



California rangeland status, structure and functioning

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California rangelands cover over half of the area of the state, and include diverse ecosystem types (grassland, hardwood woodland, shrub, conifer woodland, wetland, and desert shrub and woodland). These systems provide open space and wildlife habitat, and have large effects on surface water quality, particularly given that 2/3 of California's major reservoirs are located on rangeland. At coarse regional scales, precipitation and temperature are the main determinants of the distribution of habitat types. Grasslands and oak woodlands support most of the state's livestock production, and are largely privately owned.

These systems can exist in a variety of stable states, ranging from sparse to dense woody vegetation (shrubs and hardwood trees), and the herbaceous type dominated by native grasses and forbs, naturalized annual exotics, or a new wave of noxious exotic weeds (e.g. goatgrass, medusahead, yellow starthistle). These vegetation states differ substantially in: water provisioning, erosion control, productivity, soil carbon sequestration, and many other services. The seasonality of climate conditions (as well as annual fluctuations in precipitation) has a large impact on these states and transitions, as does: soil, grazing regime, native herbivores (e.g. grasshoppers, elk), fire regime, native granivores (e.g. voles, mice, ants), soil disturbance by animals (e.g. gophers, pigs, earthworms), pathogens, and competition between plant types. All of these factors have been implicated as potential drivers of the widespread conversion of native herbaceous species to domination of non-native annual grasses in the 1800's (the native species these invasions displaced is a topic of considerable debate).

While these now-dominant exotic annual grasses are early successional species in their native ranges, in California, they represent the predominant stable vegetation state. This annual growth habit, coupled with high inter-annual variability in precipitation, provides challenges in predicting and managing productivity and vegetation composition in these grasslands. Other rangeland types in the US and across the world often consider an annual-dominated state as an indicator of degraded, disturbed conditions. This framework does not hold in California's highly productive annual systems, which are stable in the annual state. New frameworks, based on controlling factors within the annual type are needed to assess rangeland condition and guide range management in these systems. Consideration of key processes in annual-dominated systems, such as high seed production and subsequent seedling thinning, is key to improving our understanding and predictions of variability in nutrient supply and plant production seasonally, annually, and across sites. In addition, annual and perennial grasses differ in their phenology, plant-soil interactions, and physiological response to grazing. These differences may be generating plant-soil feedbacks that help to maintain the grasslands in their invaded annual state.

More recently, grasslands have been experiencing another wave of invasion by noxious exotic rangeland weeds, such as yellow starthistle, medusahead, and barbed goatgrass. This new wave of invaders is of concern for both ranchers and conservation managers, since they can form mono-typic stands and decrease livestock productivity 50-75%. These species have a later-season phenology than the naturalized annual grasses, and their invasion may be partly

associated with a trend towards later-season rains. Livestock grazing is increasingly being used as a tool to try to manage these noxious weeds, including in conservation areas.

Climate change is likely to have significant impacts on the structure and function of California's rangelands. Particularly in northern California's Central Valley and coast, mean annual precipitation is likely to decrease. Of particular concern is the projected 1.5-2.5 fold increase in drought frequency. California's rangelands are also being increasingly impacted by nitrogen deposition, which is leading to increased prevalence of invasive species and decreases in native diversity, particularly in previously nutrient-poor sites. The biggest threat to California's rangeland ecosystems is likely to be land use change, as the open spaces of ranches is replaced by suburban/urban development and other agricultural uses (e.g. vineyards).

About Valerie Eviner

Valerie Eviner is an associated professor of Restoration and Ecosystem Management in the Department of Plant Sciences at University of California, Davis. She received her PhD from the University of California, Berkeley, and her BA from Rutgers University, New Brunswick. Her work focuses on using a mechanistic understanding of plant-soil interactions to increase our understanding and effective management of: ecosystem services, plant invasions, restoration, biogeochemical cycling, global change, and grazing systems.

In addition to research activities, Eviner collaborates closely with the land management community in California, co-convening workshops that link research and management in CA grassland restoration, and serving on the board of directors of the California Invasive Plant Council. She is on the editorial boards of Restoration Ecology and Rangeland Ecology and Management.