First-level bullets are papers; bolded text summarizes the correlation between species' environmental responses.

- Caceres, 1997, *Temporal variation, dormancy, and coexistence: a field test of the storage effect*
  - Community: *Daphnia* zooplankton in a temperate lake; Oneida Lake, New York, United States
  - **Cross-species correlations in E_j cannot be determined**. The statement "data collected over the past 30 years show a striking negative correlation between the water-column densities of two species of suspension-feeding zooplankton" (p. 9171) would seem to suggest negative correlated responses to the environment (i.e. the per-daphnia rate of recruitment to the egg-bank). However, such negative correlations in population abundances can be caused purely by competitive interactions. No data is provided.
- Pake, Venable, and Caprio, 1993, *Diversity and coexistence of Sonoran desert winter annuals* | Pake and Venable, 1995, *Is coexistence of Sonoran desert annuals mediated by temporal variability reproductive success* |
  Pake and Venable, 1996, *Seed banks in desert annuals: implications for persistence and coexistence in variable environments*
  - Community: winter annual plants in the Sonoran desert; Tuscon, Arizon, United States
  - **Table 3 (in Pake and Venable, 1993, p. 212) shows that for the vast majority of species pairs, per-capita fecundity has a positive rank correlation**. **Similarly, we computed the correlation matrix for per capita fecundity using the data found in Pake and Venable, 1996, p. 1431, Table 1. A strong majority of species pairs (23/28 ~82%) showed positive correlations (pearson)**. This makes sense, given Pake and Venable's statement, "there tends to be an increase in the number of seedlings emerging the year following a high per cpaita realized fecundity … This pattern is strongly influenced by the patter of rain fall and temperatures … Fig. 5" (Pake and Venable, 1993, p. 210). Note that according to the classic annual plant model (Chesson 1994, *Theor pop bio*), EC covariance cannot arise unless fluctuating fecundity is temporally autocorrelated. The authors do not address temporal autocorrelation explicitly, and there are only 10 years of data, but the time series in Pake and Venable, 1993, Figures 4, 5, and 6 do seem to indicate the presence of temporal autocorrelation.
  - Table 1 (in Pake and Venable, 1996, p. 1431) shows the average germination fraction of different species. We calculated the correlation matrix (excluding species with NAs) and found that **a slight majority of species pairs (49/78 ~ 63%) had positively correlated germination fractions**. This should be taken with a grain of salt, since only 3 years of data are available.
- Adler et al., 2006, *Climate variability has a stabilizing effect on the coexistence of prairie grasses*
  - Community: prairie grasses; Kansas, United States
  - **Evidence for positive cross-species correlations:** "We tested for condition 2 of the storage effect, species-specific responses to climate, by using our statistical model to project the low-density growth rate of each species, in each year, in the absence of competitors. These yearly intrinsic growth rates were weakly correlated for each pair of species (Fig. 2 D–F), but the considerable scatter suggests that the species respond differently to environmental variation" (p.12795). Table 1 reveals that species respond

similarly climatic predictor – for most predictors, the sign of the effect is identical across species. The exception is that the intrinsic growth rates of *B. curtipendula* has a unique positive association with mean annual temperature. However, this effect could be "picking up" on the effect of mean temperature from April to September, a variable that was excluded from the model for *B. curtipendula* in the the step-wise variable selection procedure. Of course, a variable that is excluded via significance testing (especially nested in a step-wise selection procedure) does not necessarily have small effects, so a direct comparison of the effect sizes in different models is difficult.

- Sears and Chesson, 2007, *New methods for quantifying the spatial storage effect: an illustration with desert annuals*
  - Community: winter annual plants; Portal, Arizona, United States
  - **Cross-species correlations in E_j cannot be determined.** No indication in the text, nor is data provided.
- Descamps and Gonzalez, 2005, *Stable coexistence in a fluctuating environment: an experimental demonstration*
  - Community: Microcosms of freshwater diatoms, taken from two temperate lakes -- Esthwaite Water and Blelham Tarn – in England.
  - **Table 1 (p. 2818) shows that species have correlated responses to the environment (here, temperature)**, with both species generally attaining higher maximum growth rates and larger half-saturation constants at higher temperature (the exception being that *Cylotella pseudostelligera* did not grow well at high temperature (i.e. 24 C).
- Angert et al. 2009*, Functional tradeoffs determine species coexistence via the storage effect*
  - Community: winter annual plants in the Sonoran desert; Tuscon, Arizona, United States. **Note: community may be a repeat of Pake & Venable's community; both projects come out of the University of Arizona's Desert Laboratory**
  - **Evidence for positive cross-species correlations:** A visual inspection of Figure 2 reveals strong correlations in per-germinant fecundity, putatively driven by seasonal rainfall. In this paper's model of annual plant dynamics, fluctuations in fecundity can generate a positive storage effect.
- Usinowicz, Wright, and Ives, 2012, *Coexistence in tropical forests through asynchronous variation in annual seed production*
  - Community: Tropical rainforest trees; Barro Colorado Island, Panama
  - Appendix B shows a matrix of pairwise correlation coefficient in recruitment rates. The average correlation is -0.05 and the percentage of positive correlations is 48%. In summary, **both positive and negative correlations are common, but species responses are approximately uncorrelated, on average.**
- Facelli, Chesson, and Barnes, 2005, *Differences in seed biology of annual plants in arid lands: a key ingredient of the storage effect*
  - Annual plants in an arid shrubland; Middleback Filed Centre, Australia
  - **Figure 3 provides evidence for a positive correlation in species' germination fractions**. All species prefer intermediate and high water treatments to the low water treatment. However, some species have their highest germination fraction at intermediate water levels. Most species have their highest germination fractions in springtime temperatures, though there are some exceptions, .e.g *Crassula Colorata* prefers cold

winter temperatures. Notably, there are temperature X water interactions, such that species can respond idiosyncratically to a particular combination of rainfall and temperature.

- Chesson et al., 2012, *The storage effect: definition and tests in two plant communities*
  - o Community: winter annual plants in the Sonoran desert; Portal, Arizona, United States
  - o **Figure 2.1 shows that the environmental responses (here, the germination fraction) are positively correlated.** A major determinate of germination is temperature at first rainfall, and most species tend to have higher germination fractions at lower temperatures. The statistical tests of the storage effect, which comprise a significant part of the paper, provide evidence for the storage effect but do not indicate whether species responses to the environment are positively or negatively correlated.
- Kelly and Bowler, 2002*, Coexistence and relative abundance in forest trees* | Kelly and Bowler, 2005, *A new application of storage dynamics: differential sensitivity, diffuse competition, and temporal niches*
  - o Community: tropical deciduous trees; Chamela Biological Station, Mexico
  - o **We were not able to find any information about correlations in species' responses to the environment.**
- Usinowicz et al., 2017*, Temporal coexistence mechanisms contribute to the latitudinal gradient in forest diversity*
  - o Community: 10 tree communities across latitudes.
  - o **Figure 2 shows that pairwise correlations in recruitment are, on average, positive; this is true at both the within-year and between-year timescales.**
- Ignace, Huntly, and Chesson, 2018, *The role of climate in the dynamics of annual plants in a Chihuahuan Desert ecosystem*
  - o Community: winter annual plants in the Sonoran desert; Portal, Arizona, United States. **Note: community is a repeat of Chesson et al.'s (2012) community.**
  - o **Evidence of positive correlations in species' responses to the environment:** "…we found a clear association between the amount of precipitation and the overall abundance of winter annual plants at flowering. This relation- ship held for native species and for the entire assemblage of winter annual plants, which includes the now-dominant invasive species, E. cicutarium." (p. 290), and "The results here are consistent with the idea that the annual plants of the Portal bajada species compete with one another, yet are positively correlated in abundance over time. Although it has been suggested that competing species ought to be negatively correlated on average over time (Houlahan et al., 2007), there is no necessity of that. A strong effect of [precipitation on total abundance], which fluctuates greatly over time, can easily lead to positive average correlations between species (Chesson, 2011)." The bracketed text has been modified from the original text for clarity – it originally read "total abundance on precipitation".
- Hallet et al., 2019, *Rainfall variability maintains grass-forb species coexistence*
  - o Grasses and forbs in a Grassland; Sierra Foothill Research Extension Center, California, United States.
  - o **Evidence for negatively correlated responses to the environment**: Table 1 shows how demographic parameter estimates change with rainfall treatments. The rainfall

treatments. *Avena* has high per capita fecundity in the consistent dry treatment and low fecundity in the consistent wet treatment. The opposite is true to *Erodium. Erodium* the competition coefficients of *Erodium,* but not *Avena,* change dramatically with the water treatments.

- Armitage and Jones, 2019, *Negative frequency-dependent growth underlies the stable coexistence of two cosmopolitan aquatic plants* | Armitage and Jones, 2020, *Coexistence barriers confine the poleward range of a globally distributed plant plants*
  - Community: duckweed species from woodland ponds; St. Joseph County, Indiana, United States.
  - **Evidence for positively correlated responses**: "In our system, despite species' differences in dormancy and thermal reaction norms, their environmental responses were still highly correlated (Appendix S1: Fig. S10)…" (Armitage and Jones, 2019, p. 10)
- Zepeda and Martorell, 2019, *Fluctuation-independent niche differentiation and relative non-linearity drive coexistence in a species-rich grassland*
  - Community: semiarid grassland; Concepción Buenavista, Oaxaca, southern Mexico
  - **Figure 3 shows that approximately 75% of pairwise correlations in the environmental response (here, maximum per-capita fecundity) are positive.**
- Letten et al., 2018, *Species coexistence through simultaneous fluctuation-dependent mechanisms*
  - Community: microcosms of nectar yeasts
  - We analyzed the parameter estimates at different sucrose levels, found in SI appendix Table S1. The maximum growth rate, μ, and the half-saturation constant, K, are expected to fluctuate with the sucrose level. Assuming that each sucrose level is equally probable we find that the average correlation in K is 0.16 and that 4/6~67% of pairwise correlations in K are positive. We find that the average correlation in μ is -0.24 and that 2/6~32% of pairwise correlations in μ are positive. **Overall, we interpret this as evidence for both positive and negative correlations in species' responses to the environment. For the purposes of categorizing studies, we will say that species' responses to the environment are approximately uncorrelated, on average.**
- Towers et al., 2020, *Requirements for the spatial storage effect are weakly evident for common species in natural annual plant assemblages*
  - Community: Understory plants in a York-gum–jam woodland; West Perenjori Nature Reserve, Australia.
  - **Table 2 shows that there is poor evidence that species respond strongly (positively or negatively) to environmental variables. This, in turn, indicates that species' responses to the environment are approximately uncorrelated.** Although the tree overstory variable and soil fertility variable seem to have consistently (across species) negative effects on per-capita fecundity, many effects are not significant, so we take the conservative approach and categorize this community as approximately uncorrelated. We suspect that most species truly respond to the environmental variables similarly, and that this would be revealed by more data; but as the authors state "weak responses to the environment may simply reflect the limitations of experiments in natural assemblages." (p. 7).

- Jiang and Morin, 2007, *Temperature fluctuation facilitates coexistence of competing species in experimental microbial communities*
  - Community: protist microcosms
  - **Table 1 shows negatively correlated responses to the environment**. "Changes in temperature had opposite effects on the intrinsic growth rates of Colpidium and Paramecium…" (p. 663)
- Holt and Chesson, 2014, *Variation in moisture duration as a driver of coexistence by the storage effect in desert annual plants*
  - Community: winter annual plants in the Sonoran desert; Portal, Arizona, United States. **Note: community is a repeat of Chesson et al.'s (2012) community.**
  - **Evidence for positive correlations in species' responses:** "These germination patterns are not independent between species, as they are often assumed to be theoretically, because the germination for each species is monotonically dependent on the same underlying fluctuating environmental variable. This means that the degree of statistical dependence between species is quite high. Indeed, beyond the delay before appreciable germination occurs, each species' germination fraction can be predicted precisely from any other species' germination fraction from the knowledge of their germination curves." (p. 37)
- Ellner, Snyder, and Adler, 2016, *How to quantify the temporal storage effect using simulation instead of math*
  - Community: 1) Microcosms of freshwater diatoms, not discussed here as it is a repeat of Descamps and Gonzalez, 2005. 2) plants in 5 grassland study sites in the United States: Sonoran Desert, Arizona; sagebrush steppe, Idaho; southern mixed prairie, Kansas; northern mixed prairie, Montana; and Chihuahuan Desert, New Mexico.
  - The model (see supplementary code, filename: rec_stan.R) included random year effects for all species, meaning that the model claims that species' responses to the environment are uncorrelated. We are unable to tell if there was exploratory data analysis that justified this decision, or if this model structure was chosen for convenience. **Therefore, we claim that this study does provide sufficient information to determine the nature of correlations in species' responses.**