The effects of winter drought on population dynamics of dormant plants

1. Background
   1. Observed diversity declines aboveground in native forbs (serp and non serp) in past 15 years
   2. Observed decrease in winter precipitation across region in the past 15 years
   3. Seedbank is thought to buffer native forb populations against these unfavorable periods however seedling drought tolerance may be more important than germination response if winter drought is the new normal
      1. Preliminary results however suggest that native forb seedbanks post drought are not depleted, suggesting that either the signal cannot be seen over this short period, or stronger dormancy actually make forbs survive winter drought by limiting germination in a good fall before a bad winter
   4. Dormancy in forbs is thought to regulate coexistence in these communities however as important climatic variable change, the beneficial effects of dormancy may change. In order to understand how these populations and the community at large will respond to future climatic changes, I will study the population responses of forbs with different dormancy strategies to variation in rainfall in order to understand the mechanisms underlying response. I will also look at community response to different rainfall regimes to forecast the limits of storage-mediated systems to maintain coexistence in a changing climate.
2. Questions
   1. Q1 – How do annual forb populations respond to variation in winter rainfall and what are the mechanisms underlying this response?
      1. What types of species (low dormancy vs high dormancy) are most likely to be lost under future rainfall scenarios?
      2. How does competition alter population response to winter rainfall?
      3. How does the maternal environment affect germination response?
         1. Within a species, do seeds produced in a wet year have higher dormancy than seeds produced in a dry year?
         2. Does a model that bases germination on previous year’s weather make better predictions than models that base germination on current year’s weather?
   2. Q2 – How do coexistence mechanisms at the community level change in response to winter drought?
      1. Do changes in the timing of annual rainfall affect the strength of the community average storage effect?
      2. Do changes in the timing of annual rainfall affect the life stage at which species differences matter?
3. Hypothesis
   1. H1
      1. H1a – Forbs with higher dormancy will show least resilience to winter drought as indicated through lower population growth rates
      2. H1b – In the winter drought treatment, elasticity analysis will reveal that population growth rates are more sensitive to performance of germinated individuals in high dormancy forbs whereas germination rates will be more important in low dormancy forbs
         1. Conversely, in drought alleviation treatment, population growth rates will be most sensitive to germination rates in both types of forbs
      3. H1c – Projections into the future will show that with increased winter drought, forbs with higher dormancy are at risk of being lost from the system.
   2. H2
      1. H2A - At the community level, plant assemblages in the winter drought treatment will show a weaker storage effect as compared to the alleviated winter drought treatment.
      2. H2B - Under the winter drought treatment more variation in the storage effect will be attributed to post-germination differences than germination differences.
   3. H3
      1. H3A – Within a species, dormancy will be stronger in seeds produced in the wet treatment than in drought treatment
      2. H3B – The model in which germination depends on the previous year’s rainfall will better predict plant cover over 15 years than the model that depends on current year’s rainfall
4. Methods
   1. Treatments
      1. Control (normal background rainfall)
      2. Drought (50% less rainfall)
      3. Alleviation of winter drought treatment
   2. Study species
      1. Low dormancy
      2. High dormancy
   3. Implementation
      1. Sowing aboveground seed
      2. Burying seed bags
5. Tests
   1. H1 – Population level response to winter drought across dormancy strengths
      1. H1A - Compare population growth rates between forbs in each treatment by parameterizing annual plant model
      2. H1B - Elasticity analysis to evaluate life stage importance to population growth rate
      3. H1C - Parameterize annual plant model with environmental stochasticity for different dormancy strengths and project out into the future to test which will be lost from system
   2. H2 – Use demographic data to parameterize storage effect model for community (ala Angert et al.) and compare:
      1. H2A - Strength of storage effect between treatments
      2. H2B - Life stage partitioning of the storage effect between treatments
   3. H3 – Dormancy predictions
      1. H3A – Collect seeds from each treatment and conduct germination trials and compare germination %
      2. H3B – Build model with germination as a function of the previous year’s rainfall and compare predictions of plant cover trends to model in which germination depends on current year type. (Tielborgher vs Levine)
6. Anticipated Results
   1. H1
   2. H2
   3. H3