Restoration of oil and gas pads in the Chihuahuan Desert of West Texas

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What is the Need for Restoration in the Permian Basin?

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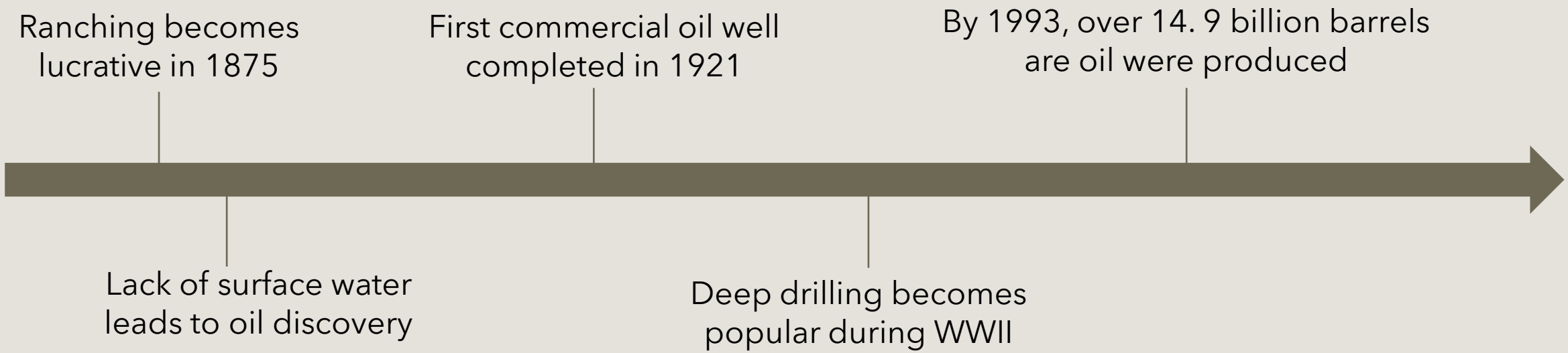
Historical Timeline



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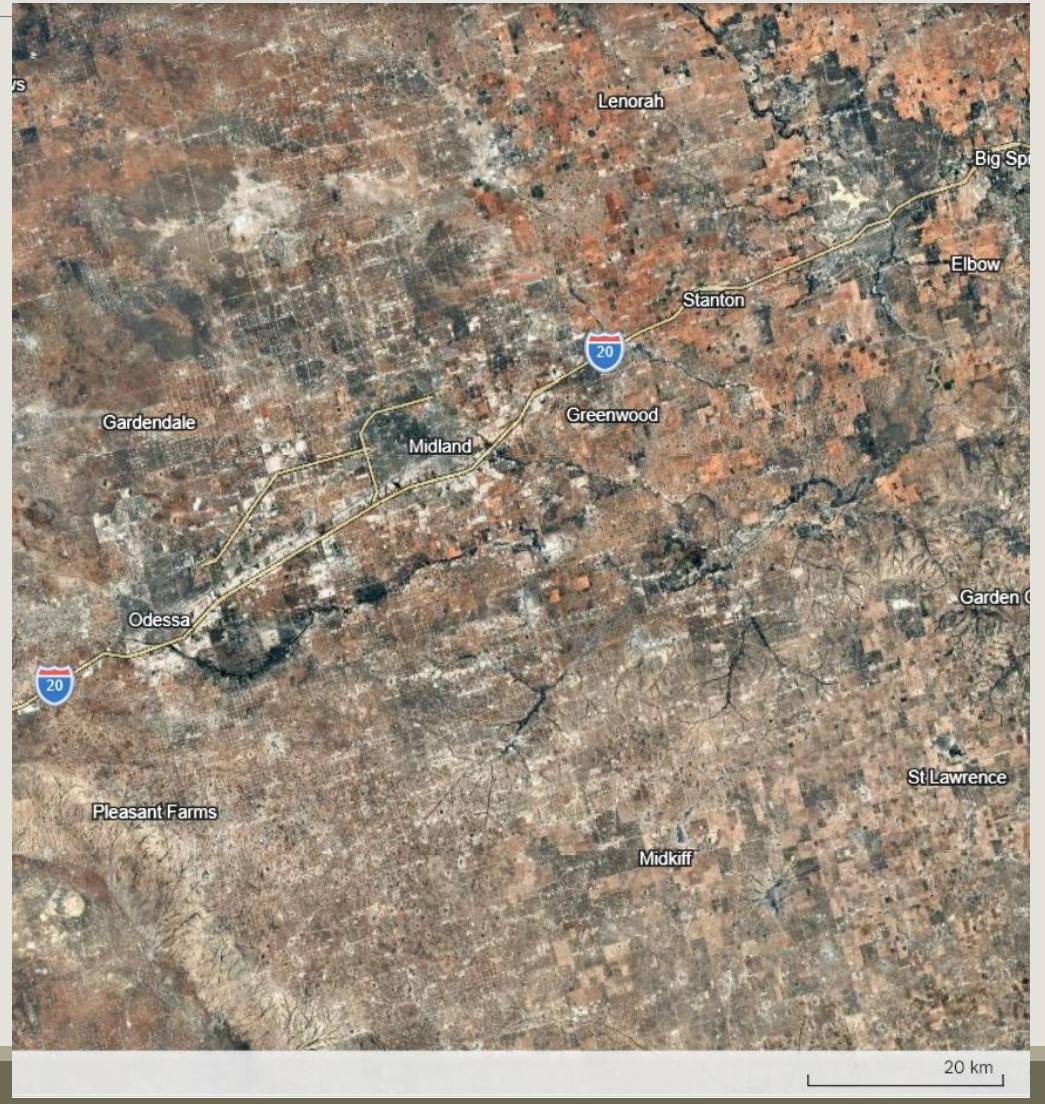
Today's Oil and Gas Production

Oil

- 40% of all US production
- Paid $27 billon in state and local taxes (2025)
- 6.6 million barrels of oil per day (2025)
- Supports over 700,000 jobs

Gas

- 15% of all US production
- Produced 27.7 billion cubic feet per day (2025)



Why Restoration is Important

- Tens of thousands of well in production
- Long-term land disturbance
- Slow recovery times due to:
  - Compact pad sites
  - Limited precipitation (34.29 cm - 35.56 cm yearly average)
  - High evapotranspiration (Highs of 36°C in summer months)

- Fragile and resource-limited areas need restoration because they struggle to recover on their own.
- Grasslands provide a wide array of ecosystem services

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Objectives and Hypothesis

- The objective of this study is to evaluate how eight different restoration treatments, each involving native seeding and varying combinations of biochar, organic amendments, and moisture-retention strategies, influence plant community composition and diversity on decommissioned oil and gas pads in an arid environment.

- I hypothesized that treatments combining biochar, organic matter, and soil moisture-retention techniques result in greater plant establishment and cover and increase native plant richness and diversity by alleviating key soil and hydrological limitations.

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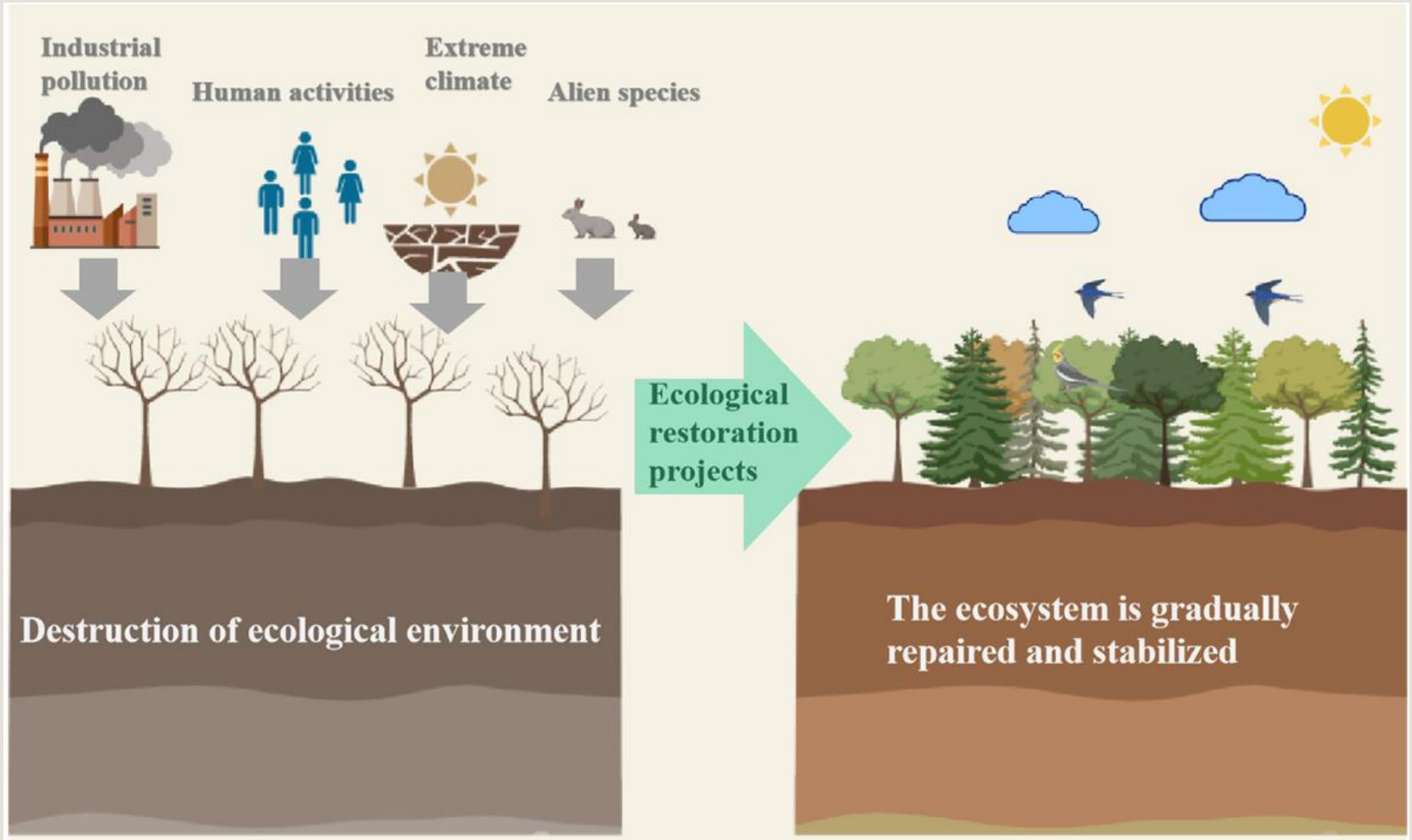
Restoration Methods

How do we decide?



Habitat Select Nursery

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Methods

- 25 decommissioned pads

- Locally adapted native seed mix
- Moisture-Retention Granules - 358.672 kg/ha (320 lbs. per acre)
- Organic Matter – 19.58 m^3/ha (25.6 yd^3/ac)
- Biochar – 7.56 m^3/ha (4 yd^3/ac)
- Soil Erosion Blankets – 120 rolls/ha (48 rolls/ac)

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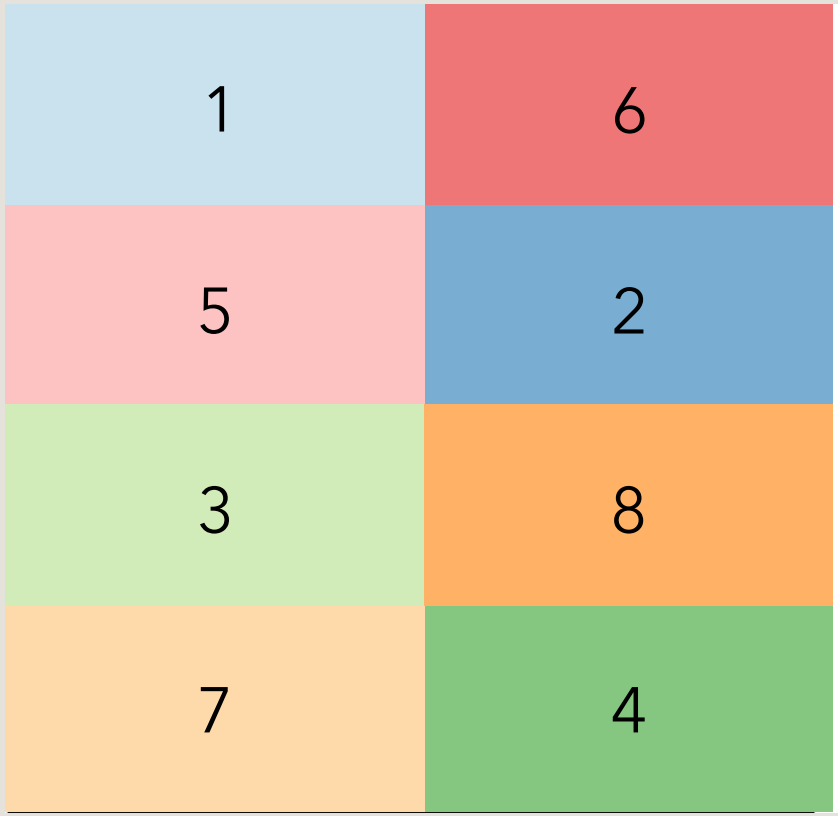
Treatments



Eight Treatments

1. Organic Matter (OM) + Seeding
2. Biochar + Seeding
3. OM +Biochar + Seeding
4. Blanket + Moisture-Retention Granule (MRG) + Seeding
5. Blanket + MRG + OM + Seeding
6. Blanket + MRG + Biochar + Seeding
7. All (OM + Biochar + Blanket + MRG + Seeding)
8. Seeding

Scientific Name	**Common Name**
Bouteloua curtipendula	Sideoats Grama
Bouteloua dactyloides	Buffalograss
Bouteloua gracilis	Blue Grama
Bothriochloa laguroides	Silver Bluestem
Chloris cucullata	Hooded Windmill Grass
Digitaria californica	Arizona Cottontop
Sporobolus cryptandrus	Sand Dropseed
Hordeum pusillum	Little Barley
Leptochloa dubia	Green Sprangletop
Pappophorum vaginatum	Whipplash Pappusgrass
Pleuraphis spp	Galleta Grass
Setaria leucopila	Plains Bristlegrass
Simsia calva	Awnless Bushsunflower

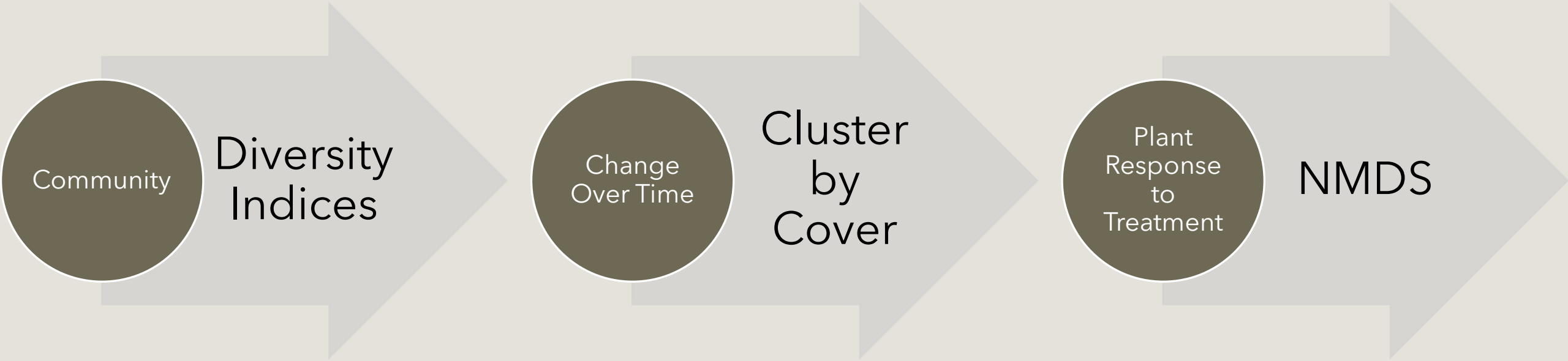
Site Preparation

Treatment Application

Sampling

- Line intercept method
- Three 3-meter transects
- Two sampling years
  - October 2024
  - October 2025

Analysis



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Results

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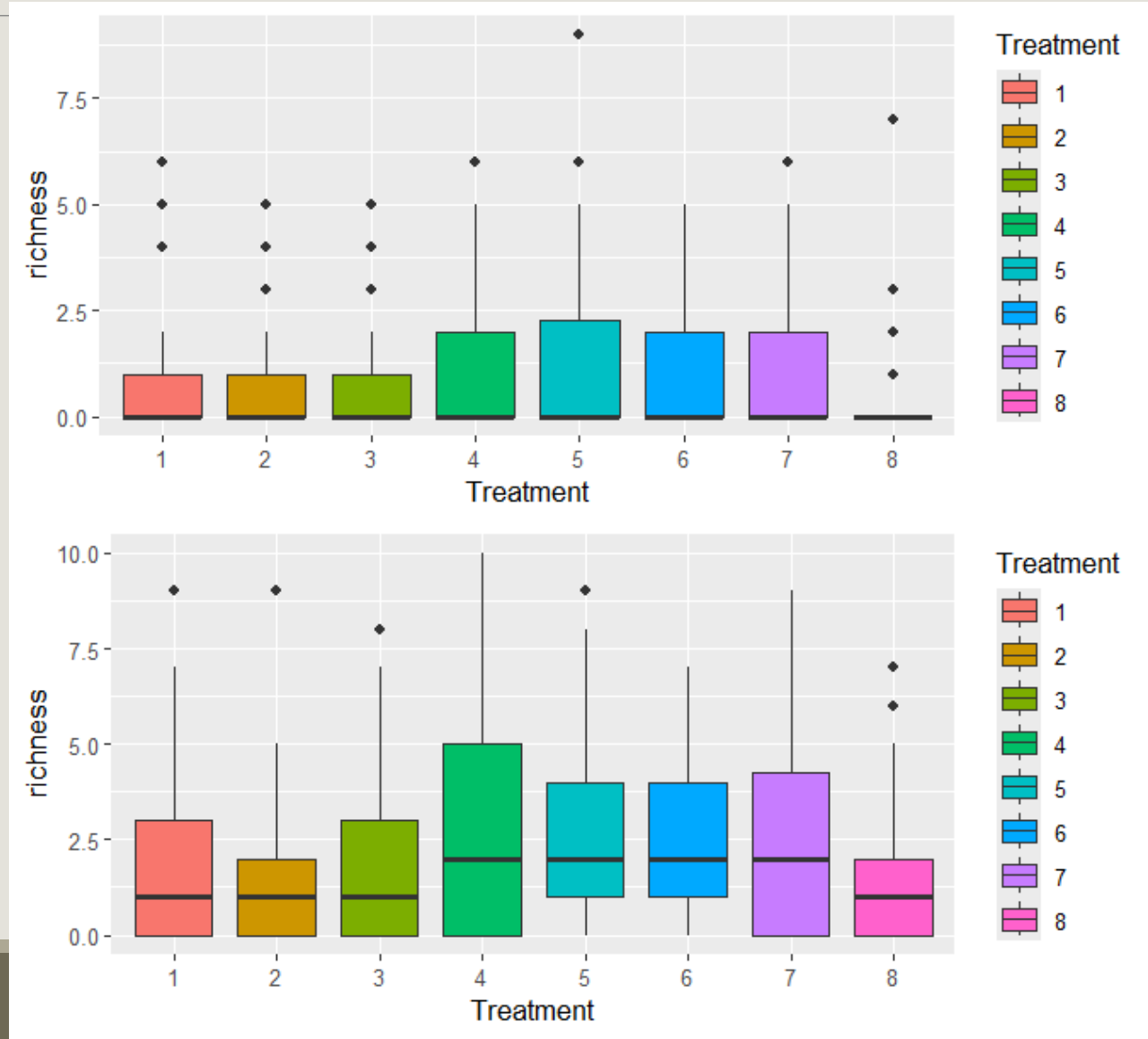
Diversity Indices



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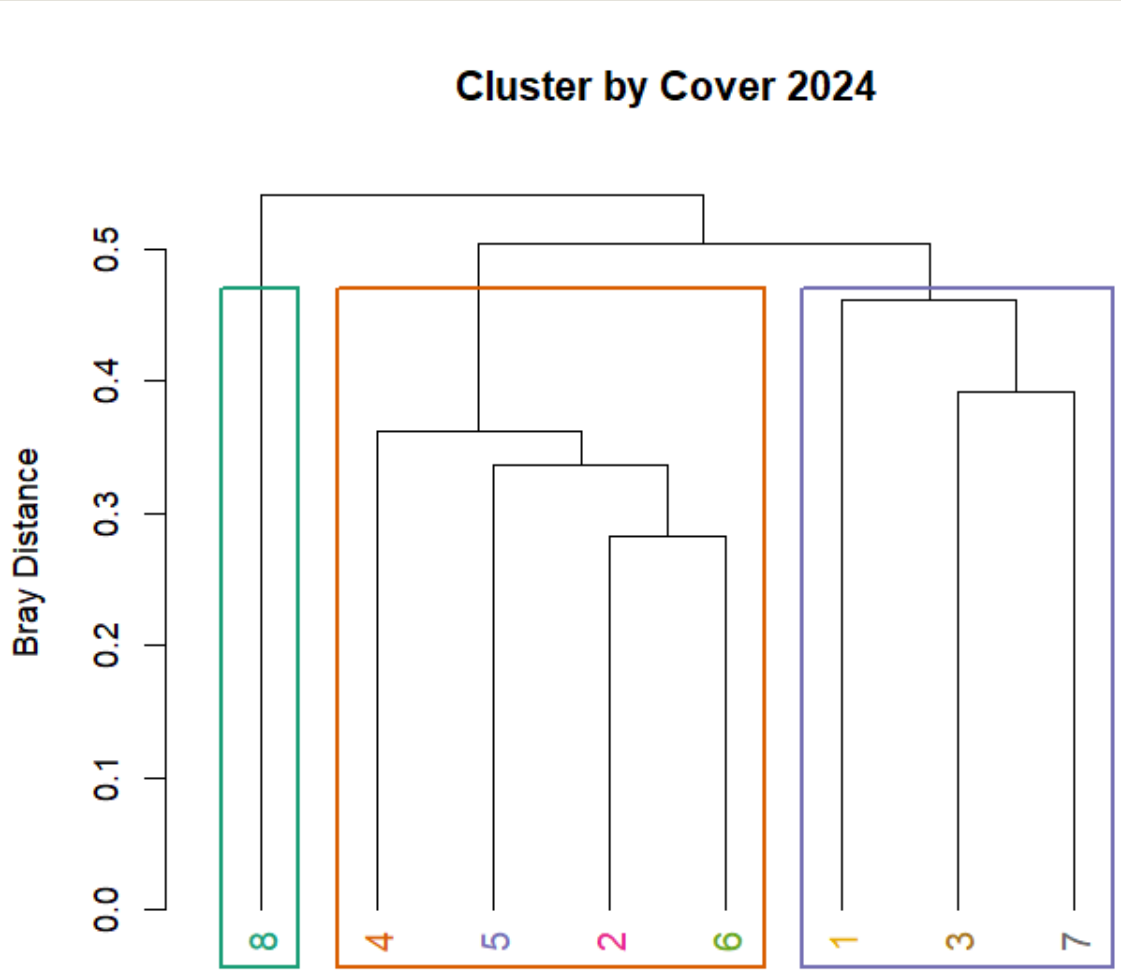
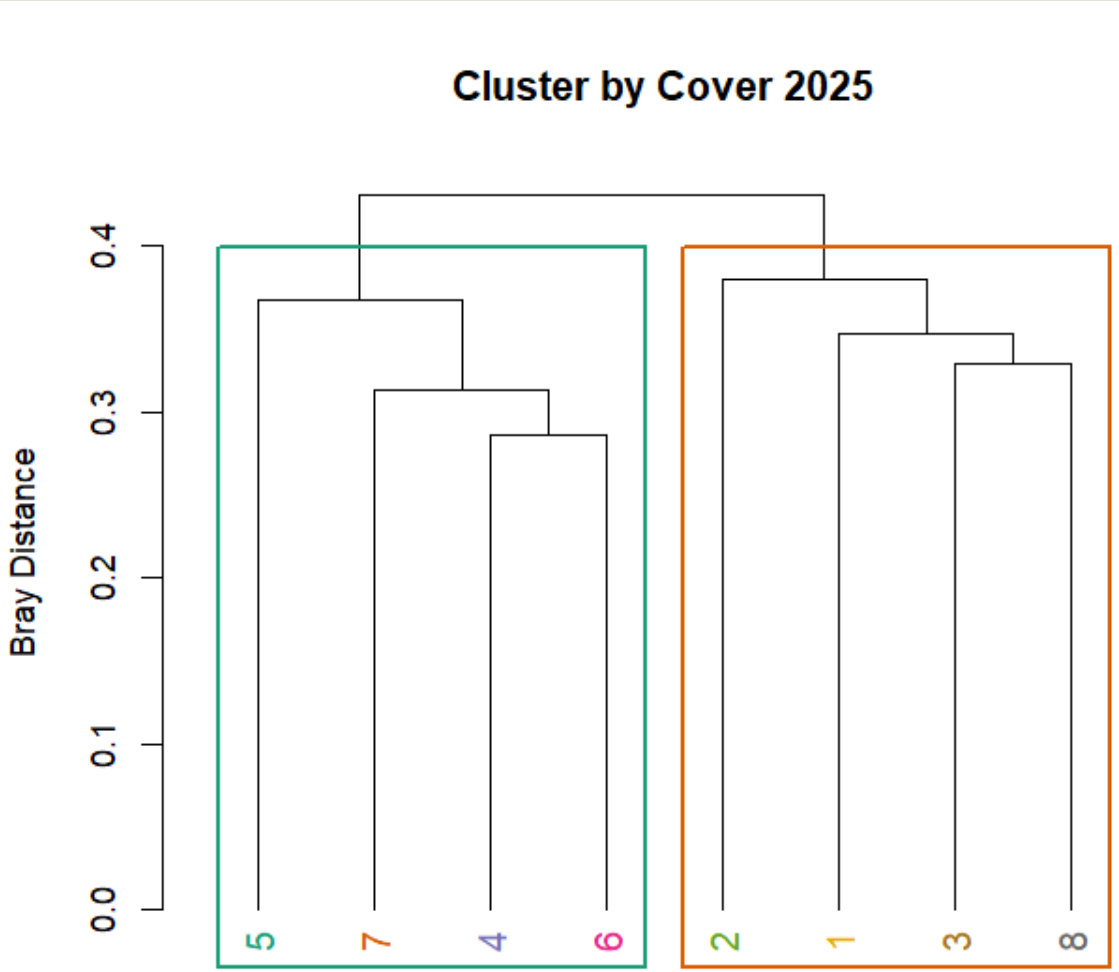
Cluster by Cover





2024 NMDS

- Non-water harvesting treatments are more similar to one another and bare soil is correlated to those treatments
- Litter was highly correlated to the water harvesting treatments
- Native grasses and forbs had a stronger relationship to water harvesting treatment

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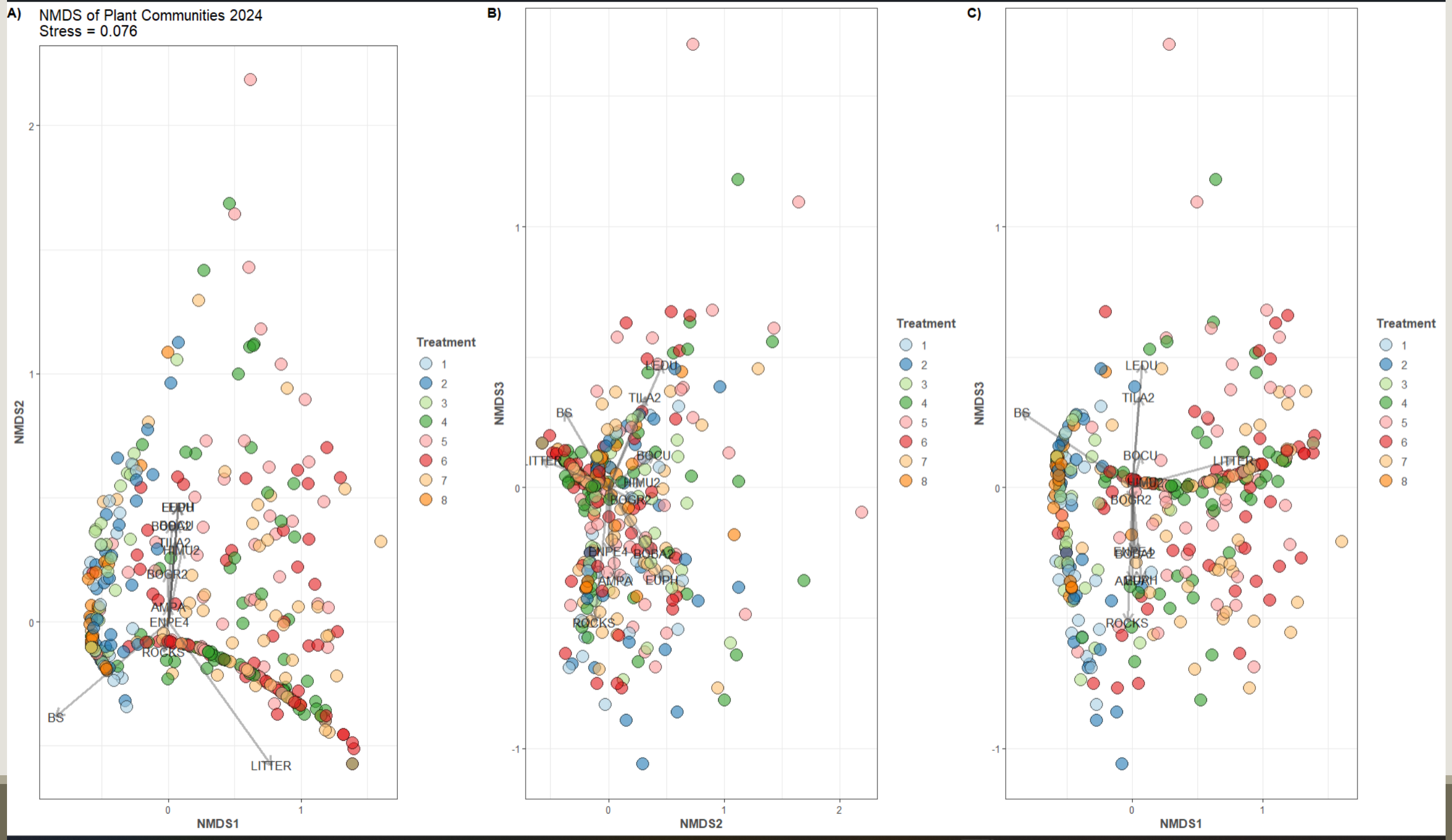
A)
NMDS of Plant Communities 2024
Stress = 0.076
NMDS1
NMDS2
Treatment
1
2
3
4
5
6
7
8
LEDU
TILA2
HIMU2
BOGR2
AMPA
ENPE4
ROCKS
BS
LITTER
B)
NMDS2
NMDS3
C)
NMDS1
NMDS3

2025 NMDS

- Bare soil remained highly correlated to non-water harvesting treatments
- Native grasses responded more to water harvesting treatments
  - Buffalograss and Side oats Grama in particular
  - Increase in perennial grass cover
- Russian Thistle is highly correlated to the water harvesting treatments

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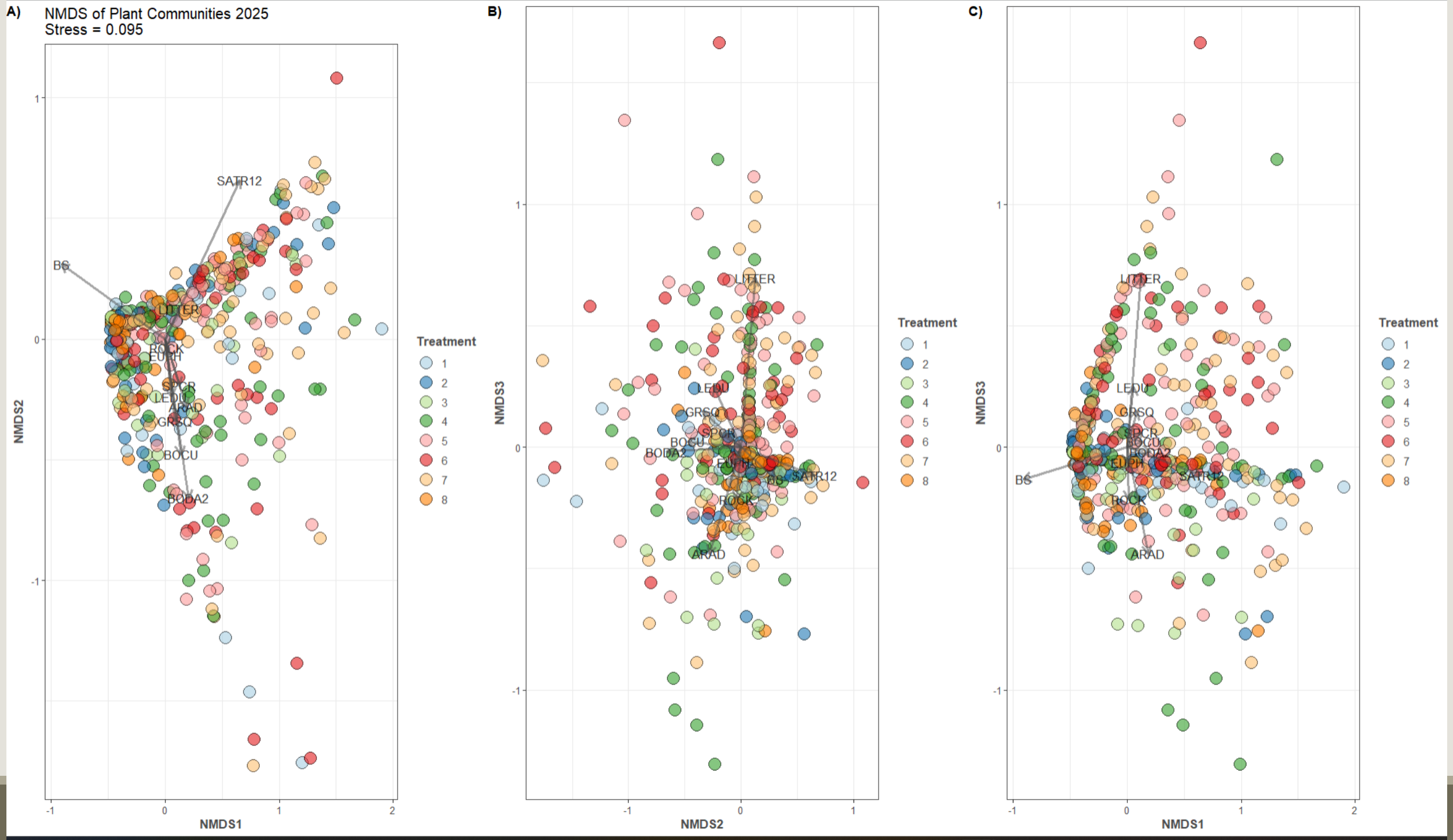
A)
NMDS of Plant Communities 2025
Stress = 0.095
SATR12
BS
LITTER
ROCK
EUPH
SPCR
LEDU
ARAD
GRSQ
BOCU
BODA2
NMDS1
NMDS2
Treatment
1
2
3
4
5
6
7
8
B)
LITTER
LEDU
GRSQ
SPCR
BOCU
BODA2
EUPH
BS
SATR12
ROCK
ARAD
NMDS2
NMDS3
Treatment
C)
LITTER
LEDU
GRSQ
SPCR
BOCU
BODA2
EUPH
SATR12
BS
ROCK
ARAD
NMDS1
NMDS3
Treatment

Field Results - 2024

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Field Results - 2025

Future Work and Management Implications

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Future Work

- Comparison studies in other degraded arid environments
- Change rate, timing, and type of treatments
- Additional sampling seasons

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Management Implications

- Identifying areas of most concern
- Water harvesting helps mitigate the most limiting factor
- Active restoration is necessary in arid environments

- Keeping water is ***just*** as important as getting it in the first place

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Thank you

- Drs. Cantu, Avila, and Gonzalez
- Borderlands Research Institute
- Sul Ross State University
- Grad Cohort and BUMP students
- Private Landowners

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Questions?

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