Effects of Tanglehead (*Heteropogon contortus*) Invasion on Soil Microbial Communities in the Texas Coastal Sandsheet

Joshua Grace[1]

Invasive Grass Research Specialist

Caesar Kleberg WILDLIFE Research Institute
Texas A&M University-Kingsville

D. B. Wester[1], V. Acosta-Martinez[2], S. Rideout-Hanzak[1], J.A. Ortega-S[1]

[1] *Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, TX*

[2] *USDA-ARS-Cropping Systems Research Laboratory, USDA, Lubbock, TX*

Introduction

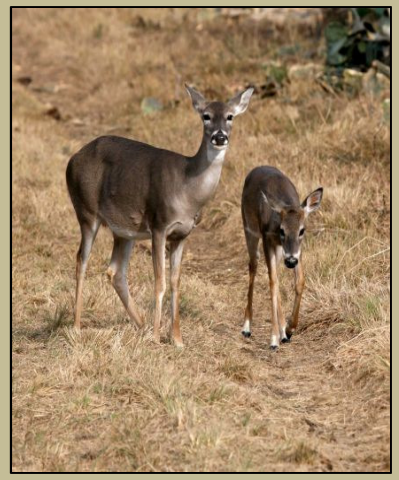
- Biological species invasion poses a great threat to biodiversity
  - Exotic species
  - Native species acting invasively

- Grasses
  - Competitive dominance
    - ↓ Native plant growth
    - ↓ Species diversity
    - ↓ Species richness

Introduction

- South Texas
  - Old World bluestem
  - Buffelgrass
  - Kleingrass
  - Lehmann's lovegrass
  - Guineagrass

Cascading effects on ecosystems



Potential impacts on livestock production

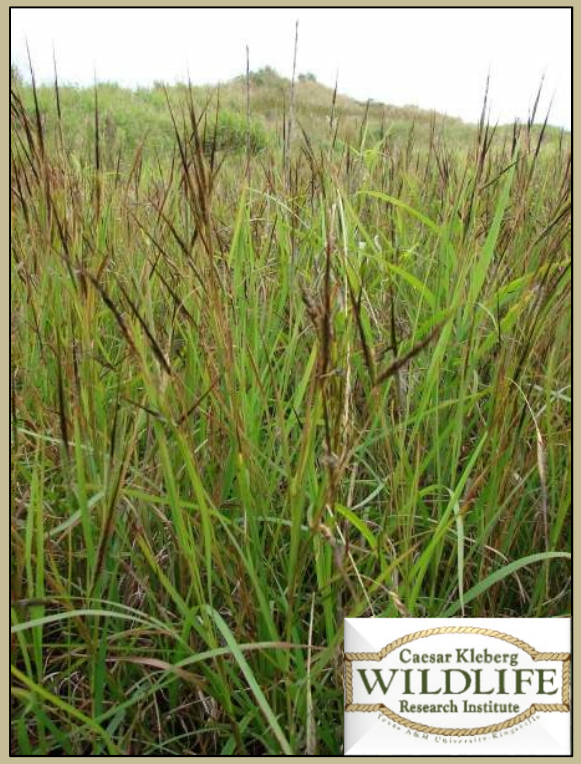
Tanglehead (*Heteropogon contortus* [L.] Link)

Introduction

- Tanglehead (*Heteropogon contortus* [L.] Link)
  - Native, warm season, perennial bunchgrass
  - Dense monotypic stands/ litter accumulation
  - Provides key wildlife habitat
- Unique situation for So. Texas landowners
  - Bobwhite Quail
  - Whitetail Deer

CKWRI Tanglehead Research

- Current Research
  - Control and management
  - Production and phenology
  - Seed viability and longevity
  - Ecosystem processes
    - Nutrient processes
    - Soil microbial dynamics
      - Community Size (biomass C, N)
      - Community Composition



Study Area

- CKWRI cooperating ranch
  - Jim Hogg County
  - Approx. 29 miles south of Hebbronville, TX

8 Native, 7 Mix, 3 Invaded (n = 18)

Methodology

- Collected 3 **soil cores** from each site
  - A-Horizon (0-10”), Delmita and Nueces
  - Mixed to form 1, 450 g combined sample from each site (*n*=18) for analysis
  - 2013, 2014, 2015

Methodology—Soil Analyses

- Microbial Biomass Carbon (**MBC**) and Nitrogen (**MBN**)
  - Chloroform fumigation extraction-method
    - (Brookes et al. 1985 & Vance et al. 1987)
  - *mg C kg^{-1} soil*, and *mg N kg^{-1} soil*

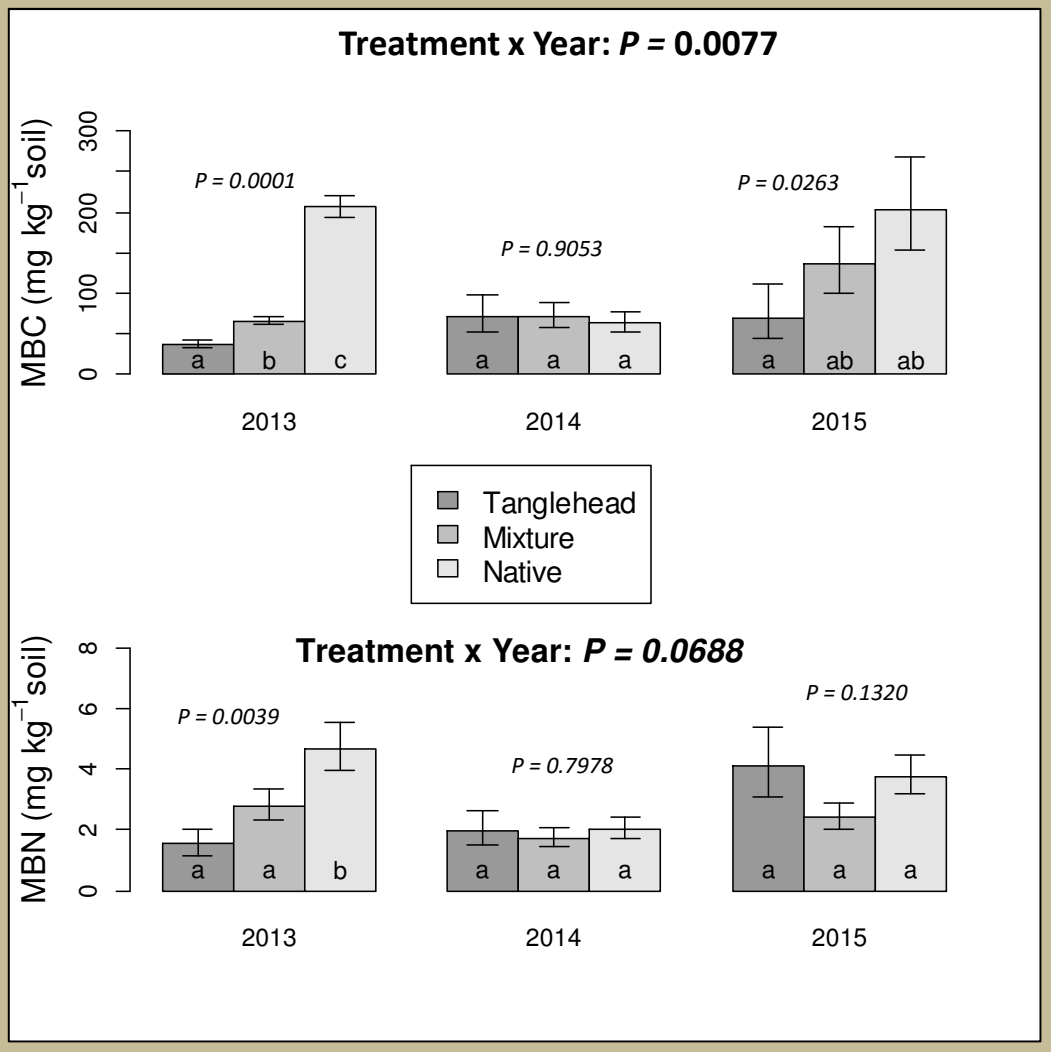
- Microbial Community Composition
  - Fatty Acid Methyl Ester (**FAME**) profiling
    - (Schutter & Dick 2000)
  - Fatty acids identified & compared by retention times and peak areas to components of MIDI standards
  - %; based on nmol g^{-1} soil

Results- Microbial Community Size

1. **Repeated Measures, Mixed Model ANOVA**

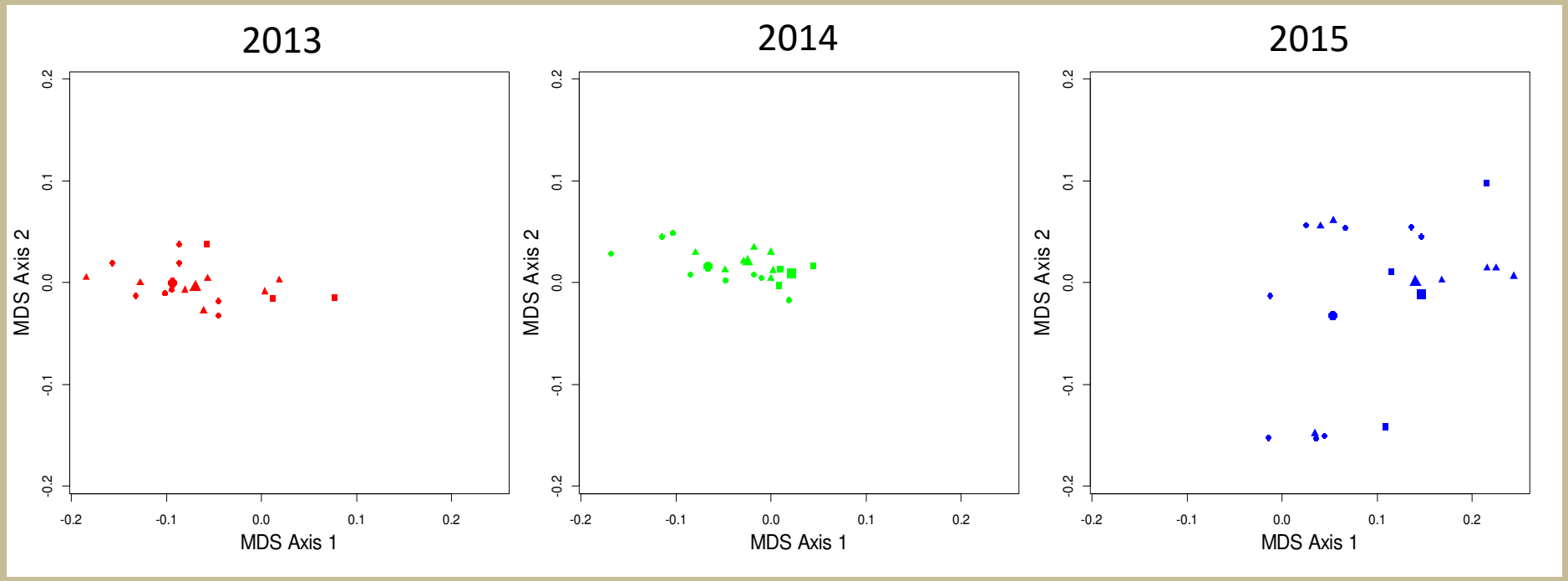
- MBC:
  - Treatment x Year interaction
  - In 2013 & 2015, MBC was lower in invaded sites than native sites

- MBN:
  - Very weak interaction effects
  - MBN was greater in native sites than invaded sites during 2013



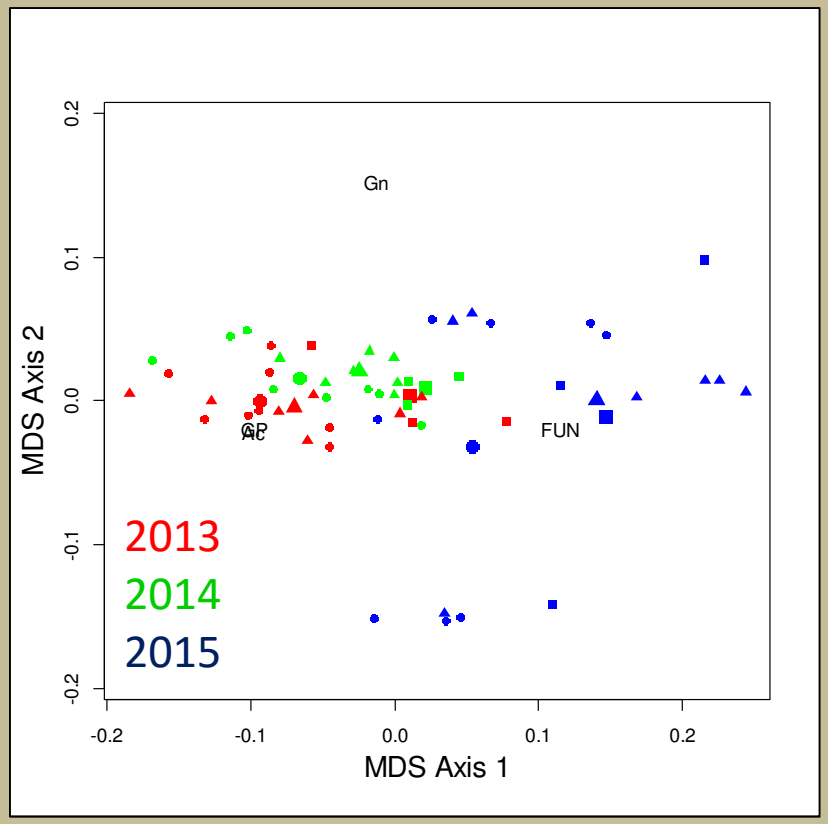
Results- Microbial Community Composition

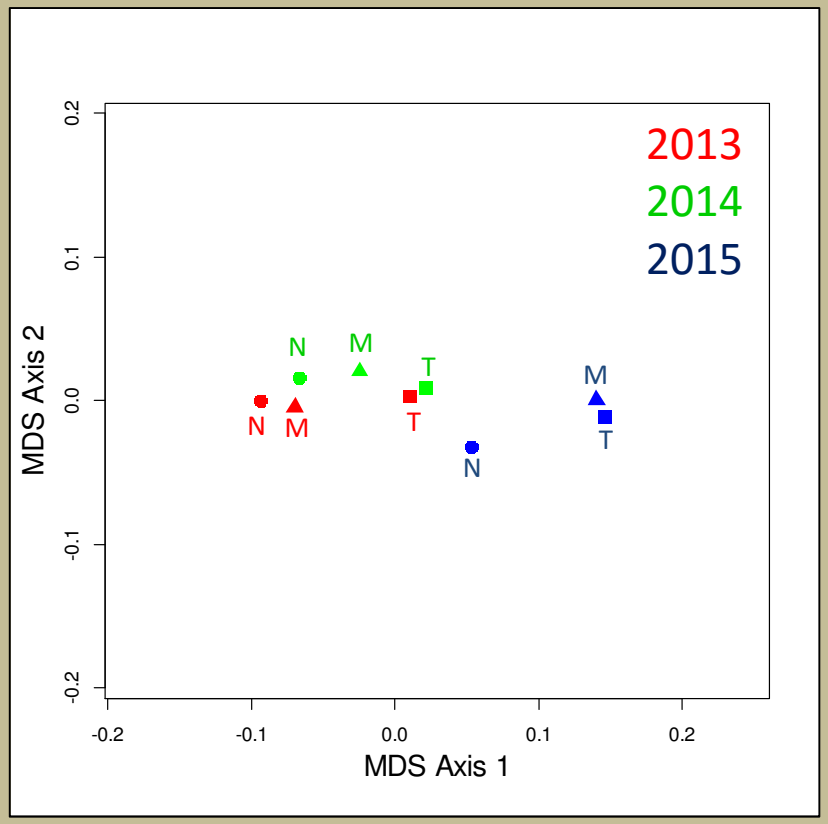
- **Nonmetric Multidimensional Scaling Ordination**
  - Using microbial indicators
  - G+, G-, Actinomycetes, Fungi



Results- Microbial Community Composition

- **Nonmetric Multidimensional Scaling Ordination**





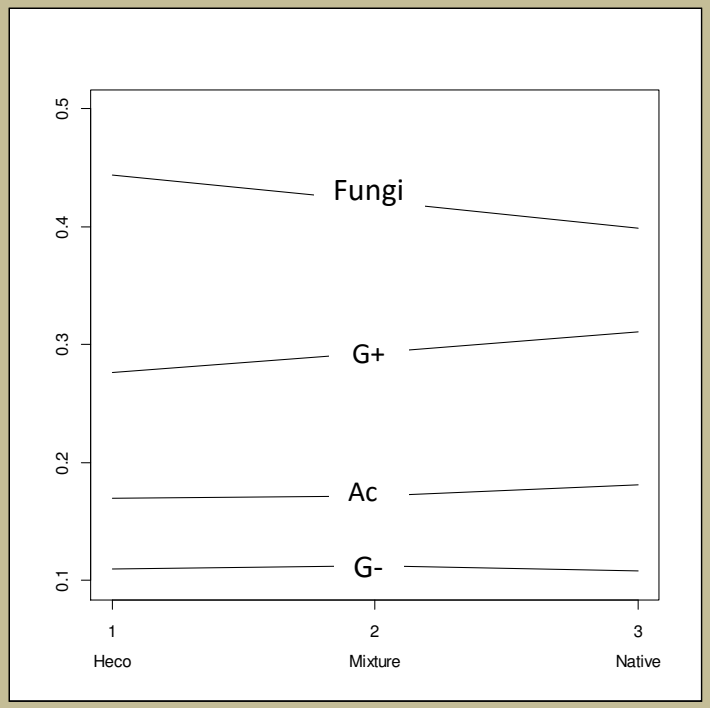
2013→2014→2015

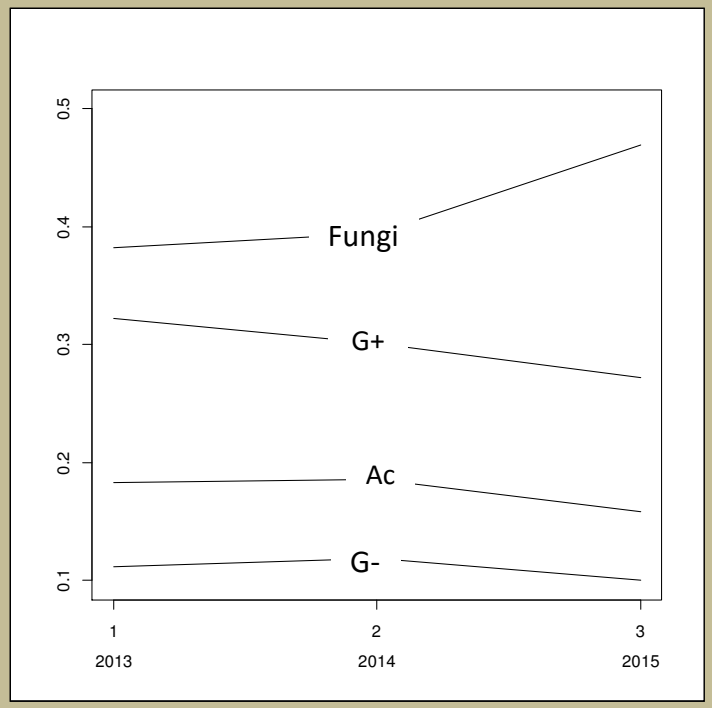
Native→Mixture→Tanglehead

Results- Microbial Community Comp.

Multivariate Analyses

- MANOVA
  - Treatment: $P = 0.0487$
    - Invaded = Native: $P = 0.0120$
  - Year: $P < 0.0001$





2013 → 2014 → 2015

- G+, Actinomycetes, and fungi increase
- Likely a precipitation factor

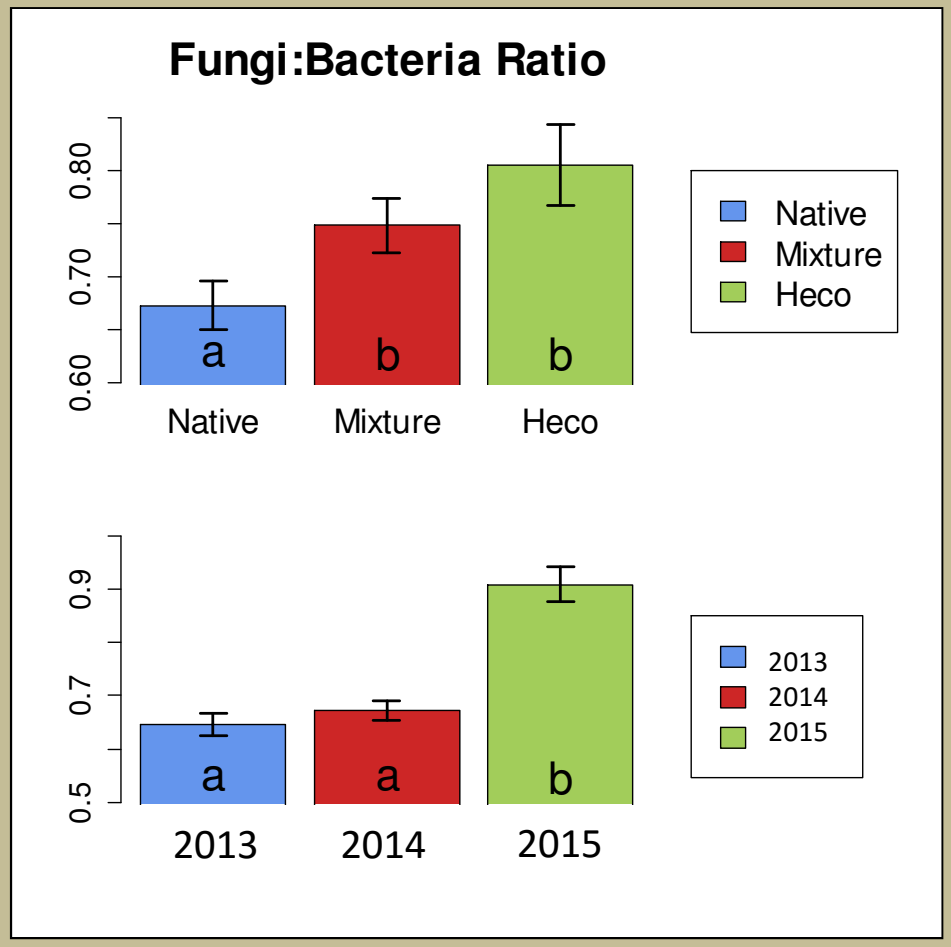
Native → Mixture → Tanglehead

- G+ and Actinomycetes decrease and fungi increase~~s~~

Results- Fungi:Bacteria Ratio

Repeated Measures, Mixed Model ANOVA

- Fungi:Bacteria Ratio
- Treatment effects (*P* = 0.0183)
  - Invaded = Mixture
  - **Invaded > Native**
  - **Mixture > Native**
- Year effects (*P* = 0.0001)
  - 2013 = 2014
  - 2015 > 2013
  - 2015 > 2014



Conclusions

- Along this invasion gradient: Microbial Community size and composition differed in tanglehead vs. native sites

- Tanglehead-invaded sites showed lower microbial biomass C and N in 2 of the 3 years
  - (smaller microbial community size)
  - Implications on soil health and functions (soil respiration, soil productivity, and health)

Conclusions

- Along our invasion gradient, we did see differences in microbial community size and composition in tanglehead sites vs. native sites
  - Had higher fungi:bacteria ratios than native sites
    - Shift to more fungi-dominated microbial communities may represent changes in nutrient levels
    - Can result in shifting of the system, including conditions favoring invasive plants

Conclusions

- We observed changes in mean microbial composition

Native → Mixture → Tanglehead

G+, Actinomycetes
↑MBC and MBN

Fungi
↓MBC and MBN

- Patterns in variation of microbial composition
  - Both a “year” and “invasion” pattern
  - Invasion pattern consistent within years
  - Left-to-right gradient

Conclusions

- Soil organisms:
  - Play vital roles in carrying out ecosystem processes such as decomposition and nitrogen cycling
  - Changes in soil community composition and size may be particularly important in S. TX ecosystems due to fluctuations in resource availability
  - Compositional changes may indicate changes in microbial diversity

- Results indicate negative changes in soil quality and microbial functioning that are key factors when undergoing restoration practices

Current Research

- What causes this change in microbial communities?
  - Residual dry matter?
  - Introduction of individual plant?
- How can we manage and control?
  - Grazing, burning, disking, herbicide?
  - All of the above?

Acknowledgements

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Questions?