The Interactive Effects of Nitrogen and Topography on the Distribution of *Stipa pulchra*

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Outline

- Anthropogenic Nitrogen (N) Deposition
- Topography and N
- *Stipa pulchra*
- Results and Discussion

Challenges for Plant Communities

- Altered disturbance regimes
- Land use change
- Non-native, invasive plant species

Photo by Matt Lavin

Buisson, E. et al. 2008. Reintroduction of Nassella pulchra to California coastal grasslands: Effects of topsoil removal, plant neighbor removal and grazing. Applied Vegetation Science 11:195-204.

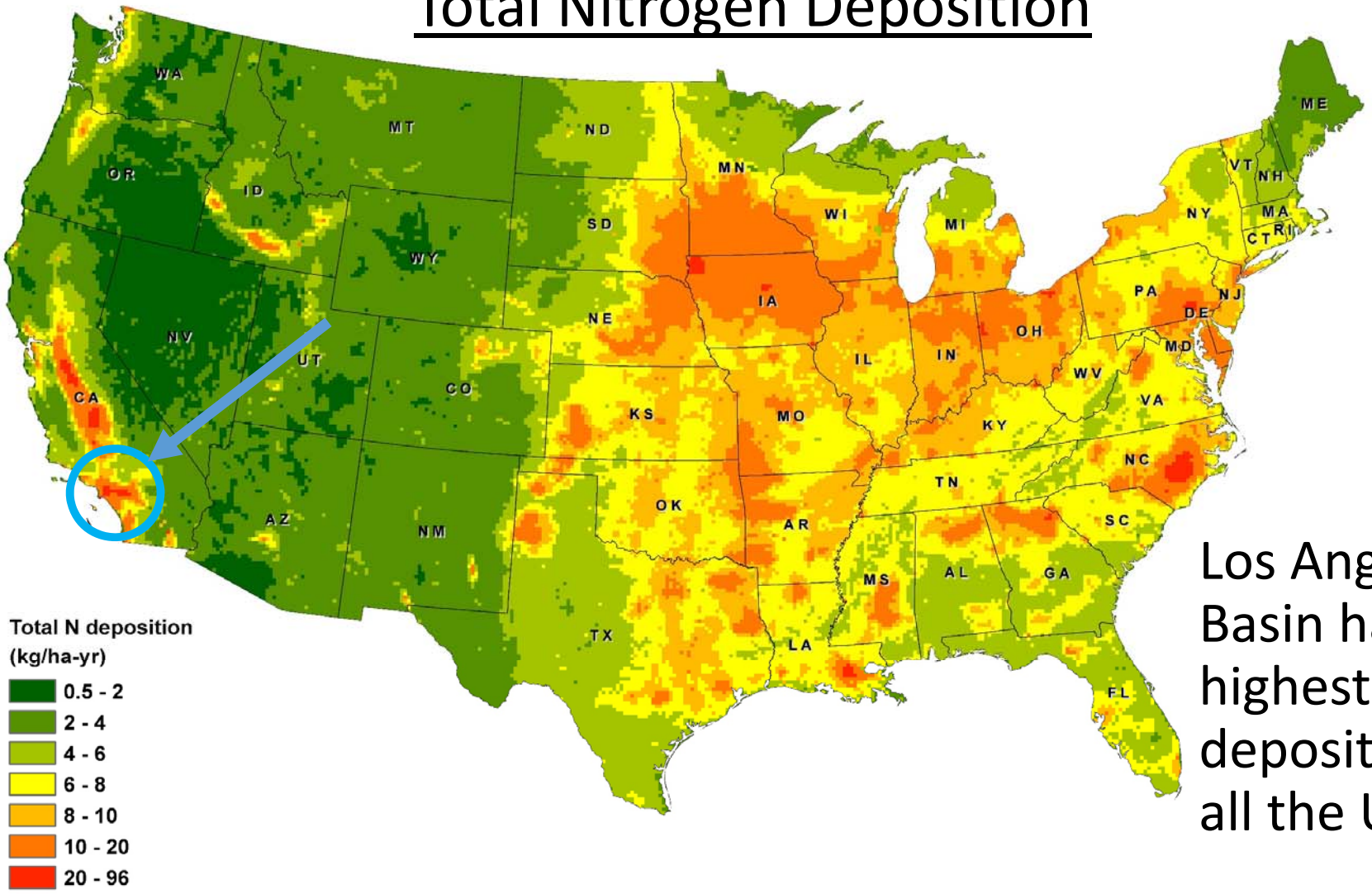
Anthropogenic Nitrogen Deposition

- NO_x^- from burning fossil fuels and NH_4^+ from fertilizer used in agriculture.

- Environmental problems: toxic effects on fresh water fish, poor drinking water quality, increases greenhouse gases, favoring invasive plant species and harming native plant species.

Fenn, M.E. et al. 2003. Ecological effects of nitrogen deposition in the western United States. BioScience 53:404-420.

Total Nitrogen Deposition

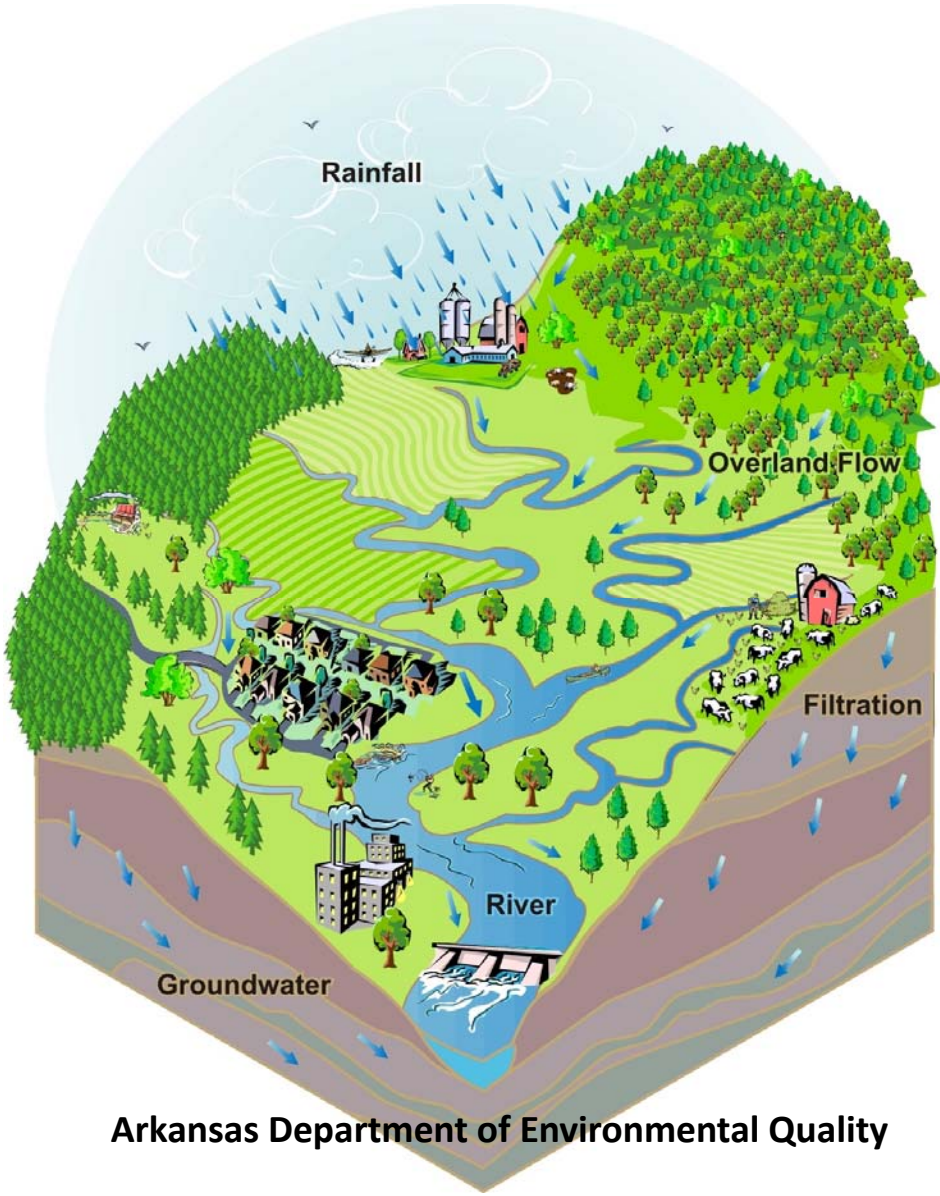


Los Angeles Air Basin has the highest N deposition rates in all the US!

Driscoll, C. et al. 2014 Co-benefits of Carbon Standards. Syracuse University

Topography and Nitrogen

- How do they relate?



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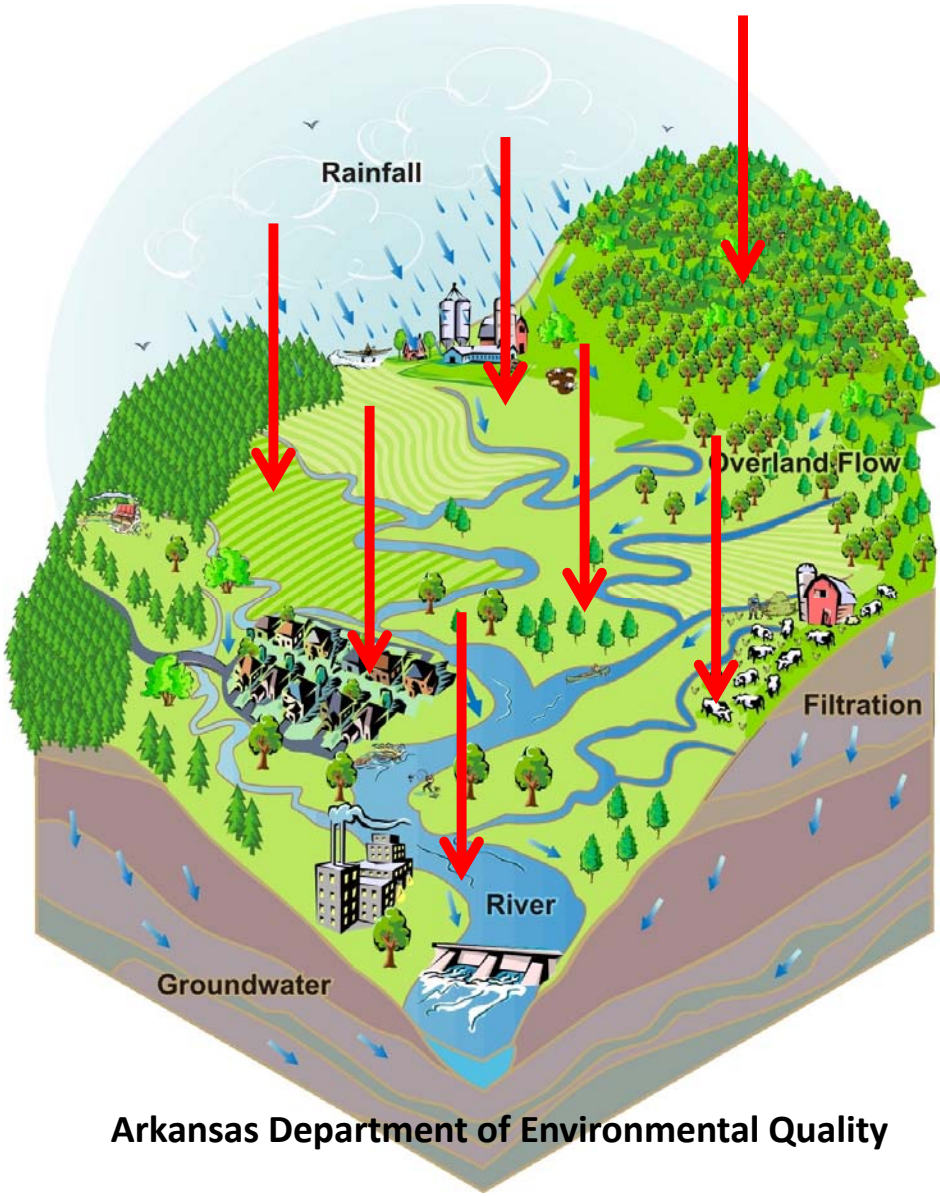
Topography and Nitrogen

N is deposited across the landscape.

Due to dry CA summers, N is allowed to accumulate over the landscape.



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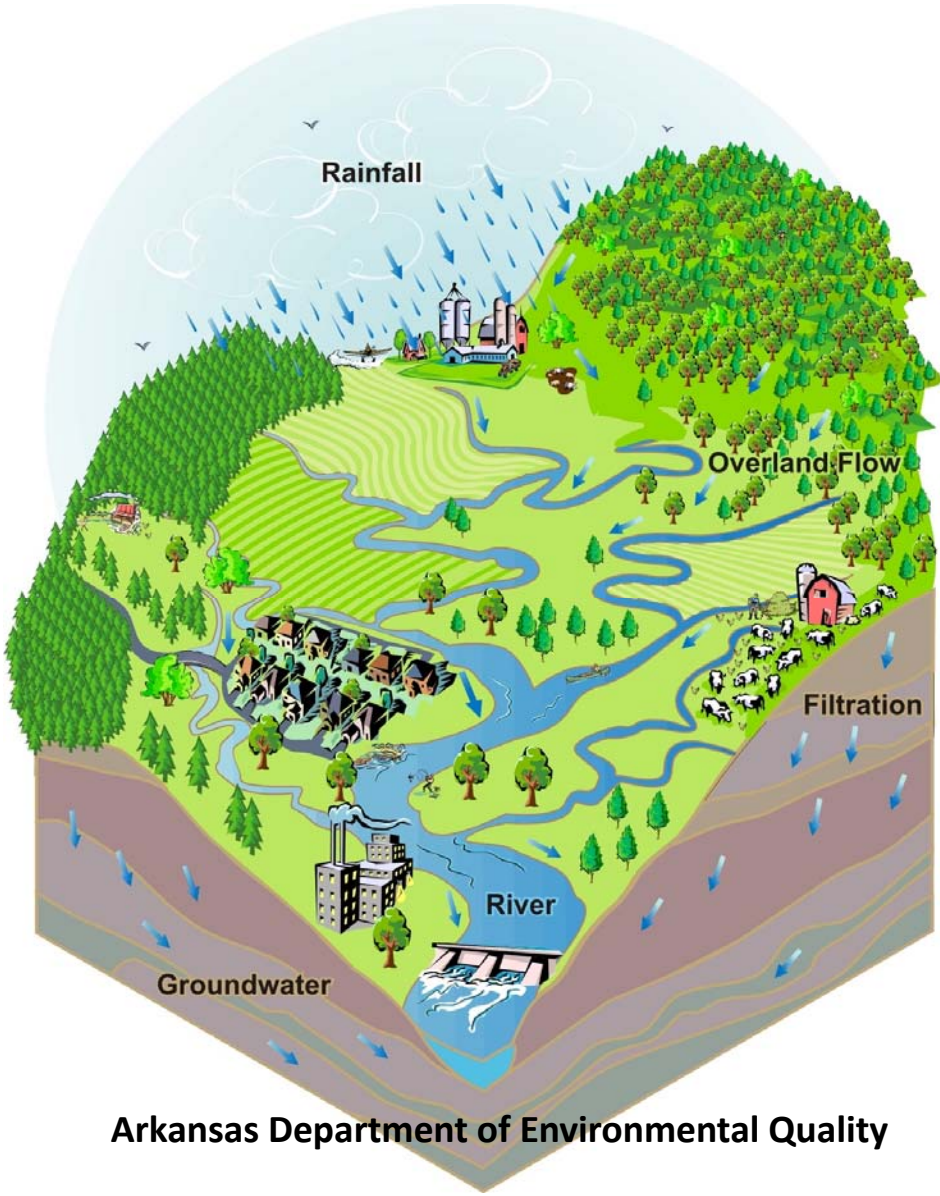
Topography and Nitrogen

During rainfall events, N is dissolved into the water and a pulse of available N is rushed into natural systems.



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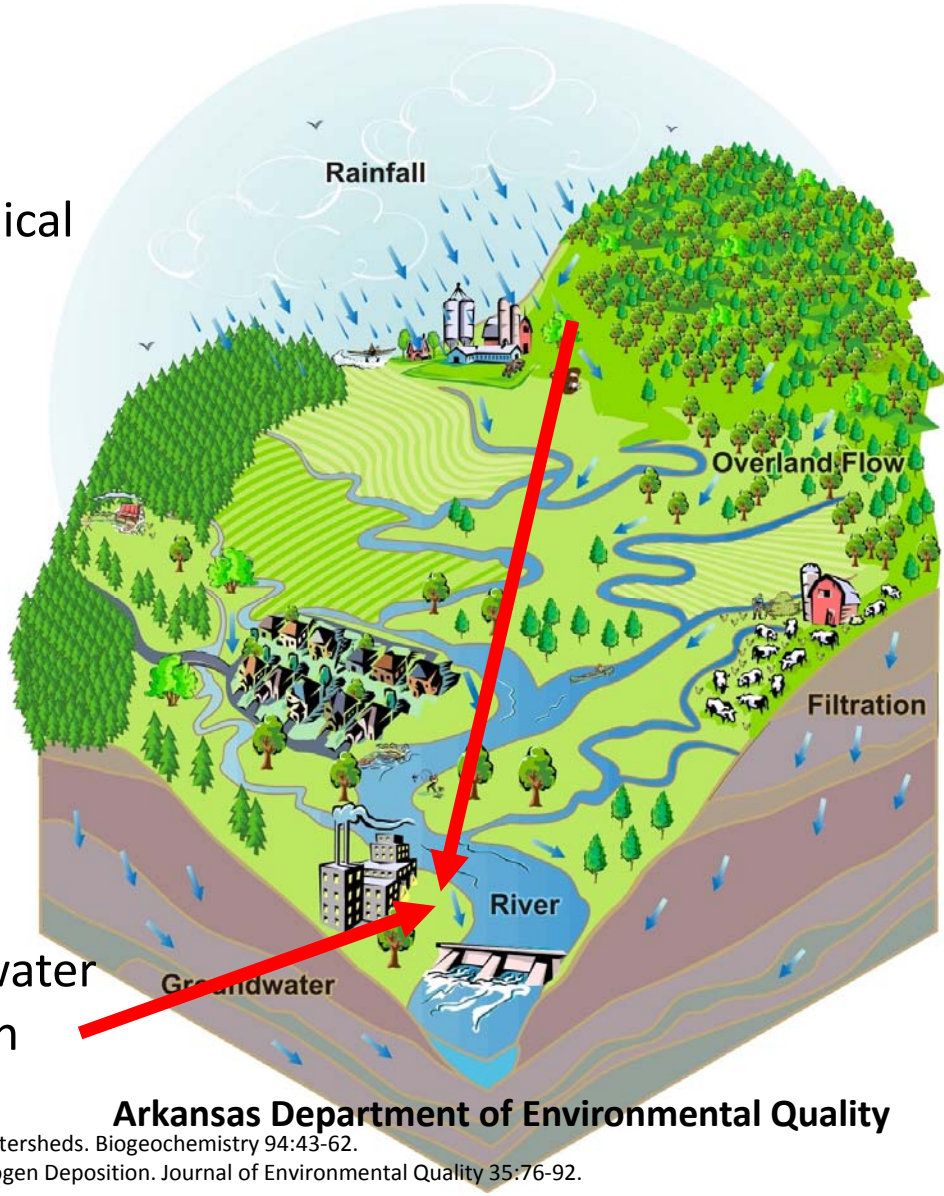
Topography and Nitrogen

- Water carries nitrogen in runoff following topographical patterns.
- Nitrogen not taken up by plants is exported down slope.

Topographical Gradient! Uphill to downhill.



Nitrogen and water accumulating in lowland areas!

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Sobota, D.J. et al. 2009. Influences of climate, hydrology, and land use on input and export of nitrogen in California watersheds. Biogeochemistry 94:43-62.
Wood, Y.A., et al. 2006. Altered Ecohydrological Response Drives Native Shrub Loss under Conditions of Elevated Nitrogen Deposition. Journal of Environmental Quality 35:76-92.

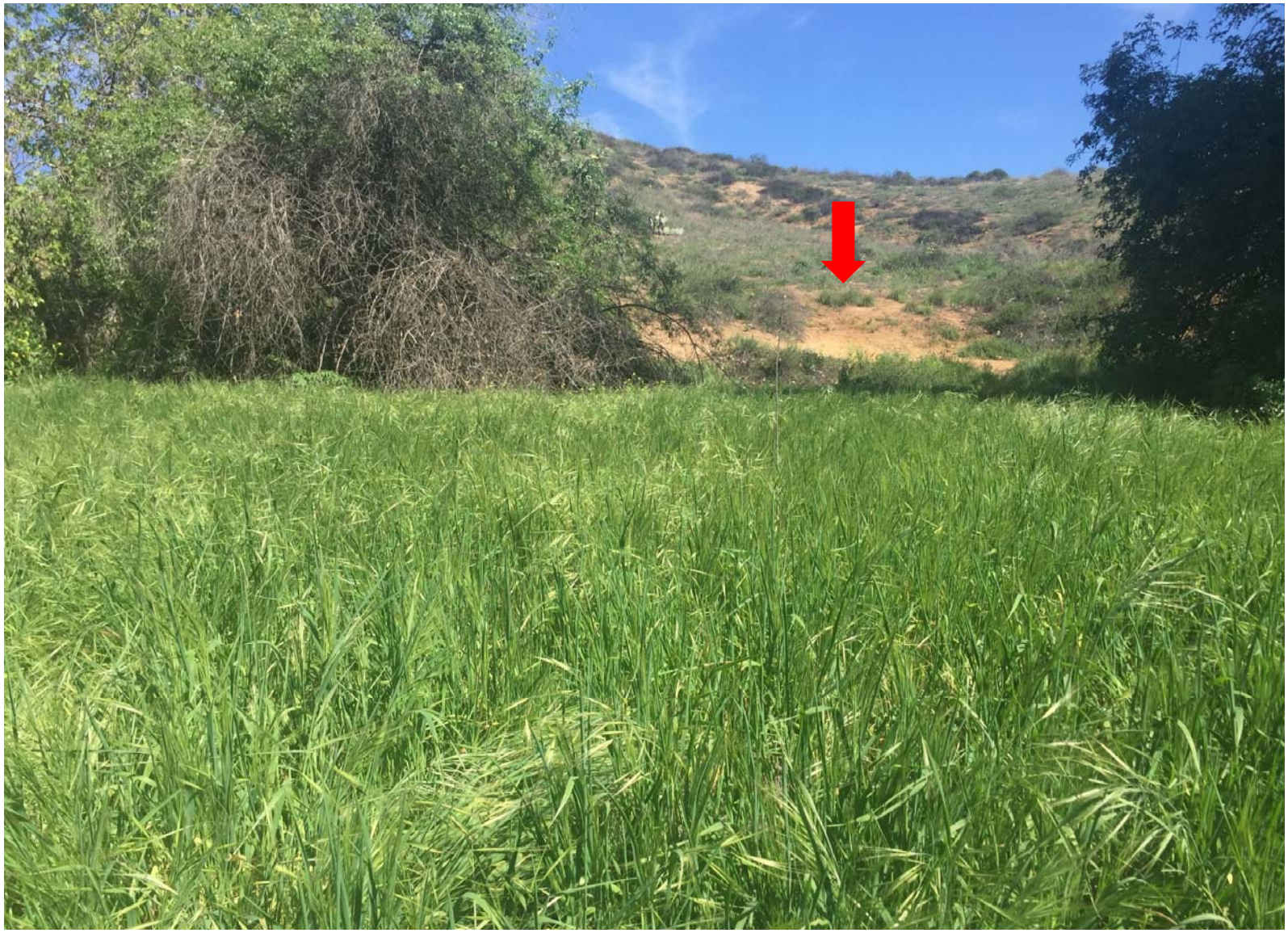
1st Objective

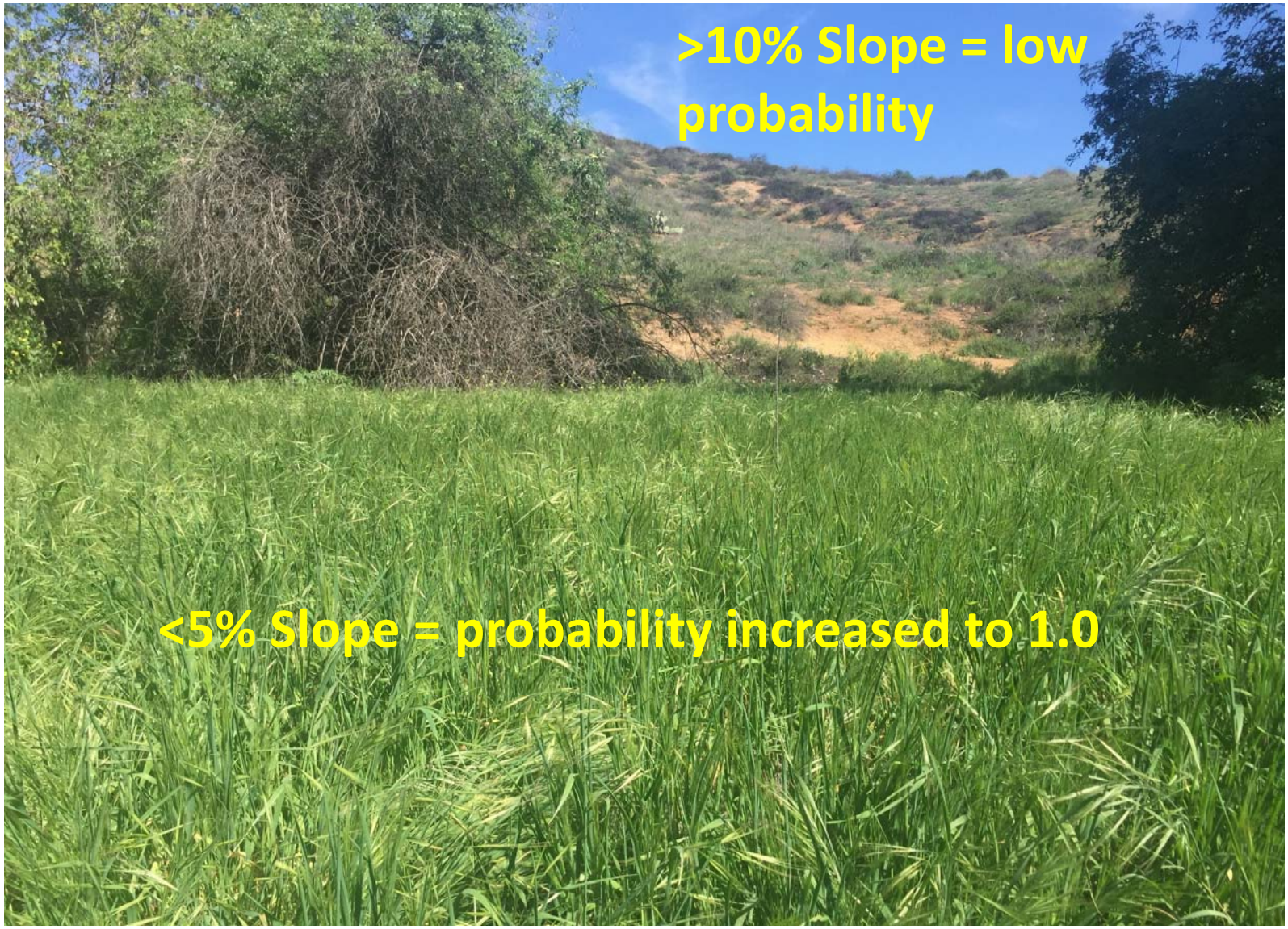
- Analyze differences in soil moisture and soil nitrogen created by a slope gradient.
- Key: smaller spatial scale
- Hypothesis: Lowland areas will contain the highest amount of soil nitrogen and soil moisture, whereas steep uphill areas will have the lowest of both.
- Application: Prioritize invasive plant control in high N areas.

Stipa pulchra, focal species

- Commonly used in restoration projects.
- Negative effects of competition with invasive annual grasses has been well established.
- Field observation: *S. pulchra* appears to rarely occur in lowland habitats and is more commonly found on gradual slopes.

S. pulchra's Distribution





Robert Cox et al. 2014. Influence of landscape-scale variables on vegetation conversion to exotic grassland in Southern California, USA. Global Ecology and Conservation 2:203-190.

Possibilities?

- Artifact of prior land use (e.g. cattle grazing)
- Fire- differentially burning topography
- N deposition?

2nd Objective

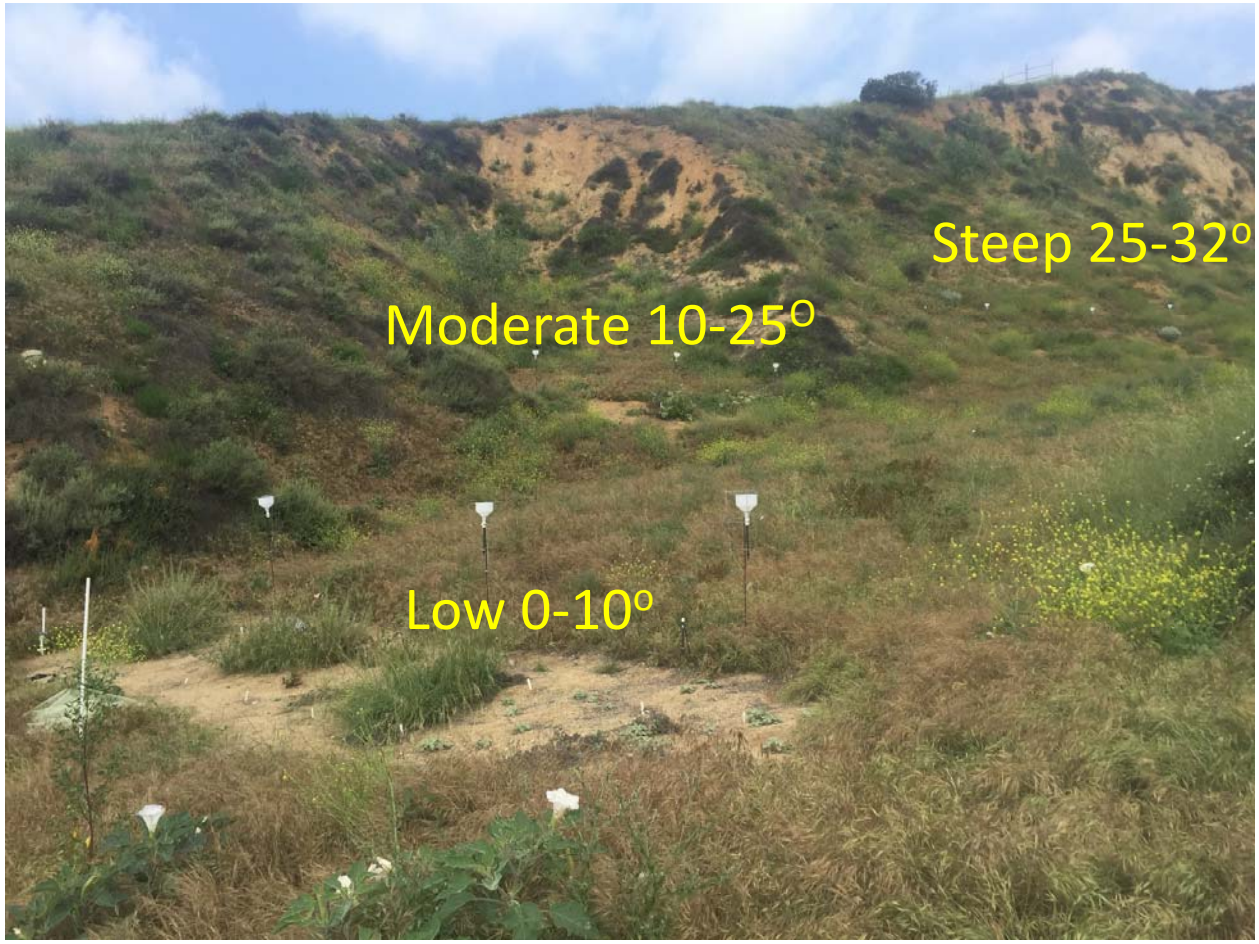
- Determine where in the soil moisture/N gradient is the most beneficial habitat for the persistence of *Stipa pulchra*.

- Hypothesis: *S. pulchra* will demonstrate the best performance in lowland areas and demonstrate the worst performance in steep areas based on available resources (soil moisture and soil N).

- Application: Improve restoration protocols for *S. pulchra*.

Voorhis Ecological Reserve 2015-2016

- Plots within three slope classes within four separate canyons (blocks) for a total of 36 plots.
- Replicated three nitrogen treatments
- Measured: soil moisture content, plant available soil nitrogen, plant biomass, growth, and stress (leaf water status).



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Voorhis Ecological Reserve 2015-2016

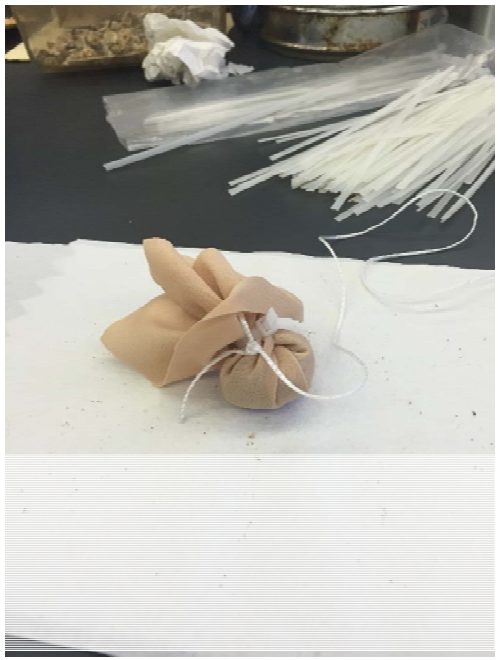
- 36 plots at three slope classes within four separate canyons (blocks)
- Replicated three nitrogen treatments
- Measured: soil moisture content, plant available soil nitrogen, plant biomass, growth, and stress (leaf water status).

Planted 5 *Stipa* seedlings

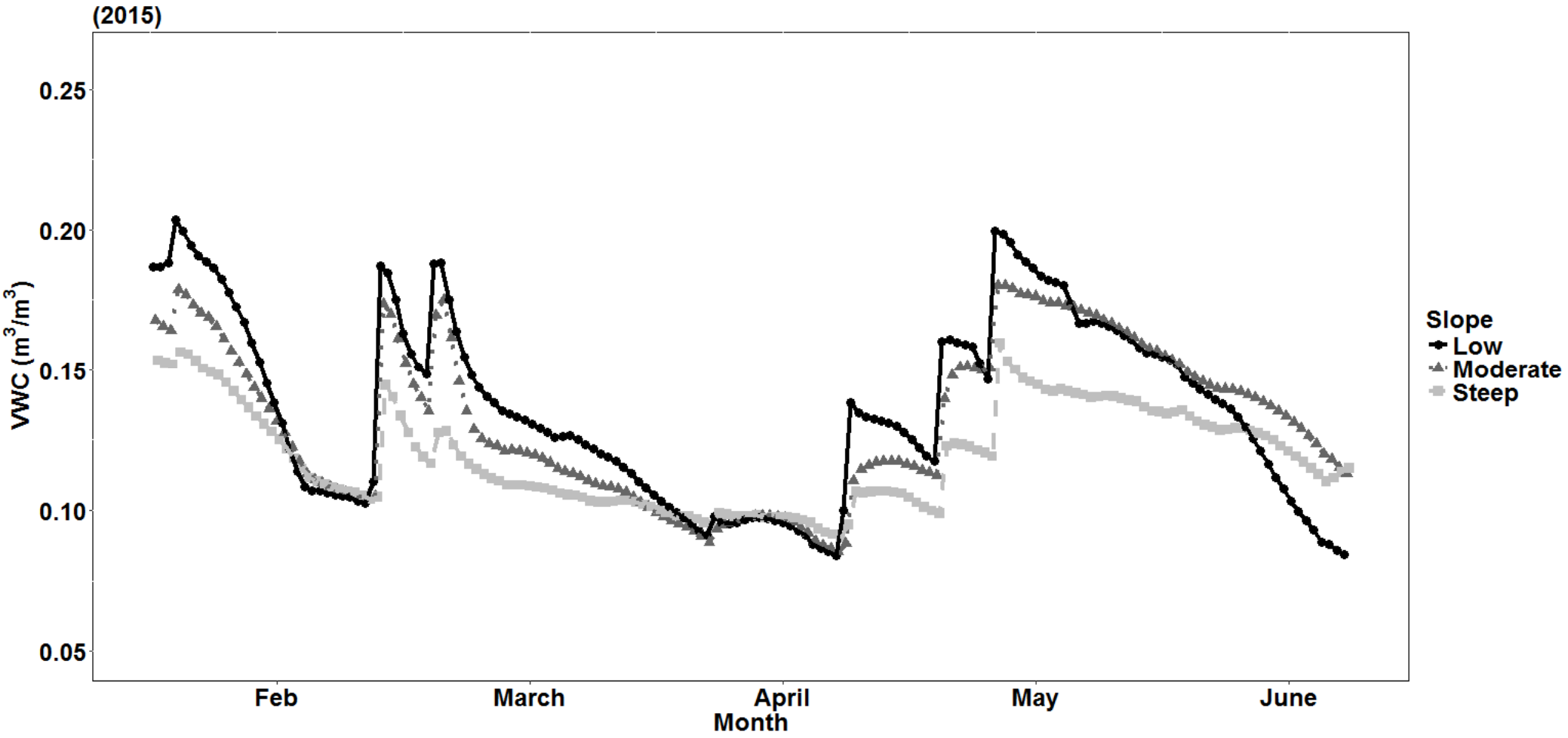
Weeded free of all invasive species!

Voorhis Ecological Reserve 2015-2016

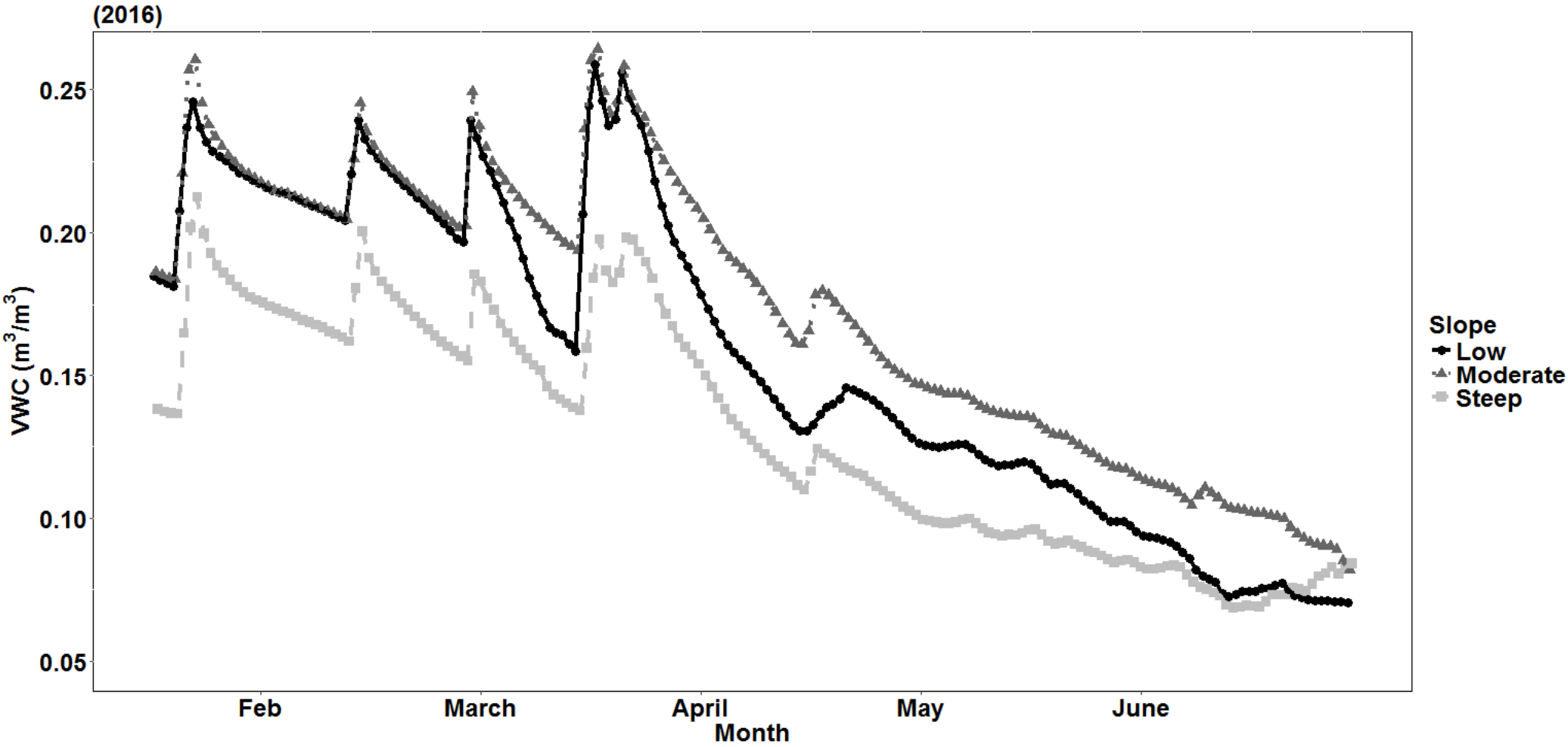
- 36 plots at three slope classes within four separate canyons (blocks)
- Replicated three nitrogen treatments
- Measured: soil moisture content, plant available soil nitrogen, plant growth, reproduction, and stress (leaf water status).



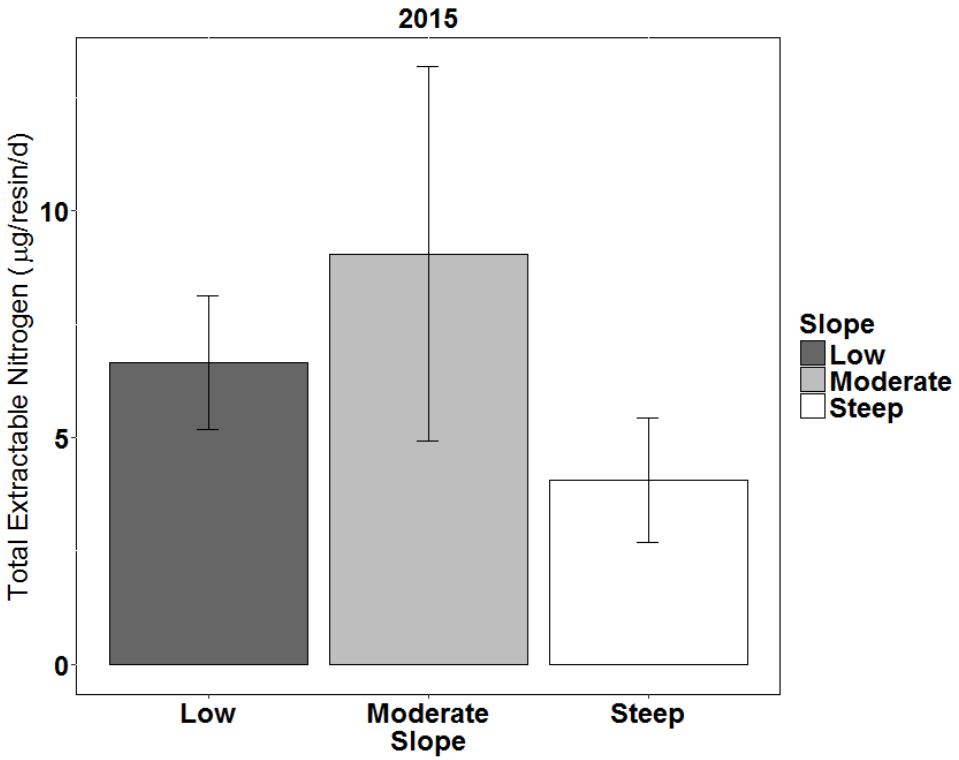
Soil Moisture

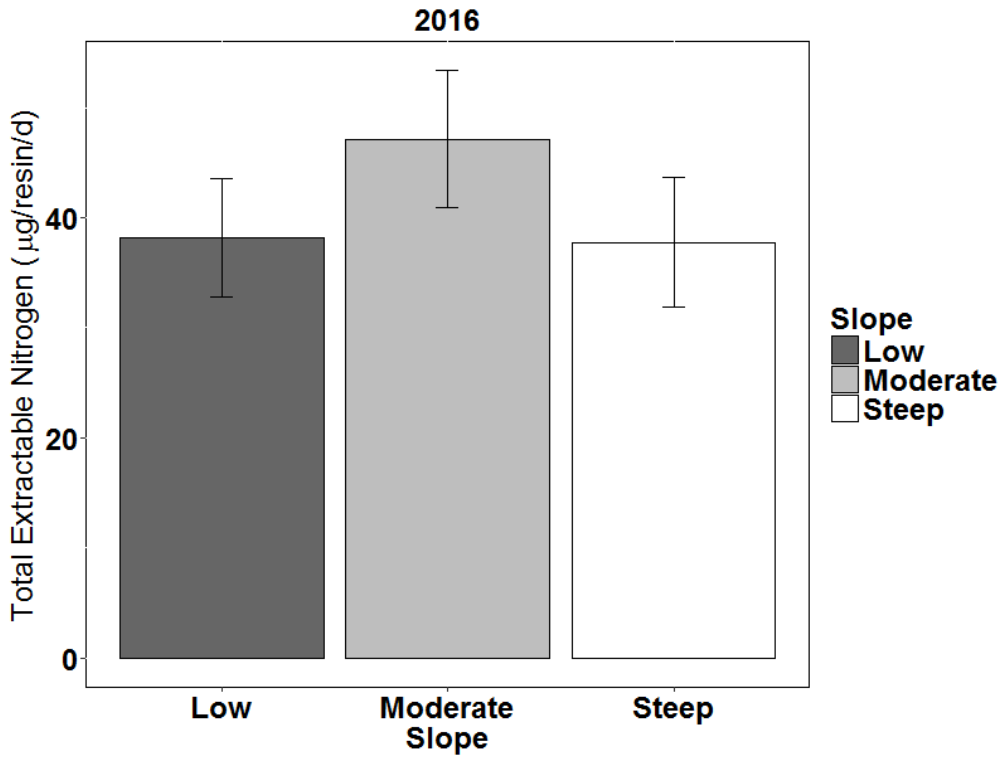


Soil Moisture



Soil Nitrogen



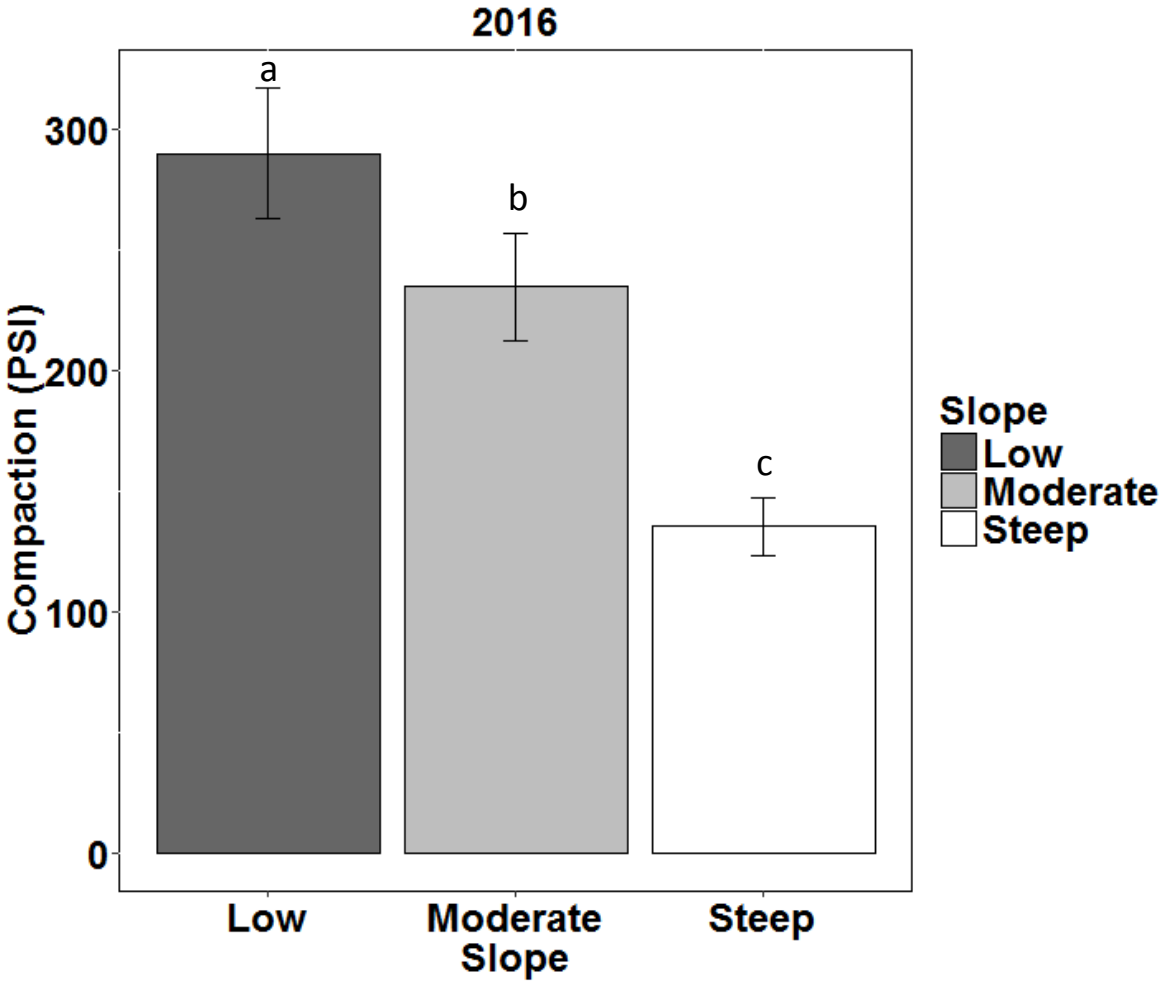


Objective 1

- Analyze soil N and soil moisture along a slope gradient.
  - Trend that soil moisture and total soil N was greatest in moderate slope plots.
  - What could be driving these patterns?

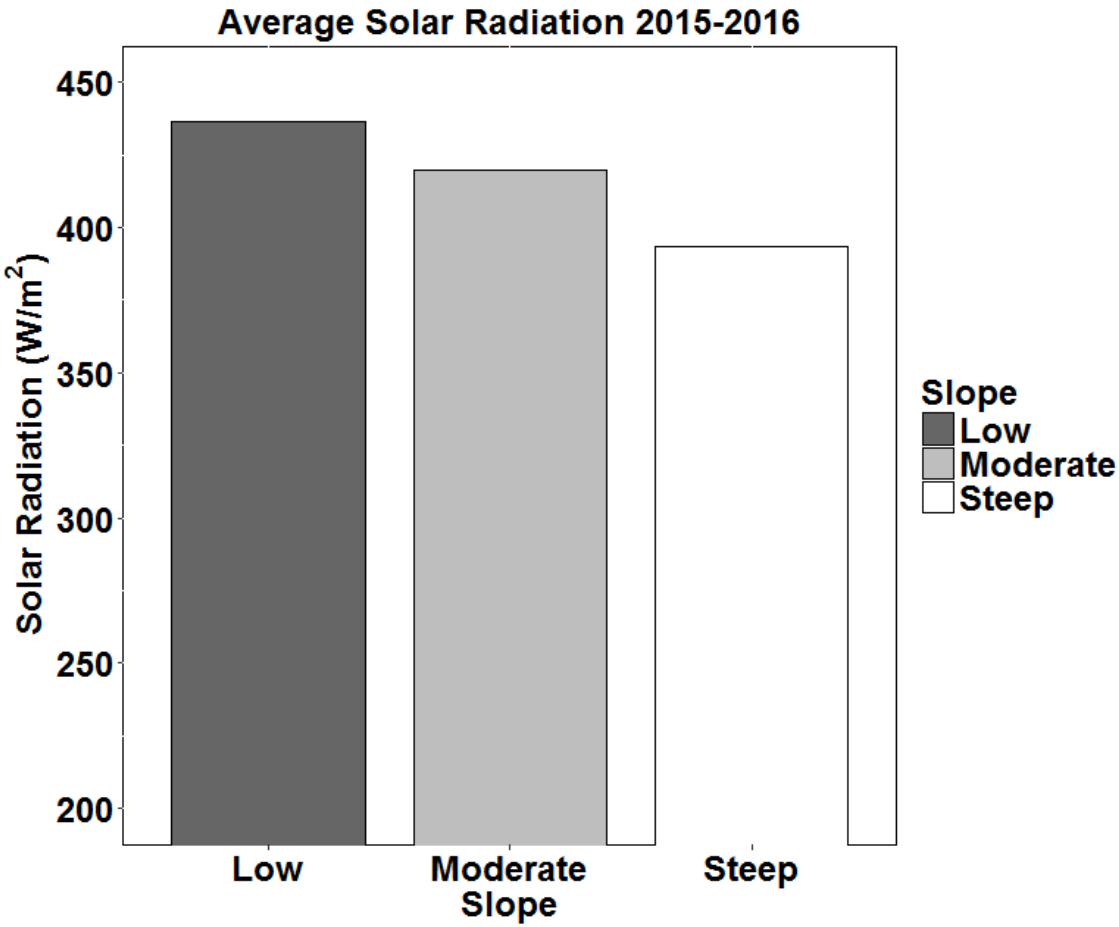
Soil Compaction

Soil of low slope plots was the most compacted and soil of the steep slope plots was the least compacted.



Solar Radiation

Low slope plots received the most solar radiation and steep slope plots received the least.

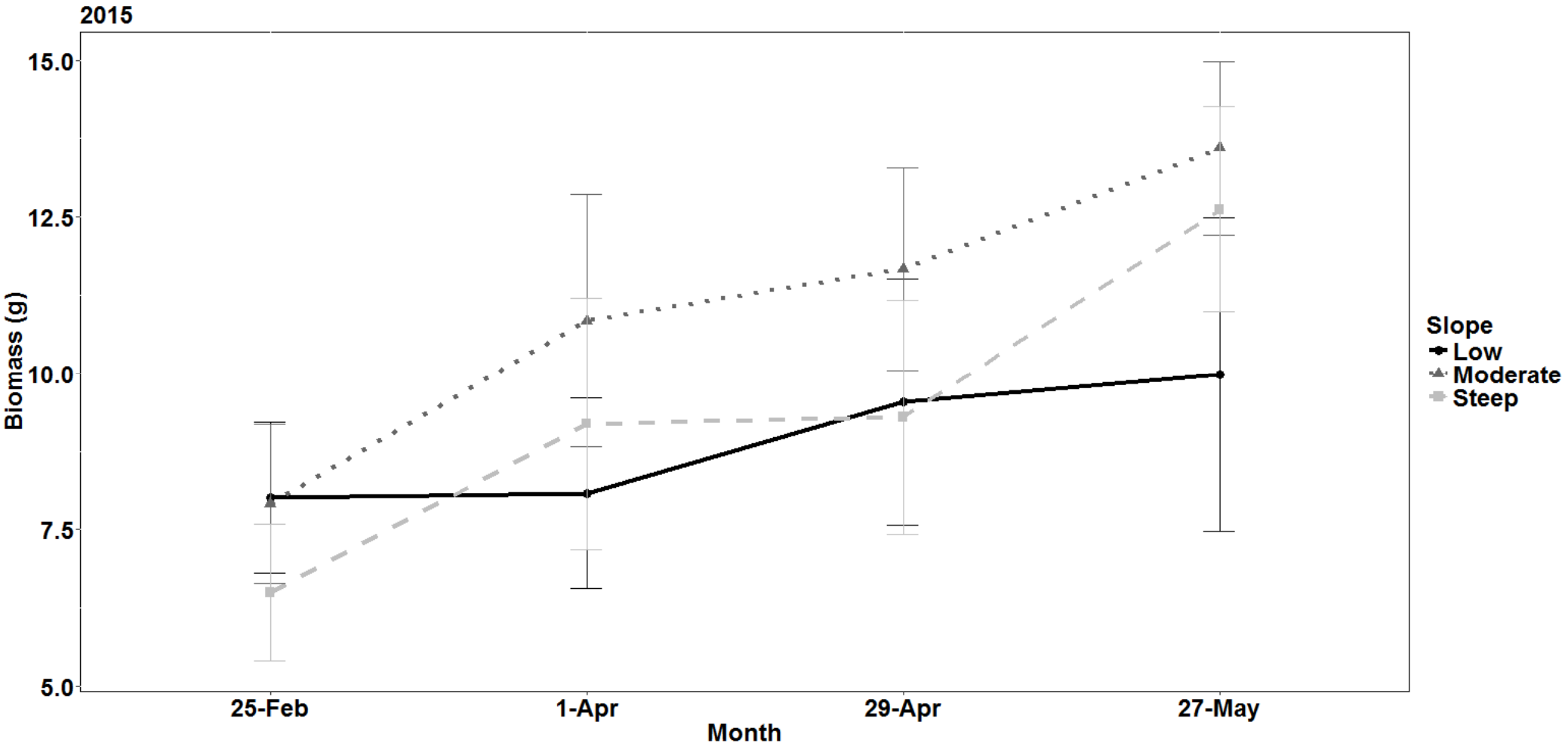


Soil Moisture Patterns

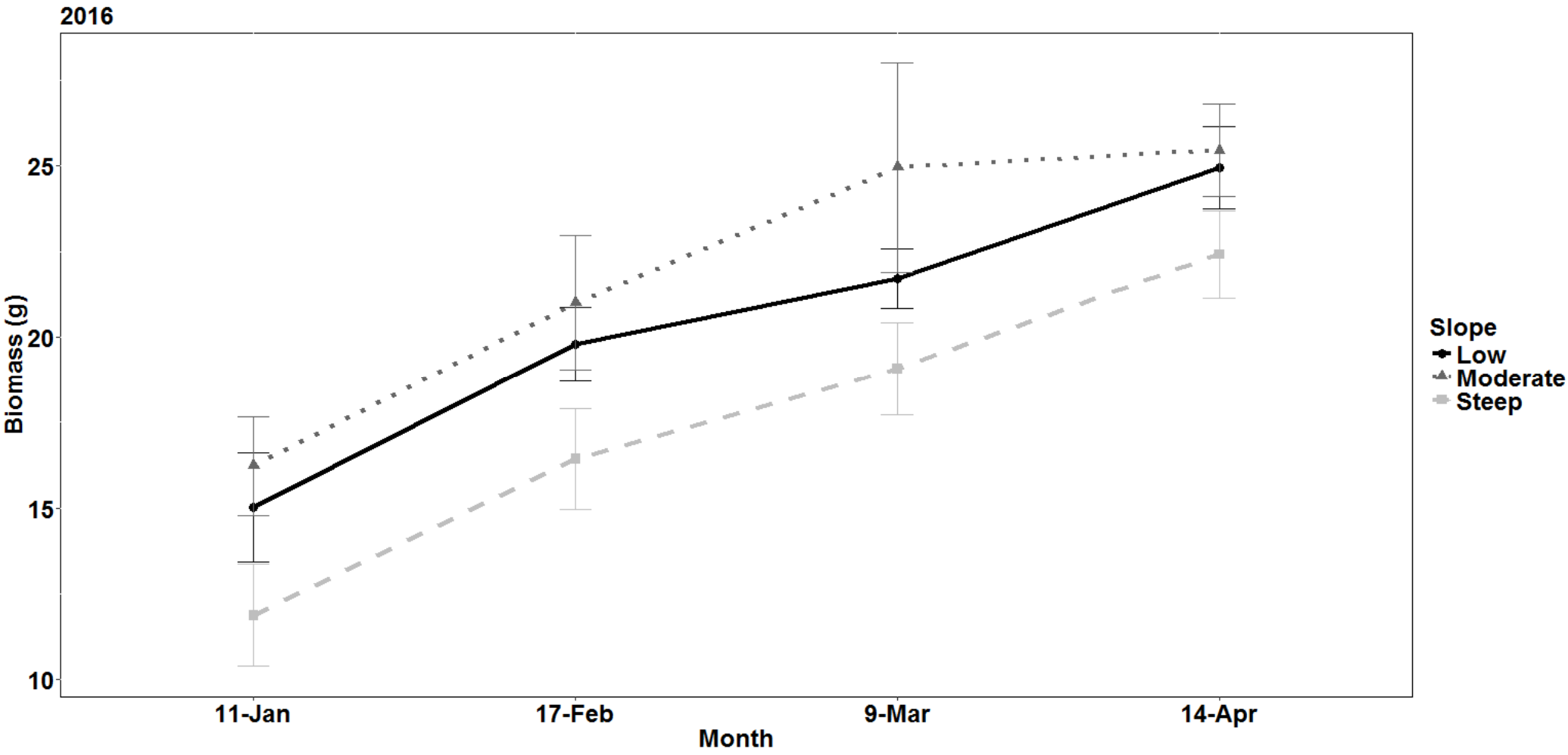
- Increased soil compaction and solar radiation, decrease water availability at low slopes.

- Increased run off rates decrease water availability at steep slopes.

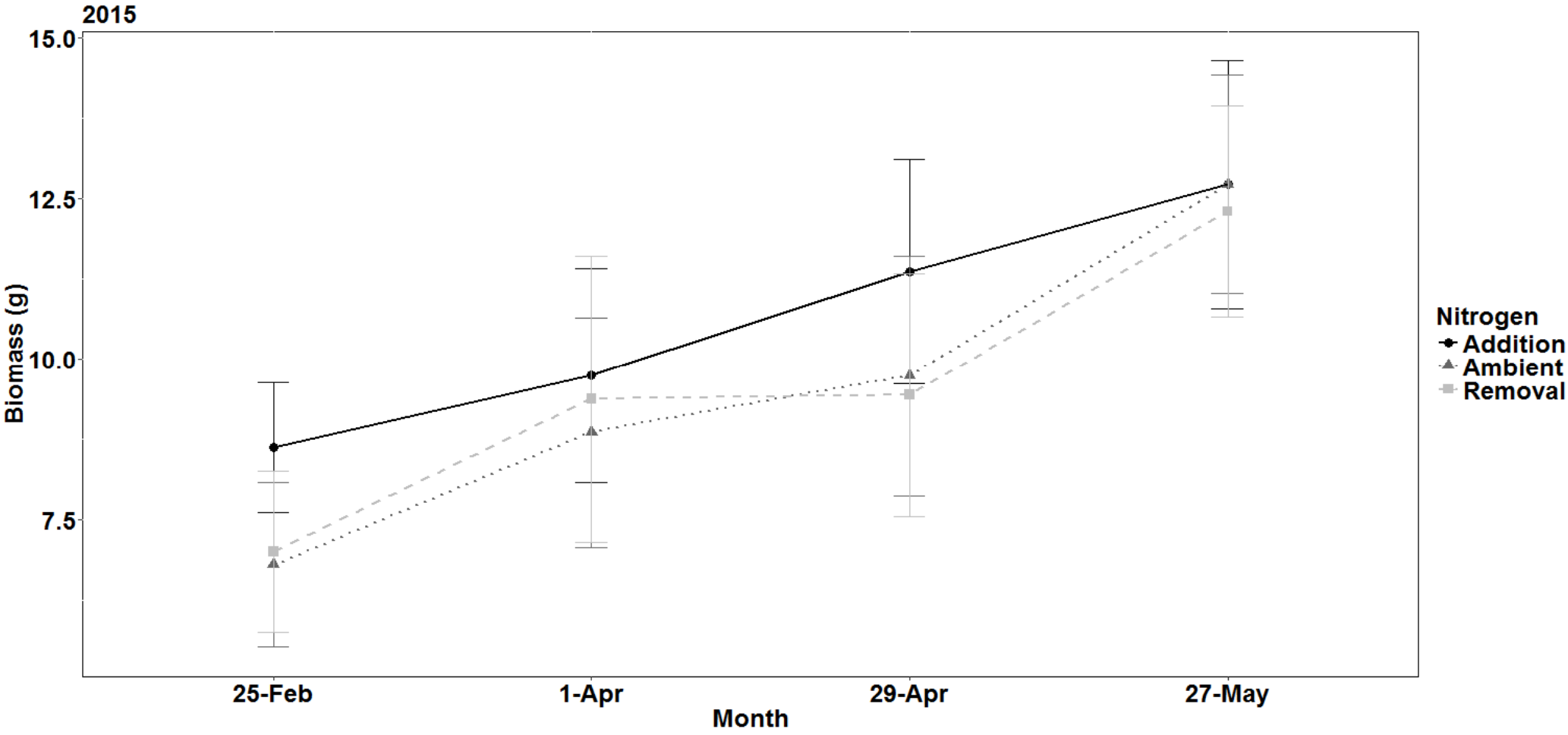
Plant Size


2015
15.0
12.5
10.0
7.5
5.0
Biomass (g)
25-Feb
1-Apr
29-Apr
27-May
Month
Slope
Low
Moderate
Steep

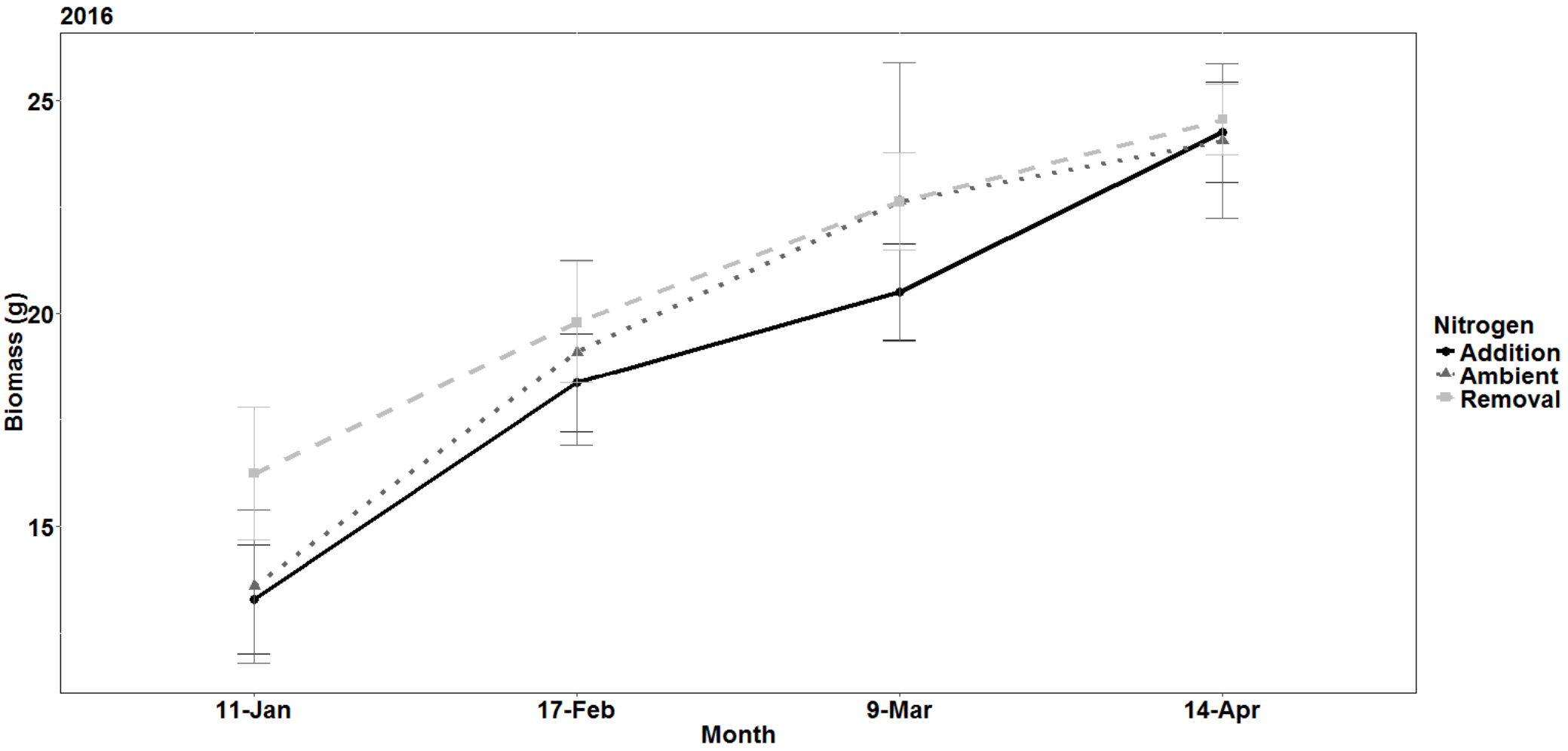
Plant Size


2016
Biomass (g)
25
20
15
10
11-Jan
17-Feb
9-Mar
14-Apr
Month
Slope
Low
Moderate
Steep

Plant Size


2015
15.0
12.5
10.0
7.5
Biomass (g)
25-Feb
1-Apr
29-Apr
27-May
Month
Nitrogen
Addition
Ambient
Removal

Plant Size


2016
25
20
15
Biomass (g)
11-Jan
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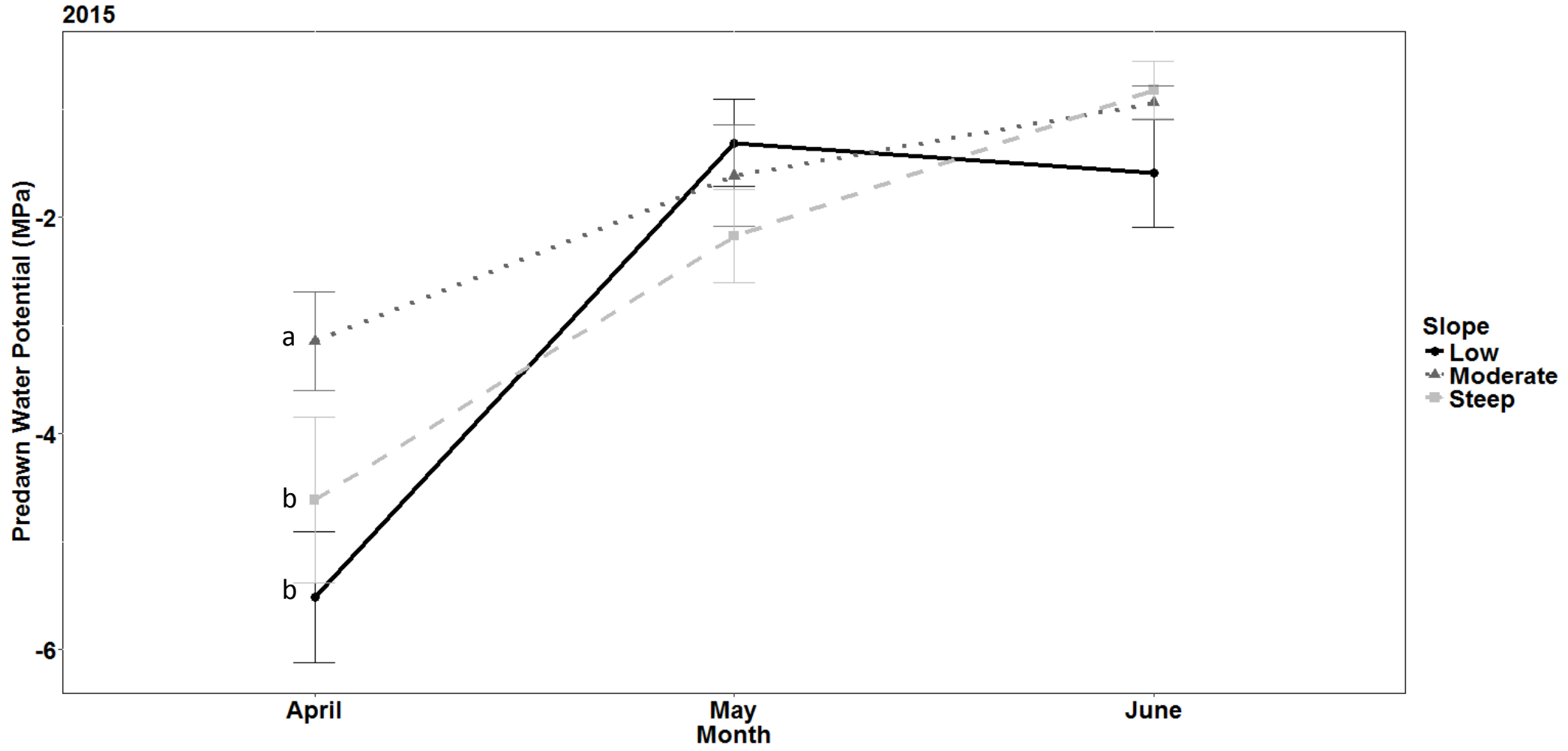
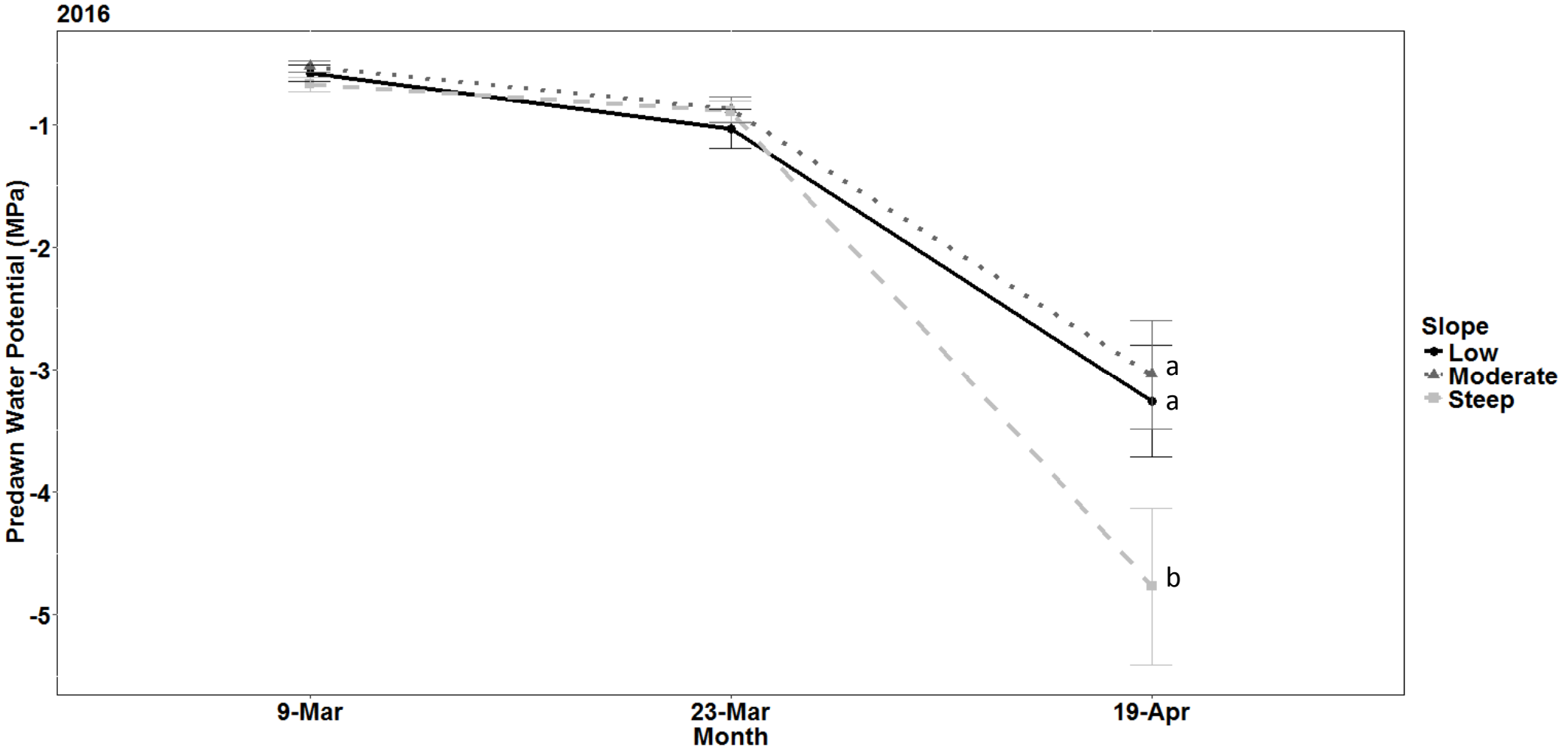
9-Mar
14-Apr
Month
Nitrogen
Addition
Ambient
Removal

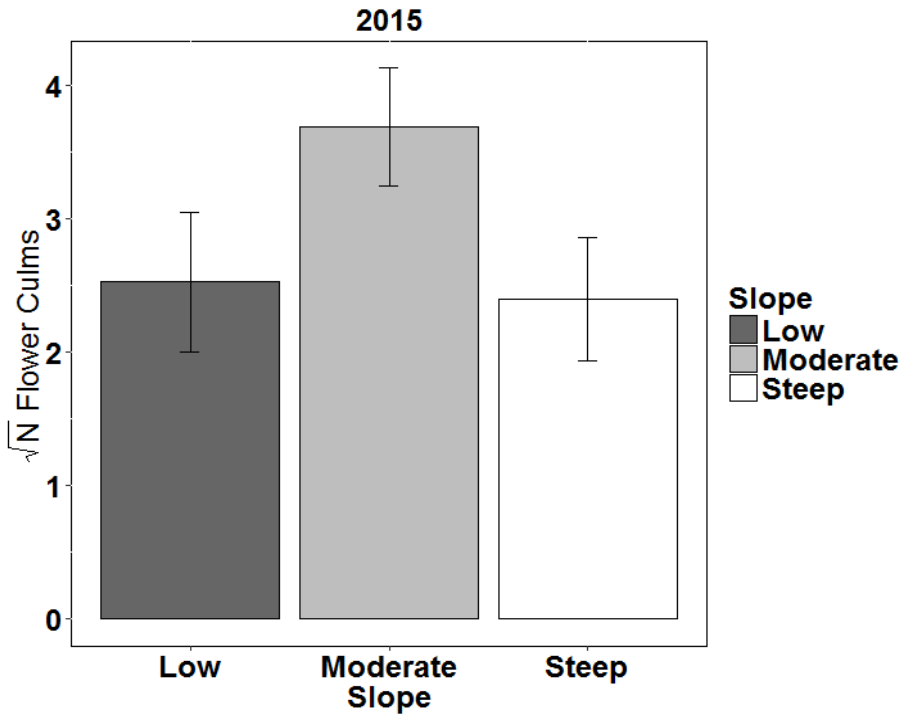
Water Potential

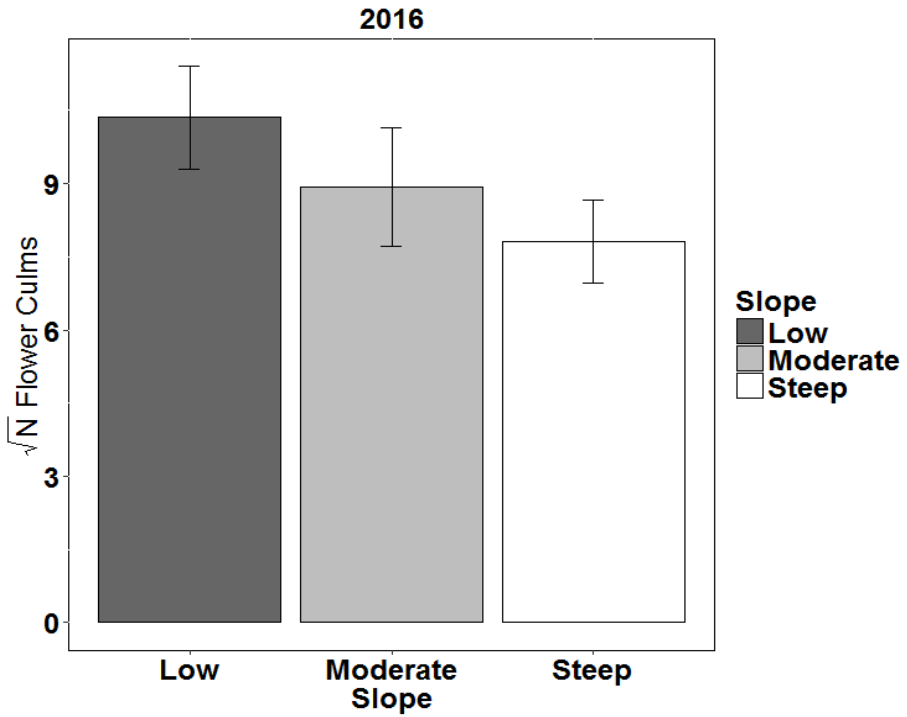


Water Potential



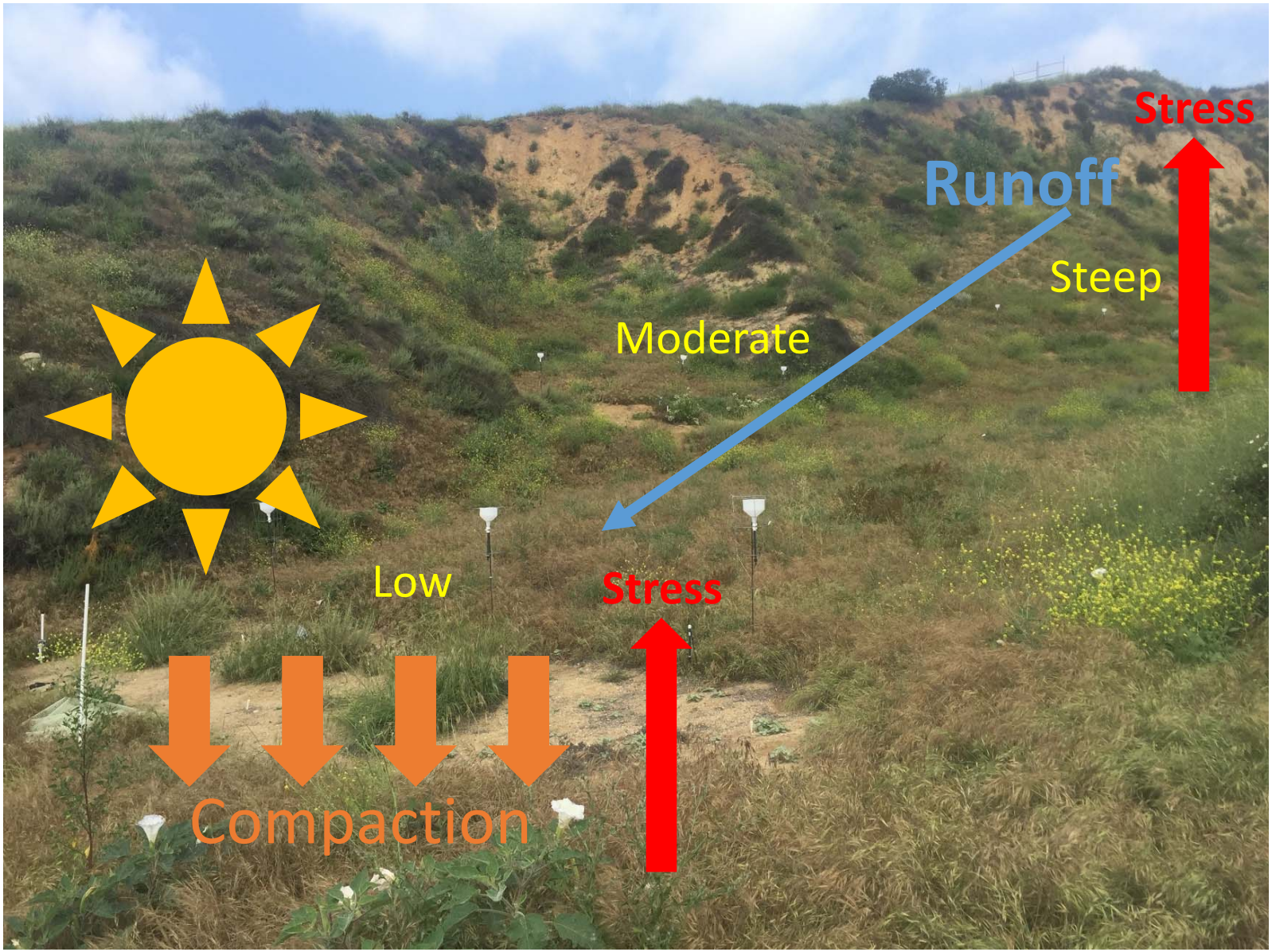
Reproduction





Objective 2

- Determine the best habitat location for *S. pulchra* within the slope gradient.
  - *S. pulchra* is best adapted to moderate slope areas because plants were largest and were the least water stressed.
  - Weak response of nitrogen across all response variables likely due to drought.


Stress
Runoff
Steep
Moderate
Low
Stress
Compaction

Application

Prioritize *S. pulchra* restoration on moderate slopes.

Acknowledgements:

- Committee Members:
  - Dr. Ed Bobich
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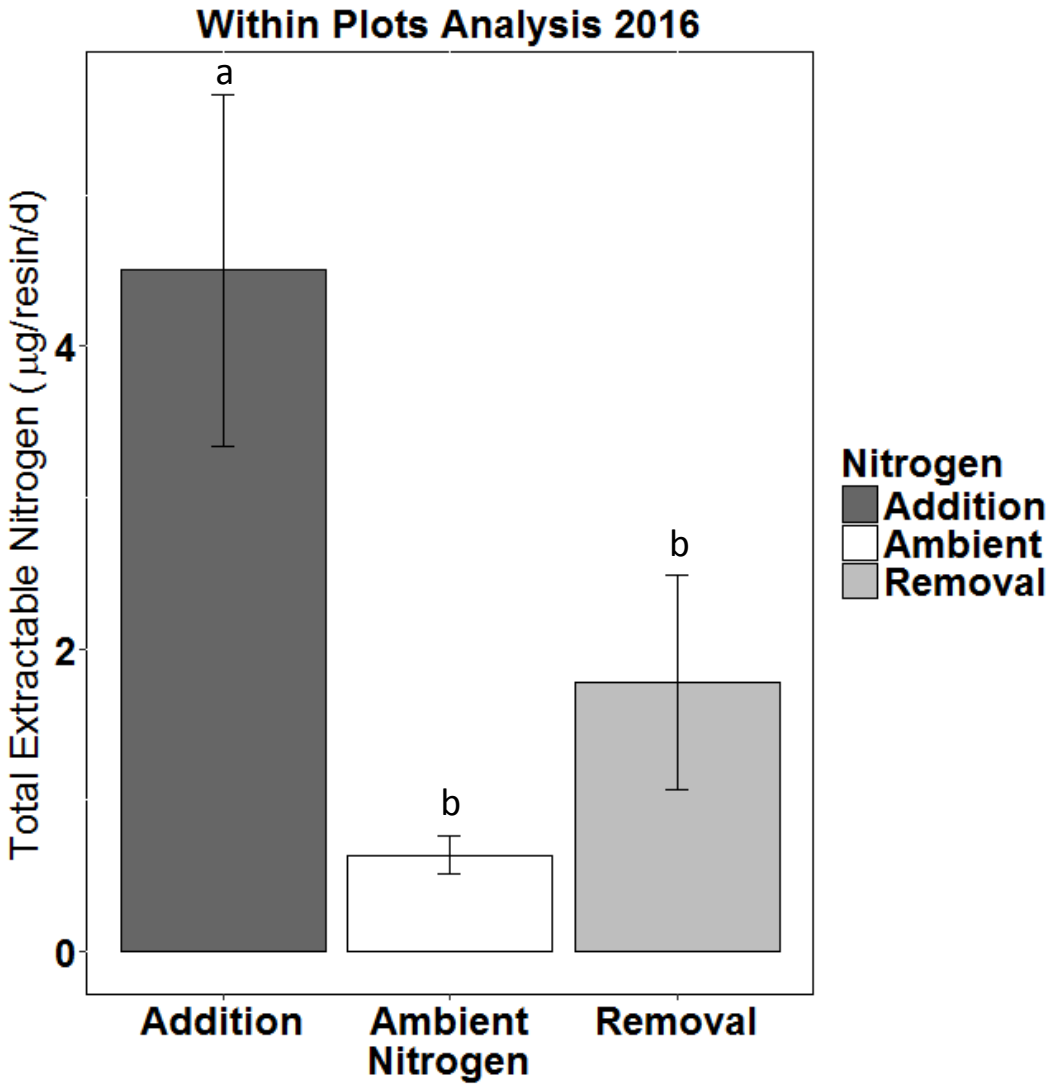
CAL POLY POMONA

Thank you


Within Plots Analysis 2016
Total Extractable Nitrogen (µg/resin/d)
0
2
4
a
b
b
Addition
Ambient
Removal
Nitrogen
Nitrogen
Addition
Ambient
Removal