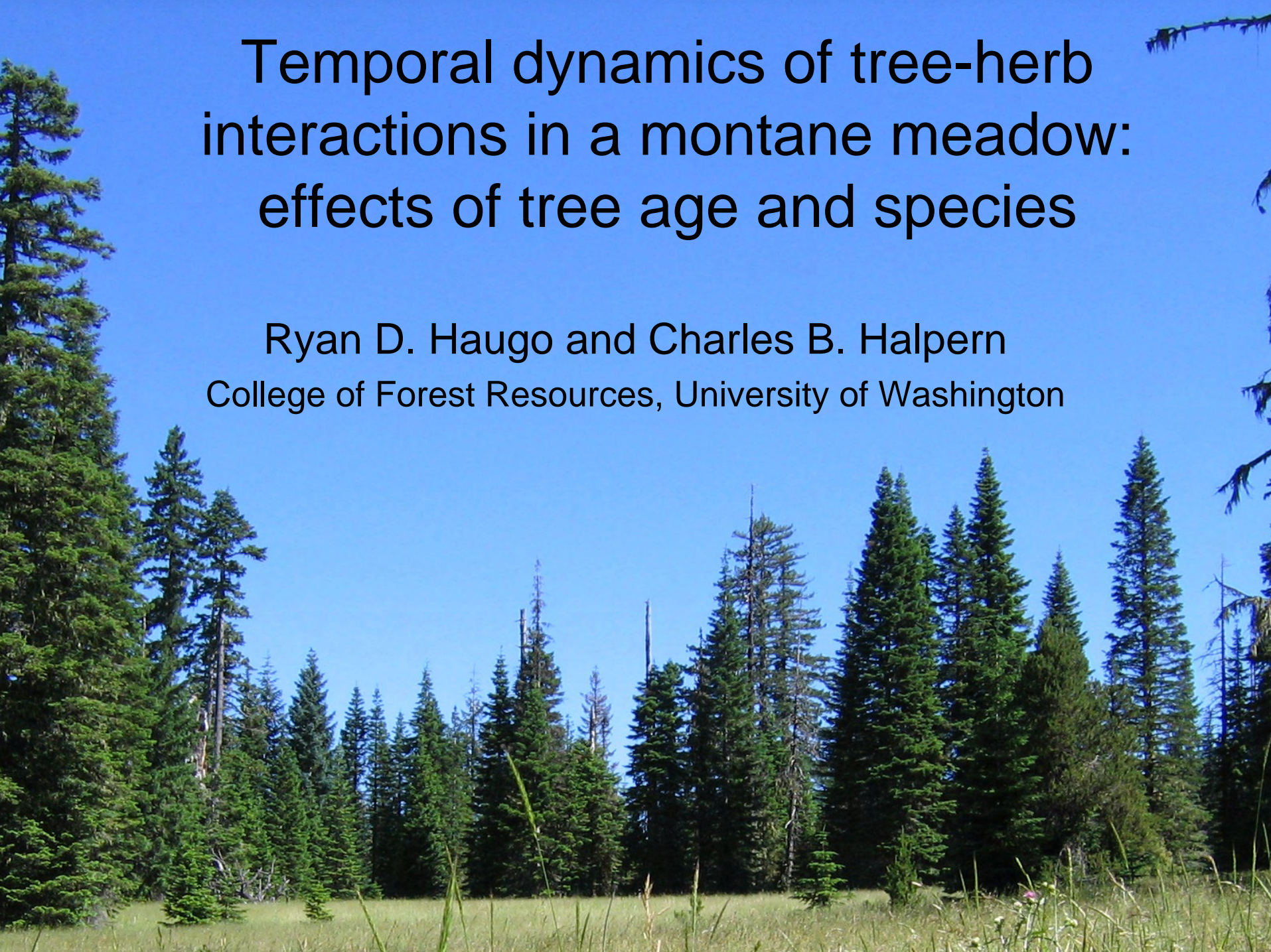


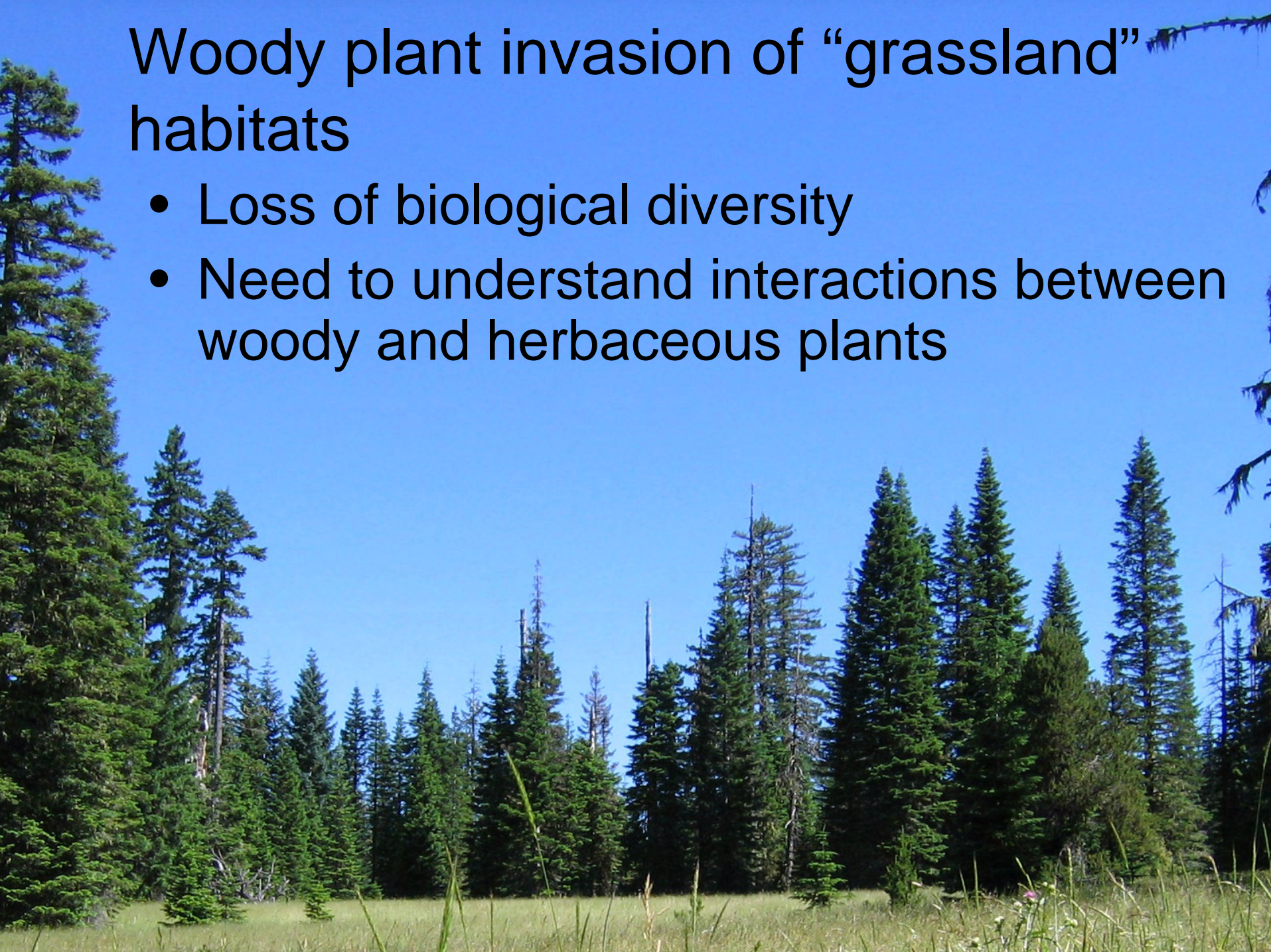
# Temporal dynamics of tree-herb interactions in a montane meadow: effects of tree age and species

Ryan D. Haugo and Charles B. Halpern  
College of Forest Resources, University of Washington



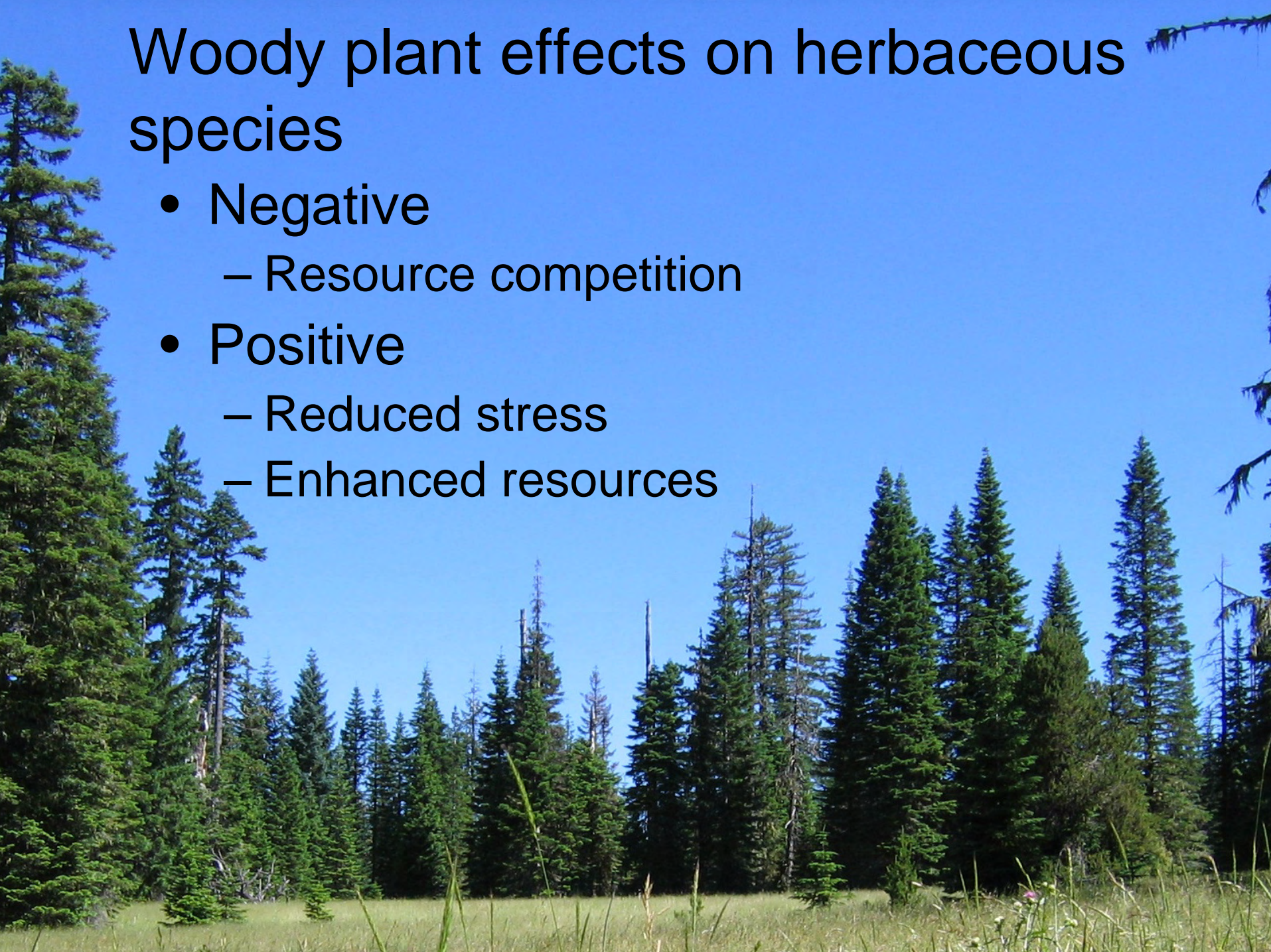
# Woody plant invasion of “grassland” habitats

- Loss of biological diversity
- Need to understand interactions between woody and herbaceous plants

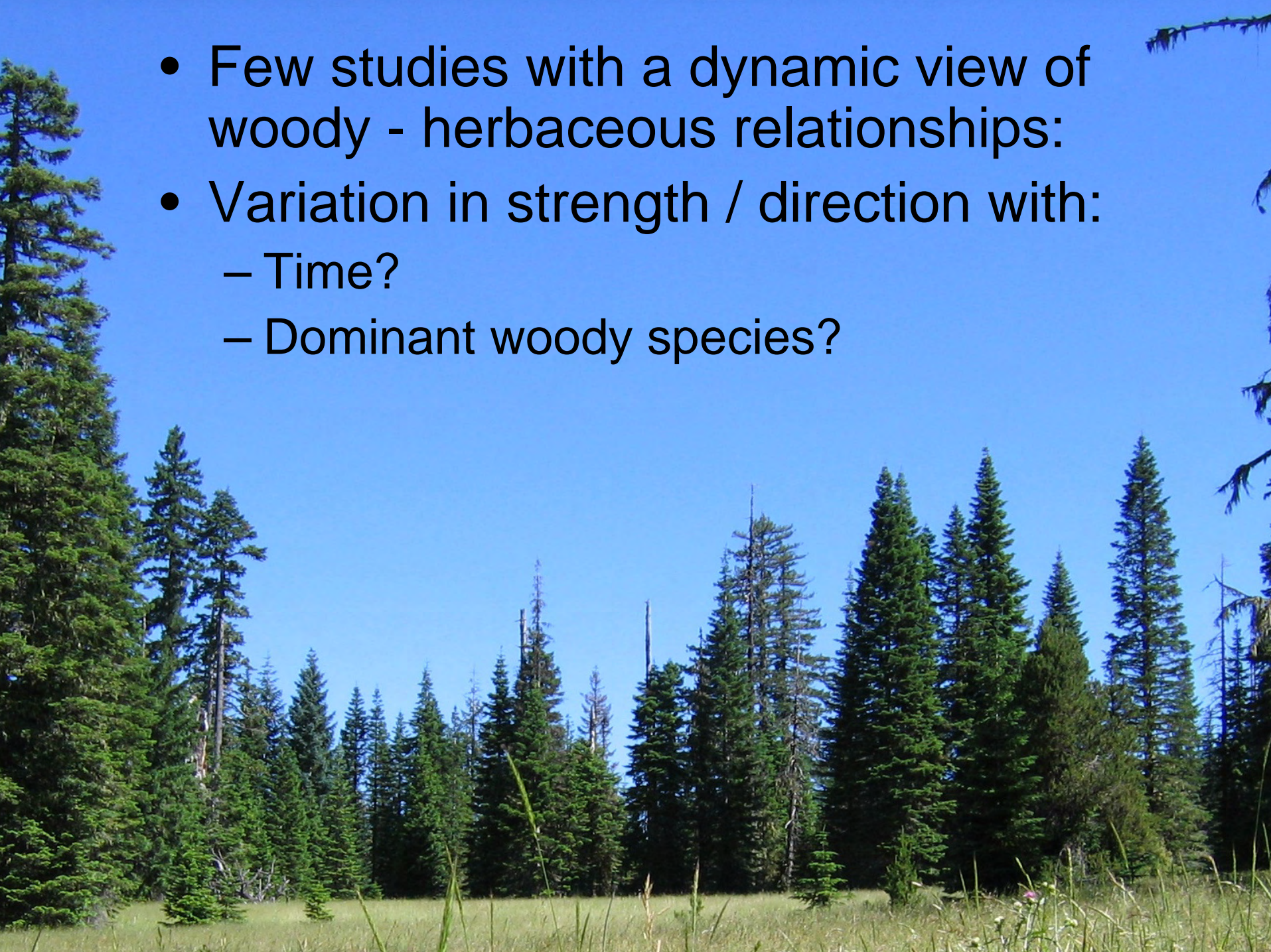


# Woody plant effects on herbaceous species

- Negative
  - Resource competition
- Positive
  - Reduced stress
  - Enhanced resources

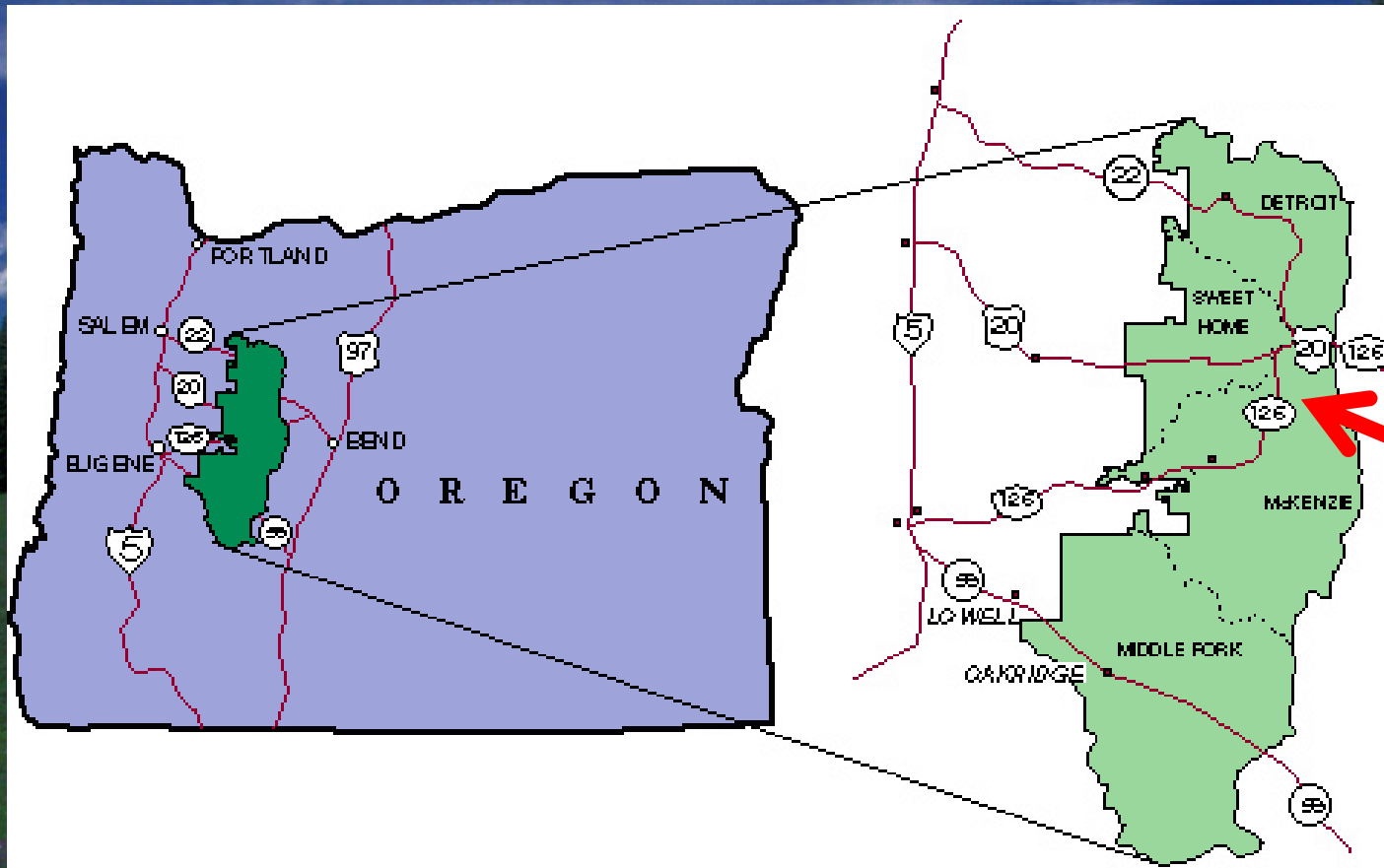


- Few studies with a dynamic view of woody - herbaceous relationships:
- Variation in strength / direction with:
  - Time?
  - Dominant woody species?



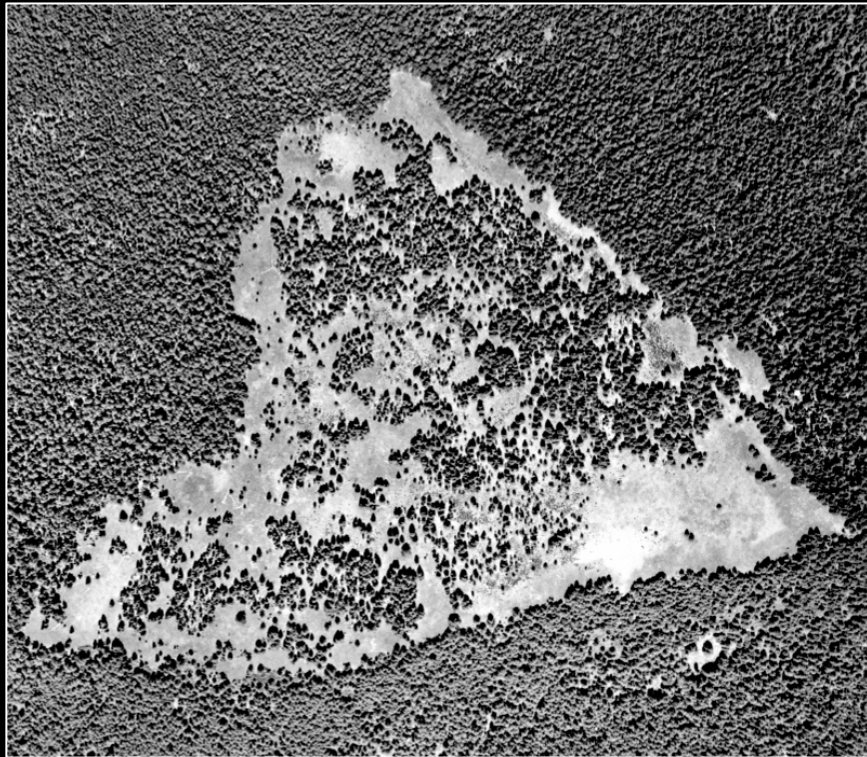
# Bunchgrass Ridge

- Western OR Cascades
- Approx 1350 m elevation



# Bunchgrass Ridge

- 100+ years of conifer invasion
- *Abies grandis* and *Pinus contorta*



1959



1997

- Continuous establishment of individual *Abies* and *Pinus* over 100+ years
  - Wide range of sizes and ages
- Chronosequence approach



# Hypotheses

## Effects of invading conifers

H1 Negative on meadow species,  
positive on forest herbs

H2 Increase with time

H3 Stronger for *Abies* than for *Pinus*





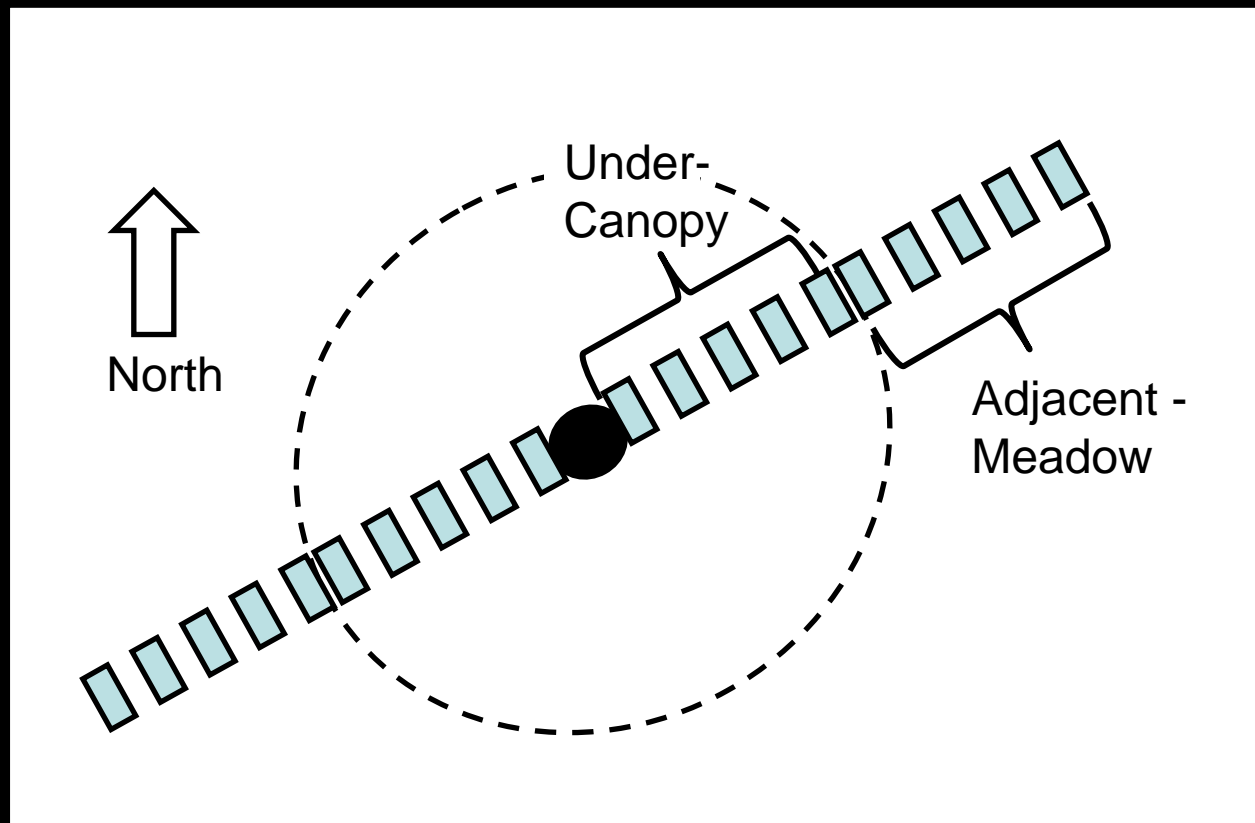
# Methods

- Select 29 *Pinus* and 28 *Abies*
  - Growing individually
  - Stratified by size – range of ages (18-73 yrs)
  - Tree age, dbh, height, canopy radius



# Methods

- Vegetation Transects
  - Series of 20 x 50 cm quadrats
  - “Under-canopy” and “adjacent-meadow” segments



# Methods

- Vegetation Transects
- Cover by species
- Functional groups:
  - Meadow
  - Forest
  - Ruderal / other



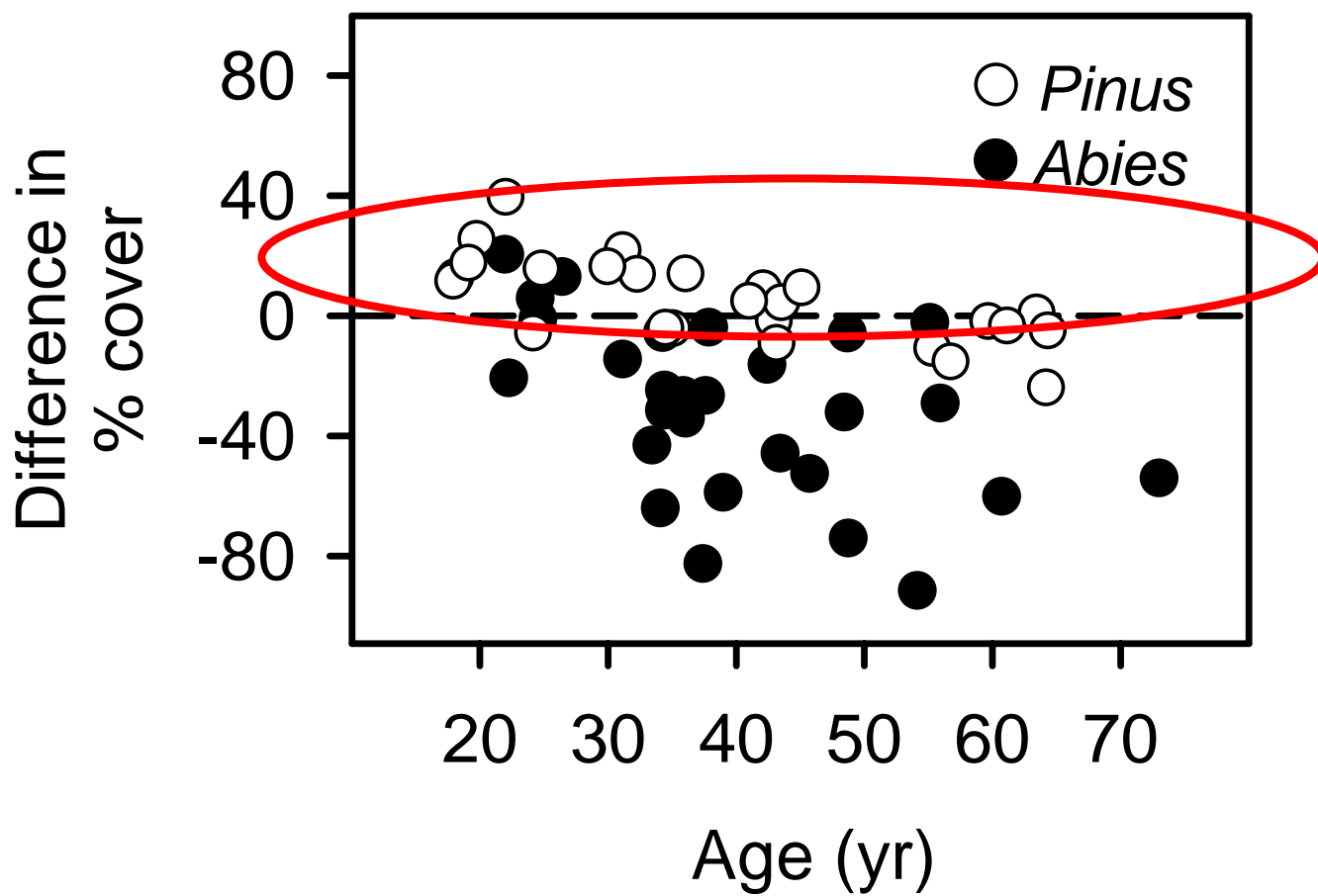
# Methods

- Response variables: under-canopy vs. adjacent meadow
  - Difference in cover and richness of meadow and forest species
  - Compositional dissimilarity
- General linear models
  - Tree age, tree species, age x species

# H1 Negative effects on meadow species

- Yes for richness and cover under both *Abies* and *Pinus*
- 3 of 4 one-sample t-tests, all  $p < 0.001$
- Exception: cover of meadow species **INCREASED** under *Pinus*

## Meadow Cover



A close-up photograph of a meadow filled with numerous small, five-petaled purple flowers. The flowers are densely packed and interspersed with green grass blades. The lighting is bright, highlighting the delicate texture of the petals and the vibrant green of the foliage.

# Increased meadow cover more common for:

- *Pinus* than *Abies*
  - 58 vs. 11% of transects,  $\chi^2 = 56.4$ ,  $p < 0.001$
- Younger (<30 yr) vs. older (>60 yr) trees
  - 77 vs. 14% of transects,  $\chi^2 = 11.6$ ,  $p < 0.001$

# H1 Positive effects on forest species

- Yes for richness and cover under both *Abies* and *Pinus*
- 4 of 4 one-sample t-tests, all  $p < 0.001$

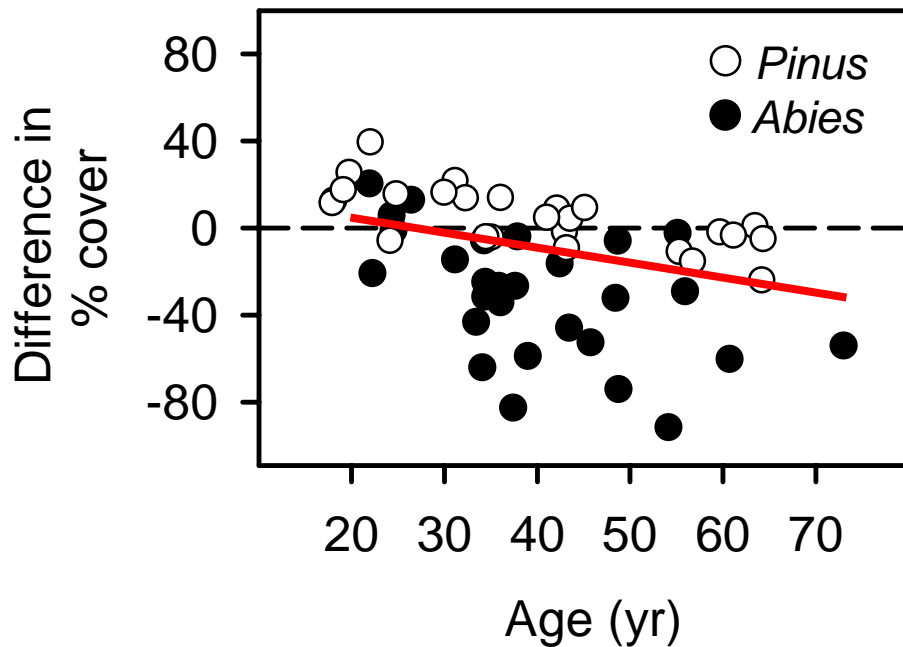


# H2 Effects increase with time

## H3 Effects stronger for *Abies* than *Pinus*

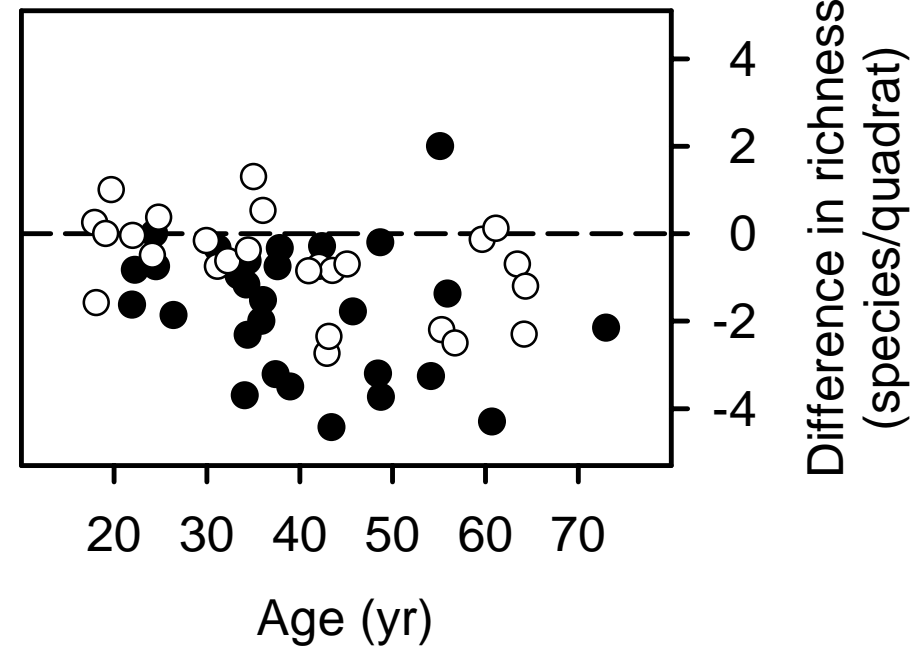
Cover of Meadow Species

GLM:  $R^2 = 0.54$   $p < 0.001$



Richness of Meadow Species

GLM:  $R^2 = 0.18$   $p < 0.001$



H2 Effects increase with time

H3 Effects stronger for *Abies* than *Pinus*

- Cover of meadow species

- Tree age:  $p < 0.001$

- Tree species: ns

- Age x species: ns

- Richness of meadow species

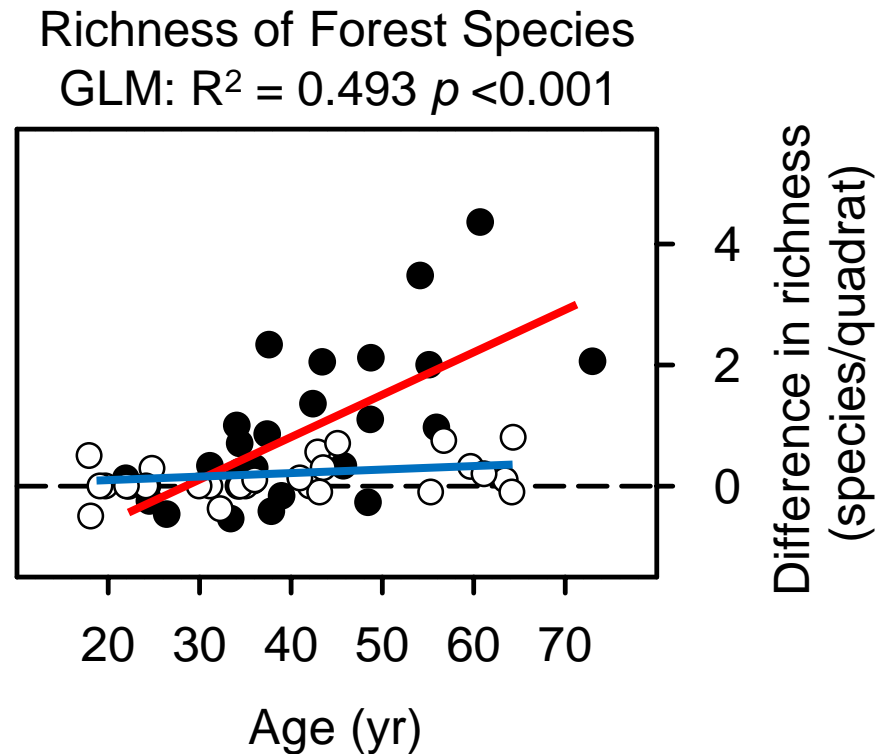
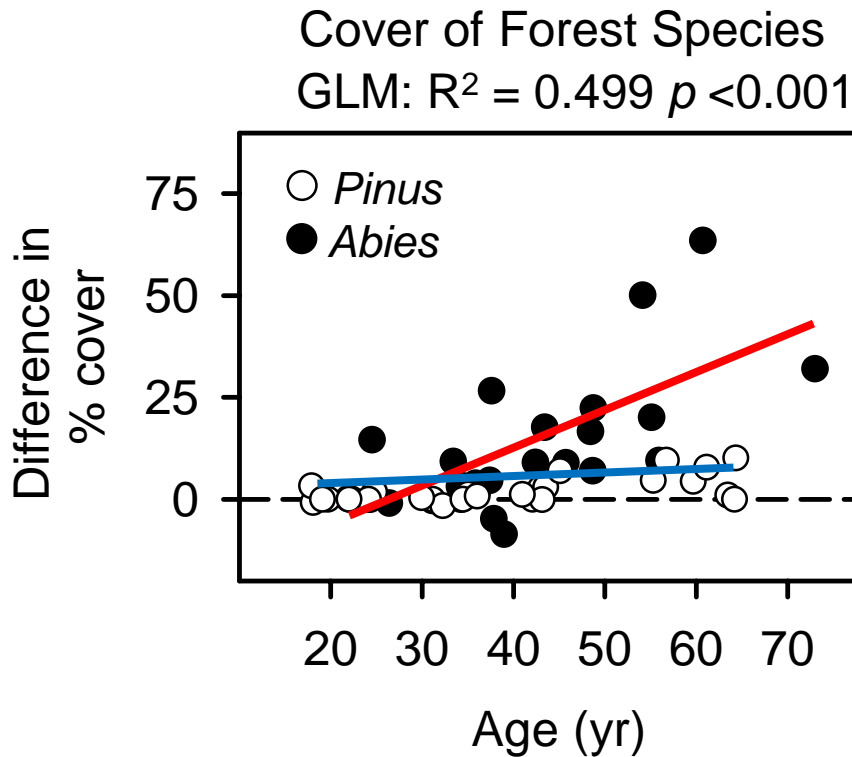
- Tree age: ns

- Tree species: ns

- Age x species: ns

# H2 Effects increase with time

## H3 Effects stronger for *Abies* than *Pinus*



H2 Effects increase with time

H3 Effects stronger for *Abies* than *Pinus*

- Cover of Forest Species

- Tree age:  $p < 0.001$

- Tree species:  $p = 0.006$

- Age x species:  $p < 0.001$

- Richness of Forest Species

- Tree age:  $p < 0.001$

- Tree species:  $p = 0.005$

- Age x species:  $p < 0.001$

# Summary: Influence of tree age and species

- Strength of conifer effects increase with time (age)
- Negative: suppress / eliminate meadow species
- Positive: facilitate colonization / growth of forest species

# Summary: Influence of tree age and species

- Tree – herb interactions vary with species
- *Abies*
  - Rapid declines in resident meadow species
  - Establishment of forest species
- *Pinus*
  - No effect on meadow species cover
  - Minimal colonization of forest species

# Thanks!

- Joint Fire Science Program, Northwest Scientific Association, UW CFR
- Nicki Lang (and Zion), Ziyu Ma, Rheta Rabe
- Halpern lab group
- HJ Andrews LTER and PNW Research Station





**Bunchgrass Ridge**  
*Restoration of montane meadows in western  
Oregon: A center for research and adaptive  
management*

<http://depts.washington.edu/bgridge/>