Community Responses to Altered Seasonal Precipitation via Seed Banks in an Annual Desert Community

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Introduction

In deserts, where rainfall is highly unpredictable across seasons (summer monsoons vs. winter rains) and years, many species persist through unpredictable conditions by storing seeds in the soil (i.e., **soil seed bank**) and germinating when conditions are favorable.

However, the extent of this buffering may differ between seasons and between native and exotic species and create **bias** - the compositional difference between the aboveground vegetation and corresponding seed bank communities.

Understanding bias is critical for understanding how these communities will change with altered precipitation. A decrease in bias may indicate that a system is losing species with altered precipitation.

Research Questions

Q1. How does seed bank composition vary between seasons, treatments (control/water+), and relative to the aboveground community?

Q2. What is the role of non-native species in driving seed bank dynamics and community structure across season and treatment (control/water+)?

Hypotheses:

H1: Winter has a stronger seed bank-aboveground match (reduced bias) due to more predictable rainfall.

H2: Non-native species help drive compositional differences, especially in winter.

Research Site

Pinyon Flats

- Located within the Colorado Desert, within the Santa Rosa Mountains
- Two growing seasons: winter (Nov-June) Summer/Monsoonal (July-Aug)
- Each growing season supports a distinct annual plant community

Figure 1. Map of the Pinyon Flats study site location. Light yellow color indicates Mojave and Colorado deserts in eastern California. (credit Joshua Sargent)

Pinyon Flats Rainfall Manipulation Experiment

- Long-term experiment est. 2018 includes **control** and **water addition** treatments applied during the winter and summer growing seasons (Fig. 2)
- Soils were sampled in 6 locations in 2019 within each rainfall plot and grown out in the greenhouse from Jan-Jun 2022 and Sept 22-Apr 23 (Fig 2C)
- Aboveground plant composition was sampled in either spring 2020 or summer 2019

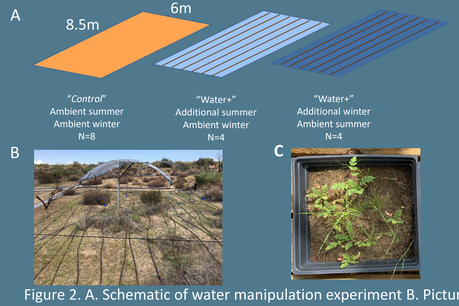

Figure 2. A. Schematic of water manipulation experiment B. Picture of water addition tubing in the field C. Picture of seed bank flat in greenhouse

Winter and Summer Seasonal communities at Study Site

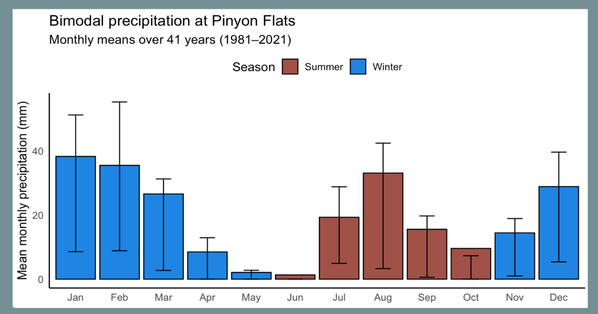

Figure 3. Historical monthly precipitation for Pinyon Flats Study (±1SE).

Figure 4. Representative native (green outline) and non-native (Fred outline) species found in either winter A,B,D) or summer (C,E,F) seasons. A. *Eriophyllum wallacei* native forb B. *Erodium cicutarium* non-native forb C. *Euphorbia micromera* non-native forb photo: Steve Matson D. *Schismus barbatus* non-native grass photo: Ron Vanderhoff E. *Portulaca oleracea* native forb photo: Ron Vanderhoff F. *Bouteloua barbata native grass* Photo: Steve Matson.

Q1. Seed bank and bias shifts with water treatments

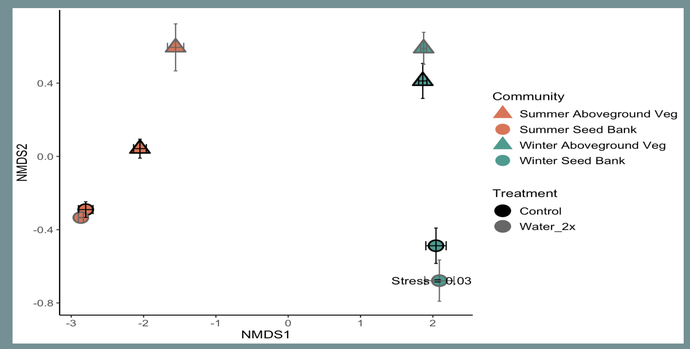

Figure 5. Non-metric multidimensional scaling plot to visualize compositional similarities between winter and summer seedbank communities aggregated by origin and life form. Stress = 0.03

Q2. Role of non-natives in mediating seedbank dynamics

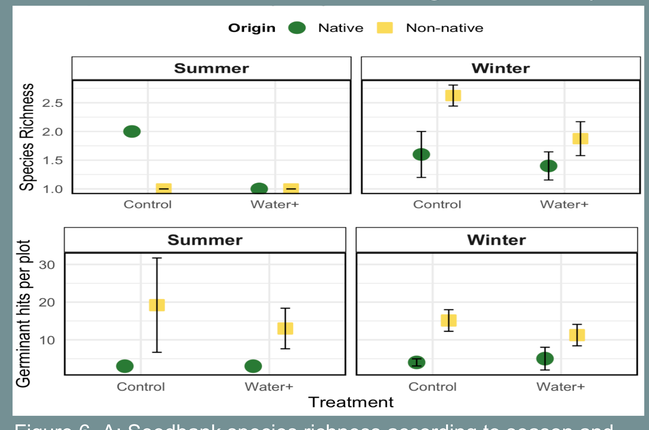

Figure 6. A: Seedbank species richness according to season and treatment. B: Seedbank germinant density according to season & treatment (means ± 1SE)

Conclusion

Across seasons, seed bank and aboveground communities were compositionally distinct, with greater bias in summer driven largely by non-native species. These results highlight the dominant role of seasonality and species origin as stronger drivers in structuring desert annual plant communities than altered season precipitation.

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