Climate tallgrass prairie papers

(Ewing and Engle 1988, Gillen et al. 1991, Knapp et al. 1993, Briggs and Knapp 1995, Turner and Knapp 1996, Turner et al. 1997, Briggs and Knapp 2001, Knapp et al. 2002, Silletti 2002, Bakker et al. 2003, Adler et al. 2006, Adler and Levine 2007, Adler and HilleRisLambers 2008)

Adler, P. B. and J. HilleRisLambers. 2008. The influence of climate and species composition on the population dynamics of ten prairie forbs. Ecology **89**:3049-3060.

Understanding the relative roles of climate and species interactions in regulating population dynamics, one of the oldest challenges in ecology, is now a prerequisite for predicting species responses to climate change. A lack of case studies limits our ability to generalize about the factors that have regulated populations in the past and will be important in the future. Here, we take a first step toward identifying the drivers of plant population dynamics by studying the influence of climate and species interactions on the recruitment and survival of ten forb species from a Kansas (USA) prairie. Combining a long-term demographic data set with a Bayesian hierarchical-modeling approach, we fit models in which annual survival and recruitment rates are driven by precipitation, temperature, and species composition. Although the effects of these covariates differed among species, three general patterns emerged. First, climate had a greater influence than species composition on historical population dynamics. Second, forecasted increases in mean temperatures are likely to impact the population growth of these species more than future changes in precipitation or composition. Third, the significant effects of both climate and species composition on recruitment suggest that range expansions will be particularly difficult to forecast. Based on these patterns, we recommend field experiments to evaluate the ability of plant species to recruit at expanding range margins under warmer temperatures

<http://www.esajournals.org/doi/abs/10.1890/07-1569.1>

Adler, P. B., J. HilleRisLambers, P. C. Kyriakidis, Q. Guan, and J. M. Levine. 2006. Climate variability has a stabilizing effect on the coexistence of prairie grasses. Proceedings of the National Academy of Sciences **103**:12793-12798.

How expected increases in climate variability will affect species diversity depends on the role of such variability in regulating the coexistence of competing species. Despite theory linking temporal environmental fluctuations with the maintenance of diversity, the importance of climate variability for stabilizing coexistence remains unknown because of a lack of appropriate long-term observations. Here, we analyze three decades of demographic data from a Kansas prairie to demonstrate that interannual climate variability promotes the coexistence of three common grass species. Specifically, we show that (*i*) the dynamics of the three species satisfy all requirements of ‘‘storage effect’’ theory based on recruitment variability with overlapping generations, (*ii*) climate variables are correlated with interannual variation in species performance, and (*iii*) temporal variability increases low-density growth rates, buffering these species against competitive exclusion. Given that environmental fluctuations are ubiquitous in natural systems, our results suggest that coexistence based on the storage effect may be underappreciated and could provide an important alternative to recent neutral theories of diversity. Field evidence for positive effects of variability on coexistence also emphasizes the need to consider changes in both climate means and variances when forecasting the effects of global change on species diversity.

Adler, P. B. and J. M. Levine. 2007. Contrasting relationships between precipitation and species richness in space and time. Oikos **116**:221-232.

Future changes in precipitation regimes are likely to impact species richness in water-limited plant communities. Regional, spatial relationships between precipitation and richness could offer information about how altered rainfall will impact local communities, assuming that processes driving the regional relationship are also dominant at fine spatial and short temporal scales. To test this assumption, we compared spatial and temporal relationships between precipitation and both species richness and species turnover in central North American grasslands. Across a broad geographic gradient, mean plant species richness in 1-m(2) plots increased significantly with mean annual precipitation. In contrast, over a 36-yr period at one mixed-grass prairie in the center of the regional gradient, single-year precipitation and richness were poorly correlated, and consecutive wet years had little effect on richness. Instead, richness increased most in wet years that followed dry years. Geographically dispersed sites receiving different levels of mean annual precipitation displayed strong differences in species composition, whereas temporal variation in precipitation at one site was not related to compositional dissimilarity, indicating that species turnover plays a key role in generating the regional relationship. Analyses of individual species' presence-absence suggest that the lagged temporal responses reflect environmental germination cues more than resource competition. These complex cues may dampen the initial impact of altered precipitation on diversity, but over the long term, turnover in species composition should lead to changes in richness, as in the regional, spatial relationship. How quickly this long-term response develops may depend on the colonization rates of species better adapted to the altered rainfall regime.

<Go to ISI>://000243636800006

Bakker, C., J. M. Blair, and A. K. Knapp. 2003. Does resource availability, resource heterogeneity or species turnover mediate changes in plant species richness in grazed grasslands? Oecologia **137**:385-391.

Grazing by large ungulates often increases plant species richness in grasslands of moderate to high productivity. In a mesic North American grassland with and without the presence of bison (Bos bison), a native ungulate grazer, three non-exclusive hypotheses for increased plant species richness in grazed grasslands were evaluated: (1) bison grazing enhances levels of resource (light and N) availability, enabling species that depend on higher resource availability to co-occur; (2) spatial heterogeneity in resource availability is enhanced by bison, enabling coexistence of a greater number of plant species; (3) increased species turnover (i.e. increased species colonization and establishment) in grazed grassland is associated with enhanced plant species richness. We measured availability and spatial heterogeneity in light, water and N, and calculated species turnover from long-term data in grazed and ungrazed sites in a North American tallgrass prairie. Both regression and path analyses were performed to evaluate the potential of the three hypothesized mechanisms to explain observed patterns of plant species richness under field conditions. Experimental grazing by bison increased plant species richness by 25% over an 8-year period. Neither heterogeneity nor absolute levels of soil water or available N were related to patterns of species richness in grazed and ungrazed sites. However, high spatial heterogeneity in light and higher rates of species turnover were both strongly related to increases in plant species richness in grazed areas. This suggests that creation of a mosaic of patches with high and low biomass (the primary determinant of light availability in mesic grasslands) and promotion of a dynamic species pool are the most important mechanisms by which grazers affect species richness in high productivity grasslands.

<Go to ISI>://000186093800010

Briggs, J. M. and A. K. Knapp. 1995. Interannual Variability In Primary Production In Tallgrass Prairie - Climate, Soil-Moisture, Topographic Position, And Fire As Determinants Of Aboveground Biomass. American Journal Of Botany **82**:1024.

<Go to ISI>://A1995RQ00500009

Briggs, J. M. and A. K. Knapp. 2001. Determinants of C-3 forb growth and production in a C-4 dominated grassland. Plant Ecology **152**:93-100.

Ewing, A. L. and D. M. Engle. 1988. Effects of Late Summer Fire on Tallgrass Prairie Microclimate and Community Composition. American Midland Naturalist **120**:212-223.

Gillen, R. L., J. E. Brummer, K. W. Tate, F. T. McCollum, and M. E. Hodges. 1991. Plant community responses to short duration grazing in tallgrass prairie. Journal of range management, Mar:124-128.

Knapp, A. K., J. T. Fahnestock, S. P. Hamburg, L. B. Statland, T. R. Seastedt, and D. S. Schimel. 1993. Landscape Patterns in Soil Plant Water Relations and Primary Production in Tallgrass Prairie. Ecology **74**:549-560.

Knapp, A. K., P. A. Fay, J. M. Blair, S. L. Collins, M. D. Smith, J. D. Carlisle, C. W. Harper, B. T. Danner, M. S. Lett, and J. K. MaCarron. 2002. Rainfall variability, carbon cycling and plant species diversity in a mesic grassland. Science **298**:2202-2205.

Silletti, A. K. A. 2002. Long-term responses of the grassland co-dominants Andropogon gerardii and Sorghastrum nutans to changes in climate and management. Plant Ecology **163**:15-22.

Turner, C. L., J. M. Blair, R. J. Schartz, and J. C. Neel. 1997. Soil N and plant responses to fire, topography, and supplemental N in tallgrass prairie. Ecology **78**:1832-1843.

Turner, C. L. and A. K. Knapp. 1996. Responses of a C-4 grass and three C-3 forbs to variation in nitrogen and light in tallgrass prairie. Ecology **77**:1738-1749.