

***Research Summary: A Comparison of Carbon Cycling and the Surface Energy Balance between Native Perennial and Exotic Annual Grass Communities in Northern Coastal California***

Grassland ecosystems of California's Coastal and Central Valley regions have undergone dramatic changes, with the almost complete replacement of native perennial grasses by exotic annuals. My research investigates the effects of this species shift on the cycling of carbon, water and energy in grassland ecosystems at two sites in northern coastal California. The broader goal is to understand how shifts in plant community composition can affect global climate change through 1. shifting the balance of carbon storage between terrestrial stocks (soil and vegetation) and the atmosphere, and 2. altering the water and energy regimes that heat or cool the earth's surface.

In essence, my research is a comparison of the ecosystem properties and processes that govern the exchange of carbon, water and energy in California grasslands before and after the invasion of exotic annual grasses. To perform these comparisons, I make use of coastal research sites where native vegetation is found growing alongside locations that have undergone exotic invasion. In research plots of each vegetation type, I measure carbon inputs (plant material) and outputs (respiration by soil microbes of CO<sub>2</sub>) to and from the soil, to elucidate the processes of plant growth and decay that lead to differences in ecosystem carbon storage. At one of the sites, I use an array of micro-meteorological sensors to consider the effects of a shift in grass dominance on surface reflectivity, (albedo), and on the partitioning of solar energy into evaporation (latent heat flux), and heating of the ground surface, (sensible heat flux). Differences in vegetation architecture, rooting depth and seasonality among plant communities may favor energy exchange in the form of latent or sensible heat flux. A higher ratio of latent to sensible heat flux produces a relatively cooler local environment because energy that is consumed in driving evaporation is unavailable to heat the surface. Albedo dictates the amount of radiation that is absorbed at the earth's surface and which is available to impart heat.

Although seemingly subtle, the shift in California grasslands from dominance by native to exotic grass communities may have profound implications for carbon, water and energy exchange, mainly because it involves a change in life form from perennial to annual grasses. Because the natives are perennial and the exotics annual, these two grass types have followed markedly different evolutionary pathways and therefore differ both in form and in the strategies they employ to survive California's summer drought. In this case, the same differentiation in plant attributes between annual and perennial grasses that allows drought survival also affects the regulation of carbon, water and energy. My preliminary results indicate that soil carbon storage is greater in regions dominated by native perennial grass communities. At the site near Bolinas, CA, I found that exotic grass invasion has resulted in a transfer of 50 metric tons of carbon per hectare from the soil to the atmosphere. Over the years 2004–2006, I found energy partitioning into latent and sensible heat fluxes similar among annual and perennial grasses during the portions of the year when water is in abundant supply. When water becomes scarce in the late Spring, however, annual grasses die, but the deep-rooted native perennial grasses persist by exploiting deep soil water reserves. Because native perennials remain active, they devote more energy towards latent heat flux and less towards sensible heat flux relative to exotic annuals. During the dry summer months, this difference in energy partitioning can lead to temperatures of up to 4 °C higher in exotic annual communities. Lower albedo, and thus higher energy capture in exotic annuals during the summer months, can raise temperatures an additional 6 °C relative to native perennials. In sum, my study reveals the invasion of exotic annual grasses has contributed to both global and local warming in California grasslands.