Direct and Indirect Effects of Precipitation, Nitrogen, and Management on a Rare Coastal Sage Scrub Species: *Acanthomintha ilicifolia*

Master's Thesis Presentation SDMMP:

Kyle Rice, February, 2017

Committee members:

Dr. Douglas Deutschman

Dr. David Lipson

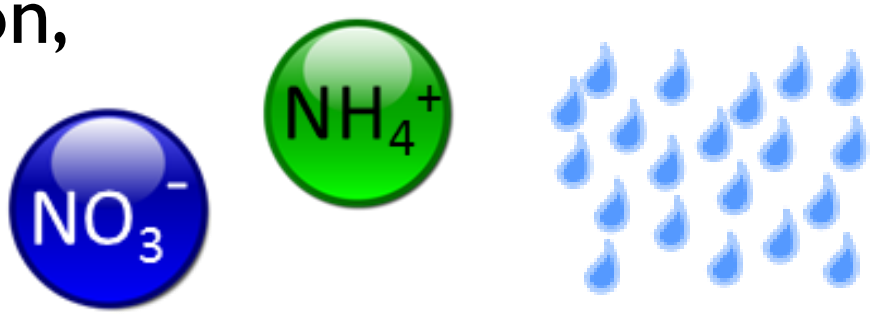
Dr. Natalie Mladenov

Outline

- **Introduction**
  - Project Selection
  - Thornmint System
  - Objectives
- **Methods**
- **Results**
  - Primary Variables: Flowering, Biomass
  - Secondary Variables: Leaf Metrics, Soil N
- **Conclusions**
  - Nitrogen, Water, Plant Treatment/Management

Project Selection

- Focus on local vegetation systems
- Nitrogen deposition, interaction with precipitation



- Species specific and compound specific responses

Study System

Native Shrub

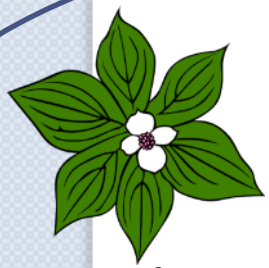
VS

Exotic Grass

Native Grass

VS

Exotic Grass



Rare forb

VS

Exotic Grass

Within coastal sage scrub habitats

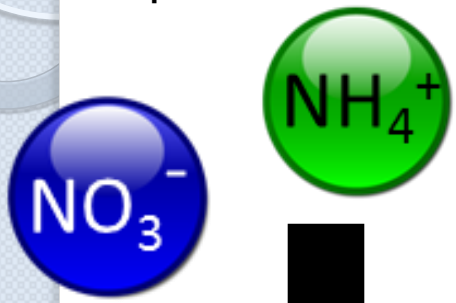
Study System

San Diego Thornmint
Acanthomintha ilicifolia (ACIL)

Purple False Brome
Brachypodium distachyon (BRDS)

Study System - Effects

Nitrogen Deposition



Precipitation

Management

Selective Herbicide – Fusilade (1%)

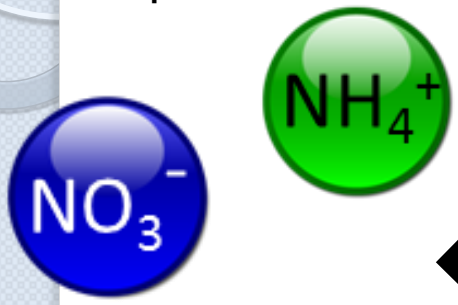
Direct Effects

San Diego Thornmint
Acanthomintha ilicifolia (ACIL)

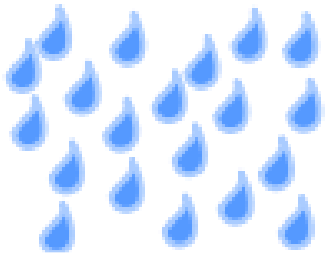
Purple False Brome
Brachypodium distachyon (BRDS)

Study System - Effects

Nitrogen Deposition



Precipitation



Management

Selective Herbicide – Fusilade (1%)

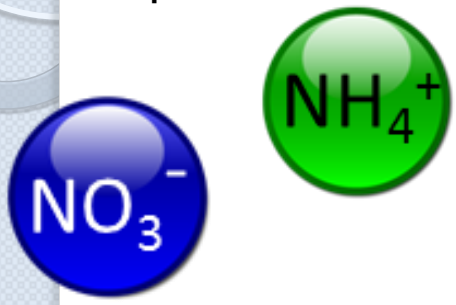
Indirect Effects

San Diego Thornmint
Acanthomintha ilicifolia (ACIL)

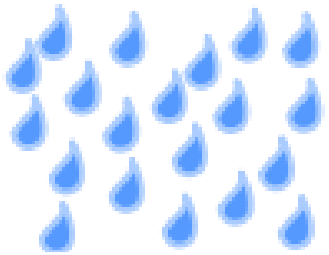
Purple False Brome
Brachypodium distachyon (BRDS)

Study System - Effects

Nitrogen Deposition



Precipitation



Management

Selective Herbicide – Fusilade (1%)

Purple False Brome
Brachypodium distachyon (BRDS)

San Diego Thornmint
Acanthomintha ilicifolia (ACIL)

Objectives

- Examine how nitrogen deposition and climate variability impact the growth and productivity of rare species, using San Diego thornmint (*Acanthomintha ilicifolia*) and Purple False Brome (*Brachypodium distachyon)* as a case study.

- Measure response changes in the presence of increased conspecific and heterospecific densities and determine whether competitor identity influences the effects.

- Assess the effectiveness of Fusilade as a long-term management option for this system.

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Methods – Experimental Design

3-way Factorial Design	Half of Average (50%)			Average Precipitation (100%)			Twice Average (200%)		
	Ambient	NH_4	NO_3	Ambient	NH_4	NO_3	Ambient	NH_4	NO_3
A. ilicifolia	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII
B. distachyon	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII
2-species Mixture	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII
Mixture with Fusilade	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII	IIIII IIIII

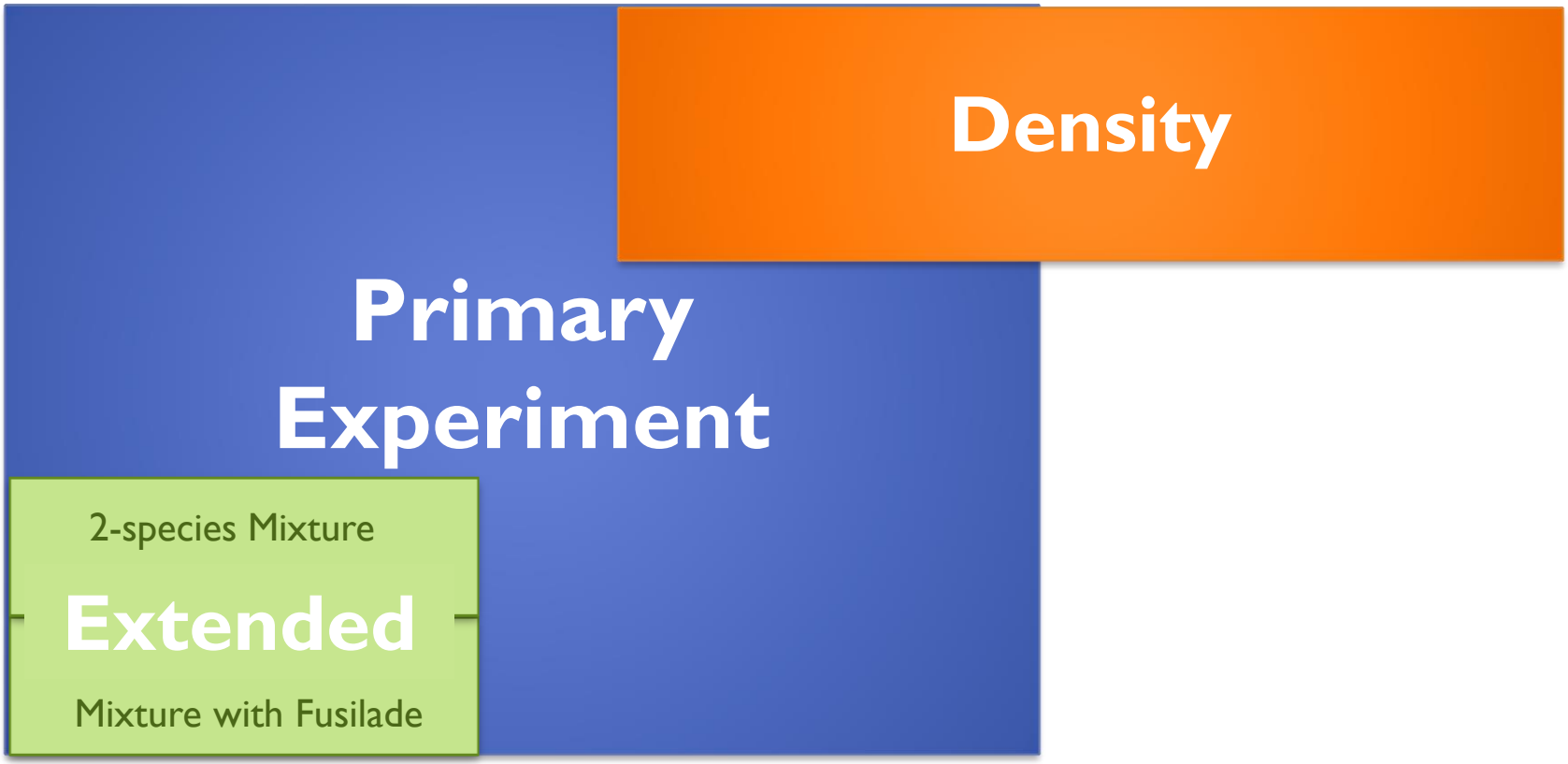
~~2~~ 8 *replicates in a 3x3x4 design = 360 experimental units*

Extended Half

	0 BRDS	1 BRDS	2 BRDS
0 ACIL	~~0X0~~	0X1	0X2
1 ACIL	1X0	1X1	1X2
2 ACIL	2X0	2X1	2X2

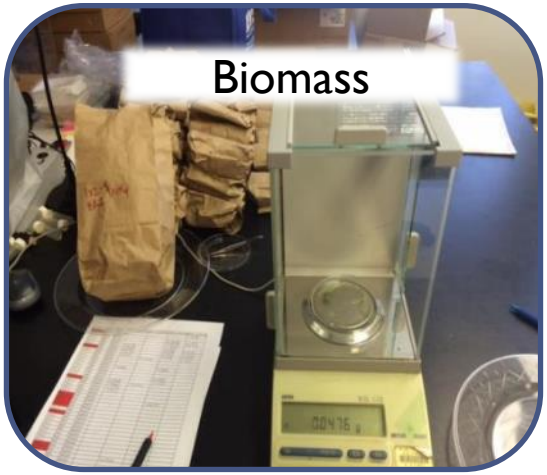
X 2

Methods – Experimental Design

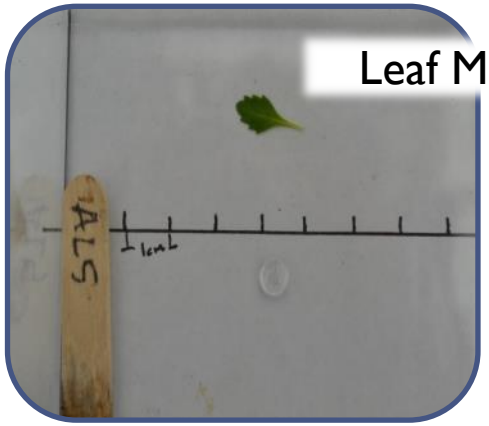


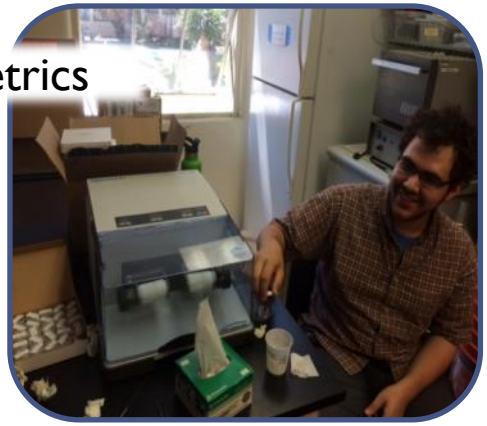
Methods – Response Variables

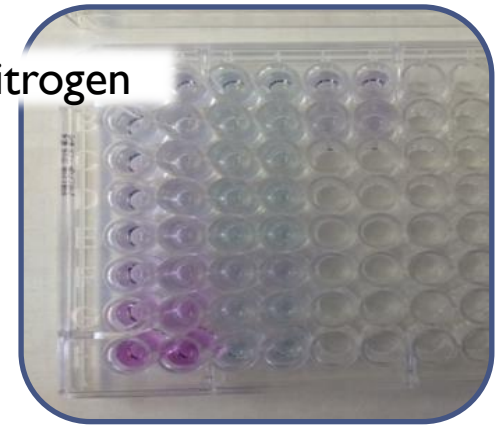
Primary



Secondary







Methods – Model/Data Analysis

Idealized Example: Soil Nitrate		
Source		**df**
Main Effects	Plant (4 Plant combinations and Herbicide)	3
	Water (50%, 100%, 200%)	2
	Nitrogen (Ambient, NO3, NH4)	2
Interactions	Plant * Water	6
	Plant * Nitrogen	6
	Water * Nitrogen	4
	Plant * Water * Nitrogen	12
Error (assuming 8 reps and no lost/extended units)		252
Total (4 x 3 x 3 x 8 - 1)		288

- Traditional analysis – 7 F-Tests evaluating if a source of variation is significantly different from zero.
- Managers often interested in major drivers/predictors
- Used model selection and interpretation approach based on Information Theory; BIC used here

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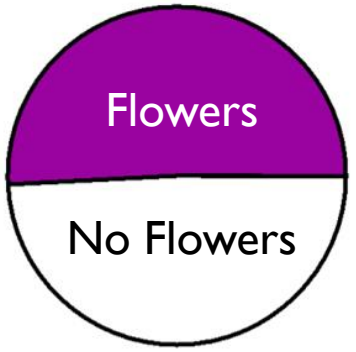
Primary

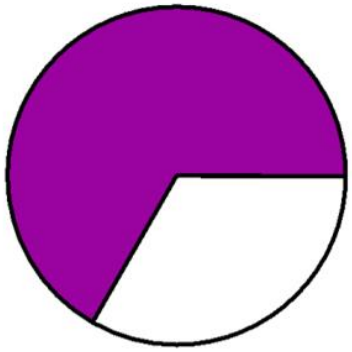
Results – Thornmint Flowering

- Proportion of containers producing flowers

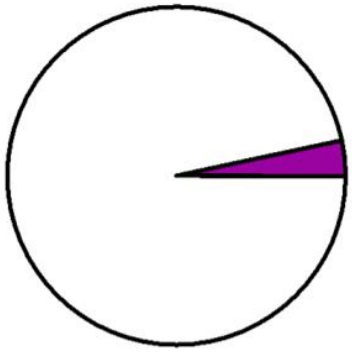
Main Experiment



ACIL

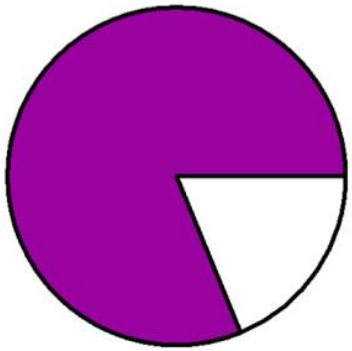


No Herbicide

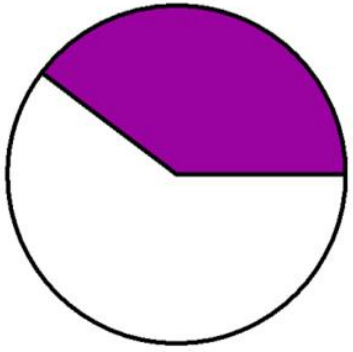


Herbicide

Extended



No Herbicide

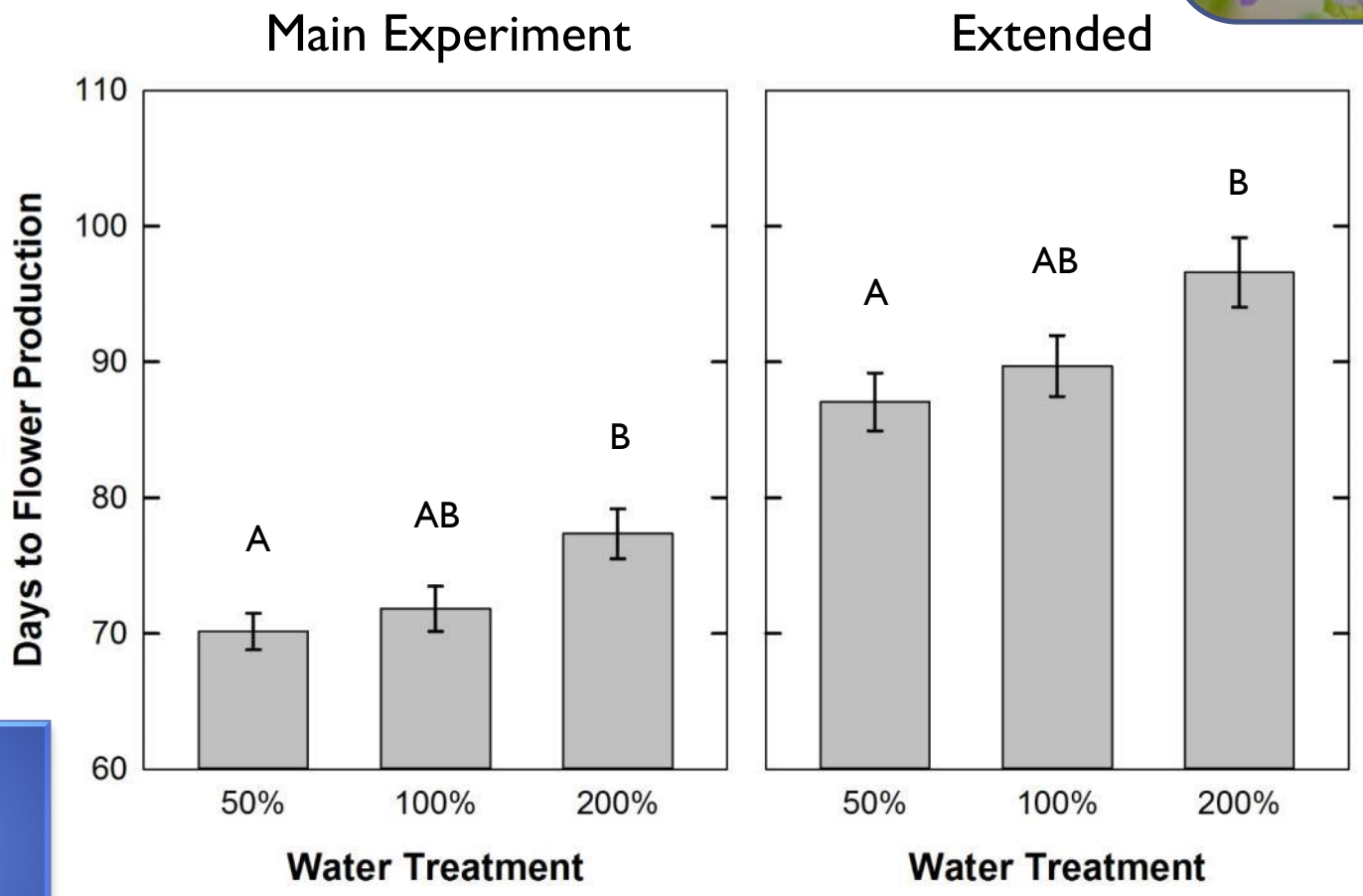


Herbicide

Primary

Extended

Results – Thornmint Flowering

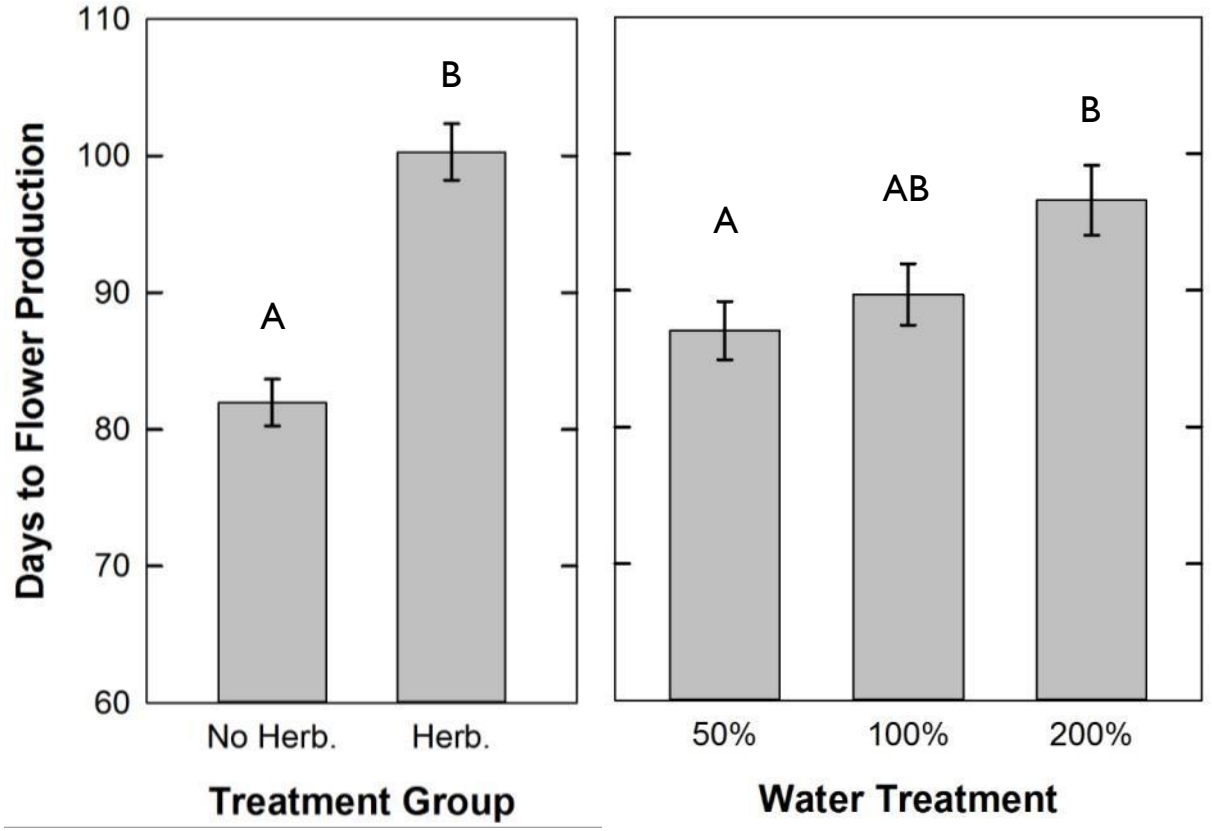


Primary

Extended

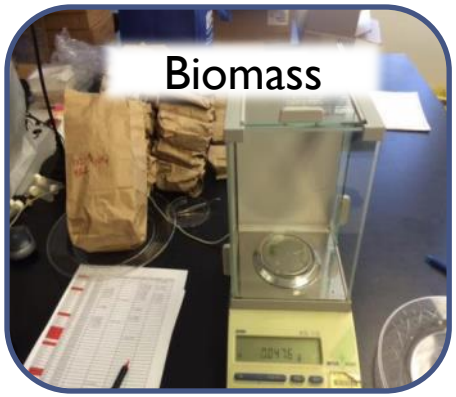
Results – Thornmint Flowering

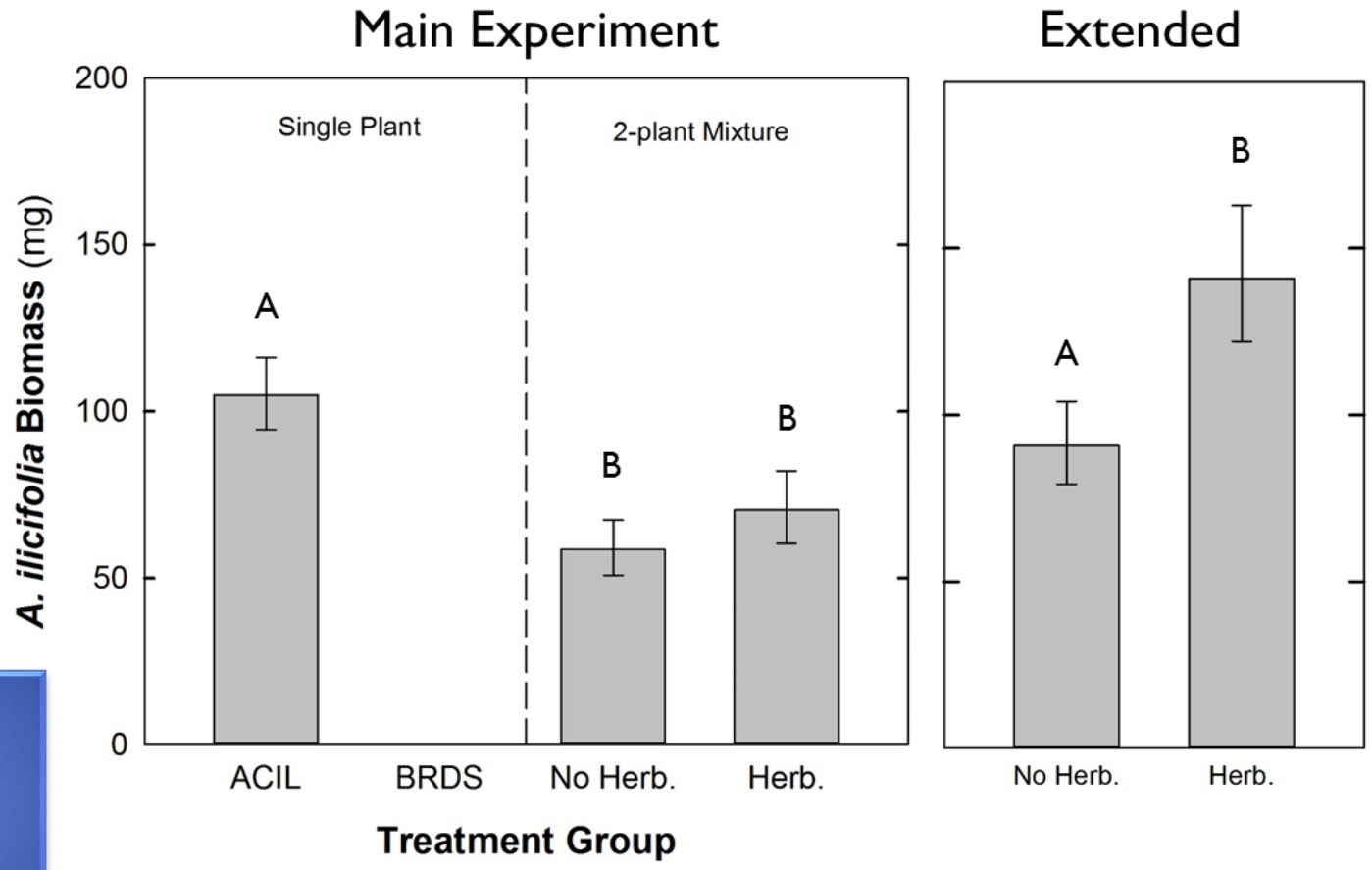
Extended



Extended

Results – Thornmint Biomass

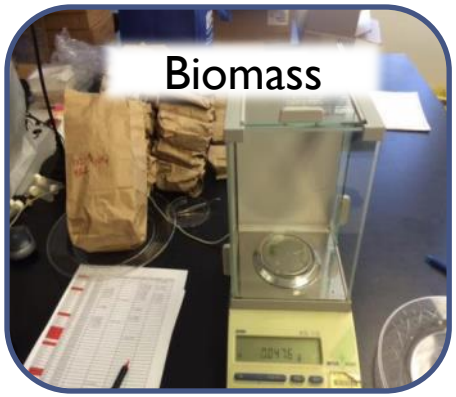


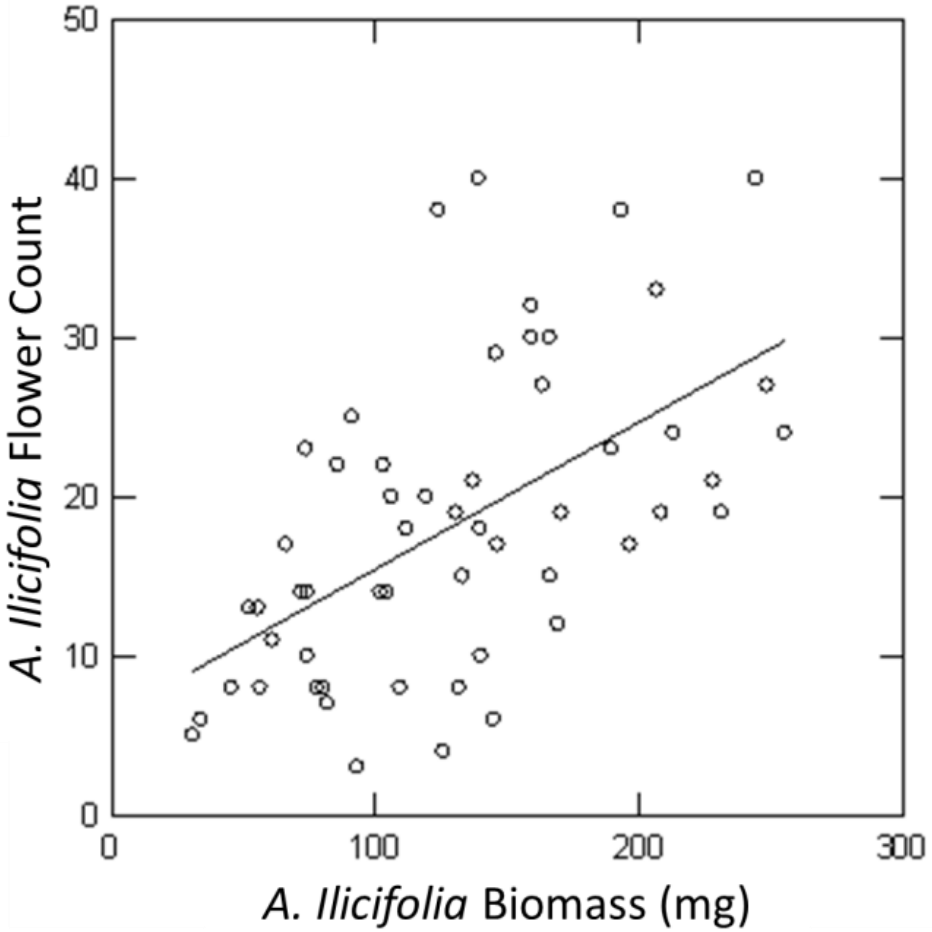


Primary

Extended

Results – Thornmint Biomass





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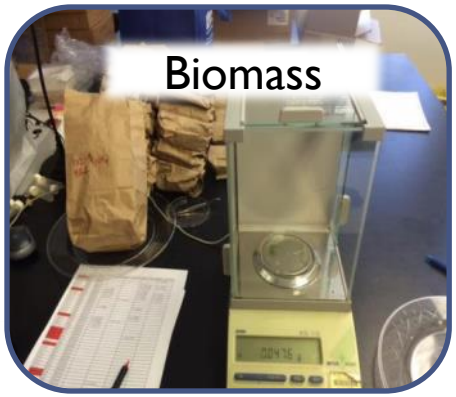
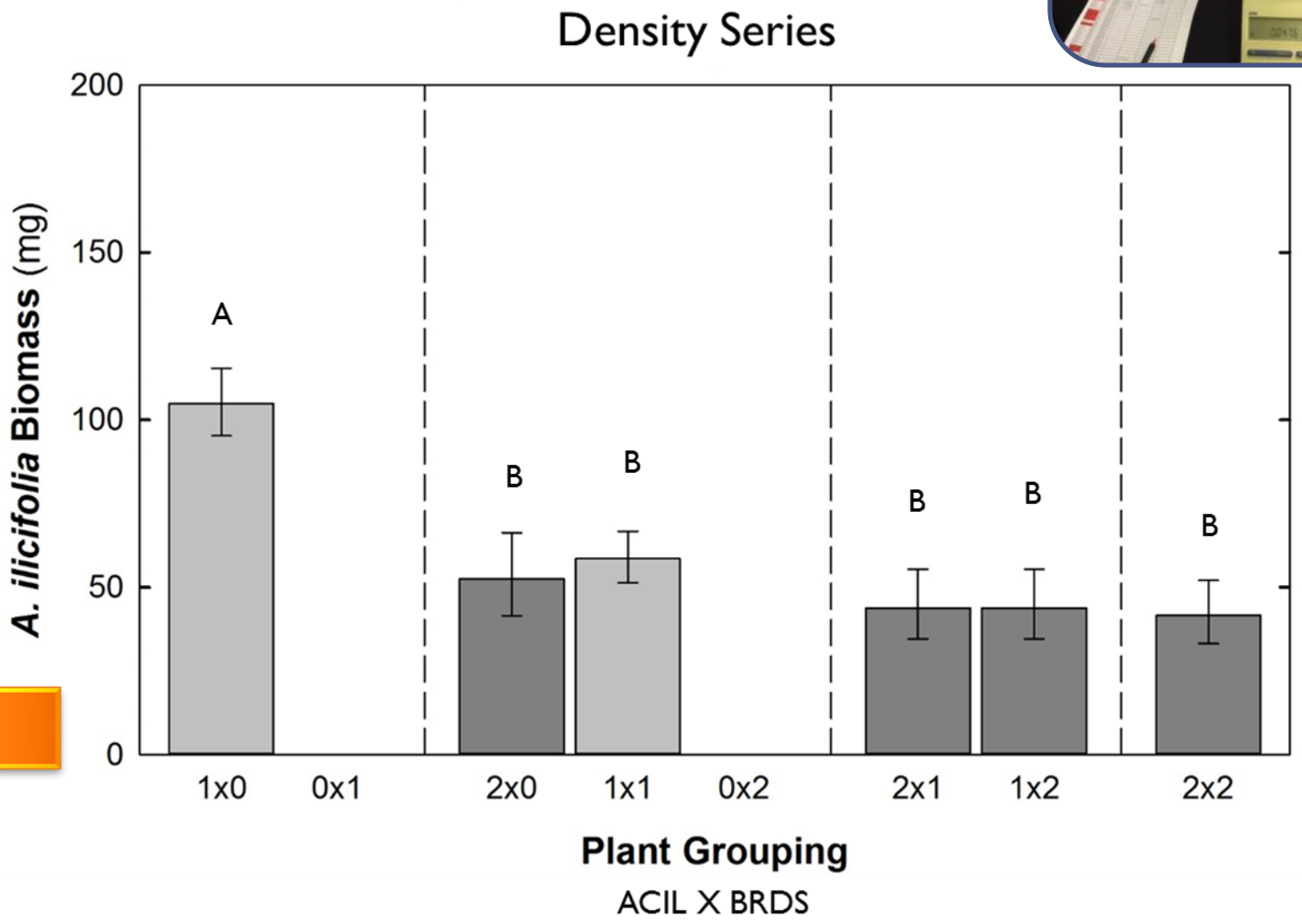
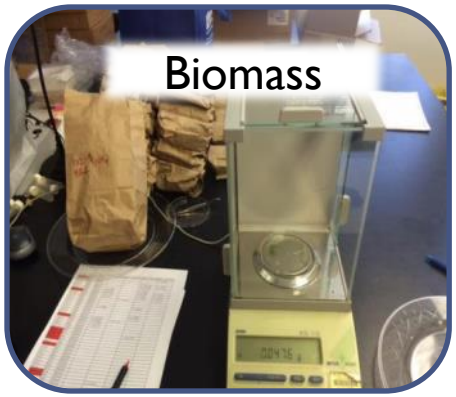
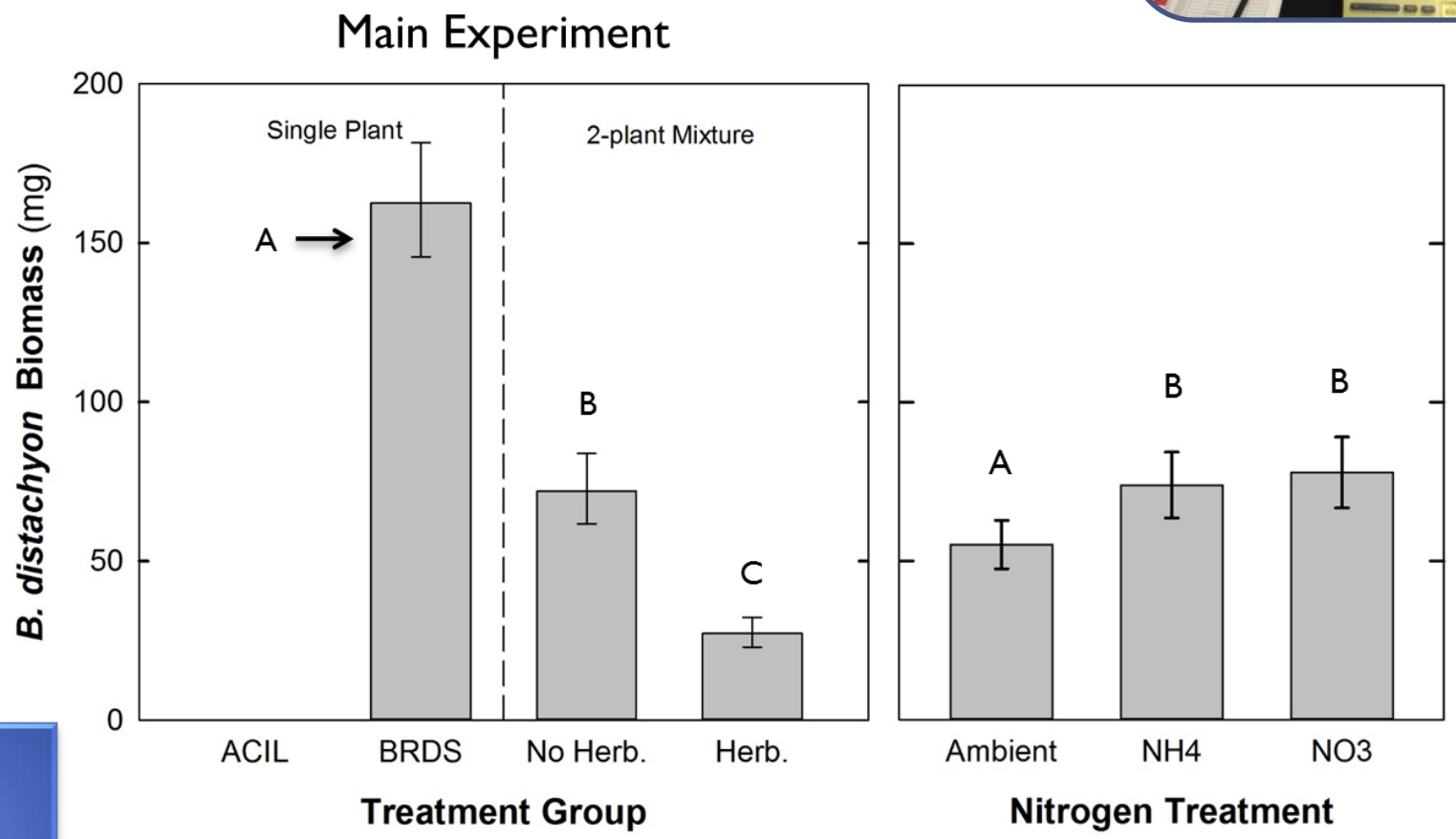




Density

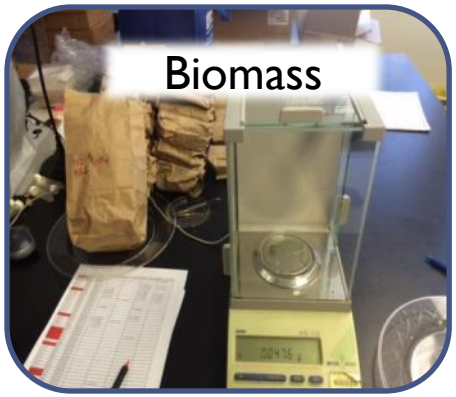
Results – *Brachypodium* Biomass

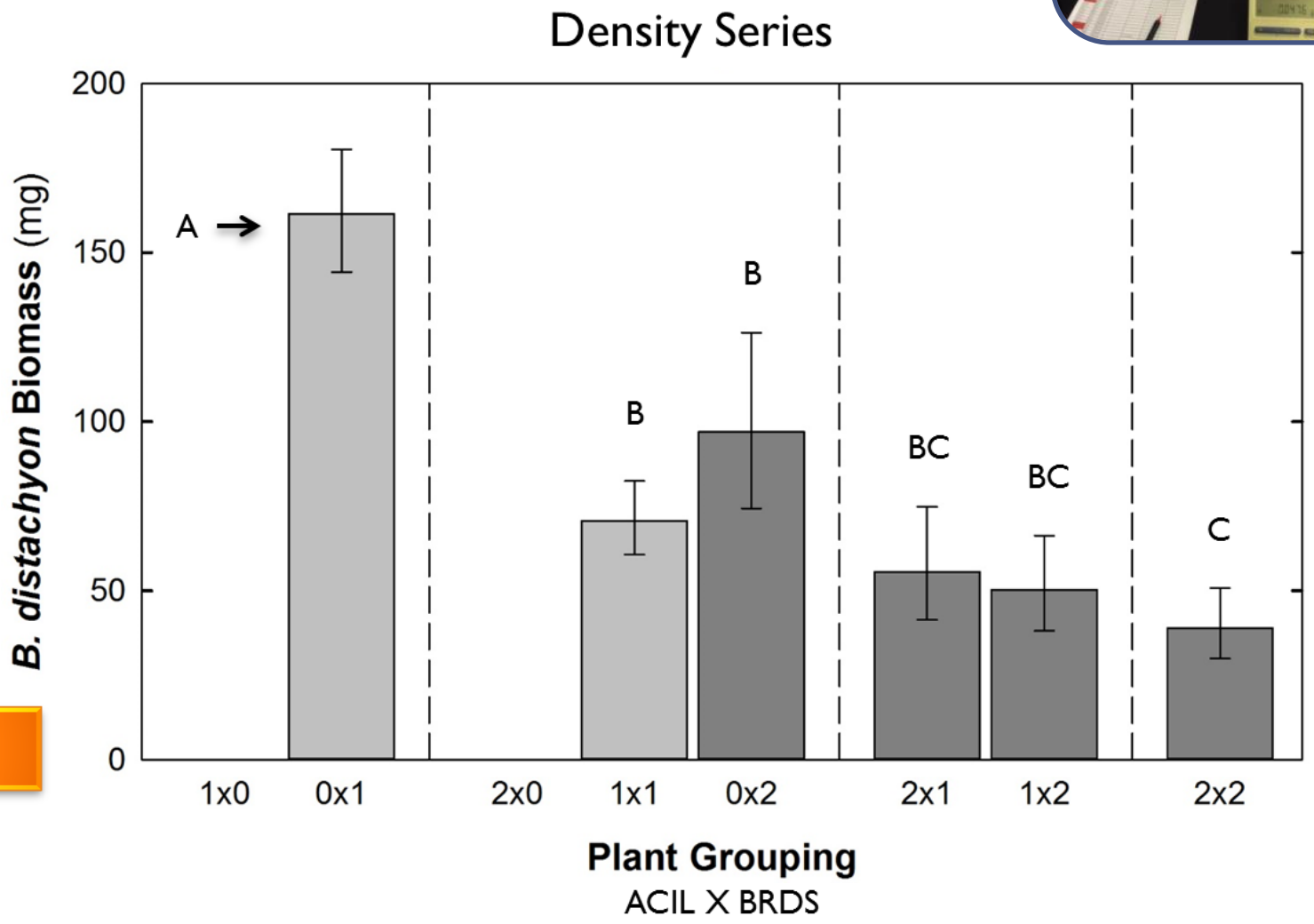




Primary

Results – *Brachypodium* Biomass





Density

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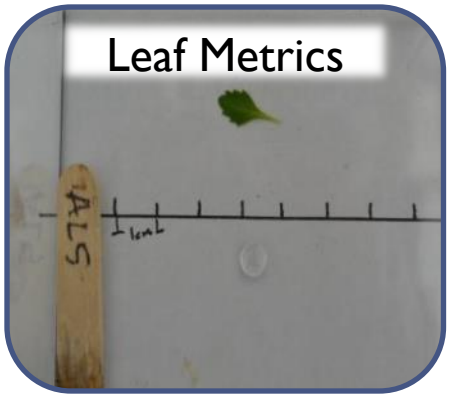
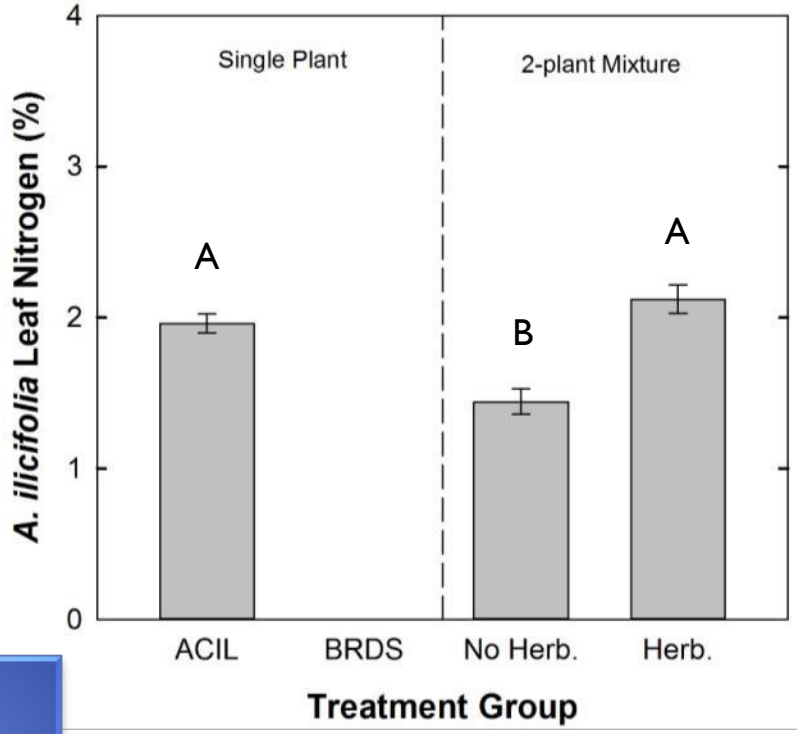
Results – Thornmint Leaf Metrics



Main Experiment



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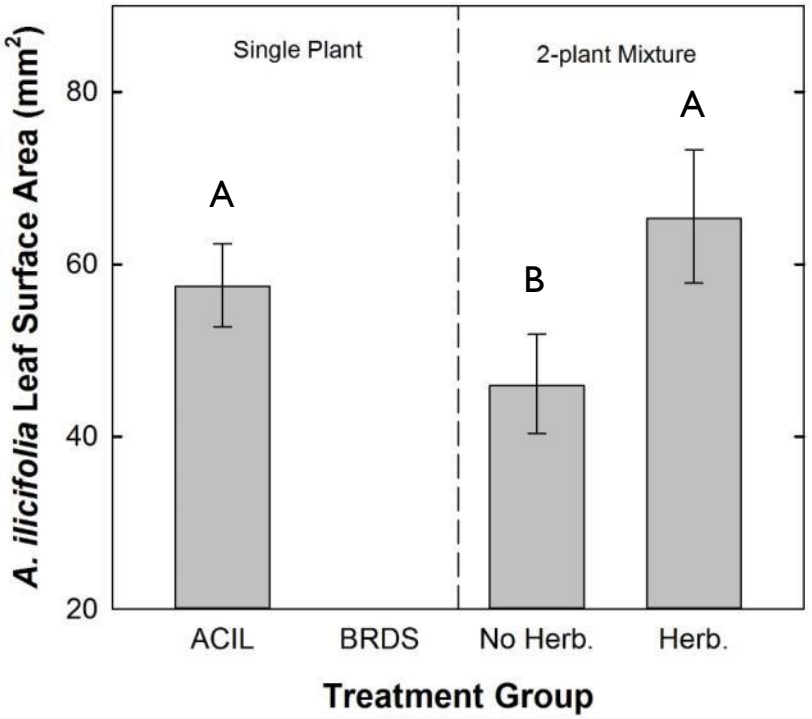
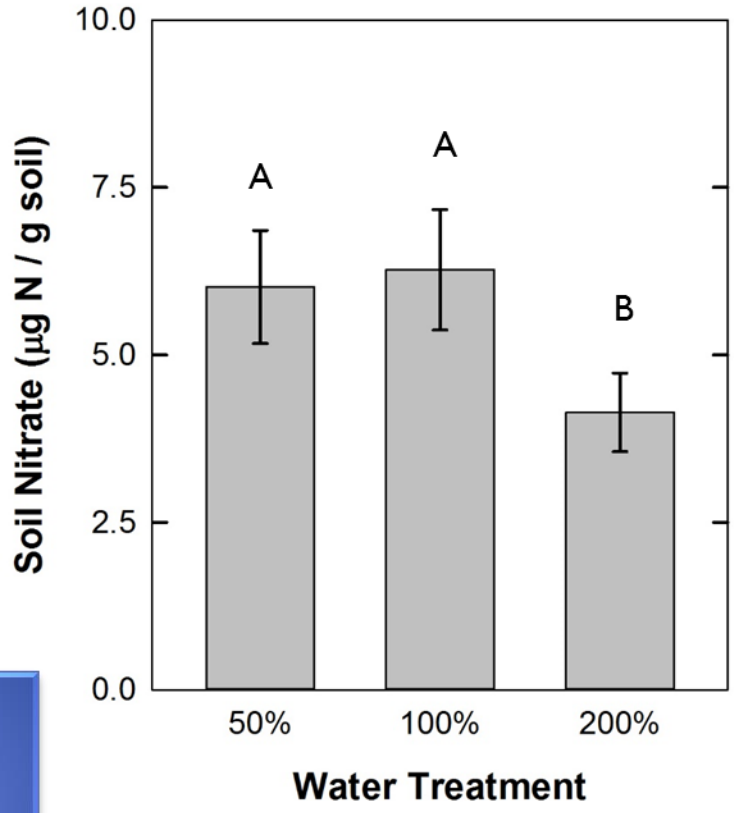


Primary

Results – Soil Nitrate



Primary

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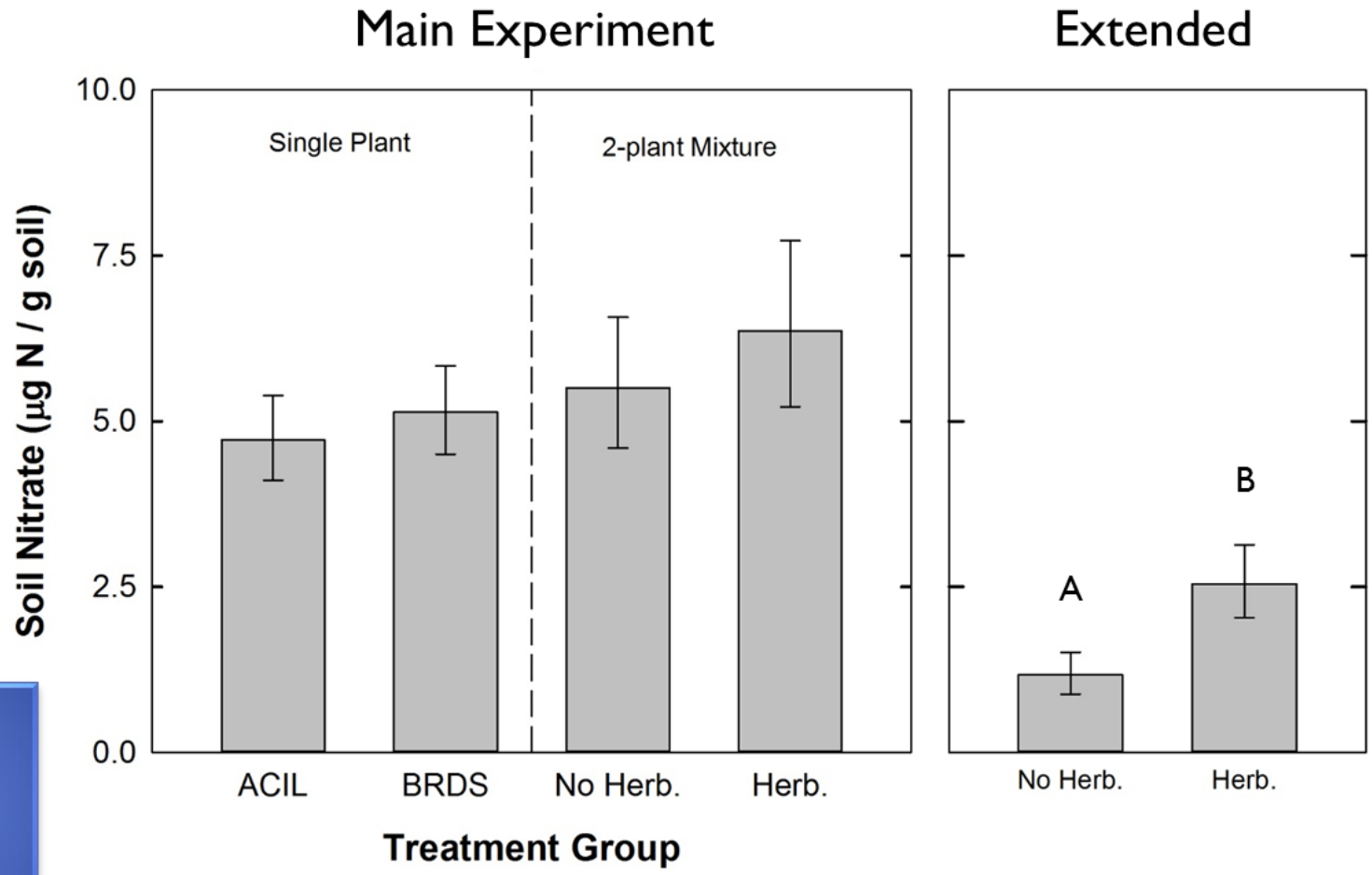
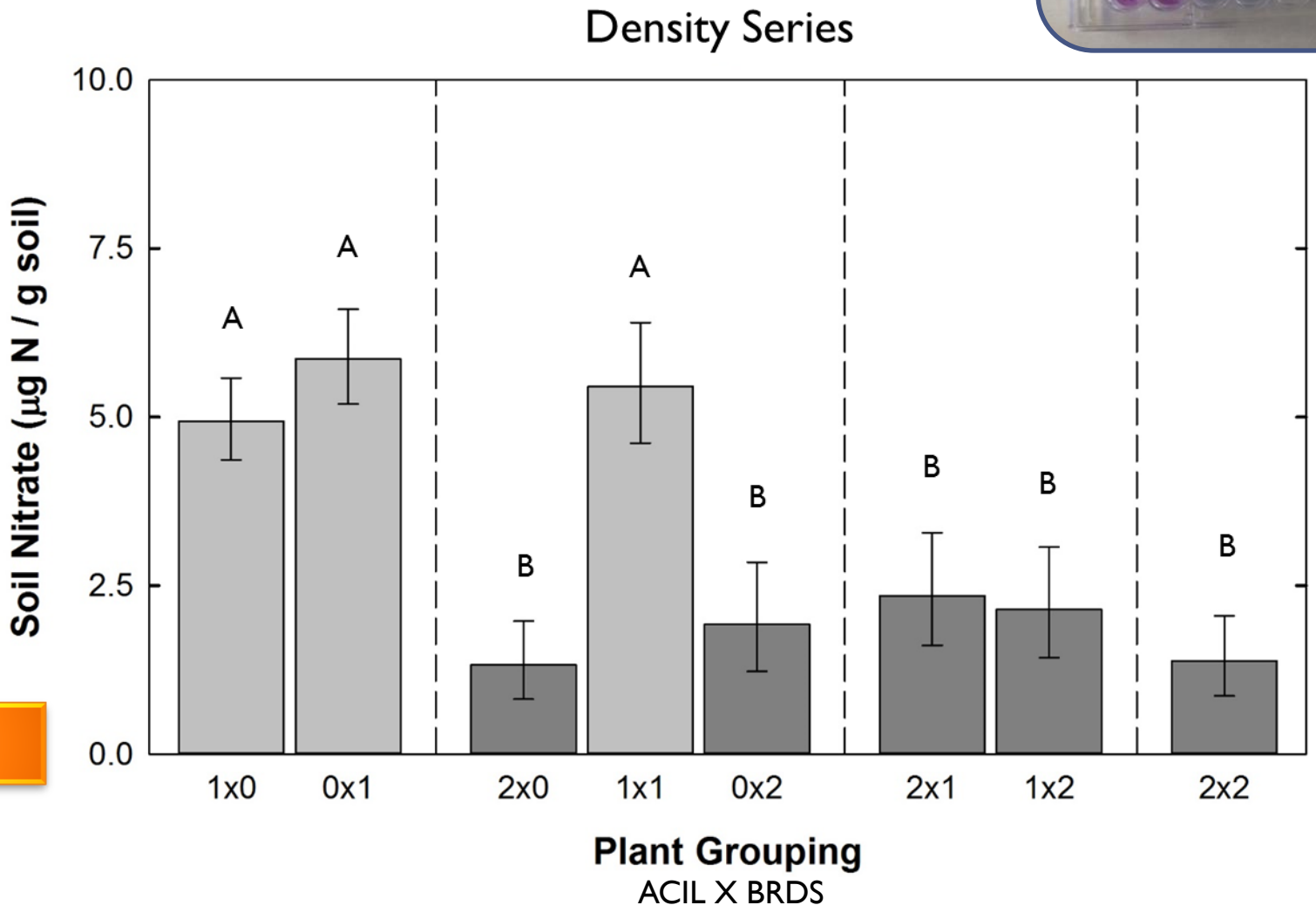


Primary

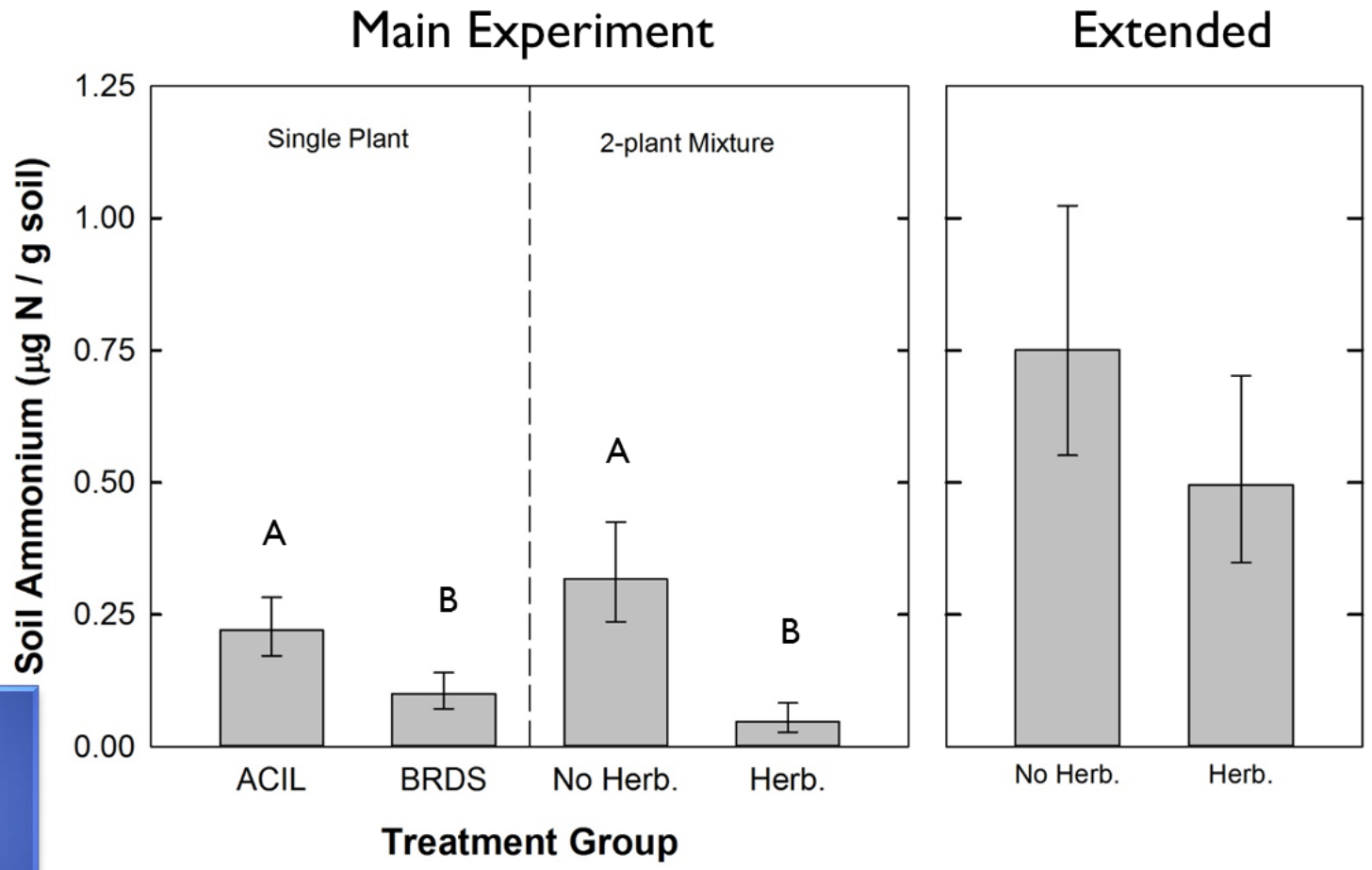
Extended

Results – Soil Nitrate



Density

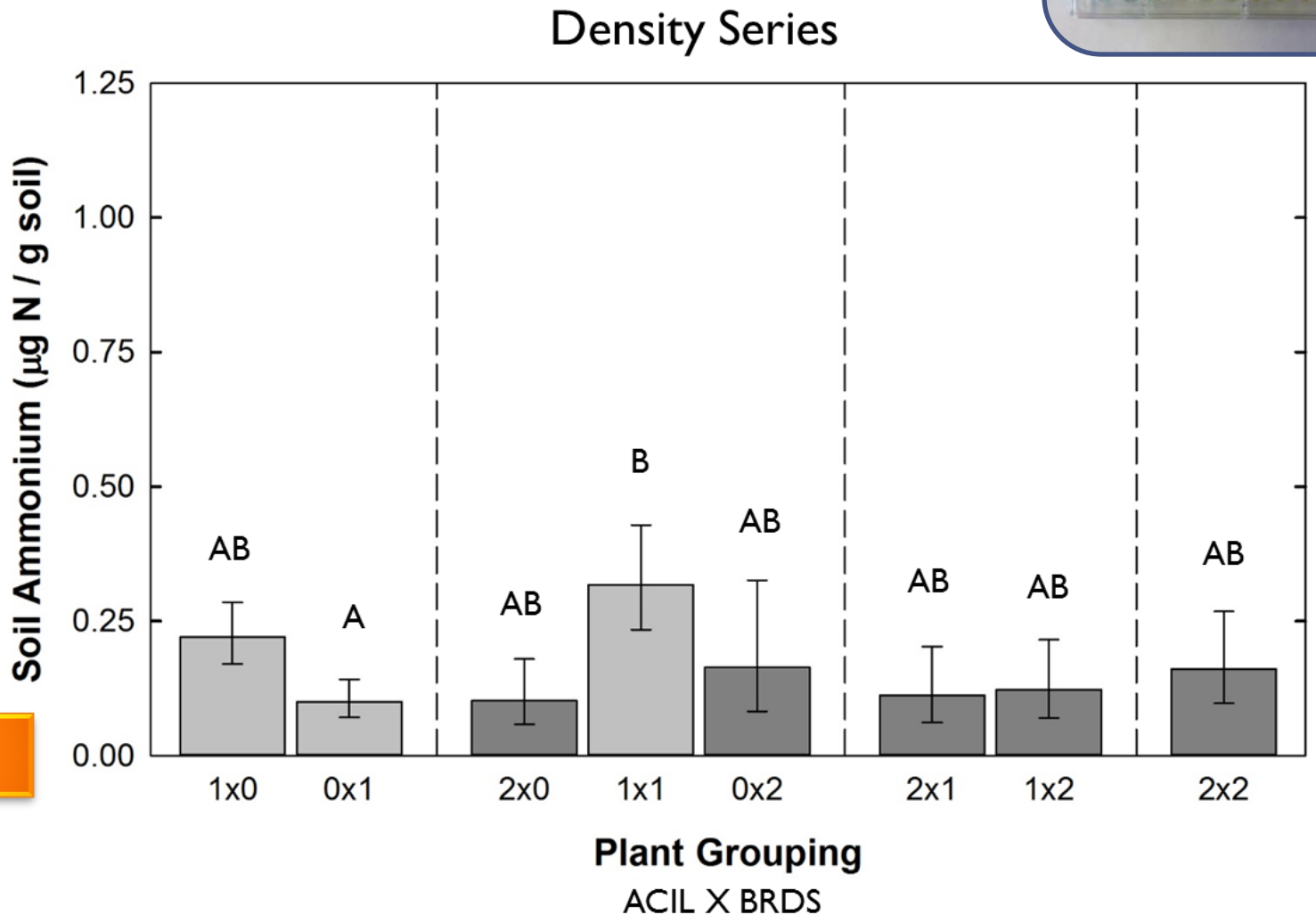
Results – Soil Ammonium



Primary

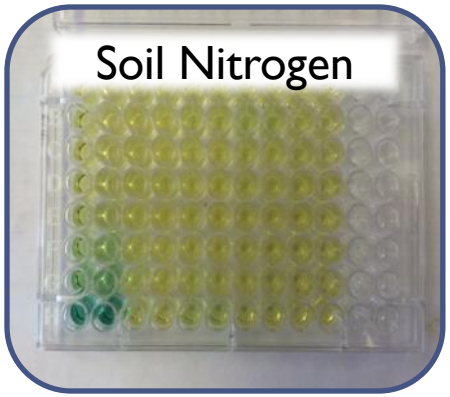
Extended

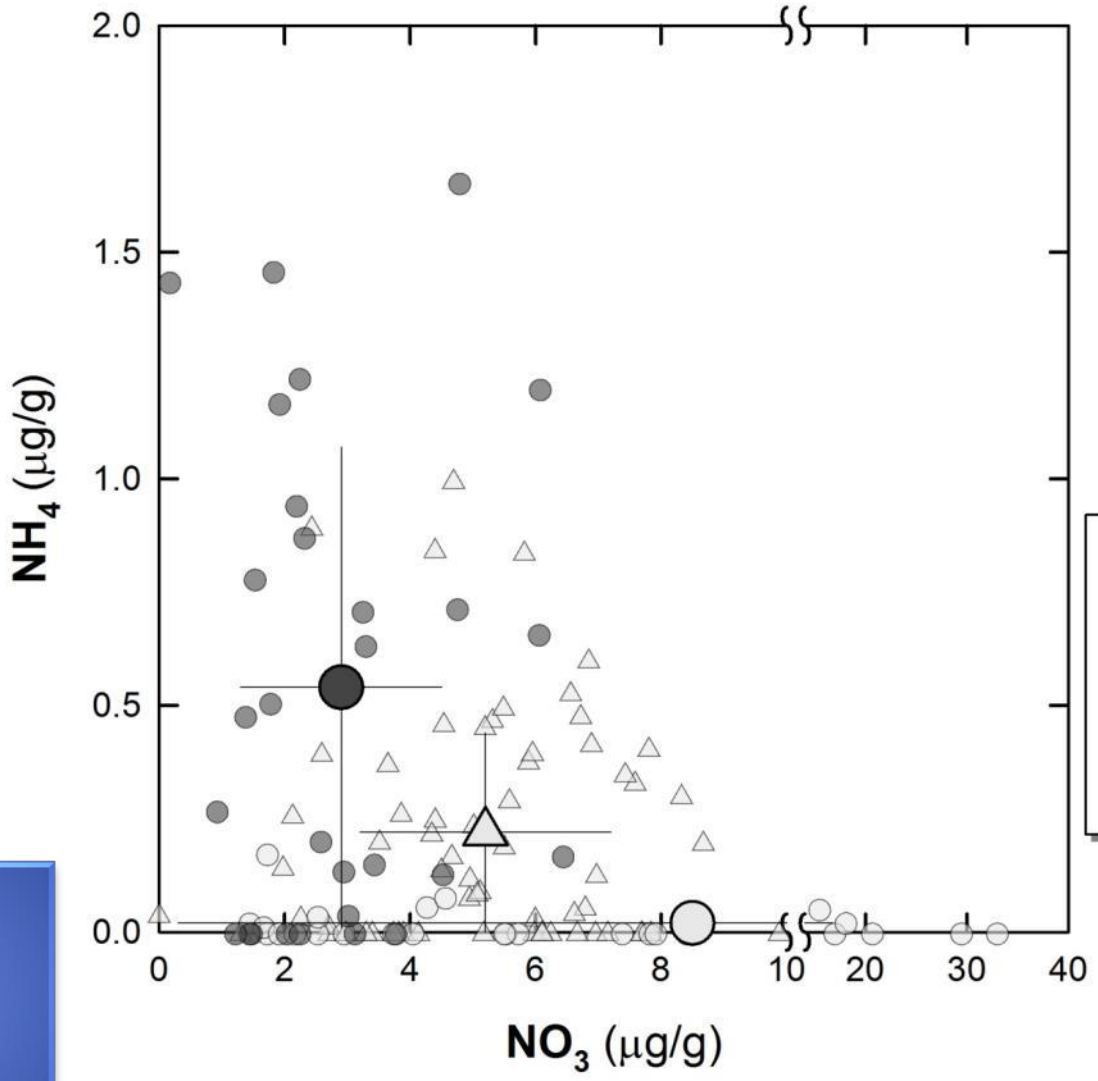
Results – Soil Ammonium



Density

Results – Soil Ammonium





Primary

Extended

Results Summary

- Nitrogen effect weak

- Some water impacts
- Herbicide beneficial to vegetative growth
  - 3 week delay in flowering
  - Uptake of ammonium or conversion to nitrate
  - System recovers with time

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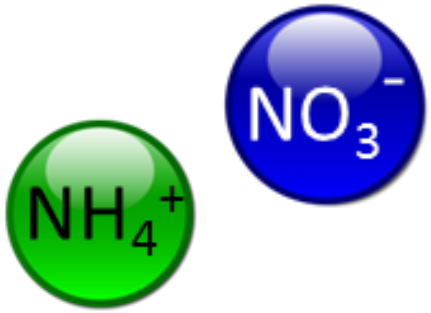
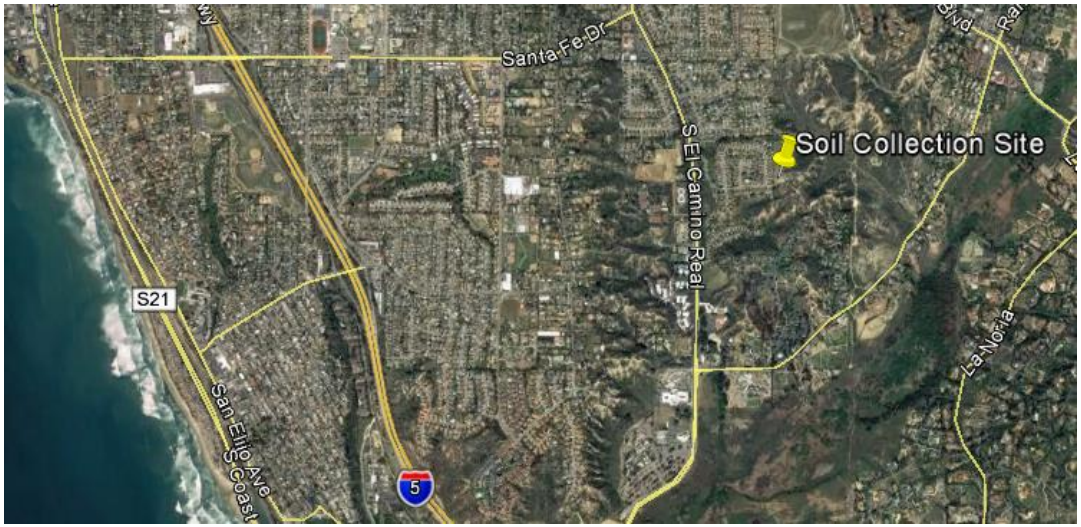
Conclusions - Nitrogen



- Nitrophilous exotic

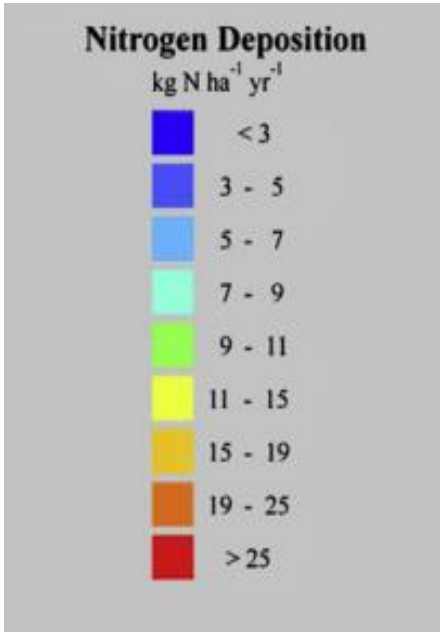
  Brachypodium response to nitrogen = performance advantage over thornmint

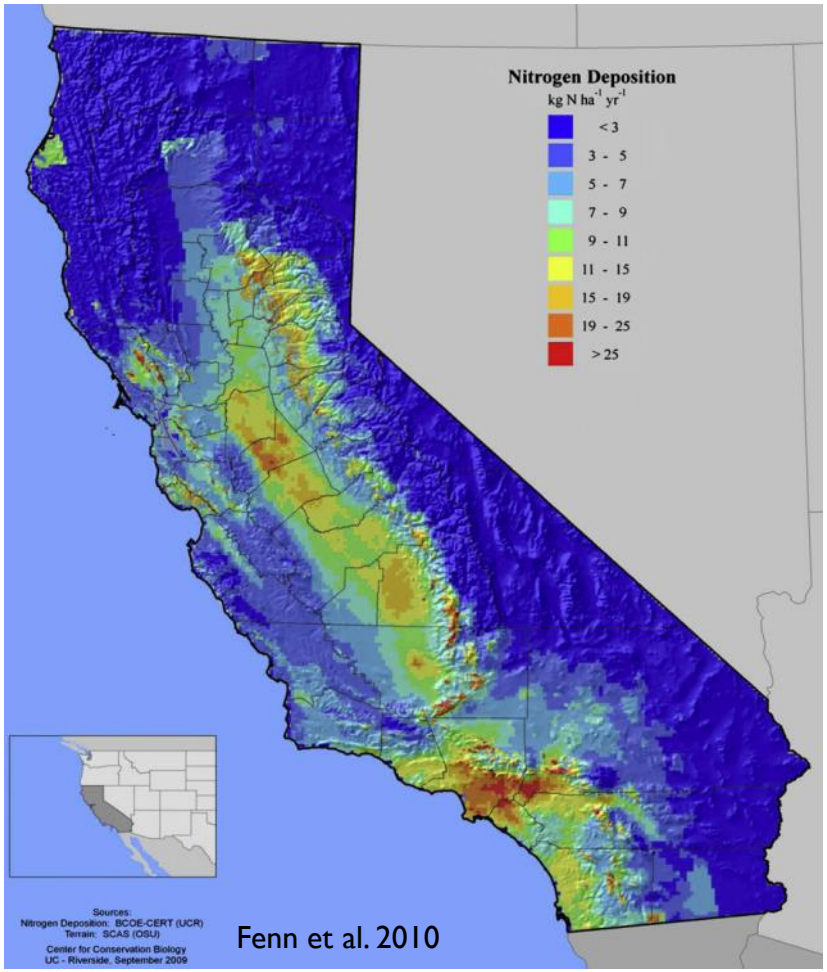
- High starting levels?



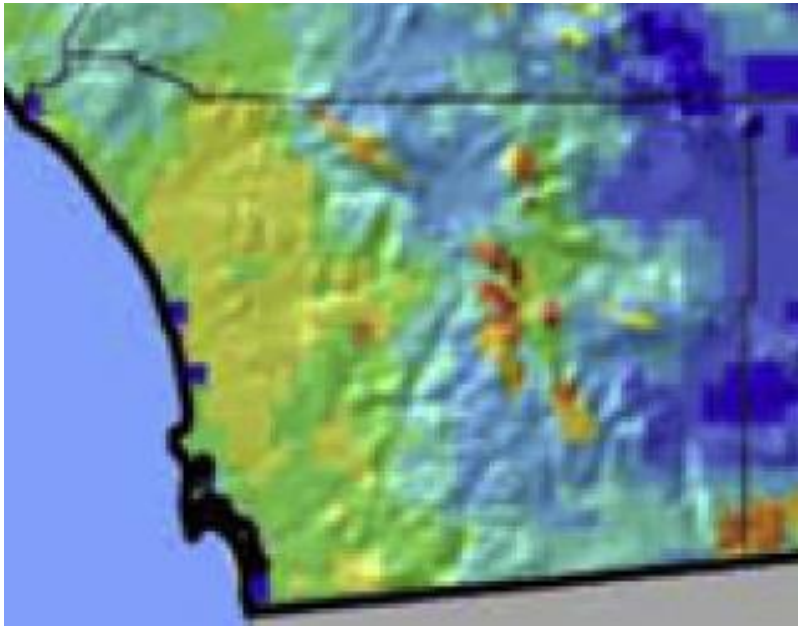
Conclusions - Nitrogen

- Understanding scale





Fenn et al. 2010

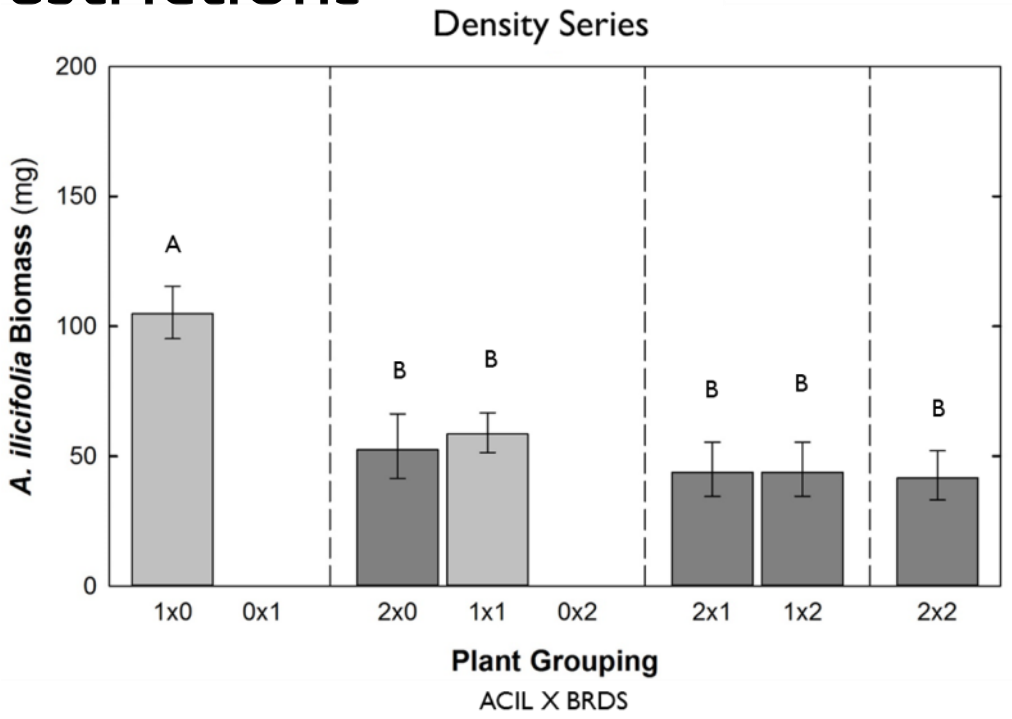


Conclusions - Precipitation

- Impacts on phenology with earlier flowering in low water
- Volume of precipitation not individually responsible for productivity. Frequency?
- Management implication – avoid long period dry spells

Conclusions – Plant Treatment/Herbicide

- Plant treatment and competitor presence have strong system effect
- Often lack of identity effects, possibly due to container restrictions



Conclusions – Plant Treatment/Herbicide

- Herbicide effective
  - Non-target effects – Mortality, dieback, flower delay, N cycling changes
  - Recovery time often needed
- Do environmental conditions always allow for recovery?

Conclusions - Recommendations

- Many new questions and avenues of research
- Use of herbicide with caution
- Surfactant or concentration?

- Implement supplemental watering
- Monitor, monitor, monitor…..

Acknowledgements

- Committee members
  - Dr. Douglas Deutschman
  - Dr. David Lipson
  - Dr. Natalie Mladenov
- The Deutschman Lab
  - Gabriel!
- Soil Ecology Restoration Group (SERG)
- Rancho Santa Ana Botanical Garden
- Center for Natural Lands Management
- Endangered Habitats League
- Conservation Biology Institute
- CDFW
- Caroline (Fiancé)

Questions