Managing Climate Change Adaptation in Forests: a Case Study from the U.S. Southwest

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PIPO Forest Restoration

Forest restoration thinning & burning

Low-density forests

Less competition for water & light

Increased growth in residual trees

Increased resilience against drought, pathogens & catastrophic fire

Perpetual forests

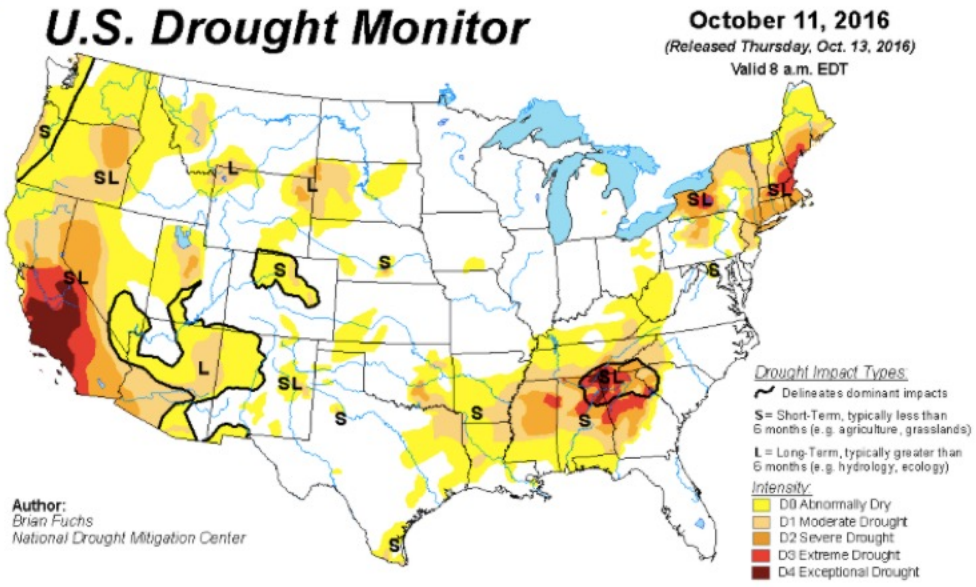
Research Questions

Forest restoration thinning & burning

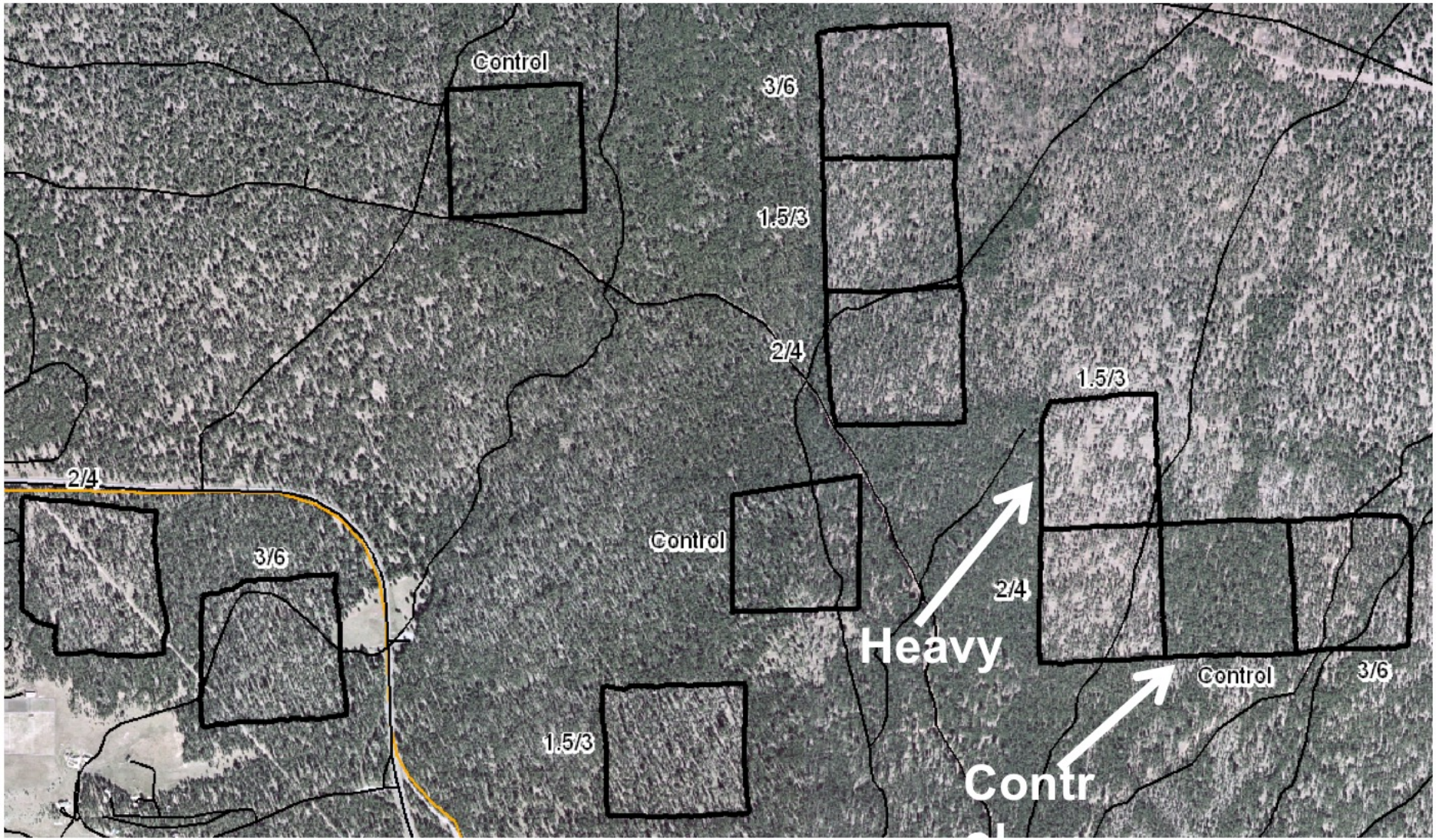
1) Growth?

2) Drought resilience?

3) Seasonal Water Use?



Fort Valley Experimental Forest



Tree Growth Patterns

Previous Research

1. Thinning creates a release effect
2. Large trees less responsive to thinning than small trees
3. Variable growth rates within large trees

Tree Growth Patterns

Treetop

Mid-Crown Branch

Base of Live Crown

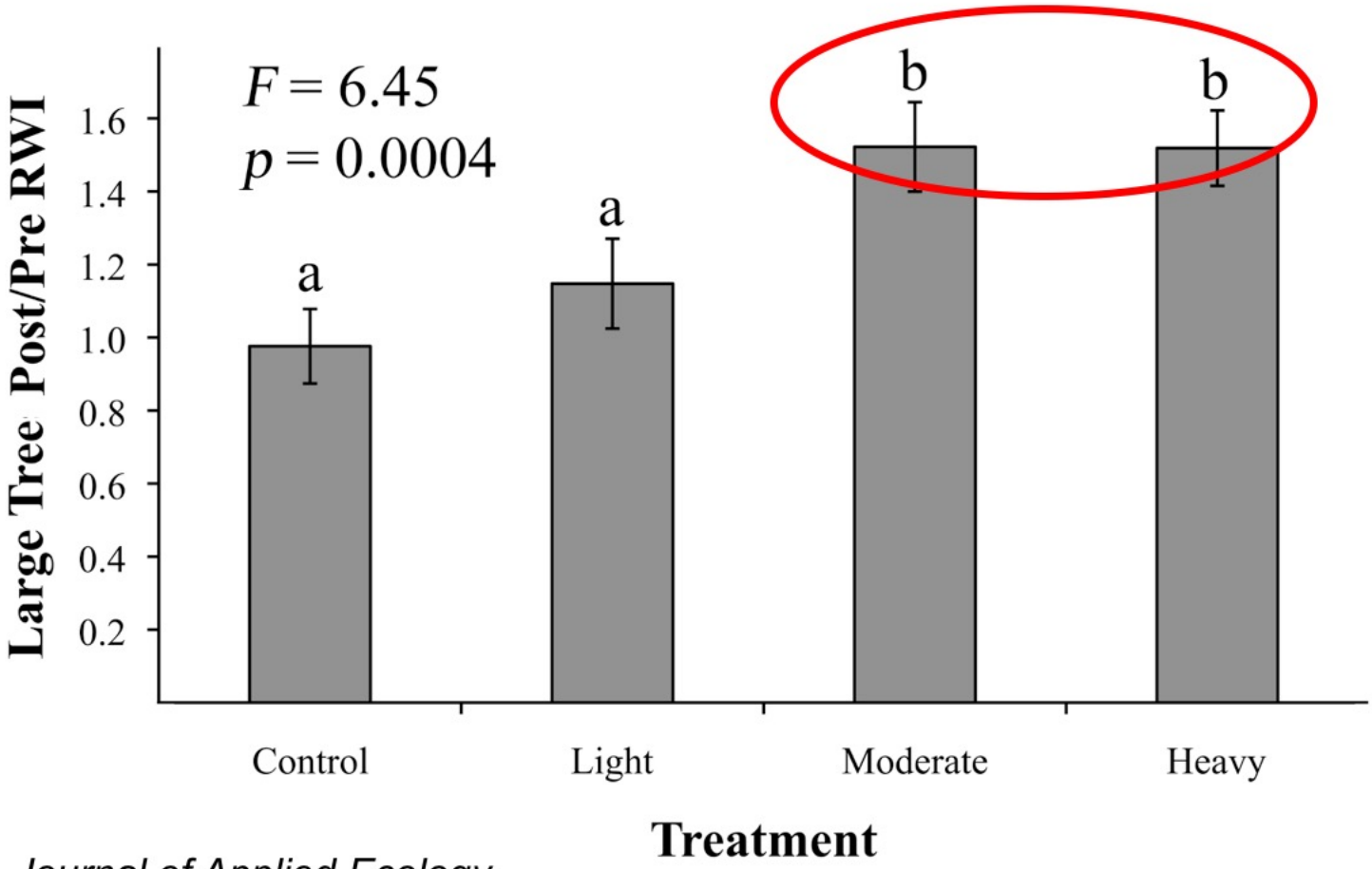
Breast Height

Coarse Root

Tree Growth Patterns

Results

1. Moderate & heavy treatments had greatest release effect and this was uniform throughout large trees

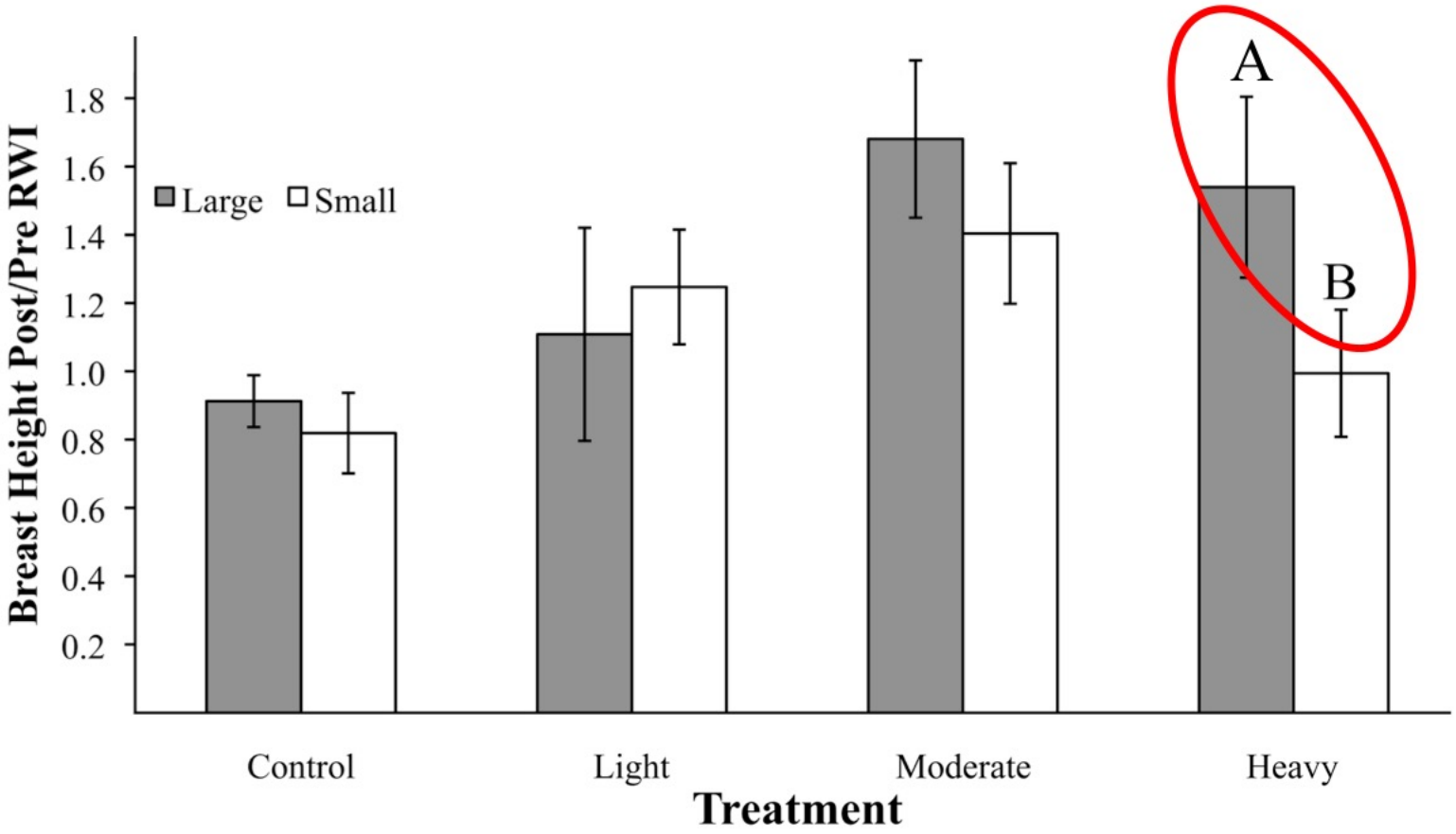


Kerhoulas et al. 2013, *Journal of Applied Ecology*

Tree Growth Patterns

Results

2. Large trees more responisive to heavy treatment than small trees

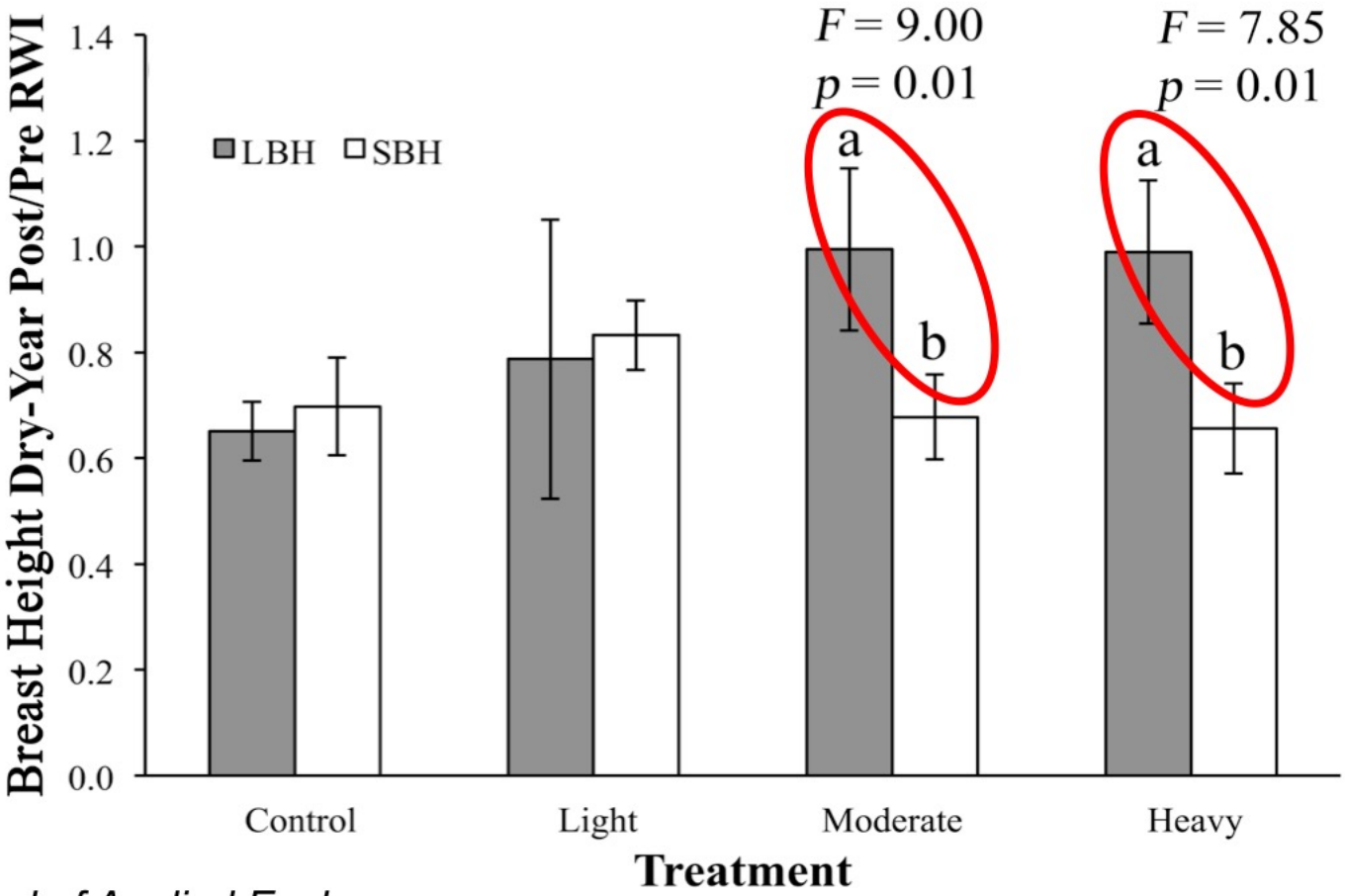


Kerhoulas et al. 2013, *Journal of Applied Ecology*

Tree Growth Patterns

Results

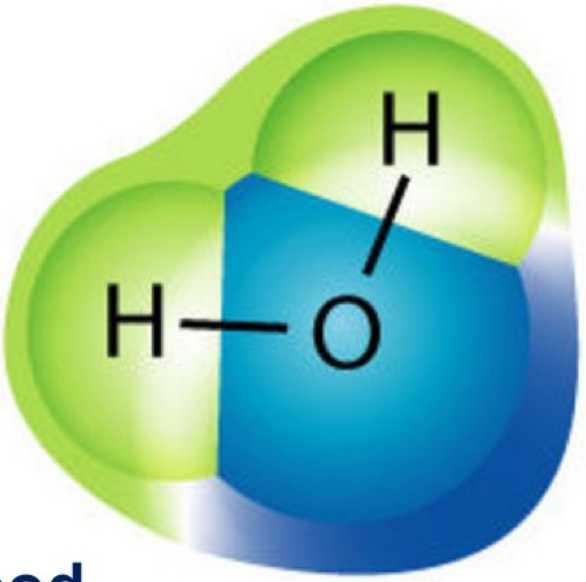
3. Moderate & heavy treatments buffered dry-year growth in large trees

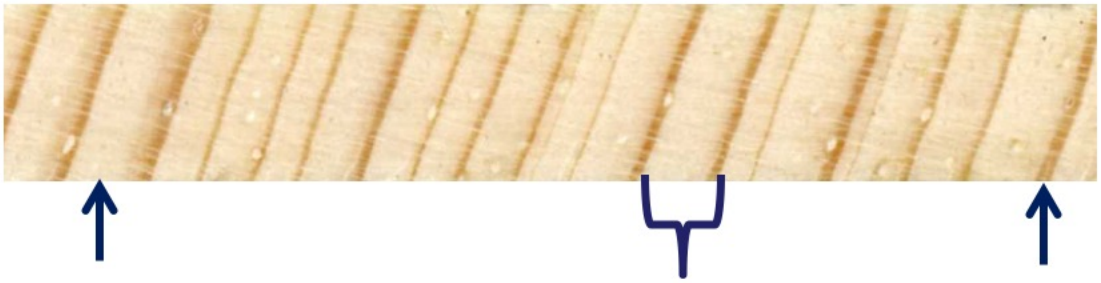


Kerhoulas et al. 2013, *Journal of Applied Ecology*

Bimodal Precipitation

- ~50% Winter snow = light δD
- ~50% Monsoon rain = heavy δD



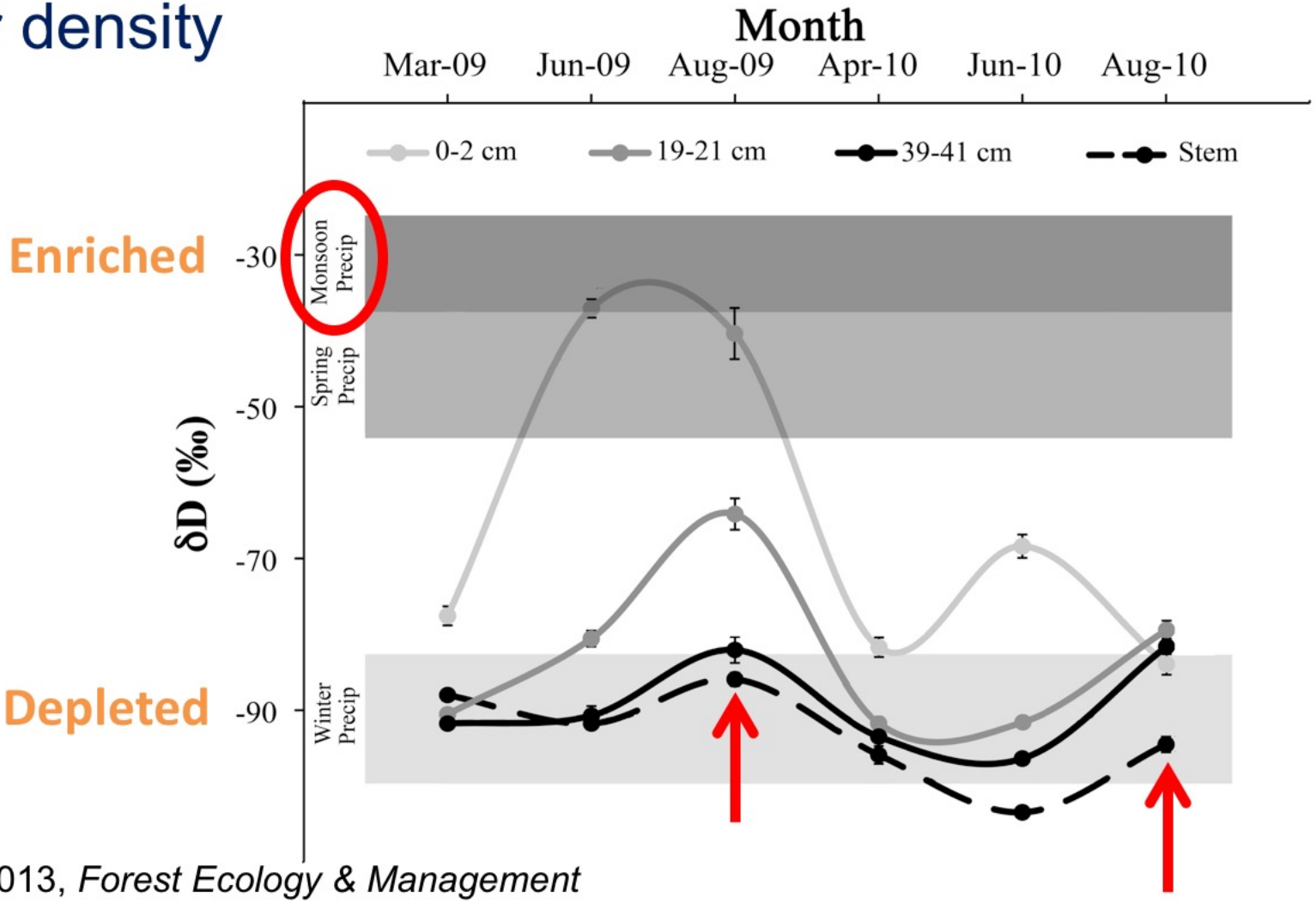


Earlywood **1 Annual Ring** **Latewood**

Seasonal Water Use

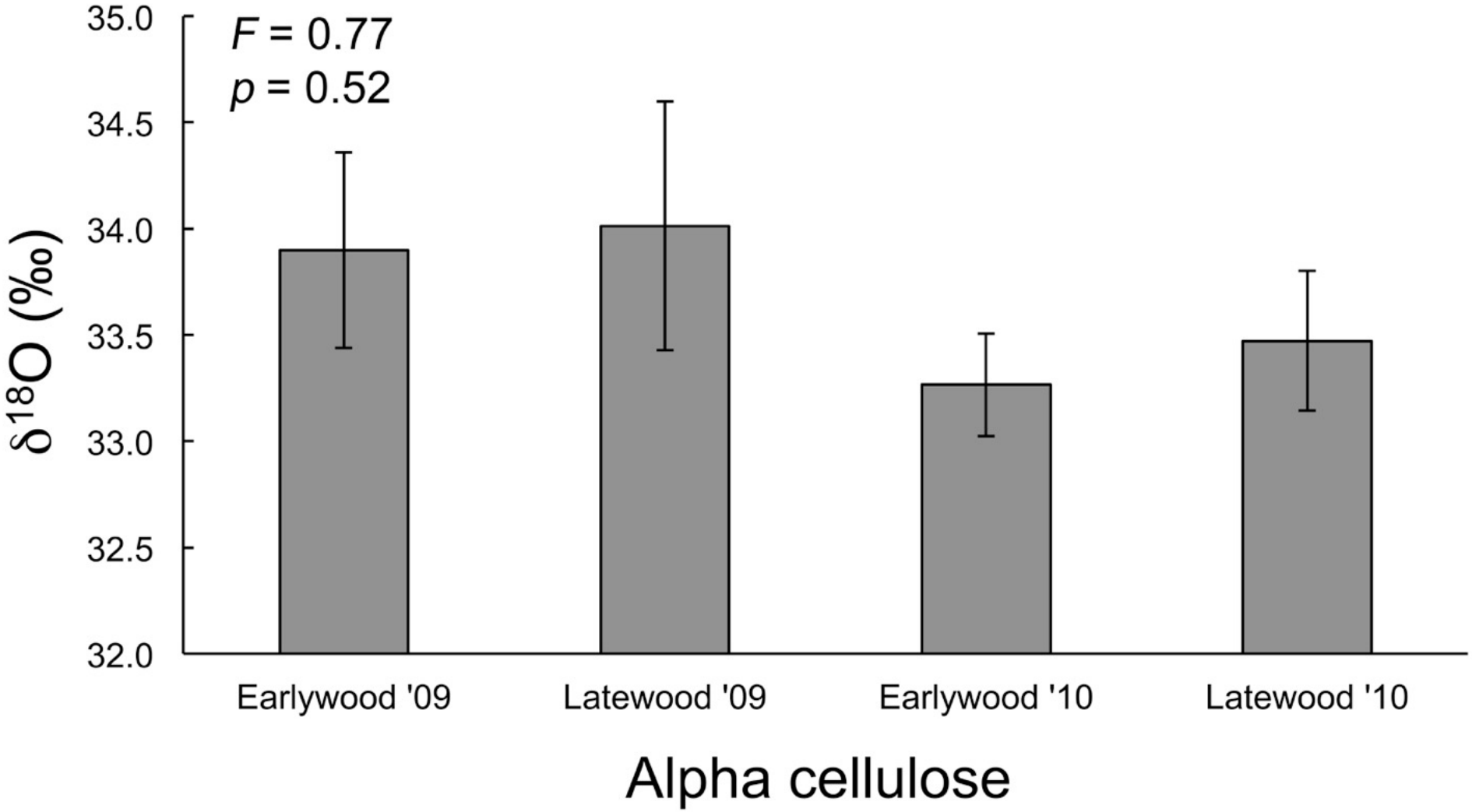
Results

1. Trees use winter water for EW & LW regardless of size or density



Kerhoulas et al. 2013, *Forest Ecology & Management*

Seasonal Water Use



Kerhoulas et al. 2017, *In Preparation*

Seasonal Water Use

a) Multivariate model using VPD, PDSI, and precipitation

Time	Model Statistics	Parameters	*t* Ratio	*p*
August	$F = 13.55$	PDSI	-2.23	0.01
	$p < 0.0001$	VPD	4.40	<0.0001
	$R^2 = 0.42$	Precipitation	1.46	0.15

b) Model after reverse order stepwise linear regression

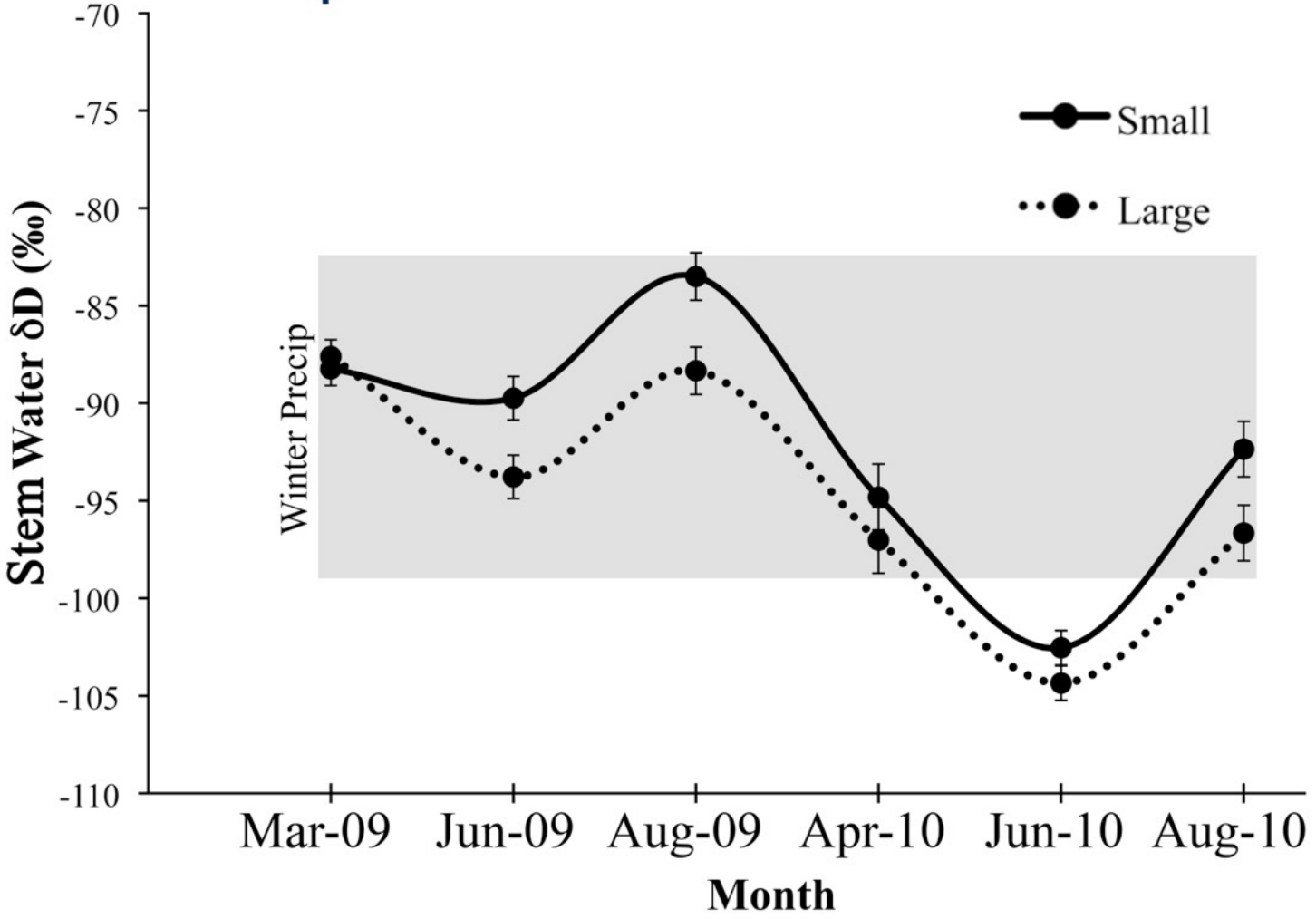
Time	Model Statistics	Parameters	*t* Ratio	*p*
August	$F = 18.89$	VPD	-3.50	0.001
	$p < 0.0001$	PDSI	4.76	<0.0001
	$R^2 = 0.39$			

Kerhoulas et al. 2017, *In Preparation*

Seasonal Water Use

Results

2. Large trees use deeper water than small trees



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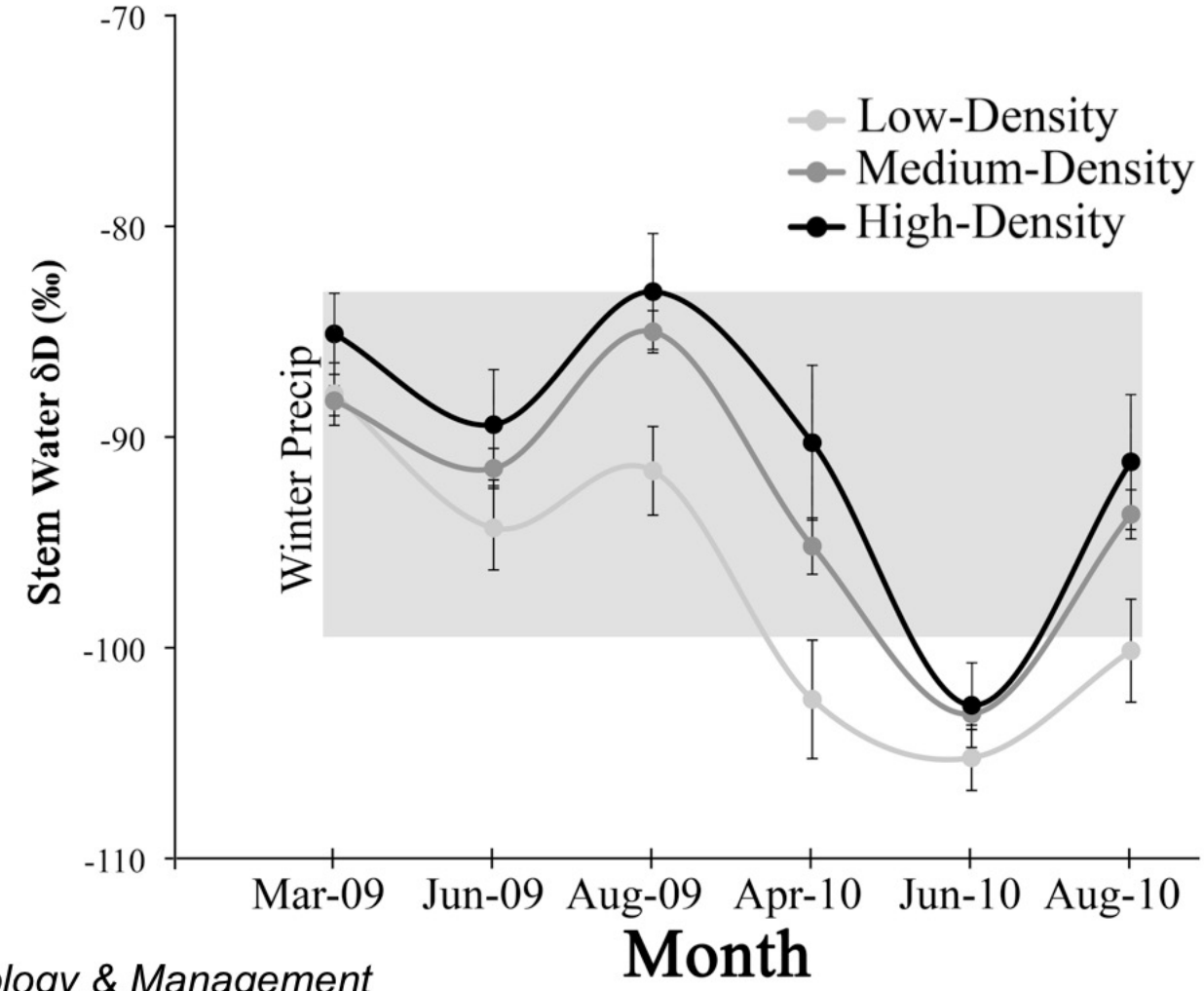
Seasonal Water Use

Results

3. Stem water more depleted in low-density stands



Kerhoulas et al. 2013, *Forest Ecology & Management*

Conclusions

1. Heavier thinning treatments yield greatest release effect & drought resilience
2. Large trees more responsive to treatments than small trees & use deeper water source
3. Winter water inputs used for EW & LW growth
4. August VPD & PDSI stronger influence on LW growth than precipitation

Acknowledgments

- Field help
  - Nick Kerhoulas
  - Nick Umstattd
- NAU
  - CPSIL
- Funding
  - DOE
  - NSF
  - SFAZ
  - ARCS
  - WREP
  - WRRC

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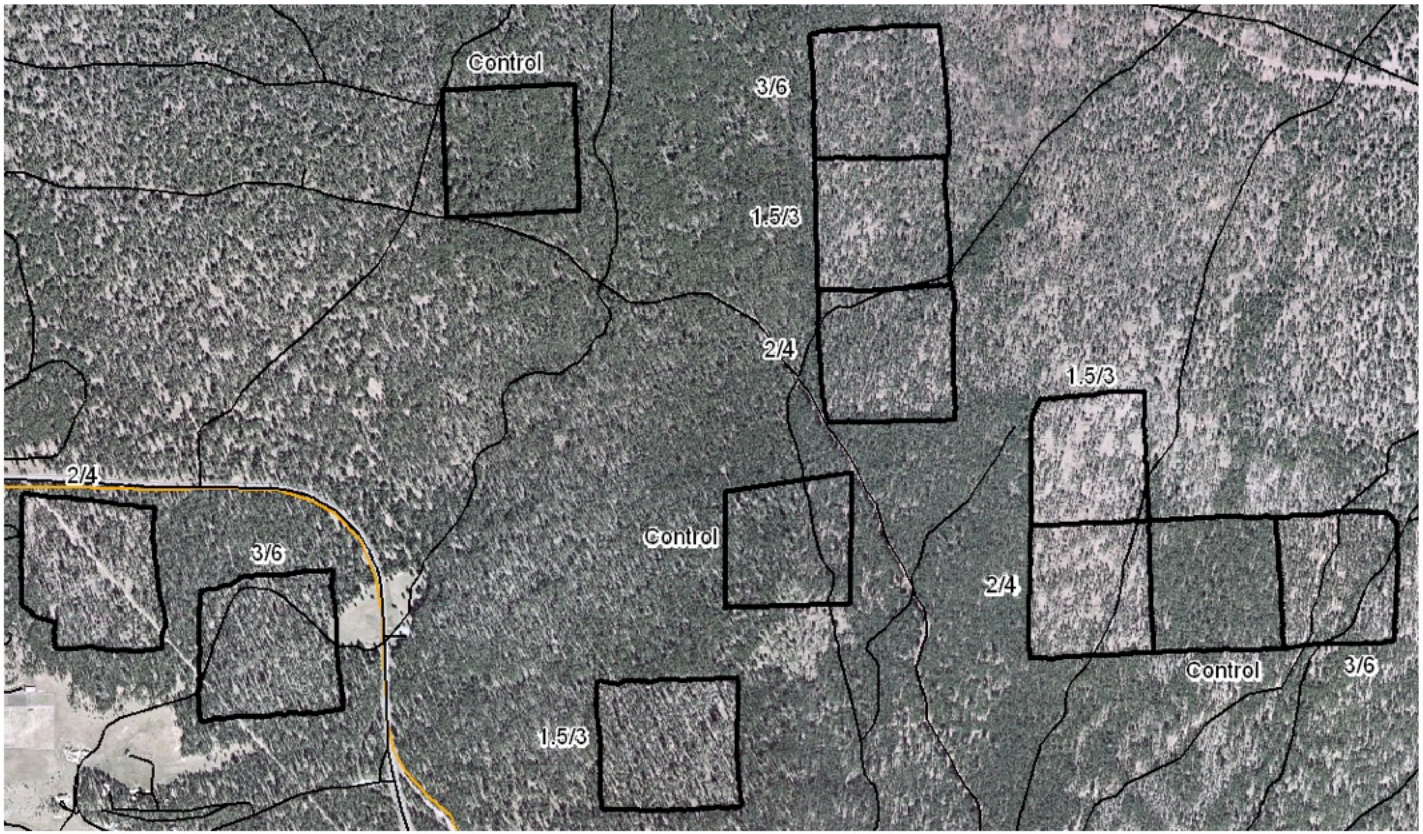
Thank You!

Questions?

Talk Outline

1. Background SW PIPO forests
2. Study site & design
3. Tree growth responses to treatment
4. Tree seasonal water use



Southwestern PIPO Forests

Late 1800's: European settlement

Fire suppression & livestock grazing

Dense forests

Increased competition for water & light

Vulnerable to drought,
pathogens & **catastrophic fire**

Carbon source

Uncertain forest regeneration

High density forest → ↑ Interference

↓ Snowpack

↓ Winter recharge → Winter water used quickly

Trees have greater relieance on MONSOON water

Low density forest → ↓ Interference → ↑ Snowpack

↑ Summer rain to understory

↑ Sunlight to understory

↑ Winter recharge

↑ Understory veg

Winter water lasts longer

↓ Available summer rain for trees

Trees have greater relieance on WINTER water