# Understanding Change in Vegetation Cover in a Wet Meadow Tundra Community

Jessica Gregory

Grand Valley State University

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# Overview

- Introduction
- Research Objective
- Methods
- Results
- Discussion/Conclusion
- Additional Research

# Climate Change Overview

- Most significant warming in Arctic regions[21] (source et al. 20XX)
- Effects of warming observed in the Arctic [2, 8, 13, 12]
  - Earlier snowmelt(source et al. 20XX)
  - Longer growing season(source et al. 20XX)
  - Plant phenological shifts(source et al. 20XX)
  - Altered distributions of organisms (thru acclimation to changing climate conditions or competitive interactions; survival range expanding)(source et al. 20XX)

# Introduction

- Response of vegetation to warming will impact the entire ecosystem[3, 5, 30]
  - $CO^2$ cycling
  - Hydrologic cycling
  - Energy balance
  - Habitat quality
  - Herbivore forage quality

# Introduction

- Cover is a widely-used method of documenting vegetation change
- International Tundra Experiment (ITEX)
  - Est. in 1990
  - long-term vegetation change (arctic & alpine)
- Unclear whether plant growth or alterations in the number of individuals (density) are driving these changes

# Research Objectives

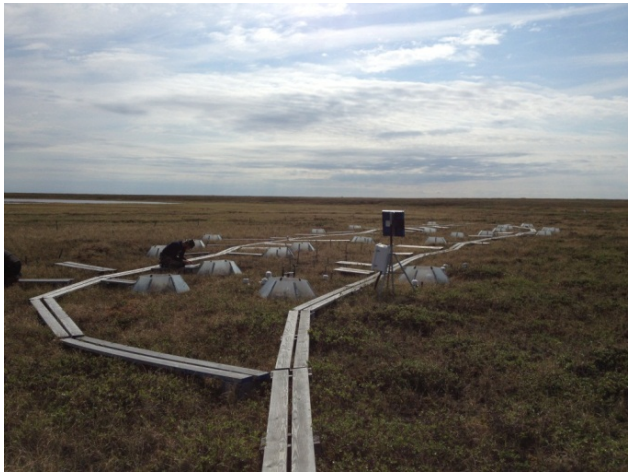
- Do proxies ~~measures~~ of plant growth or density more effectively reflect recorded changes in cover in a wet meadow tundra community?
  - Growth forms
  - Select dominant species

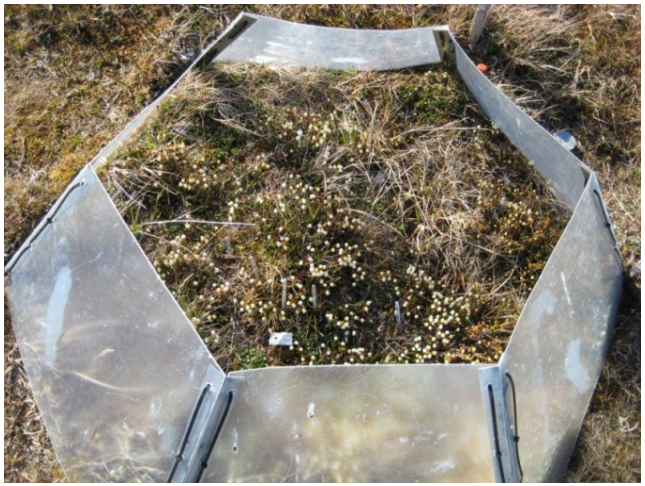
# Methods: Study Area

- Atqasuk, Alaska (1996)
  - 9 ° C
  - 20.8 mm
- Wet meadow community
  - Dominated by graminoids and bryophytes
  - Vulnerable to expansion of deciduous shrubs
  - Edge of thaw lake

# Methods: Study Site

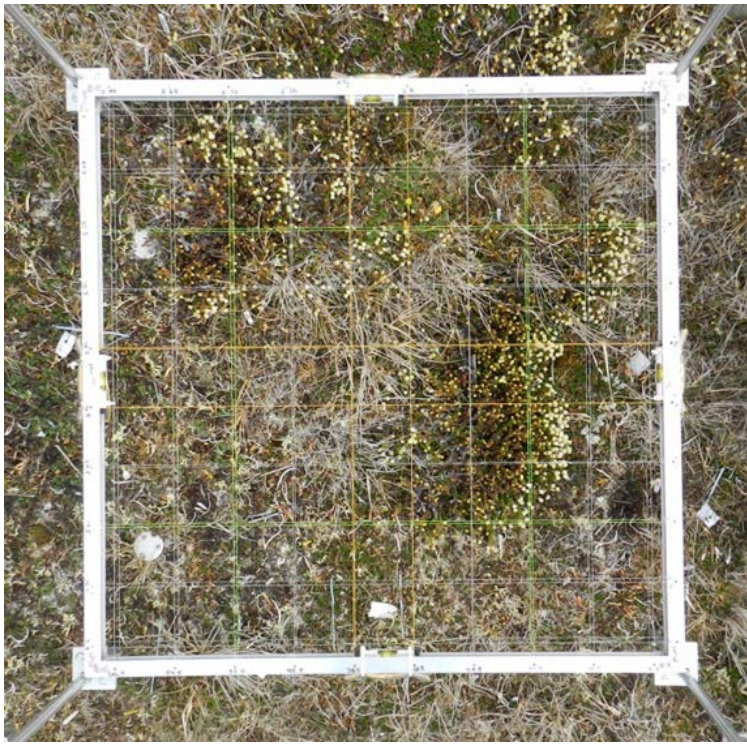
- Atqasuk Wet (AW) site
  - Long-term warming experiment
  - 48 plots ~~at each site~~ (24 control, 24 warmed)
- Experimental Warming
  - 1-$m^2$ open-top chambers (OTC)
  - Passively warm air on average by 0.6 to 2.2° Celsius[12, 16, 17]





# Methods: Vegetation Measures

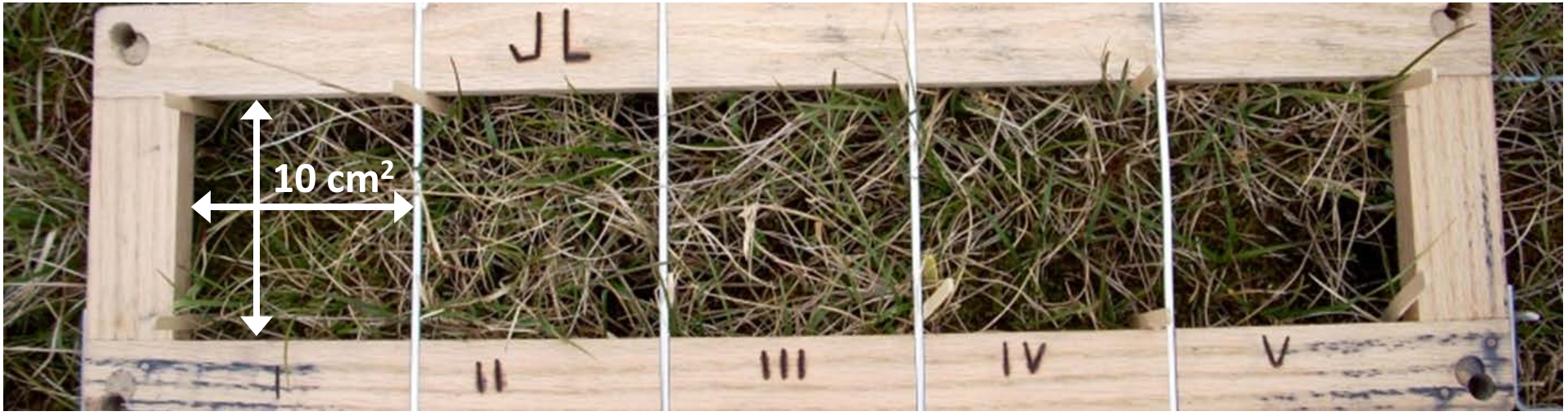
- Percent Cover
  - Point frame method (Cottam & Curtis, 1956)
  - Recorded in 2007 & 2012 at AW
  - # Hits / Total # available points * 100



- Canopy height (point frame method)
  - Recorded in 2007 & 2012
  - Calculated using ‘Hit 1’ from point frame
  - Ground height – hit height

# Methods: Vegetation Measures

- Density
  - Measured using a 10 x 50 cm frame
  - Recorded from 2011-2013 at AW
  - Individuals counted by status (live, dead, juvenile)
  - Provides the density of all vascular plants



# Methods: Vegetation Measures

- Leaf length & Inflorescence length
  - Recorded at end of season (~August 15)
  - Length of longest leaf & longest inflorescence for 3 individuals within each plot

# Methods

- Study species
  - Graminoids:
    - *Carex aquatilis*
    - *Eriophorum angustifolium*
    - *Eriophorum russeolum*
  - Deciduous shrubs
    - *Salix spp.*
  - Forbs
    - Considered only at the growth form level

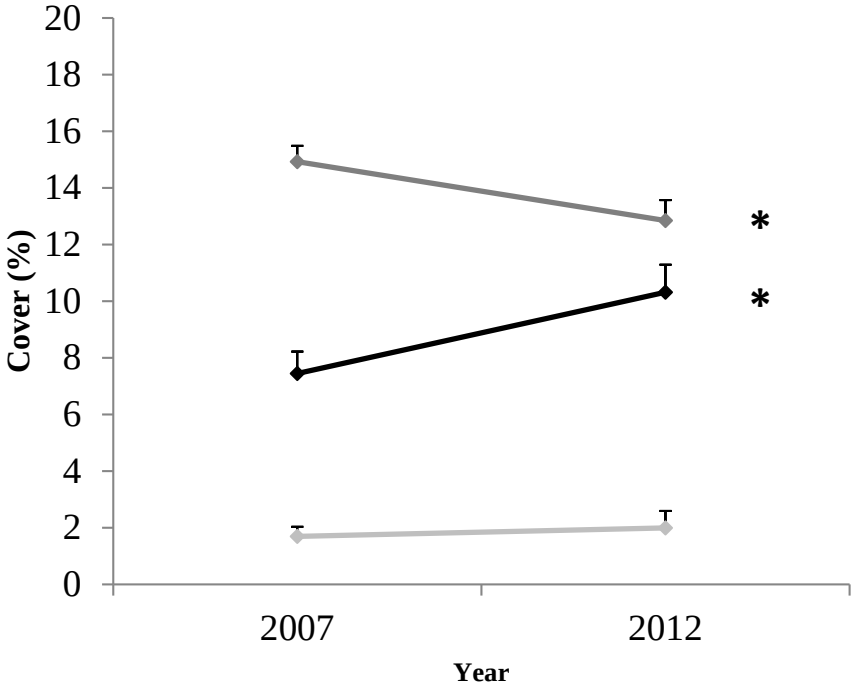
# Methods

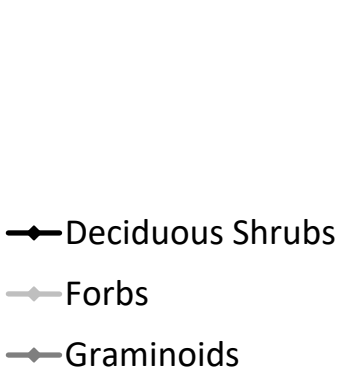
- Statistical analysis—2012 Data
  - Analysis of variance (ANOVA) w/ post-hoc
    - Year & Treatment effects
  - Multiple linear regression (MLR)
    - Cover as response variable; other veg measures as explanatory variables
    - Isolate best predictors of cover
  - Simple linear regression (SLR)
    - Relationships between cover & explanatory factors from MLR models

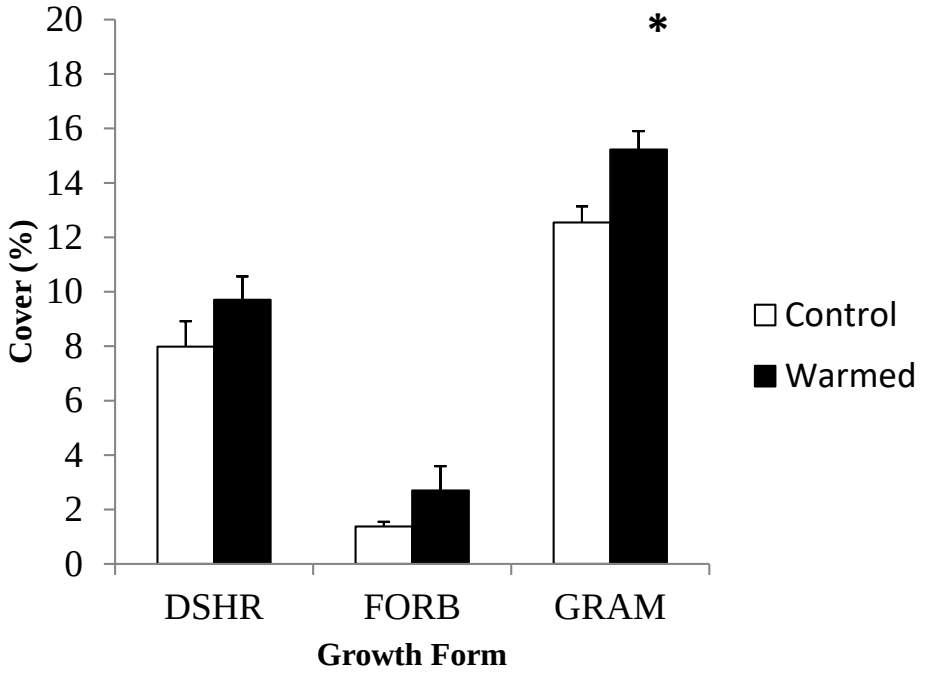
# Results

- ANOVAs—differences by year and treatment for growth forms (show graphs)
  - How do species compare to overall growth form results?
- MLR results—best models for growth form
  - (only mention species models if they are super different)
- SLR results—display graphs

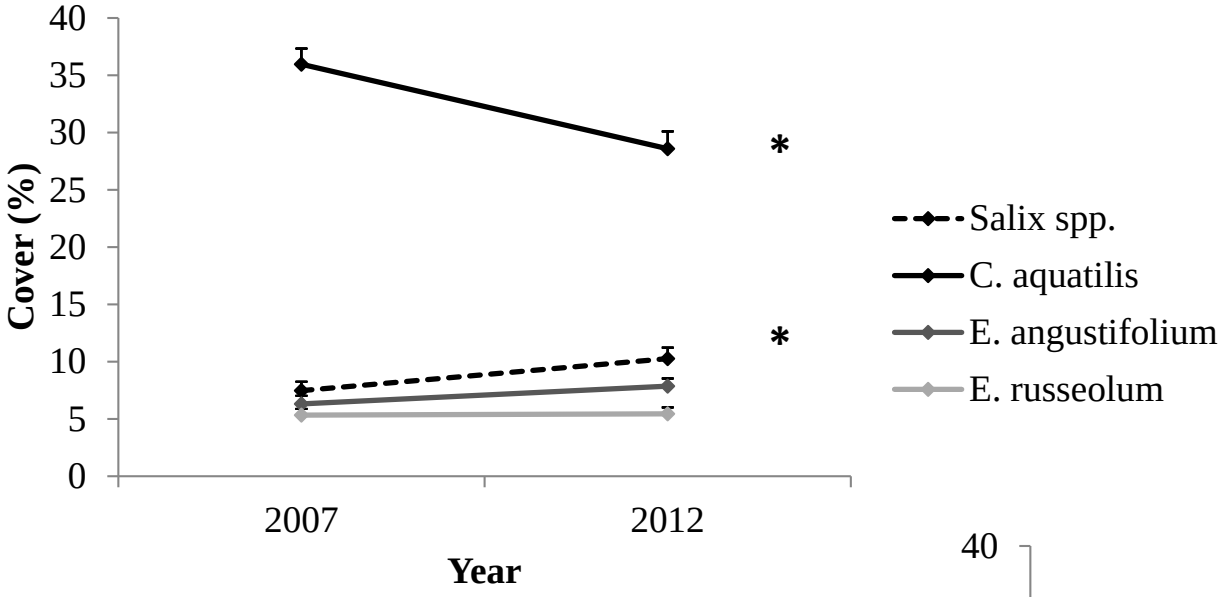
- Change in percent cover by growth form (2007 – 2012)



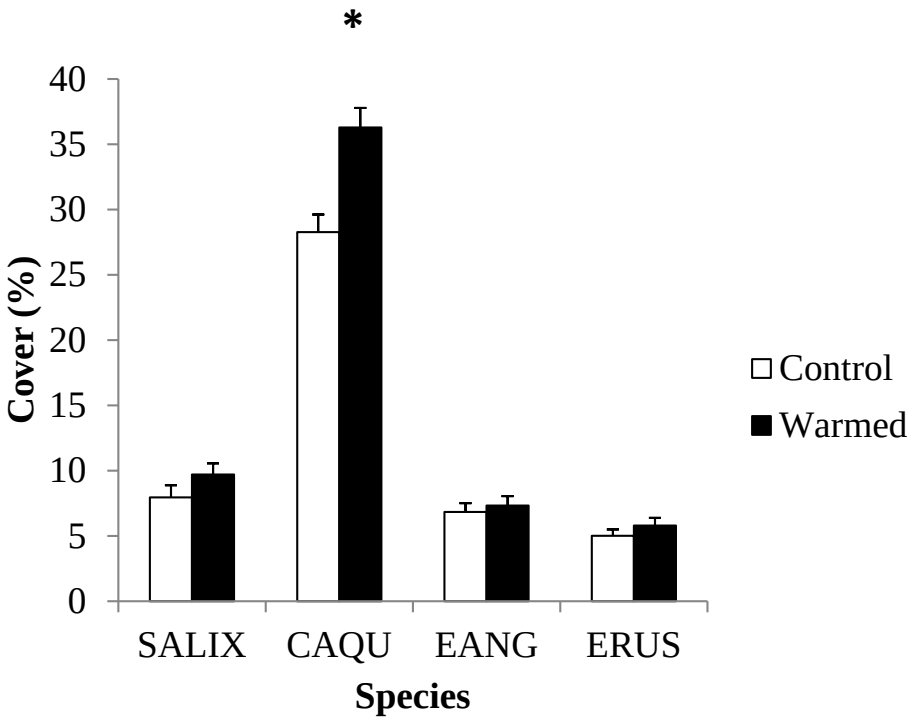



- Change in percent cover by species (2007-2012)




**Results driven by *Salix spp*. and *C. aquatilis***

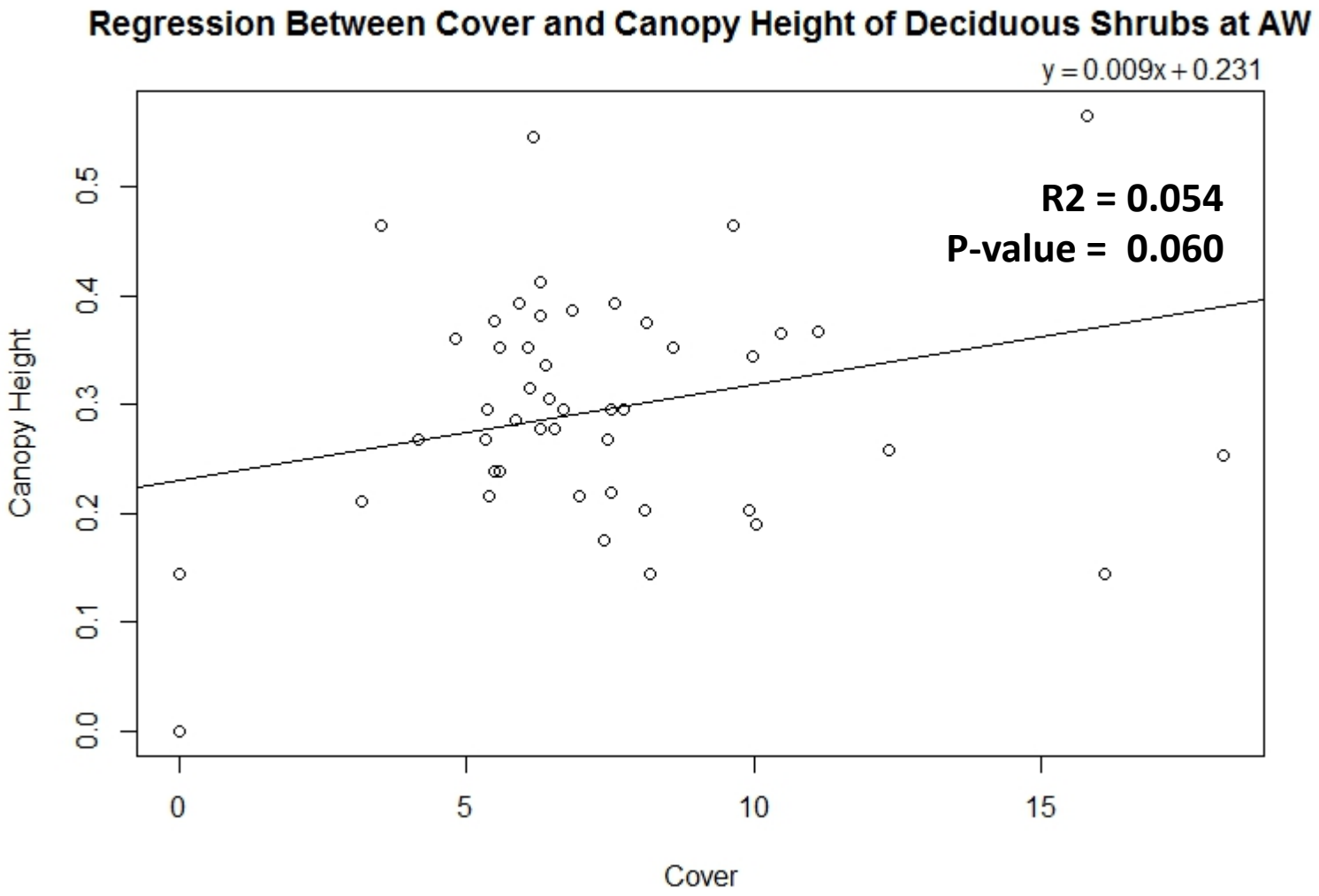


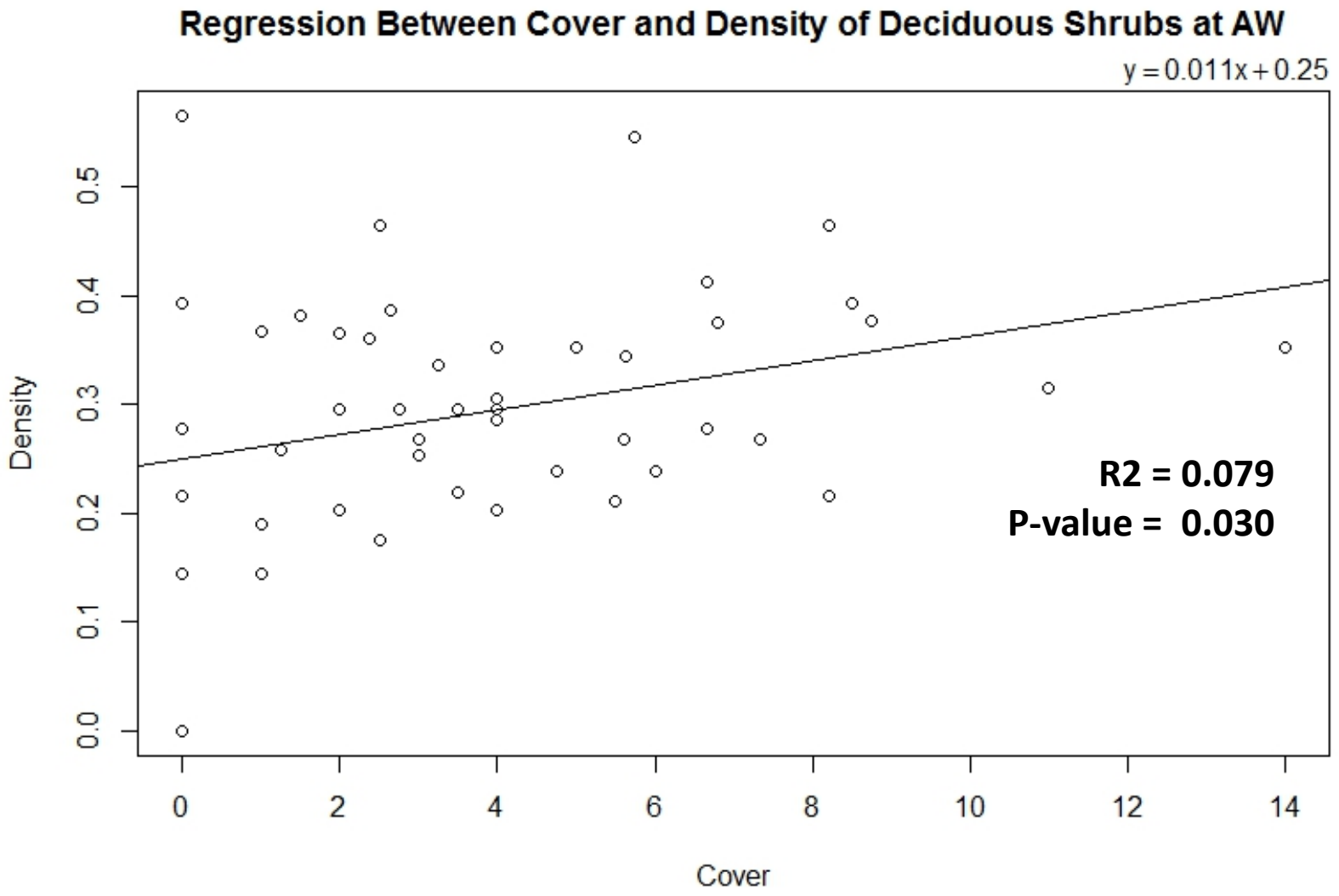
- MLR Results by Growth Form
  - Give final model with R2adj. & p-values; show graphs from SLR for explanatory variables (DSHR & GRAM)
  - Maybe on next slide also show MLR equations for other species, but don't show graphs (too many slides)?

- Final MLR Model for Deciduous Shrubs:

  **Cover ~ Canopy Height + Density + Treatment**

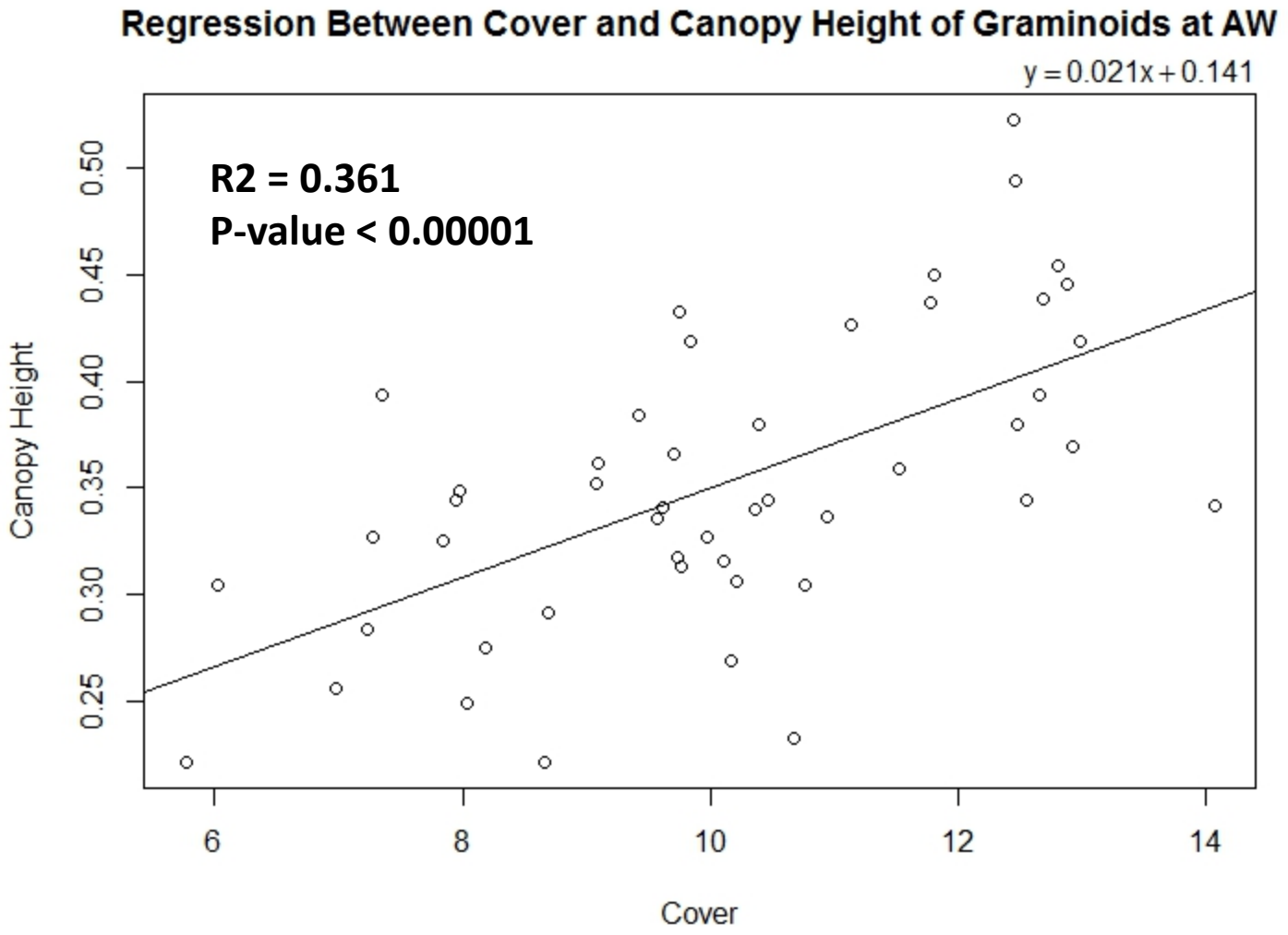
  **(R2 adj. = 0.206, p-value = 0.0042)**

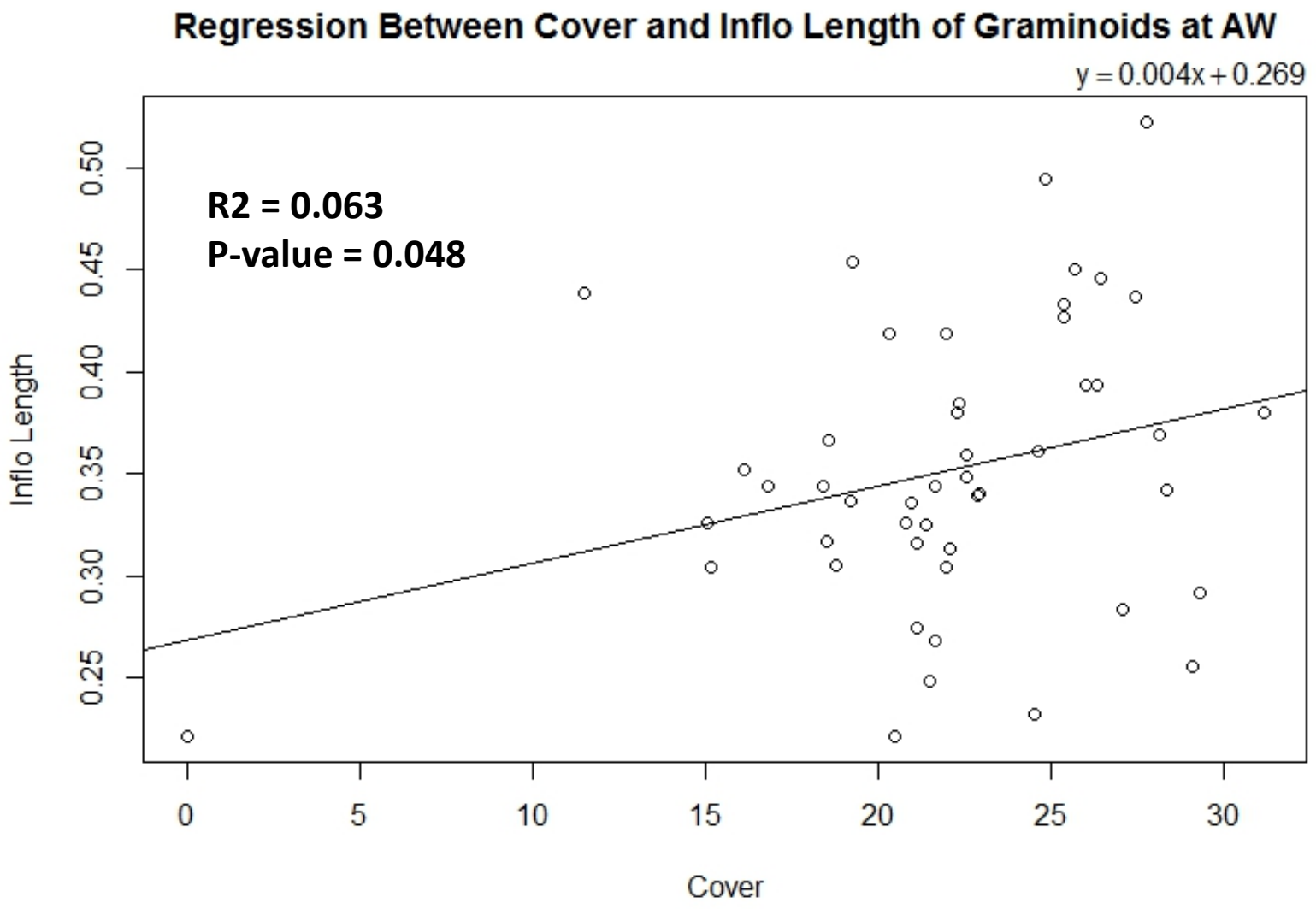



Regression Between Cover and Density of Deciduous Shrubs at AW
y = 0.011x + 0.25
Density
0.0
0.1
0.2
0.3
0.4
0.5
0
2
4
6
8
10
12
14
Cover
R2 = 0.079
P-value = 0.030

- Final MLR Model for Graminoids:

  **Cover ~ Canopy Height + Inflo Length + Treatment**
  **(R2 adj. = 0.4053, p-value < 0.00001)**




Regression Between Cover and Inflo Length of Graminoids at AW
y = 0.004x + 0.269
R2 = 0.063
P-value = 0.048
Inflo Length
0.25
0.30
0.35
0.40
0.45
0.50
0
5
10
15
20
25
30
Cover

- Species show similar trends:
  - *Salix spp.* → **Cover ~ Canopy Height + Density + Treatment (R2 adj. = 0.207, p-value = 0.0041)**
  - *C. aquatilis* →**Cover ~ Leaf Length + Canopy Height (R2 adj. = 0.436, p-value < 0.00001)**
  - *E. angustifolium* → **Cover ~ Biomass + Inflo Length + Density (R2 adj. = 0.262, p-value = 0.00093)**
  - *E. russeolum* → **Cover ~ Canopy Height + Density + Treatment (R2 adj. = 0.411, p-value < 0.00001)**

- These results are mirrored by changes over time and by treatment

*Table listing ANOVA results for DSHR & GRAM*

# Discussion

- Deciduous shrubs are expanding laterally more (increase in #branch tips = density) with warming
- Graminoids are growing taller & increasing in canopy height BUT actually decreasing in density with warming
- Results driven by dominant species
  - Response of rare species (i.e. forbs) masked
  - Vulnerability of wet meadow to biomass losses with expansion of shrubs?

# Conclusions

- Changes in cover have different underlying drivers, varying by growth form and by species
- Not all species/growth forms respond to climate change in the same way!
  - This becomes important for making accurate future predictions
- Other factors to consider…
  - Non-vascular cover
  - Environmental variables (soil moisture, thaw depth, organic matter, etc.)

# Additional Research

- Examining similar trends among dominant species in a dry heath tundra community Broader landscape-level observations
  - Comparison of patterns across a range of abiotic conditions and community types

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  - Rob Slider-Barrett
  - Jennifer Liebig
  - Kelseyann Kremers
  - Timothy Botting
  - Andrew Smith
  - Michaela Clingaman





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