Short-term resource response to pre-commercial thinning across a range of site conditions in the Inland Pacific Northwest

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Introduction

- Stands across the Inland Northwest are overstocked from fire suppression and economic constraints

- Overstocked stands have greater competition and stress

Introduction

More competition and stress leads to:

- Mortality
- Lower growth rates
- Less adaptability to climate change
- Susceptibility to insects and disease
- Higher risk of stand replacing wildfire

http://ext.wsu.edu/forestry/foresthealth/foresthealthnotes.htm

http://www.fs.fed.us/r3/resources/health/field-guide/bb/douglas.shtml

Introduction

- Forest management practices need to address these issues in an effective, costly way

- How can this be done?

- Reduce the density of the forest

Pre-commercial thinning (PCT)

- Reduces the density of the forest to a specific target
- Young forests (~ 20-30 years)
- Remove undesirable trees or species
- Un-merchantable timber

Pre-commercial thinning (PCT)

Pros

- Reduced competition
- Increased resource availability
- Higher individual growth rates
- Resiliency to wildfire, insects and disease

Cons

- Expensive
- No immediate commercial gain
- Decreased total volume of timber

Pre-commercial thinning (PCT)

Questions:

- How to identify and or prioritize which stands receive PCT?
- Which site and stand conditions impact response to PCT?
- How do light, water, and nutrients change after PCT?
- What is the best target density or tree spacing?

Objectives

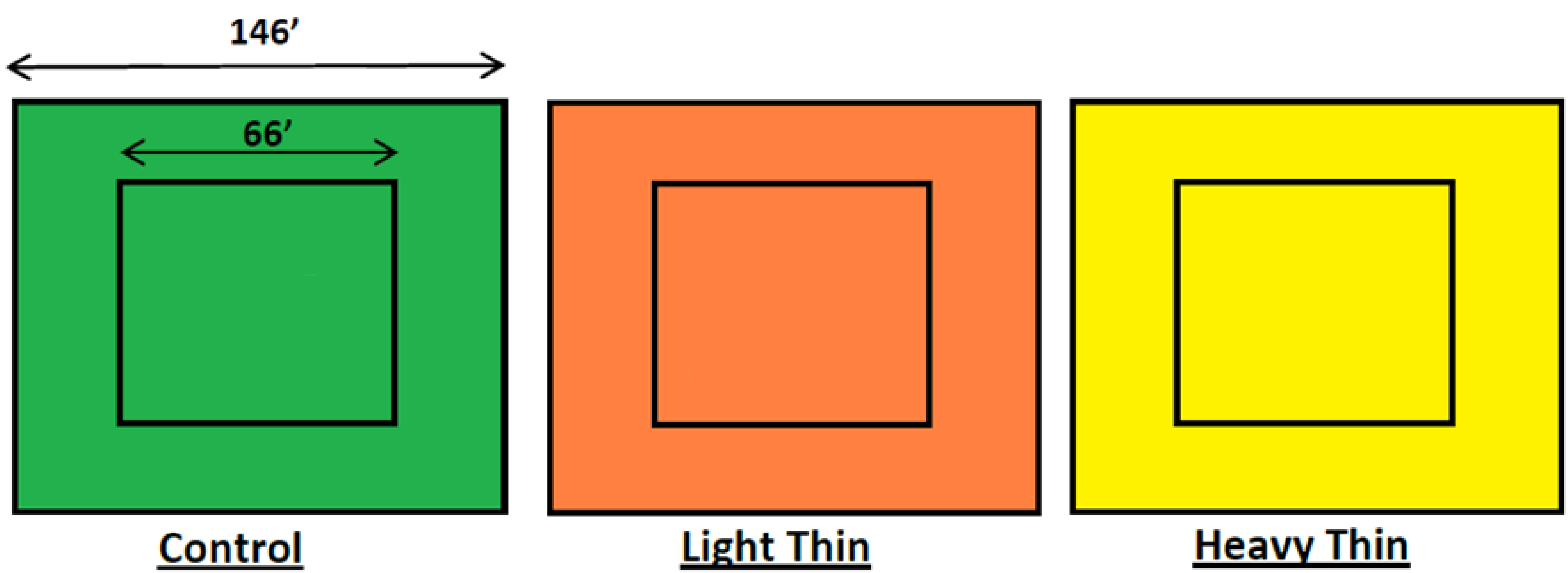
1. Quantify how light, water, and nutrients respond to PCT at different sites

2. Measure plot and dominant tree response to PCT at a range of stand productivities and densities

3. Examine how different thinning regimes impact forest growth and resource response

Methods

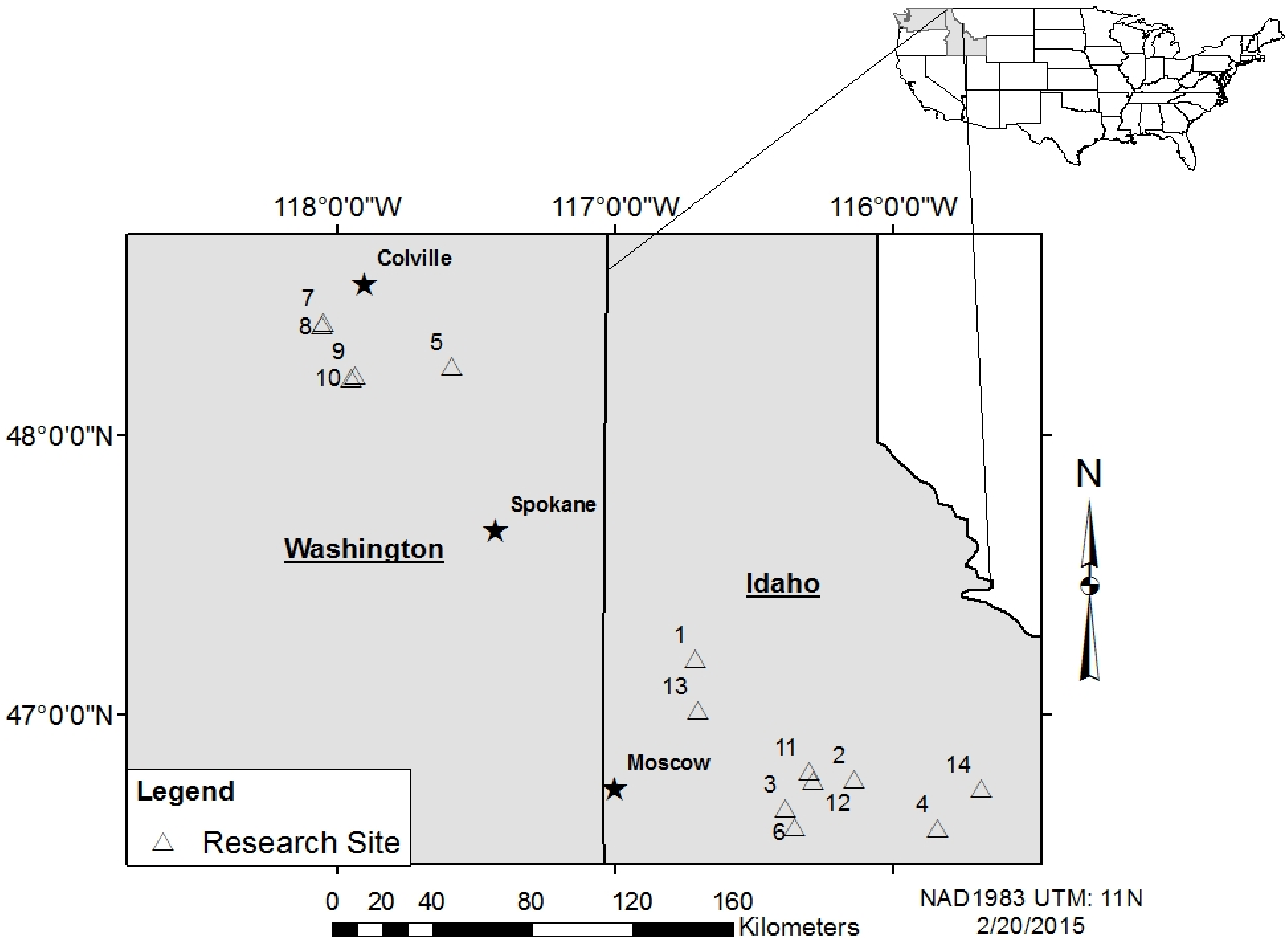
- 14 locations chosen based on density and productivity
- 3 x 0.2 hectare (half-acre) plots at each location
- Control, 4.3 m (14 foot), and 5.5 m (18 foot) spacing
- Dominated by Douglas-fir (*Pseudotsuga menziesii*)



Methods

Other site variables:

- Ash depth and duff layer depth
- Bulk density
- Precipitation and temperature from ClimateWNA model
- Parent material from site observations and soil survey maps


118°0'0"W
117°0'0"W
116°0'0"W
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Colville
Spokane
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1
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11
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13
14
N
Legend
Research Site
0 20 40 80 120 160
Kilometers
NAD1983 UTM: 11N
2/20/2015

Stand and Site Characteristics

	Basal area ($m^2\ ha^{-1}$)	Productivity ($m\ decade^{-1}$)	Stand age (years)	Trees ha^{-1}	QMD (cm)	Control SDI	Volume ($m^3\ ha^{-1}$)	Proportion Douglas-fir (%)
mean	19.21	6.52	22.14	4183.21	13.33	197.25	33.08	76
min	9.12	5.12	14.00	1112.00	9.44	106.01	10.52	47
max	28.37	7.74	30.00	8624.00	17.66	303.56	57.97	98

	Mean annual temperature (°C)	Mean annual precipitation (mm)	Elevation (m)	Ash depth (cm)	Soil bulk density (g/cm^3)
mean	6.48	931.29	1063.63	51.44	0.76
min	5.70	641.00	900.66	36.97	0.54
max	7.40	1343.00	1233.18	80.57	0.92

Habitat type	Parent materials
THPL/ASCA	gneiss
THPL/CLUN	Tertiary sediments
TSHE/ASCA	quartzite
TSHE/CLUN	mica schist
ABGR/CLUN	schist
ABGR/LIBO	granitic
	glacial
	siltite-argillite

Methods

Tree growth

- DBH and species recorded on all trees in every plot for both 2013 and 2014
- Random subsample of 5 trees per 1 inch diameter class for:
  - Total height
  - Base of live crown
  - Current year leader growth
  - Crown classes

Methods

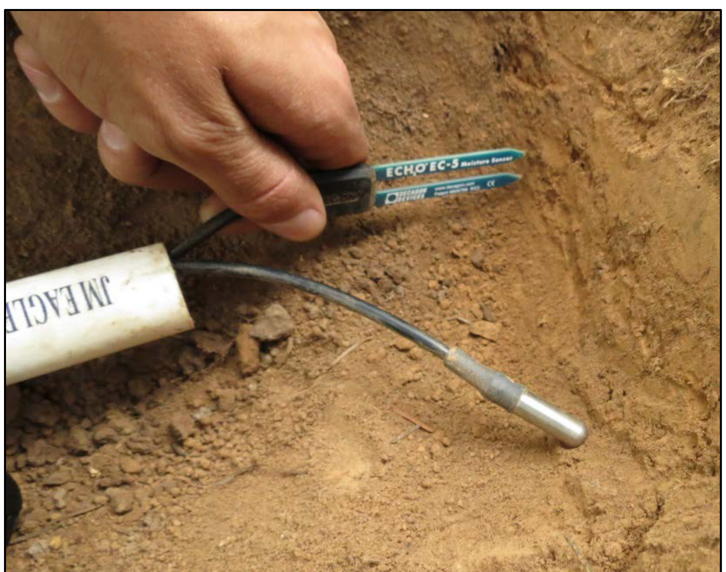
Physical Resources: Light

- Photosynthetically Active Radiation (PAR) measured with a ceptometer
- Calibrated with a beam fraction sensor measuring total available light
- Difference between total and PAR is intercepted (iPAR)

Methods

Physical Resources: Water

- 6 sites measuring soil VWC every 3 hours
- One logger per plot with 2 sensors at 15 cm depth
- Other 8 sites had 3-5 “spot” soil moisture measurements
    - Spring, summer, and fall 2014



Methods

Physical Resources: Temperature

- All 14 sites had soil temperature sensors taking measurements every 3 hours
- 2 per plot at 15 cm depth
- Installed during Summer 2013
- Removed late Summer 2014

http://www.maximintegrated.com/en/app-notes/index.mvp/id/5405

Methods

Chemical Resources: Soil nutrients

- Collected during the Summer of 2014
- 3 random bulk density samples per plot
- Analyzed for pH, K, SO_4, P, OM, NO_3, NH_4, and B

http://www.bapequipmentstore.com/index.php?l=product_detail&p=615

http://www.soilquality.org.au/factsheets/bulk-density-measurement

Methods

Chemical Resources: Resin capsules (soil solution)

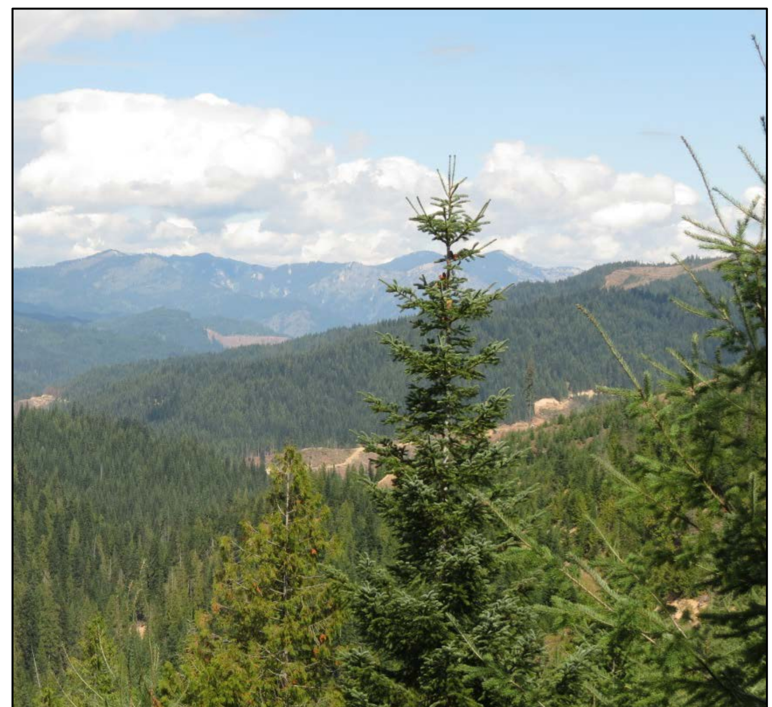
- On 6 of the 14 sites
- 5 per plot, 15 cm depth
- Installed summer of 2013, removed summer 2014
- Analyzed for:
  - total N, NO_3, NH_4, Al, B, Ca, Cu, Fe, K, Mg, Mn, Na, P, S, and Zn

Methods

Chemical Resources: Foliage (field)

- Collected after bud set (September) 2014
- 5 dominant Douglas-fir sampled in every plot
- 4 branches from the top 1/3 of the crown
- Current year needles

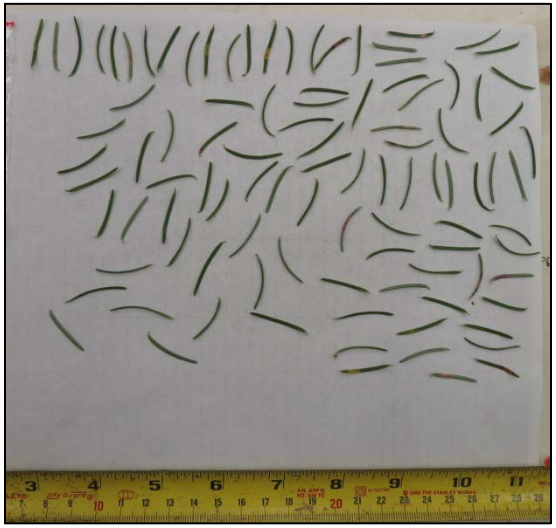
http://www.amleo.com/leonard-pole-pruner-%2526-saw-combination-with-wood-poles/p/740W/



Methods

Chemical Resources: Foliage (Lab)

- Composite sample of 100 needles for each tree
- Pictures taken and analyzed using ImageJ for leaf area
- Needles dried at 65 °C for 48 hours, then ground
- Analyzed for:
  - N, P, K, Mg, Ca, S, Zn, Mn, Cu, Fe, B, and Al



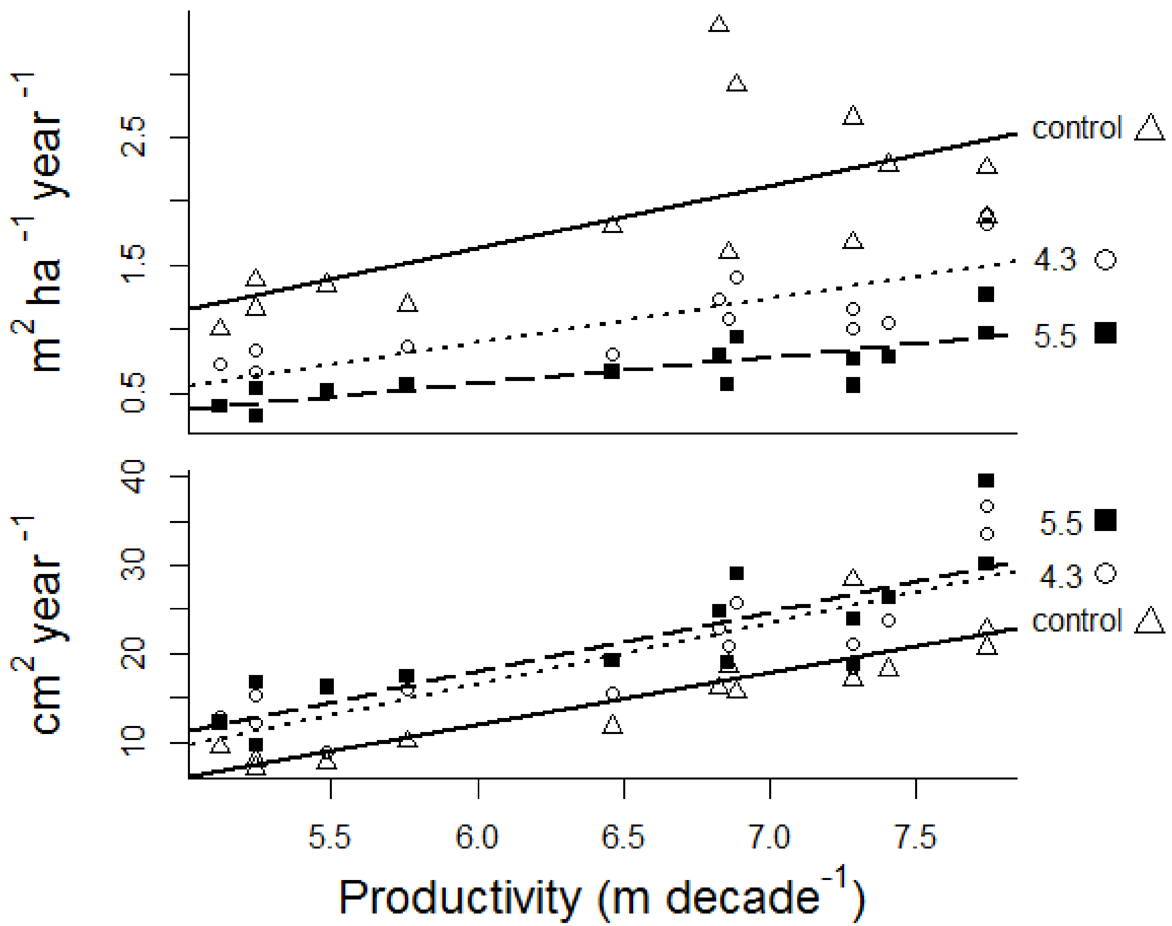
Data Analysis

- Analysis of covariance (ANCOVA) design
- Response variables included:
    - Light, water, nutrients, tree growth
- Thinning was a factor
- Productivity, and density were continuous covariates
- Other covariates:
    - Elevation, precipitation, bulk density, etc. . .
- Analyzed using R studio (R version 3.0.1)

Results

Tree growth:

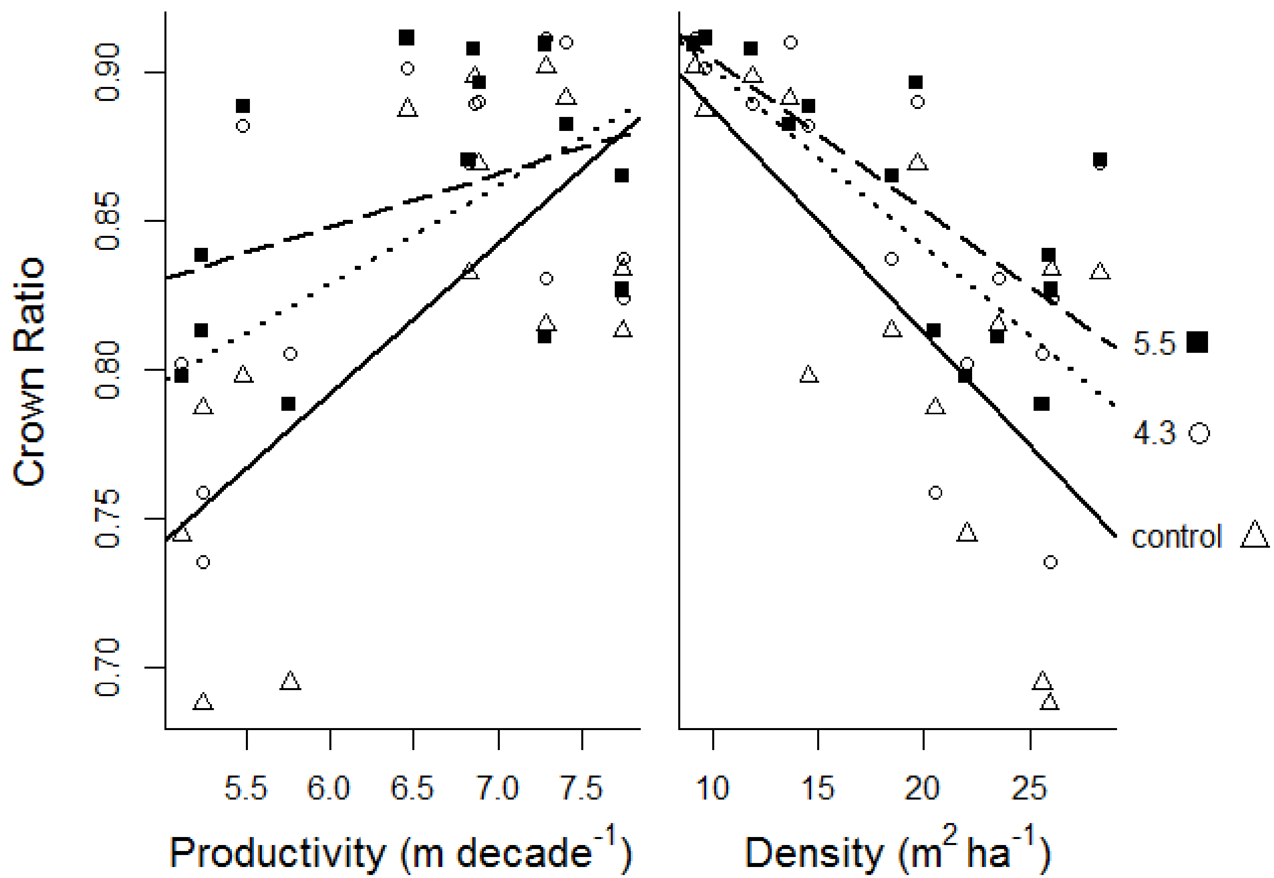
- More growth at higher productivity sites
- Plot (top) and dominant tree growth (bottom)



Results

Crown ratio:

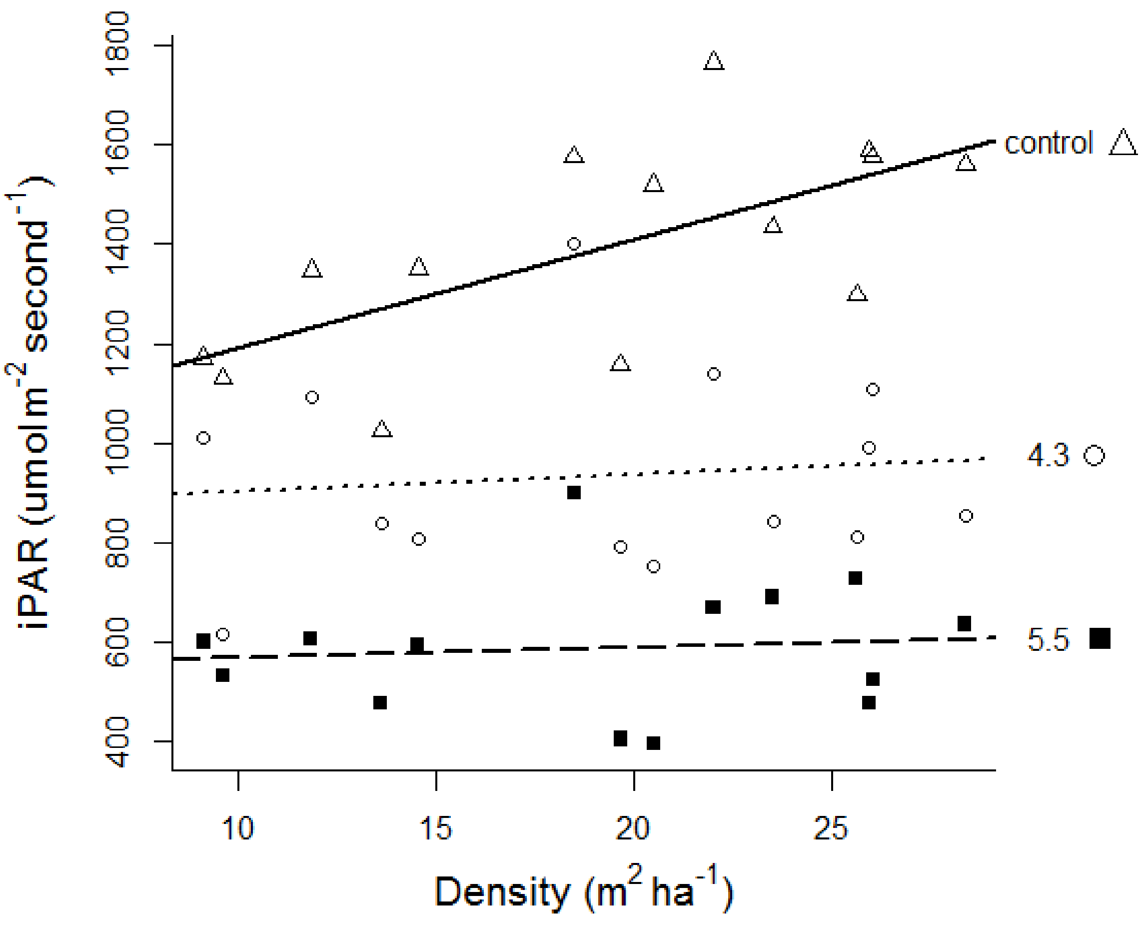
- Positively correlated with productivity
- Negatively correlated with density
- Increased by PCT!



Results

Physical Resources: Light (iPAR)

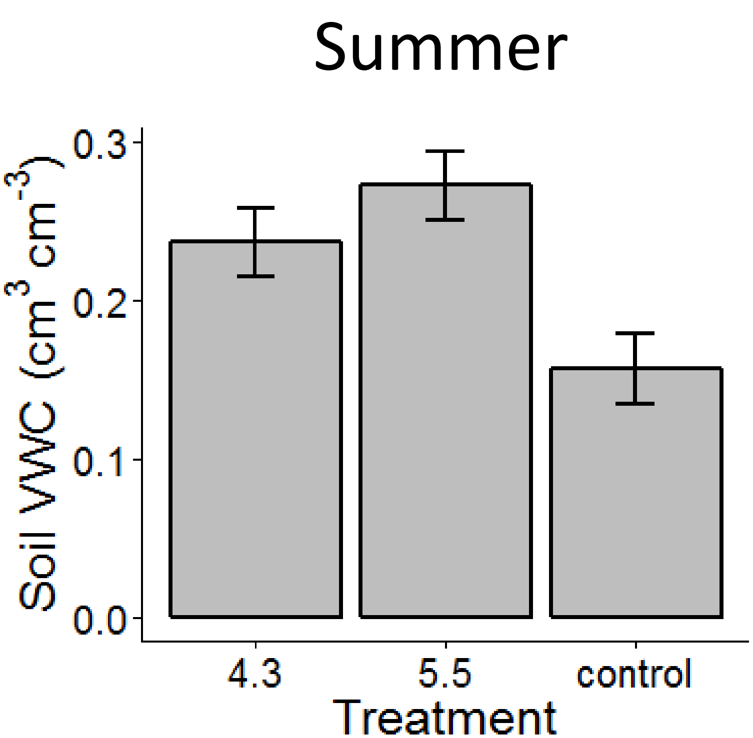
- More light interception at higher densities
- Thinning decreased light interception

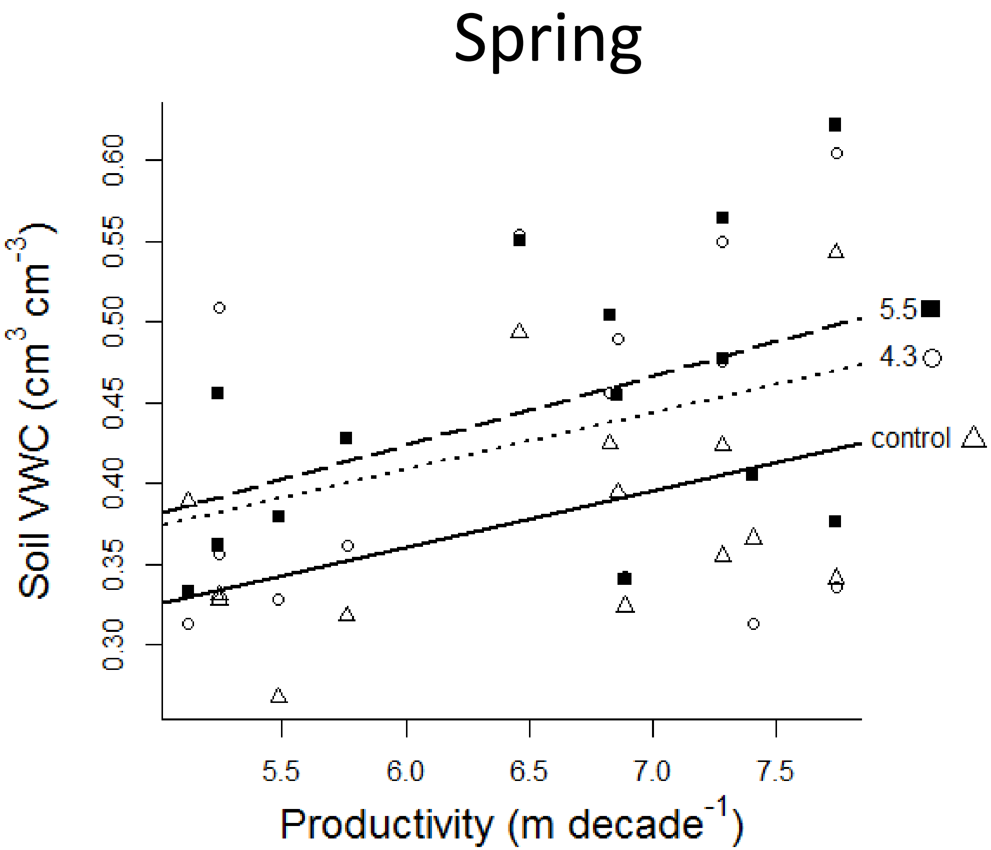


Results

Physical Resources: Water

- Thinning increased Spring and Summer soil moisture
- Spring VWC influenced by productivity

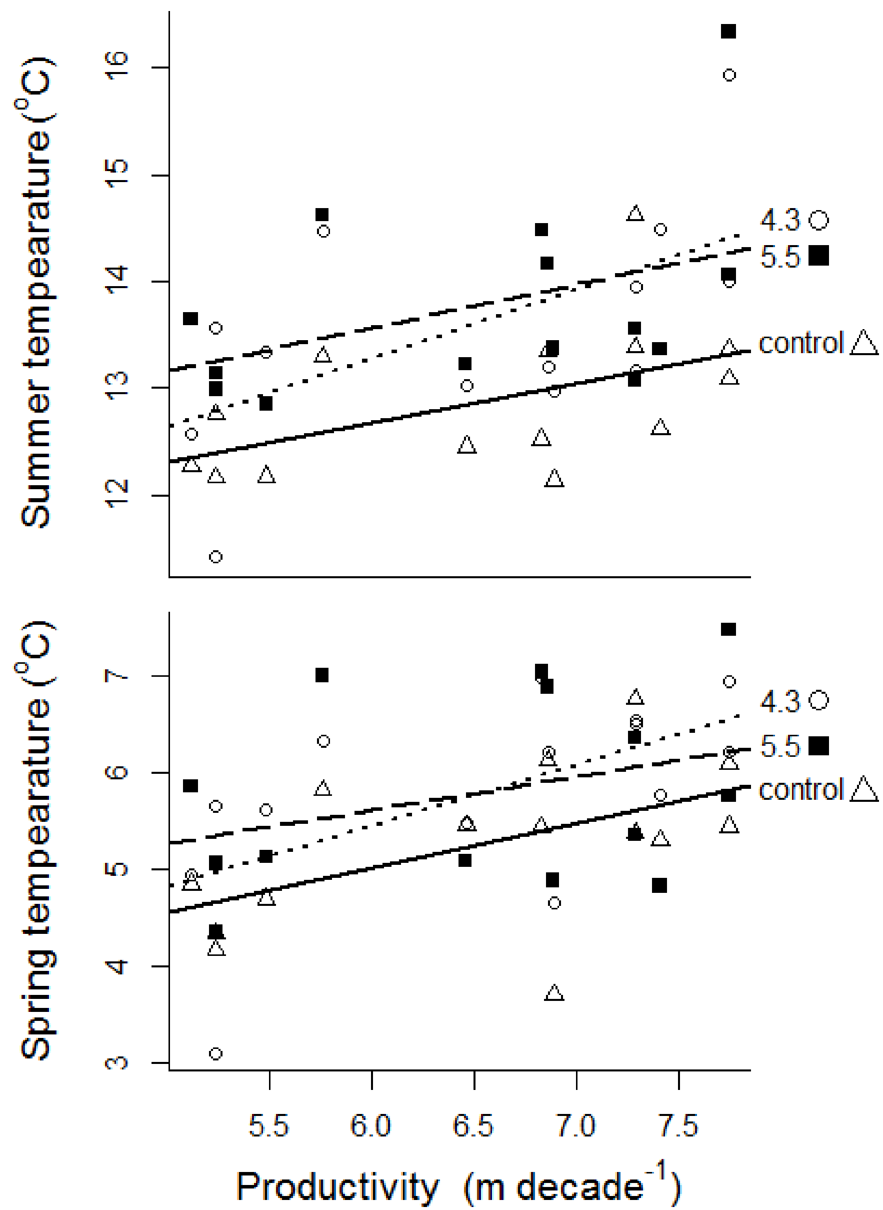




Results

Physical Resources: Temperature

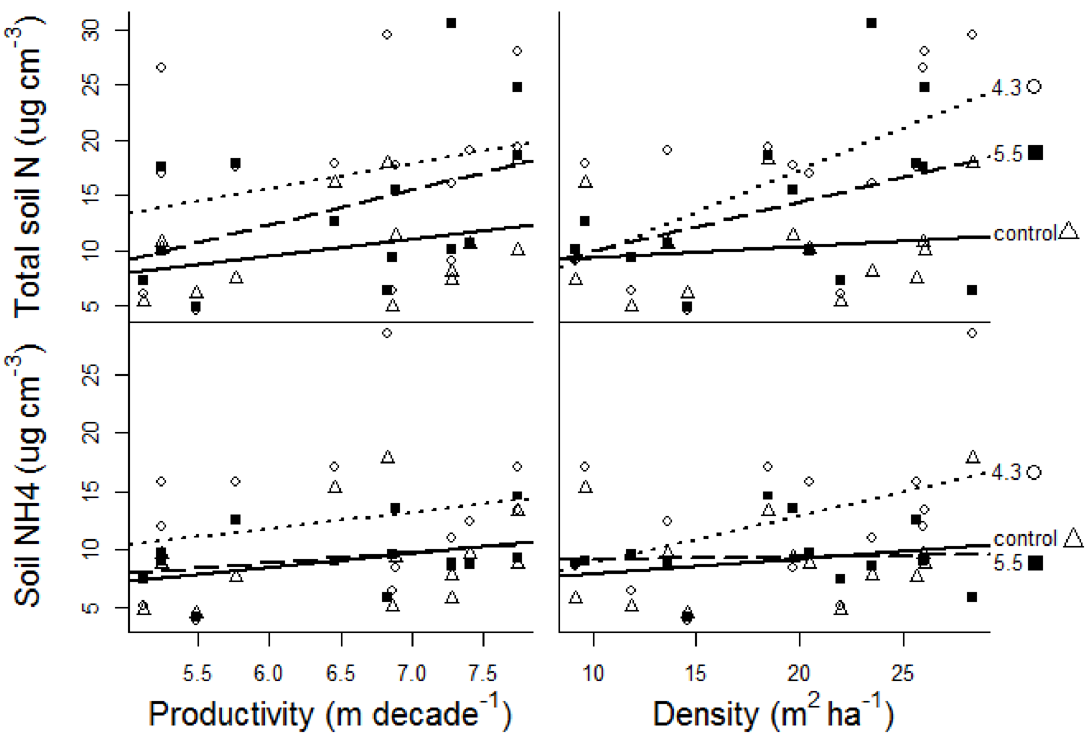
- Increased in both the spring and summer
- Positively correlated with productivity

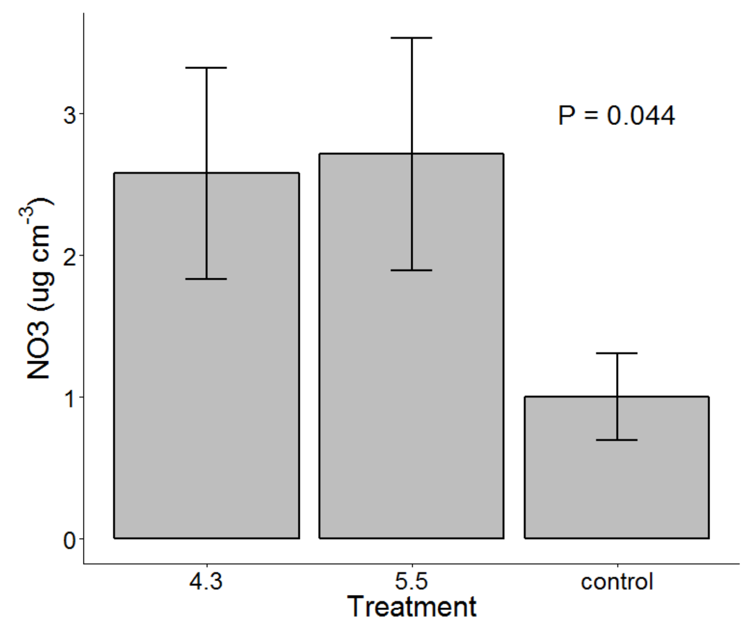


Results

Chemical Resources: Soils

- Higher total N and NO_3
- NH_4 wasn't significant but still influenced response

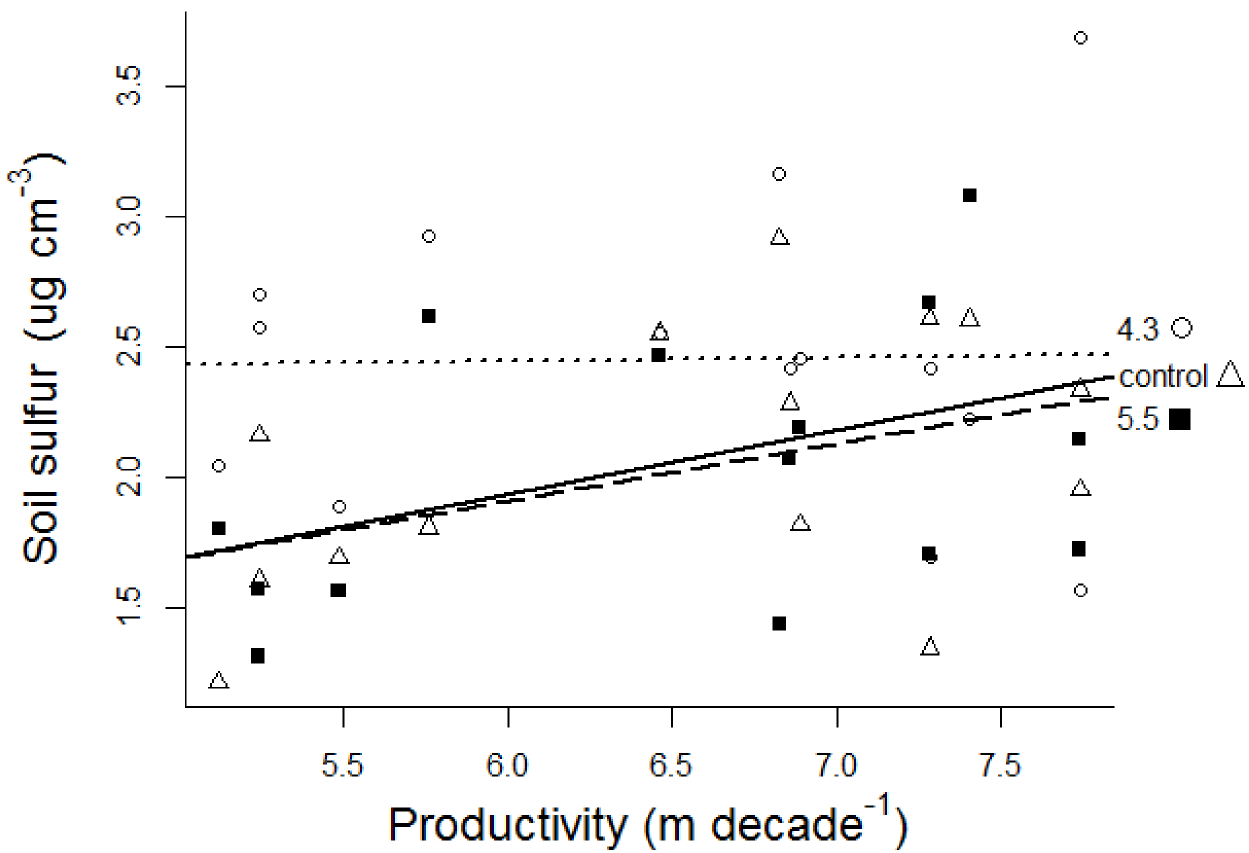




Results

Chemical Resources: Soils

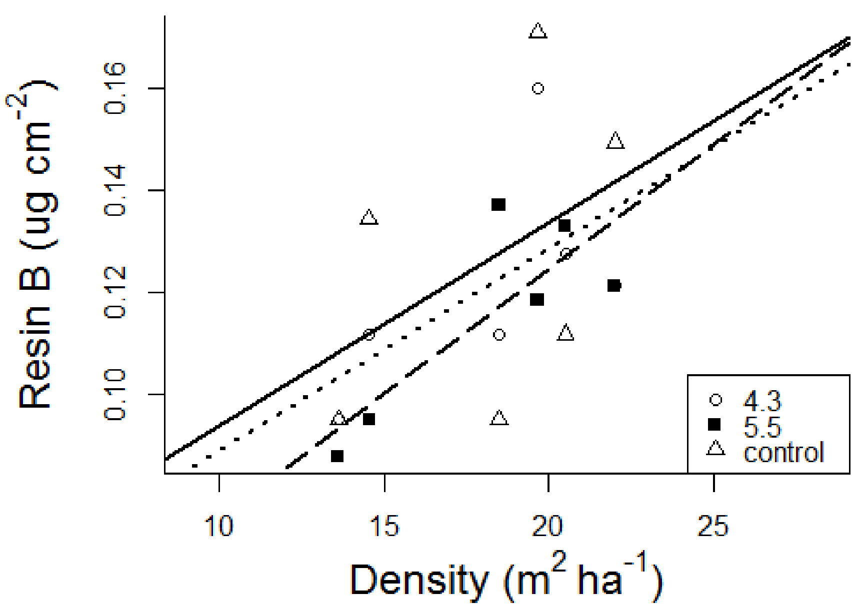
- Sulfur increased by thinning and productivity
- $P < 0.1$

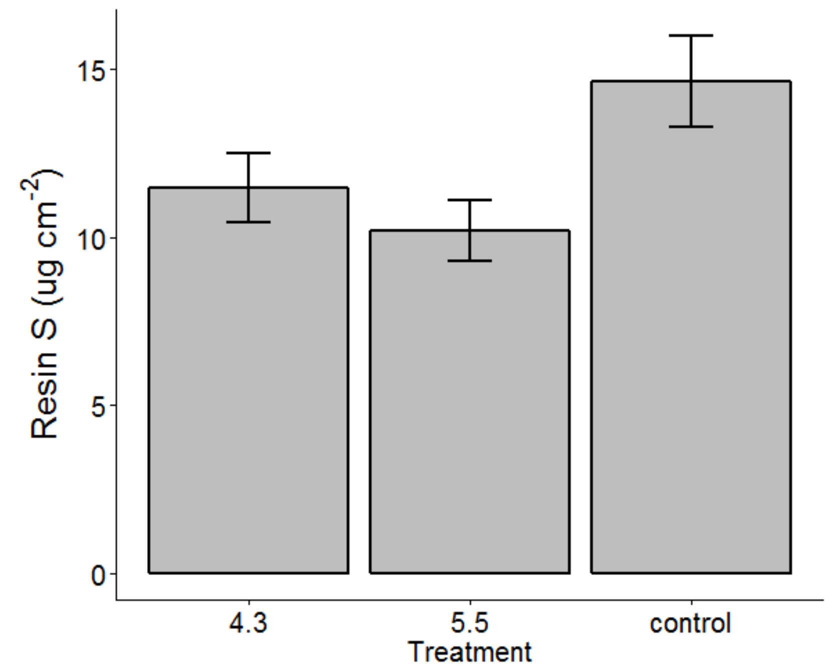


Results

Chemical Resources: Resin capsules

- Less B available in the soil solution after thinning
- More B in solution at greater initial stand densities
- Less S in resin capsules after thinning

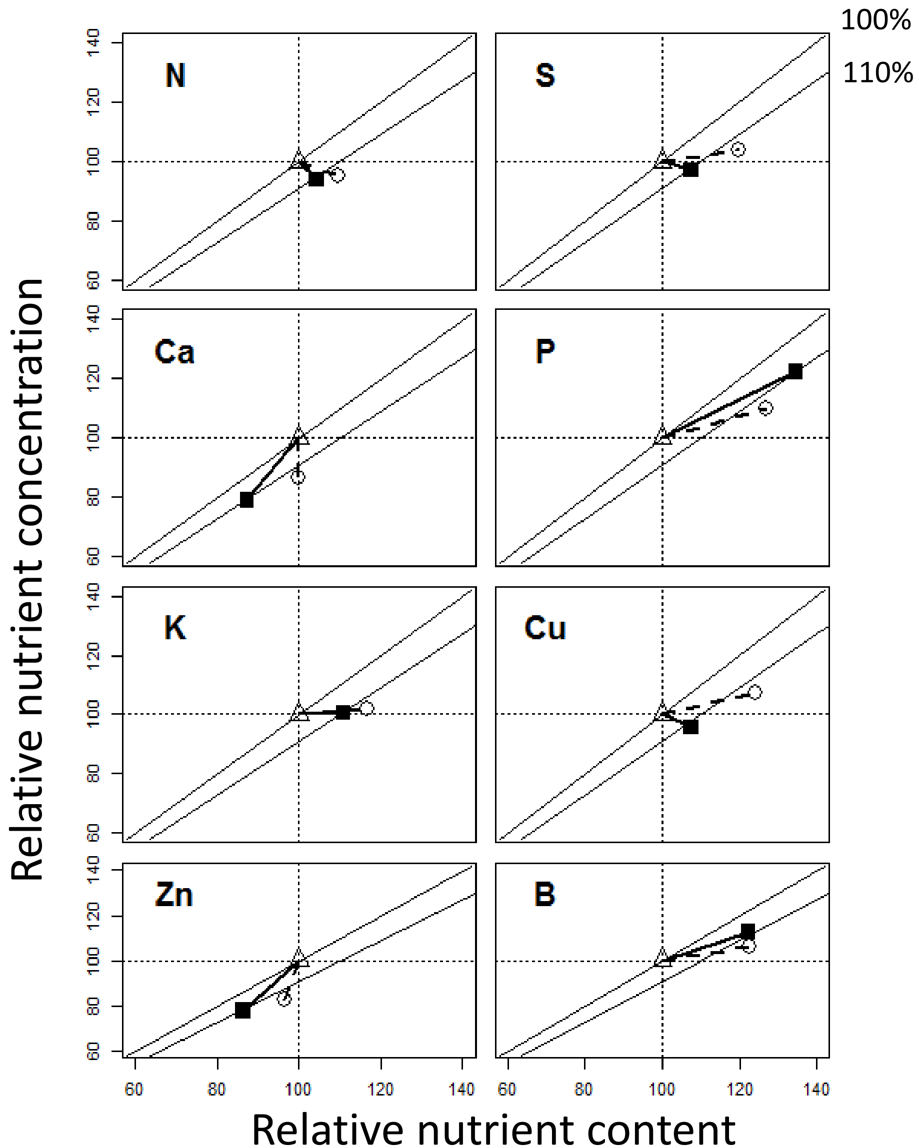




Results

Chemical Resources: Foliage

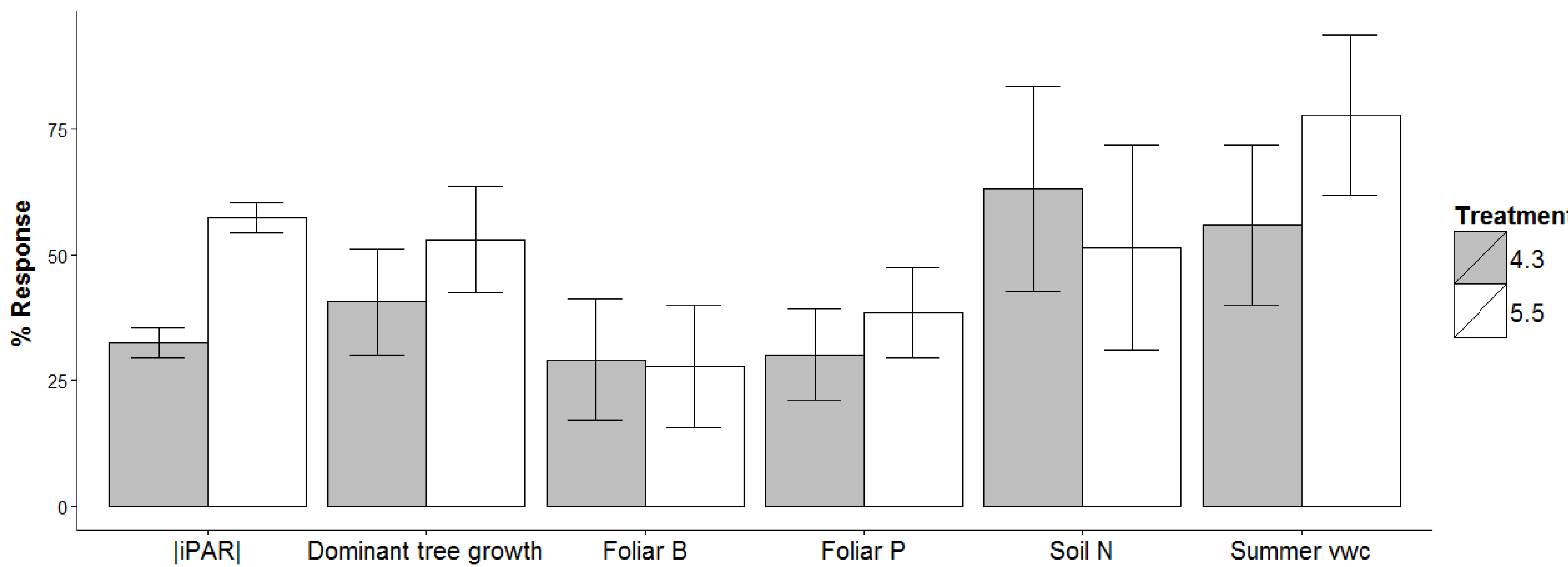
- Concentrations of N, Ca, and Zn declined
- P concentration increased
- P, K, S, Cu, B, and Al content increased
- Zn, Ca content decreased



Treatments include a control (△), 4.3 m spacing (○) and 5.5 m spacing (■).

Summary

- Water, soil N, and light had the highest relative response



Conclusions

- PCT improves the availability of:
  - Light
  - Moisture (spring and summer)
  - Temperature (spring and summer)
  - Soil N
  - Uptake of P, S, K, B, and Cu

- Greater availability of resources after thinning will reduce stress, improve growth, and resistance to insects and disease

- Most stress relief at low productivity sites with high densities

Acknowledgements

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  - Hancock Forest Management
  - Stimson

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Questions