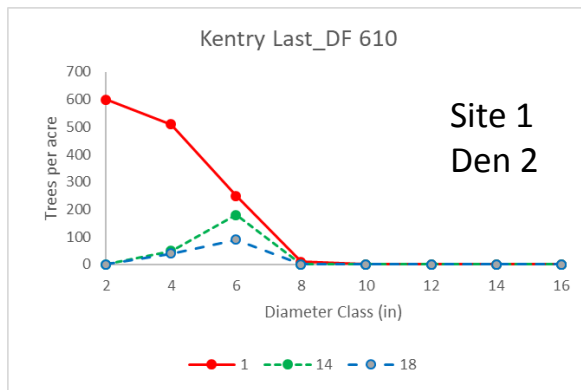
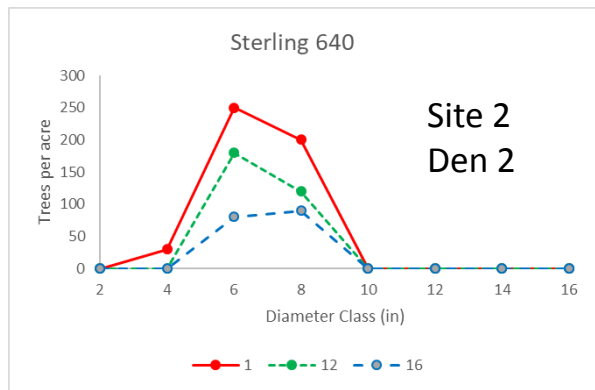
Structure modified by thinning



- Removal of ingrowth
- Shift mean diameter right

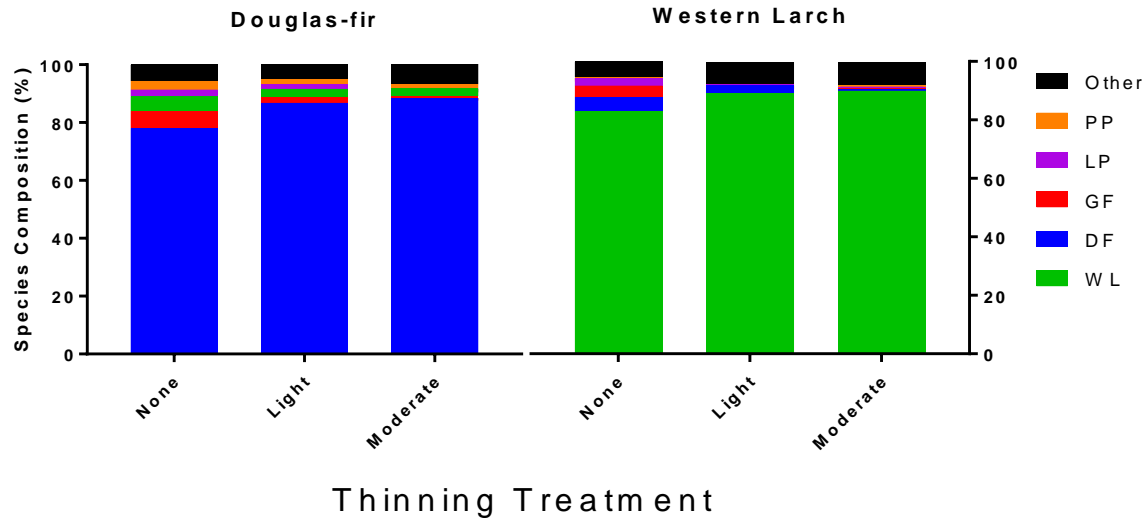


DF examples



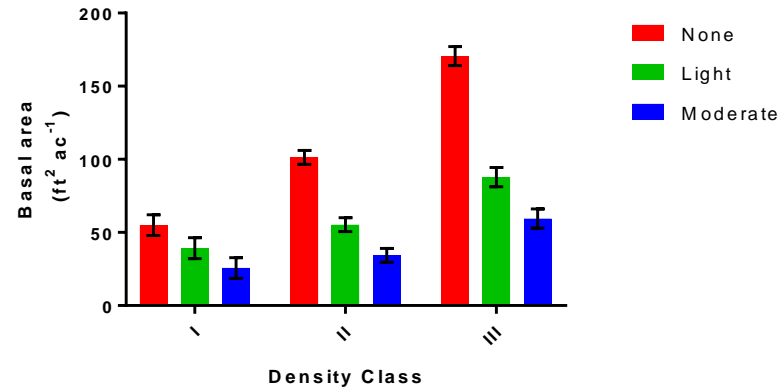
Composition modified by thinning

- Increased composition of target species to almost 90%
- Little additional effect between spacing levels
- PP was less affected than others



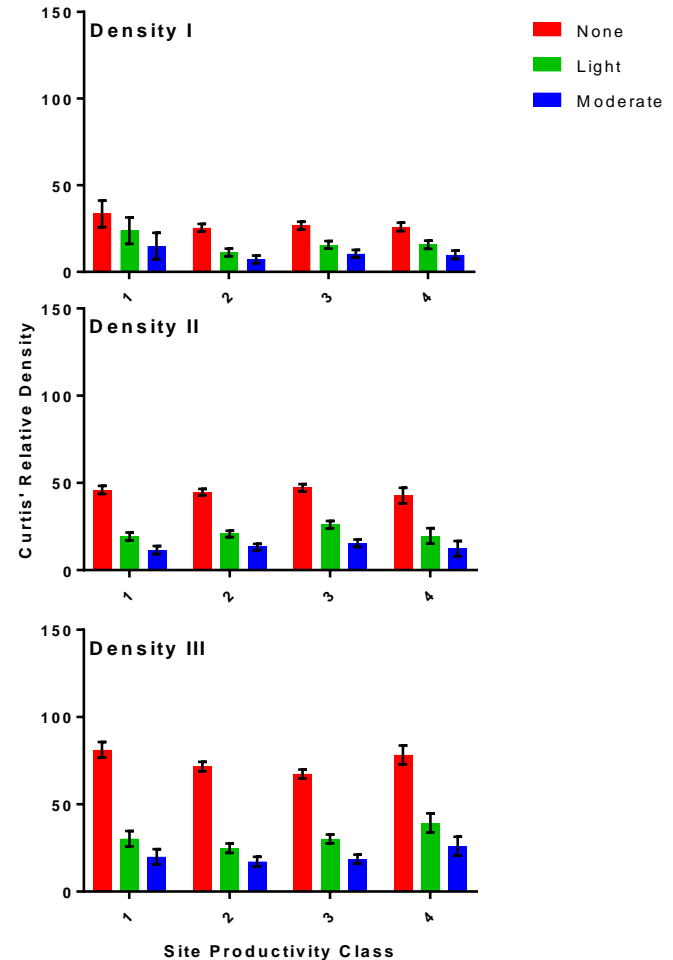
Stand metrics among experimental factors

- Basal Area
 - Reflects experimental design
 - Increases with density class in no-thin plots
 - Decreases with thinning
 - BA is not affected by productivity class



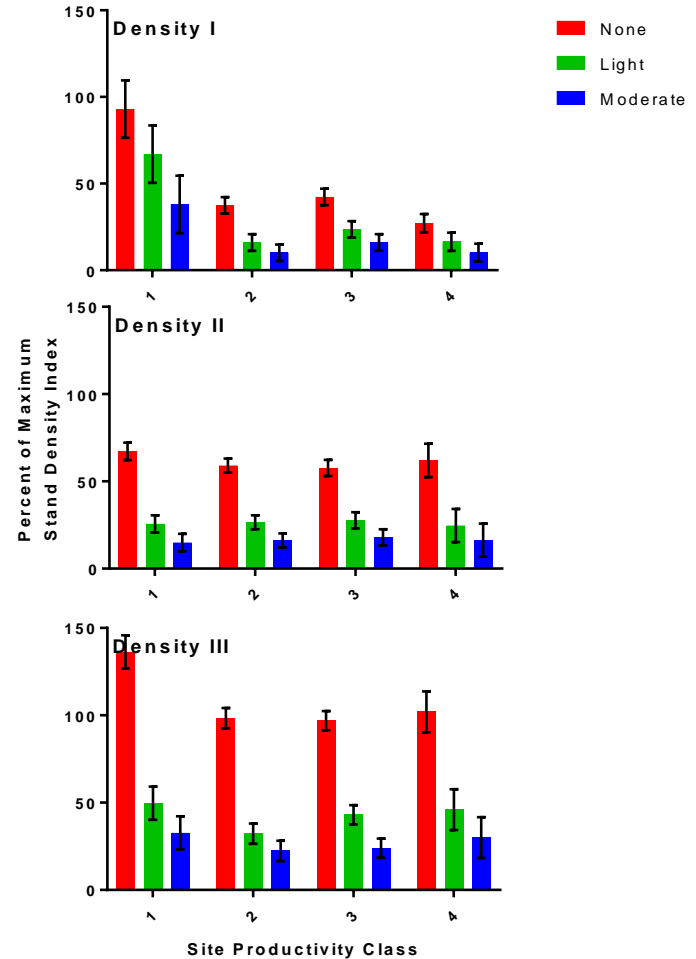
Stand metrics among experimental factors

- Stand Density
i.e. Curtis' RD
 - Increases with density class
 - Thinning decreases density
 - RD is not affected by site productivity class

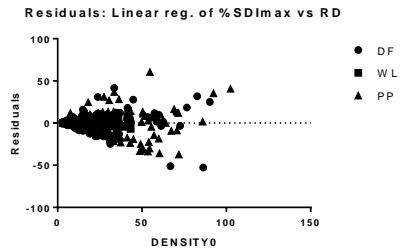
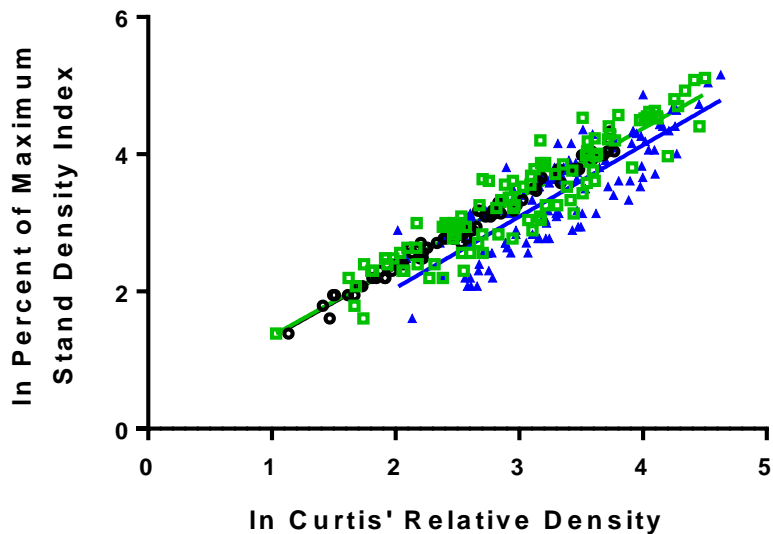


Stand metrics among experimental factors

- Stand Density
i.e. Portion of SDI_{max}
 - Increases with density class
 - Thinning decreases density

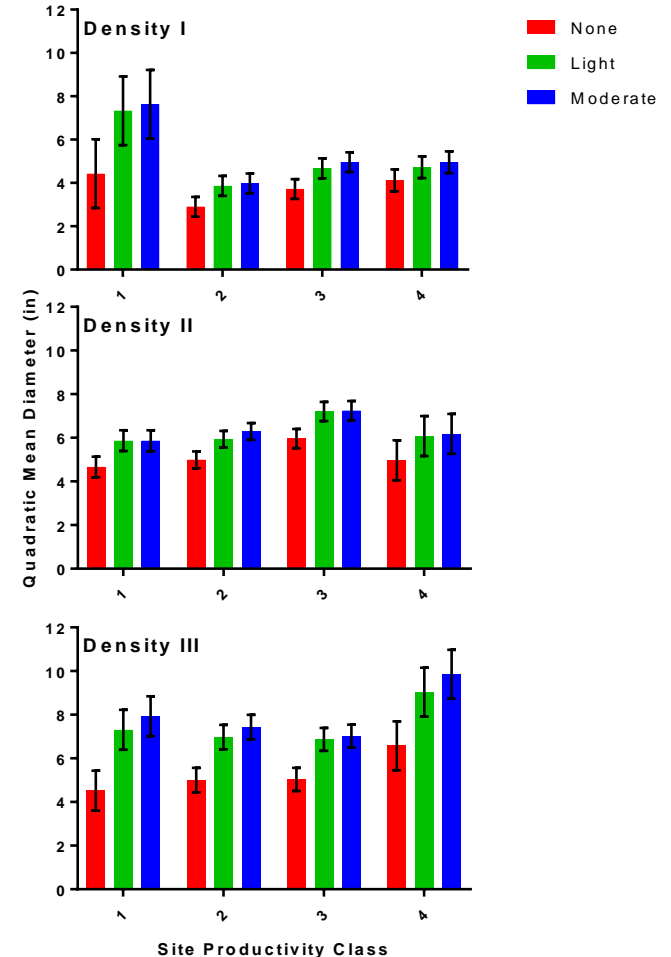
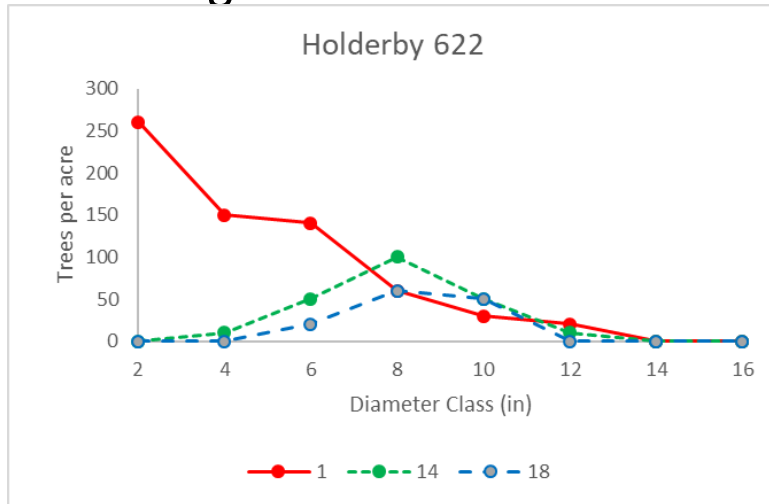


Comparison among density metrics



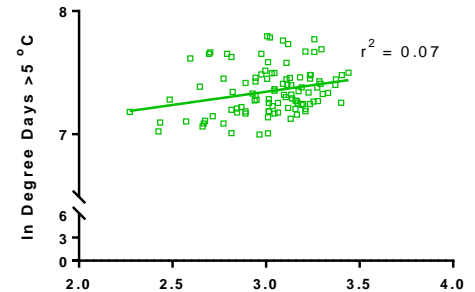
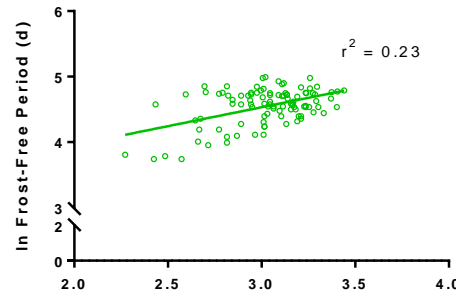
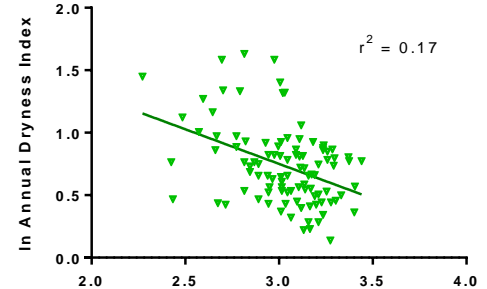
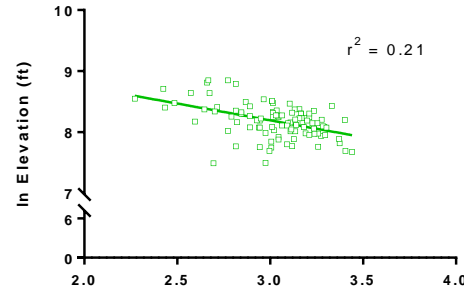
Stand metrics among experimental factors

- Diameter
 - Low in stand density class I
 - Thinning increases mean diameter, thinning from below



Ten-year Site Productivity explained by Climate and Topography

- Moisture
- Temperature



\ln Ten-year Height Growth

PPDM Establishment Summary

- Rotation-long study designed to validate SDI_{max} estimates
- Addresses where and when to most effectively thin stands
- Includes full range of productivity and stand densities
- Data analyzed through regression analysis or with analysis of variance
- Plot network will serve many purposes

