# Konza LTER – Plant Community Dynamics

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# Overview

- Highlight major accomplishments during last five years
- Present new research activities that may be incorporated into the LTER VI proposal

# Plant Community Dynamics: Metrics

- Richness, diversity (H’), dominance
- Qualitative and quantitative changes in composition over time
  - Community heterogeneity (dissimilarity)
  - Time-lag analysis – rate of change
- Turnover of species
  - Loss – species extinctions
  - Gain – patterns of invasion, invasibility

# Plant community dynamics: Sampling

- Permanent sampling transects are replicated at various topographic positions (n = 4/topo position/watershed) in replicate watersheds subjected to the different fire frequency, fire season, and grazing treatments
  - Plant species composition (estimated cover of individual species) is measured in spring and fall in 5 10-$m^2$ circular plots/transect (20 plots/topo position)

- Data collected since 1984, 1993 (seasonal burns)

Since 2002, plant species composition data have been included in at least 9 cross-site comparisons or syntheses.

- **Belowground Plot Experiment** (1986) – burning, mowing, and nutrients
- **Irrigation Transects** (1991) – growing season water additions
- **Cattle-Bison Comparison** (1995) – assess effects of cattle vs. bison
- **Dominant Species Removals** (1996/2000) – assess long-term response to removal of dominant grasses
- **RaMPs** (1997) – timing of precipitation, warming
- **Fire Reversal Experiment** (2001) – fire history and changing fire regimes
- **Water and N limitation Experiment** (2002) – water and nitrogen limitation
- **Phosphorus Plots** (2003) – assess relative P and N limitation
- **Savanna Convergence Project** (2006) – interactions between fire and herbivory in North American and South African grasslands
- **Nutrient Network** (2007) – multiple resource limitation, bottom-up vs top-down control

# Other resources: KSU Herbarium

- NSF-funded project to database label and annotation data for all KSC specimens (Kansas vascular plants are complete).
- Development of a digital KSU Biodiversity Information System (BiodIS)
- Continue to work to enhance the collections through ongoing and targeted collecting

# Plant community dynamics are relevant to many contemporary global change issues…

**Land Use Practices**
- Fire
- Grazing
- Land use history

**Climate Change**
- Rainfall timing and amount
- Temperature

**Nutrient Enrichment**
- Elevated N deposition
- Fertilization

**Biological Invasions**
- Exotic species introductions

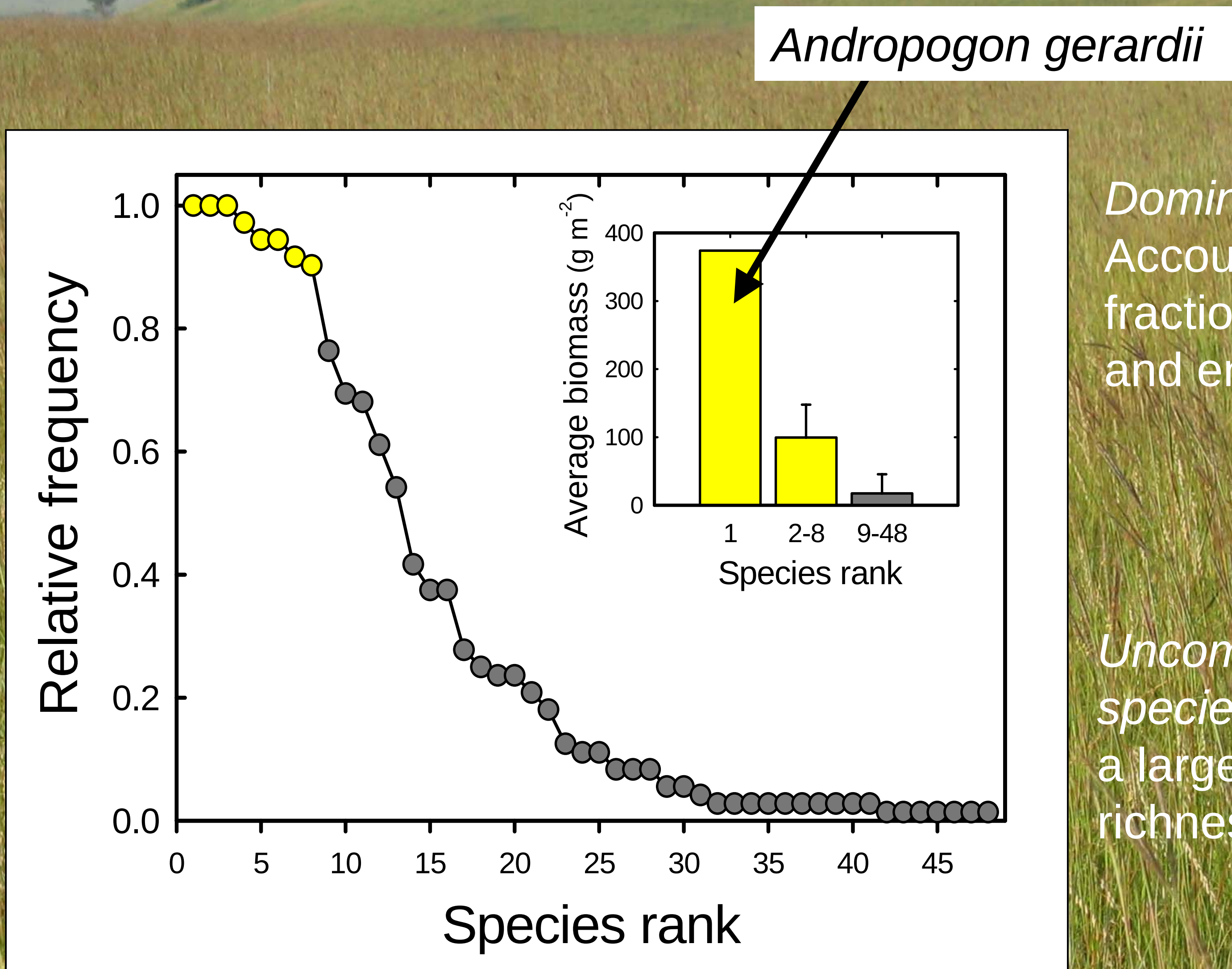
## Tallgrass Prairie Ecosystems

Structure
Function
Biotic Interactions

Altered Hydrology

Land Cover Change/ Woody Plant Expansion

Altered Biogeochemical Cycles




*Dominant species* – Account for a large fraction of biomass and energy flow

*Uncommon and rare species* – account for a large fraction of richness

*Smith & Knapp 2003*

# Fire and grazing as drivers of plant community dynamics

- Historically important, key components of land use

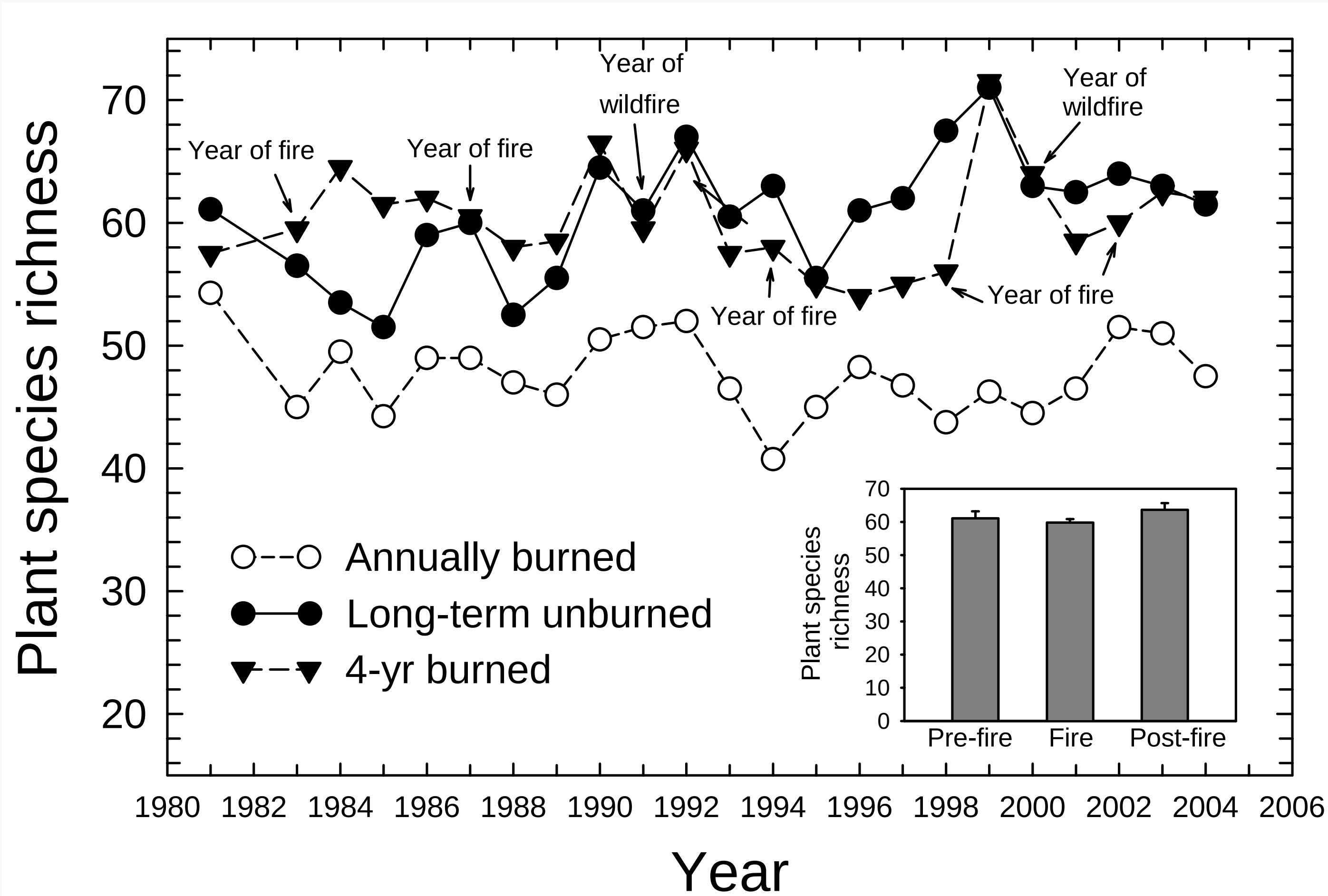
- Considerations:
  - Fire regime – frequency and timing of fires
  - Type of grazer – native vs. domesticated



# Fire and grazing

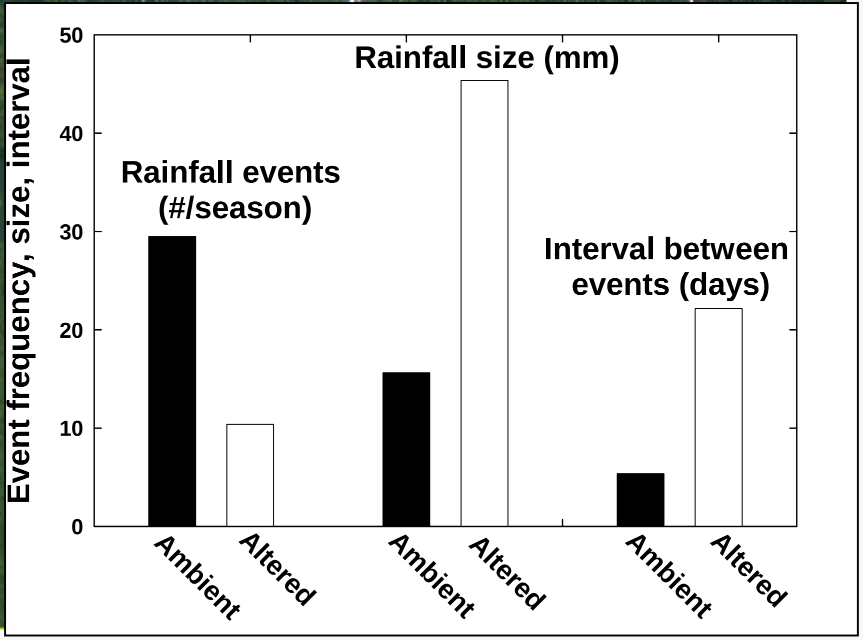


# Long-term dynamics



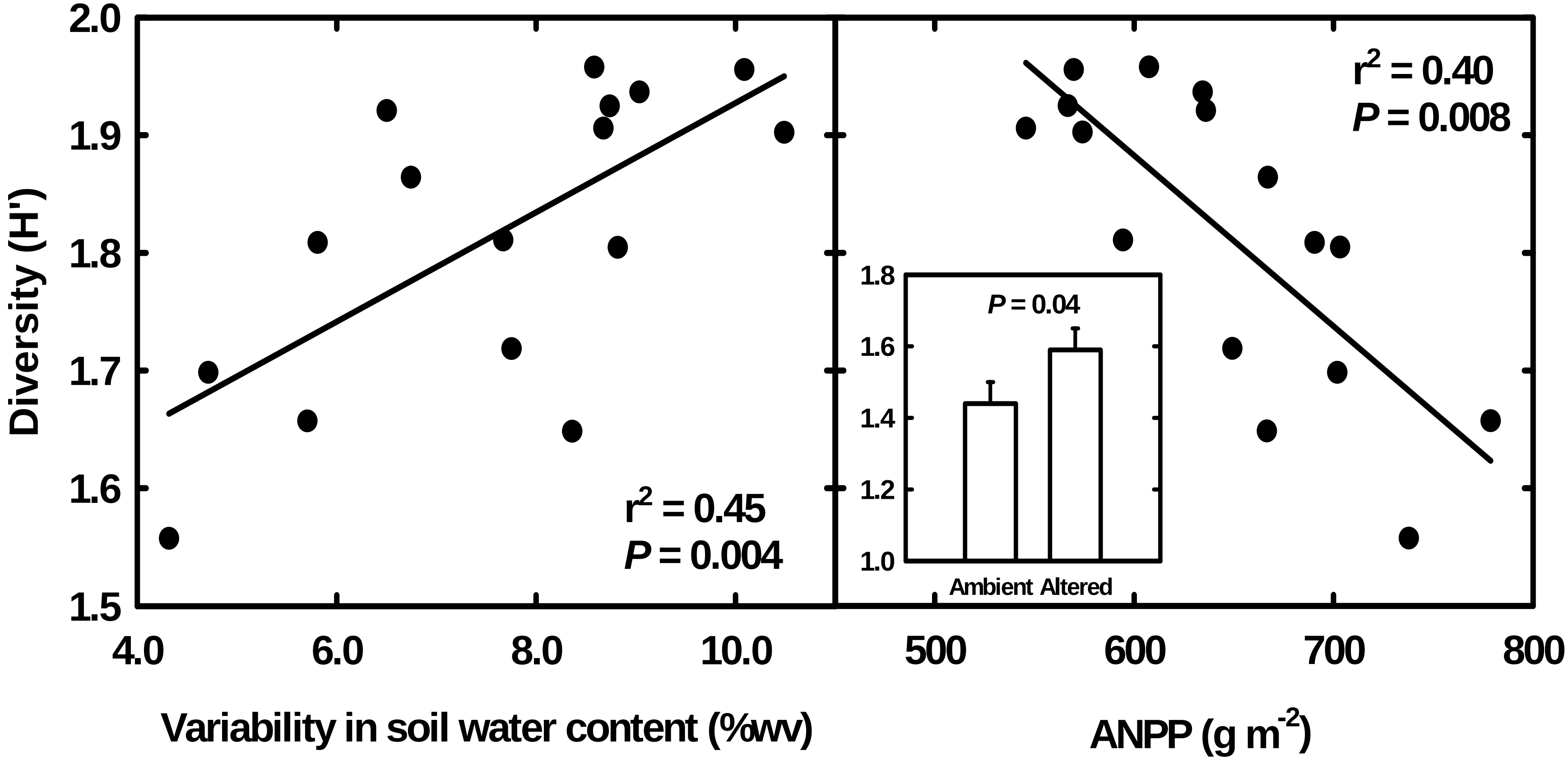

Need to move beyond patterns of change to implications for ecosystem function

# Rainfall Manipulation Plots Experiment



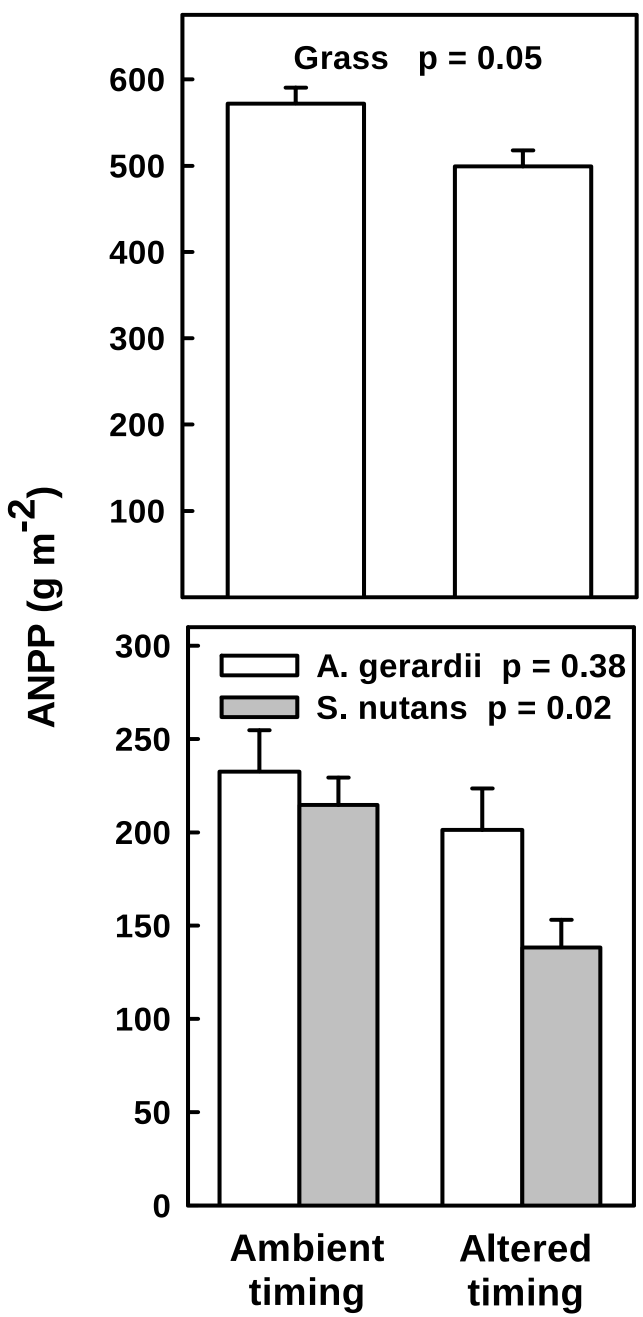

- **Average soil water content in top 30 cm** reduced by 12%.
- **Variability in soil moisture** increased by 27%.
- **Soil temperature** increased by 1.4 °C

# Impacts on plant species diversity




*Knapp et al. 2002*

# Differential species responses



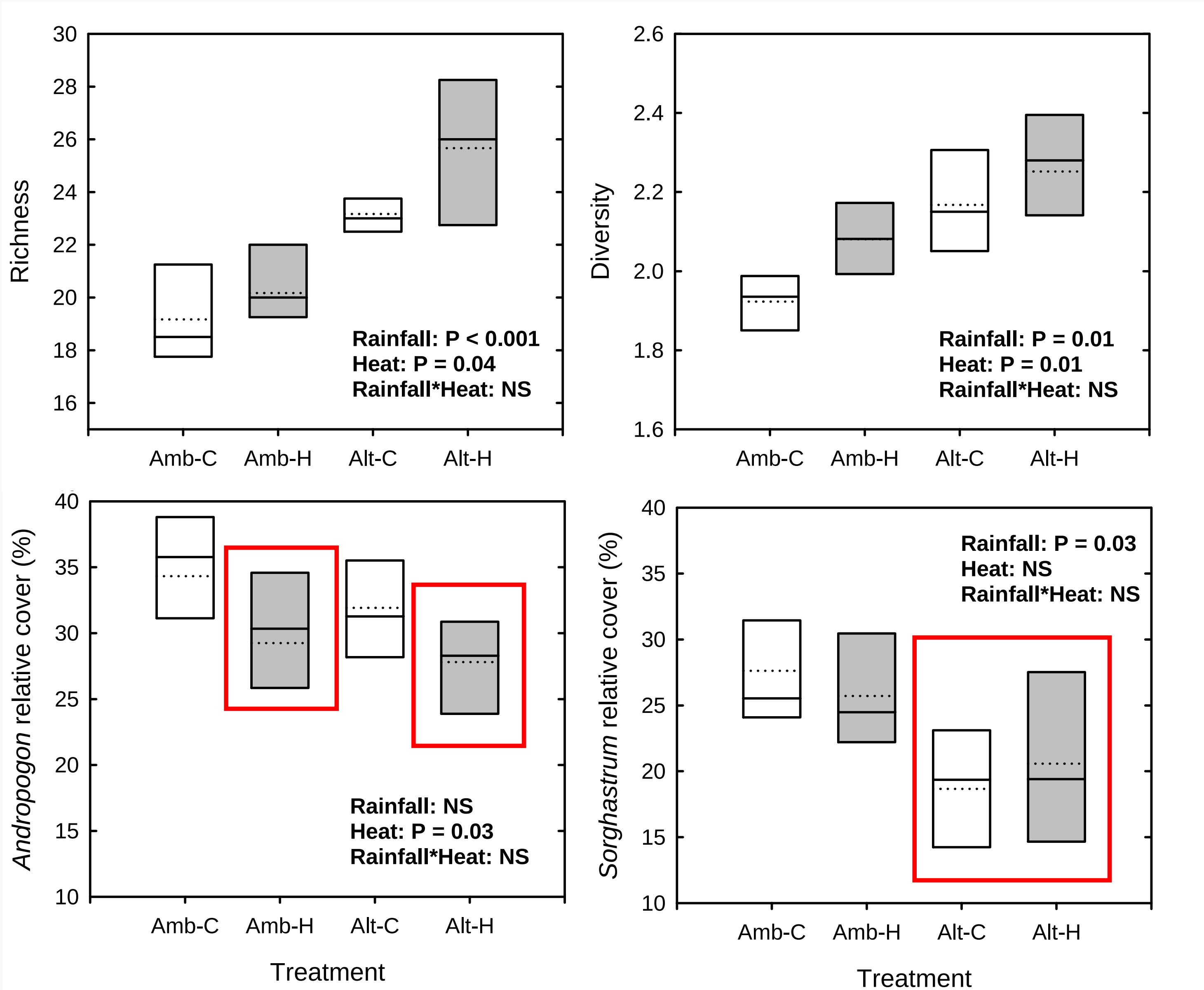

## Dominant $C_4$ grasses

*Andropogon gerardii*

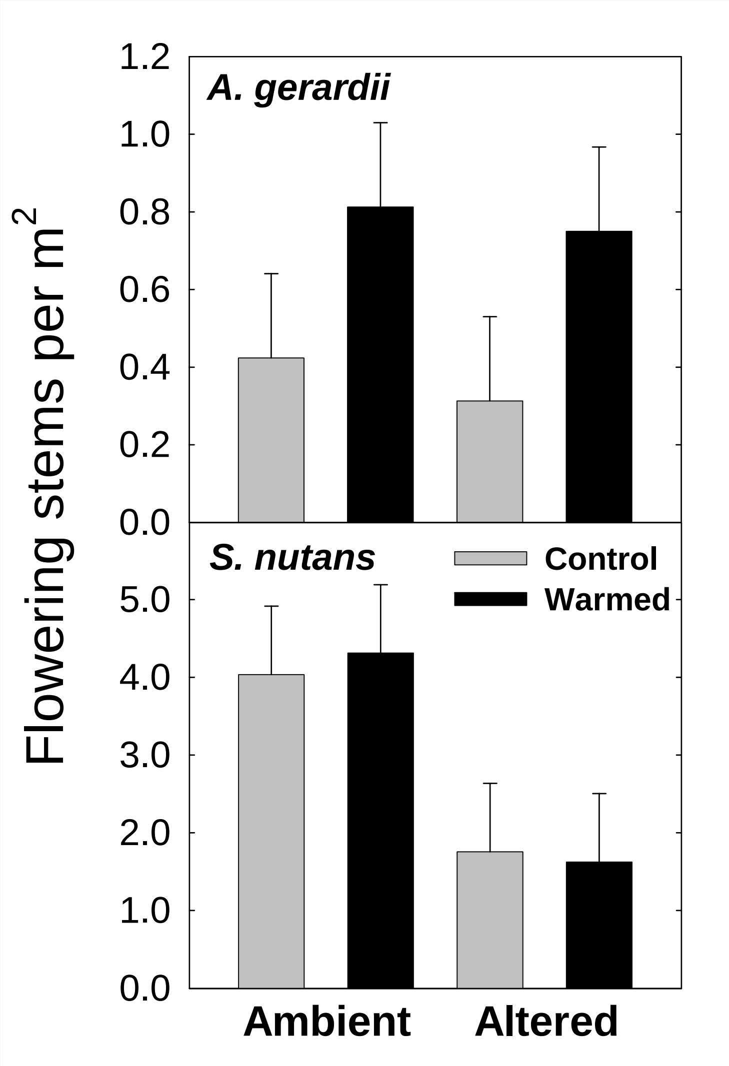
*Sorghastrum nutans*

*Fay et al. 2003*

# Effects of warming of community diversity



# Differential species responses: Flowering

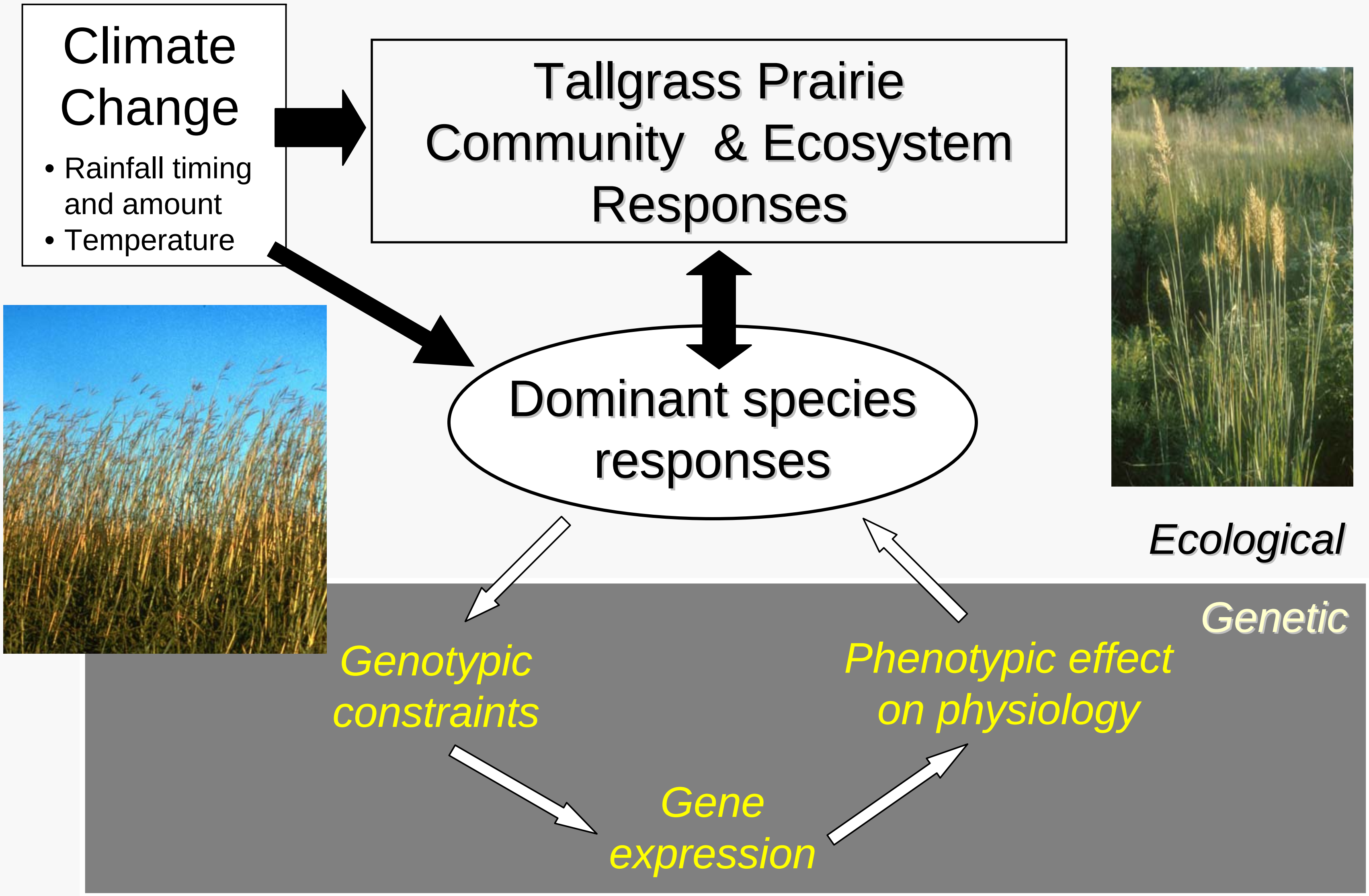



*Andropogon* more sensitive to warming

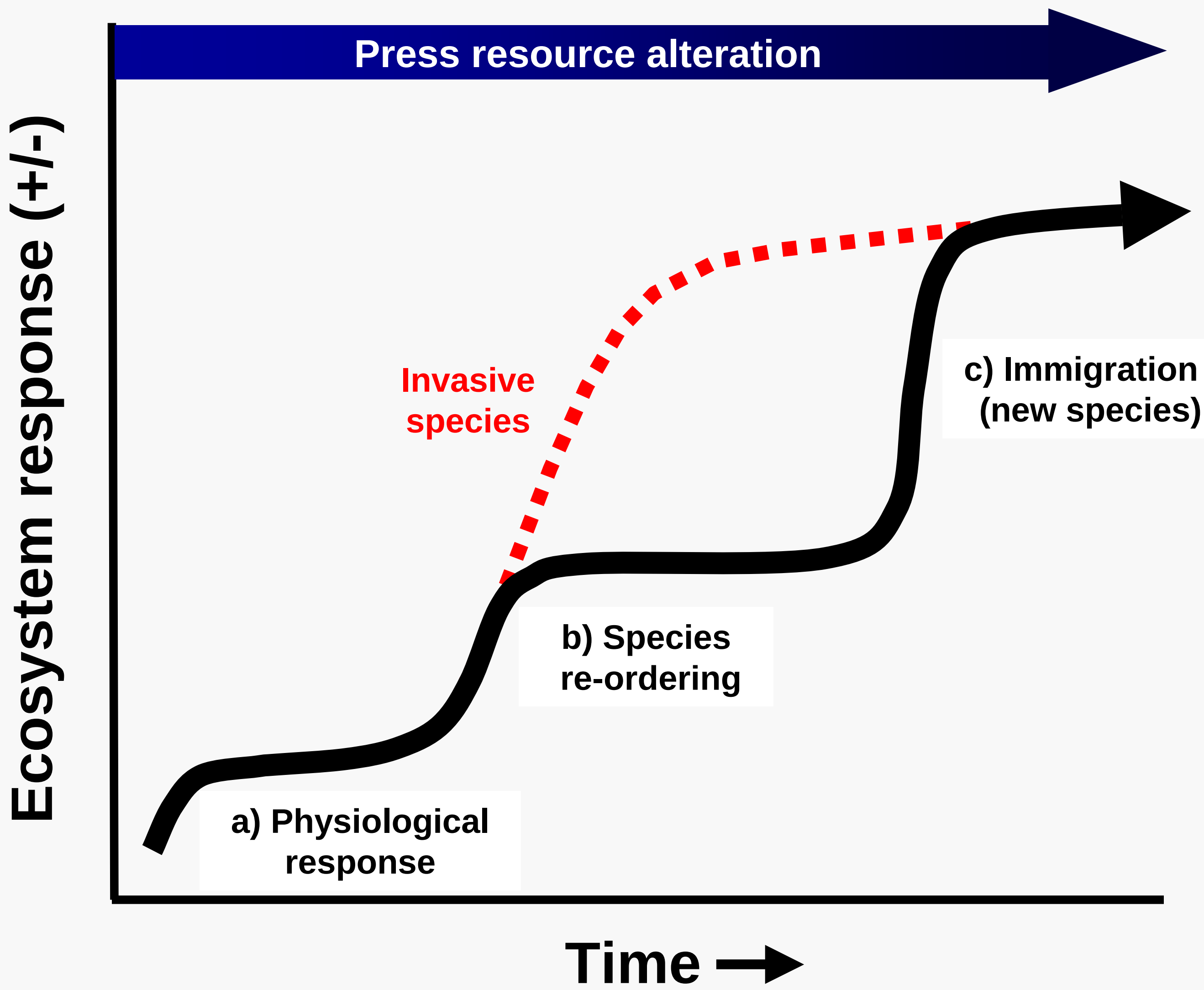
*Sorghastrum* more sensitive to water availability

What are the mechanisms underlying differential sensitivity?

# Linking responses across scales



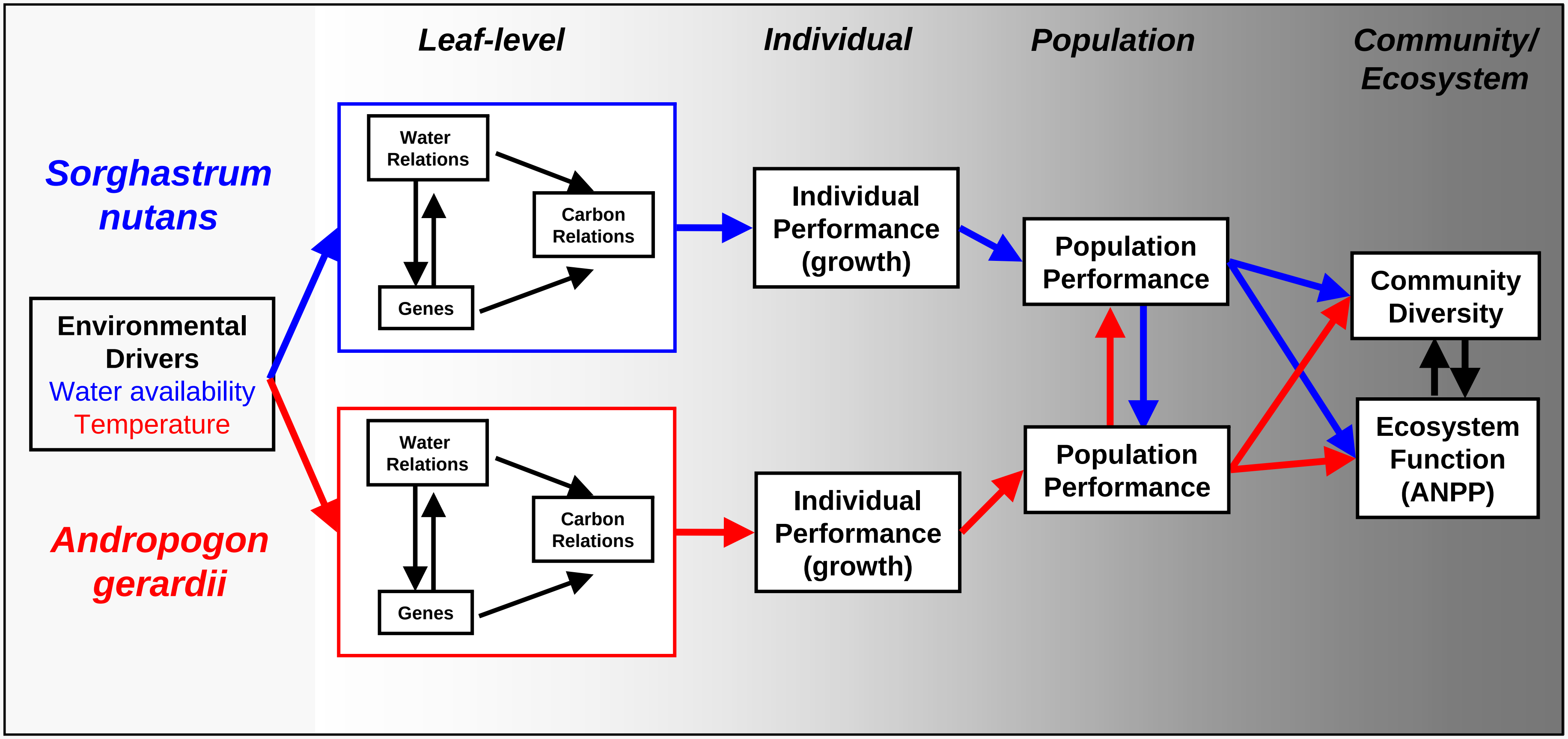
# Hierarchical Ecosystem Response Model



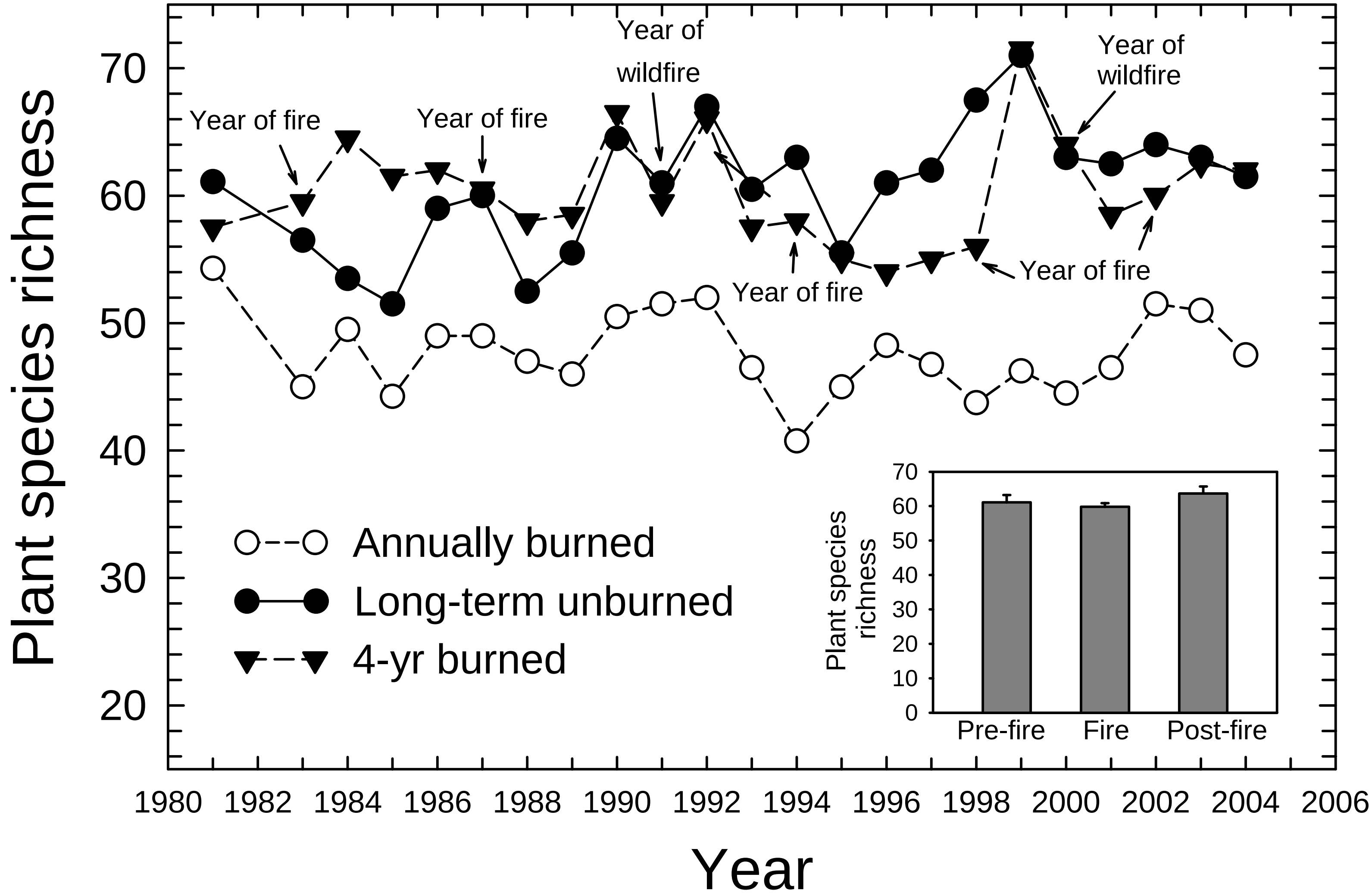

*Smith, Knapp and Collins, in prep*

# Linking genetics to ecosystem responses

What is the genetic basis for ecosystem responses to altered climate?

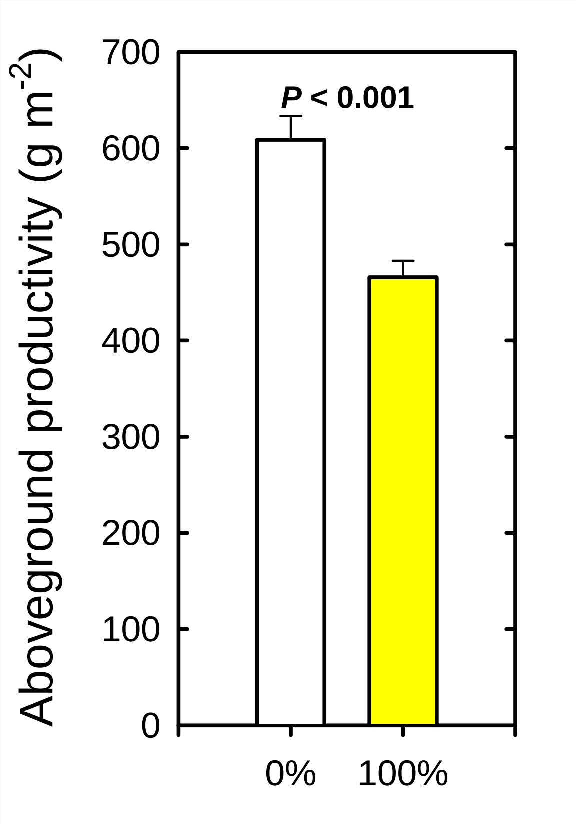


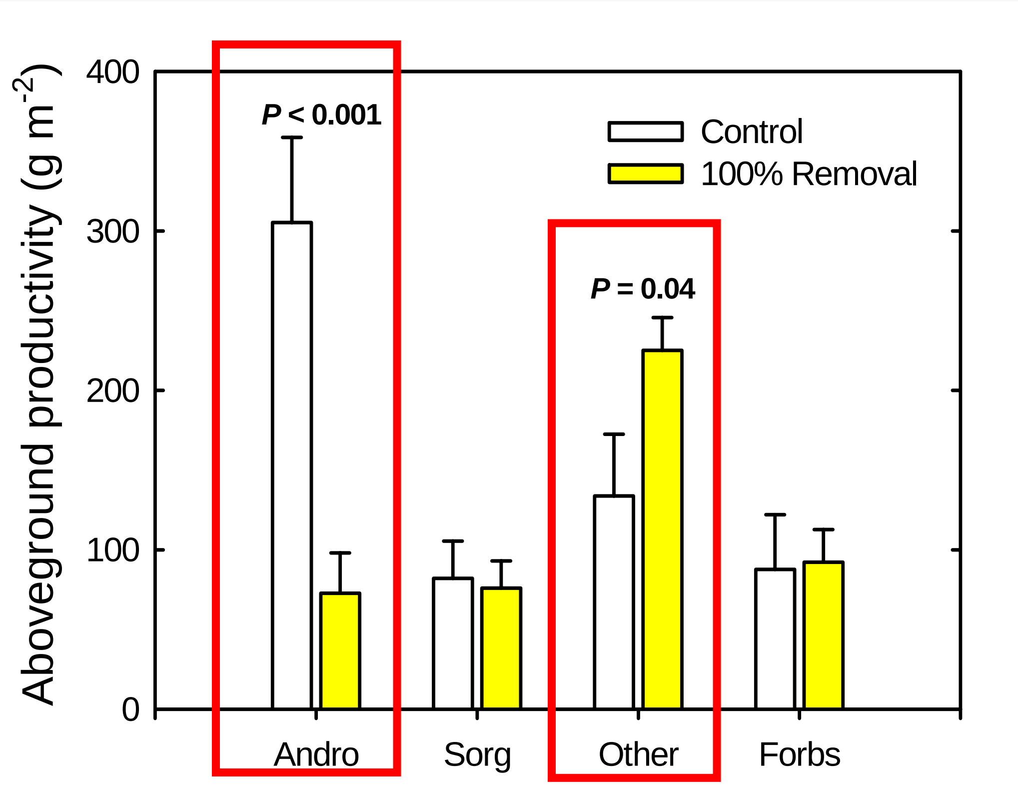
# Where do we go from here?



# Why a new approach to assessing community change should be considered…

In 1996, 100% of *A. gerardii* and *S. nutans* were removed from 8 plots
- Resampled 8 years later




*Relative cover data suggested compensation*

# Additional recommendations

- Take advantage of existing data from long-term experiments to assess how changes in abundance of dominant species influence community change

- Targeted, more comprehensive sampling of existing manipulations
  - Resample long-term dominant species removal experiments
  - Nutrient manipulation experiments, etc…

# Integrate across scales

- Broaden our definition of plant community diversity to include other levels of diversity – e.g., *genetic* (of dominant species), pathogen, microbial
  - Assess change in genetic diversity of dominant species in response to long-term manipulations
  - Consider archiving samples for measuring genetic diversity

- Linkage of dynamics across hierarchical scales

- Explicitly include physiology-population-community linkages in ongoing research