Changing rainfall patterns and grassland biodiversity:
climate change impacts from individual to ecosystem scales

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I propose to evaluate how predicted changes in California's rainy season will affect grassland biodiversity. My research, underway now for seven years, manipulates rainfall levels over large swaths of grassland in a protected Mendocino County reserve and examines effects throughout above- and belowground communities. Rainfall is adjusted to match the predictions of leading climate models, and the scale and timeframe of the experiment allow for the study of impacts on individual species, food webs through which they interact, and the ecosystem as a whole.

Background: Increases in global temperature will alter patterns of regional precipitation throughout the world. In areas with Mediterranean climate regimes, impacts of climate change could be strongly driven by the redistribution of water in space and time. Forecasting these impacts is one of the greatest challenges facing ecologists today. Predictive efforts so far have been based primarily on individual species' tolerances to changing temperature and moisture regimes. Yet with Earth's species embedded in complex webs of interactions, the fate of any single species in a changing climate could depend on untold numbers of others. This a major source of uncertainty in our interpretation and prediction of climate change impacts, and to address it we must understand the balance between an organism's response to climate and its response to climate-driven changes in its resources, competitors, consumers, and pathogens.

Proposed BICCCA project: This is the focus of my work in California grasslands. I investigate impacts of changing precipitation regimes on grassland species with respect to their positions in food webs, nutrient cycles, and competitive hierarchies. This approach places climate change impacts on biological diversity within a framework reflective of how nature actually operates: species interacting with each other and with their chemical and physical environment.

I have undertaken this by simulating climate change at the scale of ecological communities and measuring effects on component species *and* the interactions among them. I have a seven-year record of responses spanning several levels of biological organization—from individual physiology to landscape biodiversity—and have recently expanded the research to consider effects on soil microbial communities and carbon and nitrogen cycles. Support from PIEREA will enable a synthesis of these many components into a cohesive understanding of climate change impacts across the entire grassland ecosystem. This will allow critical questions of grassland management and protection, questions over the fate of important species and functions, to be addressed in a manner that yields reliable predictive understanding.

In addition to broad-scale impacts on biodiversity, the proposed study will examine certain species in great detail. For plants and animals of particular conservation or management concern, I will gauge how well physiological responses to climate predict population-level changes over time. Put another way, how much ecological context around a species we need to anticipate climate change impacts on it? I will determine how far outward into the surrounding ecosystem we must zoom to forecast climate change impacts on native bunchgrasses, once abundant in grasslands throughout the state but now lost from all but a fraction of that range**;** on exotic annual grasses, which in displacing native species have degraded grassland habitats for wildlife and livestock**;** and on grasshoppers prone to destructive population outbreaks. Answers to these questions will help policy makers, land managers, and scientists direct limited resources toward greatest effect in contending with the myriad challenges presented by a changing climate.