Case Study

Applying Ecological Site Concepts to Adaptive Conservation Management on an Iconic Californian Landscape

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On the Ground

- Managers of large landscapes with limited financial resources can use ecological sites and state-and-transition models to identify landscape divisions with the highest chances of responding favorably to management activities.
- This conceptual framework can help determine the optimal configuration of pastures and water developments so that conservation-focused grazing and response monitoring align with focal landscape divisions.
- As communication tools, these models can help conservation land managers and graziers to better understand how the variation in landscapes affects the distribution of conservation targets and the specific locations where management can be tailored to enhance biodiversity.

Keywords: ecological sites, state-and-transition models, conservation management planning, adaptive management, non-equilibrium.

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Tejon Ranch is a spectacular landscape valued for its cultural heritage, livestock production, and biological diversity. At 109,000 ha, it is the largest contiguous, privately owned property in California. Its varied terrain and types of rock demonstrate its complex geologic history, and this geophysical composition is ultimately responsible for many of the biological patterns seen in the grasslands, shrublands, savannas, and wetlands of the ranch today.

Tejon lies at the convergence of three of California's major biogeographic zones (Fig. 1). The Tehachapi Mountains, part of the Montane biogeographic zone, trend diagonally on the property. The Garlock Fault runs through the spine of the range. North of the fault at the base of the mountains lies the San Joaquin Valley in the Mediterranean biogeographic zone. The southern face of the Tehachapis gives way to the Antelope Valley, the westernmost wedge of the Mojave Desert. Overall, the climate of this ecotone is Mediterranean, with cool, wet winters, and warm, dry summers. The air temperature, on average, is 25°C in August and 9°C in January. Rainfall varies greatly among years, with an overall long-term average of 22 cm (Fig. 2).

Under the 2008 Tejon Ranch Conservation and Land Use Agreement, the Tejon Ranch Company (landowner) retained the right to conduct commercial ranching and other commercial uses within 97,000 ha of conserved lands, while the Tejon Ranch Conservancy established specific conservation objectives and grazing management tactics that govern livestock management on those lands. Ranch-wide management plans that determine the landowner's reserved land use rights are to be revised every 5 years. In June 2013, with the adoption of its first ranch-wide plan, the Conservancy became one of the first non-governmental organizations in California with a full-fledged adaptive management plan for grasslands. The Tejon Ranch Conservancy and University of California partnered to make testable predictions about the effects of management on the 44,000 ha of grasslands on the ranch.

Important Concepts Defining Ecological Site Groups and Vegetation Dynamics

California's Mediterranean climate, along with its active geology, creates regional islands of native species diversity. However, these regional islands are also susceptible to invasions by plants and animals from other Mediterranean areas of the

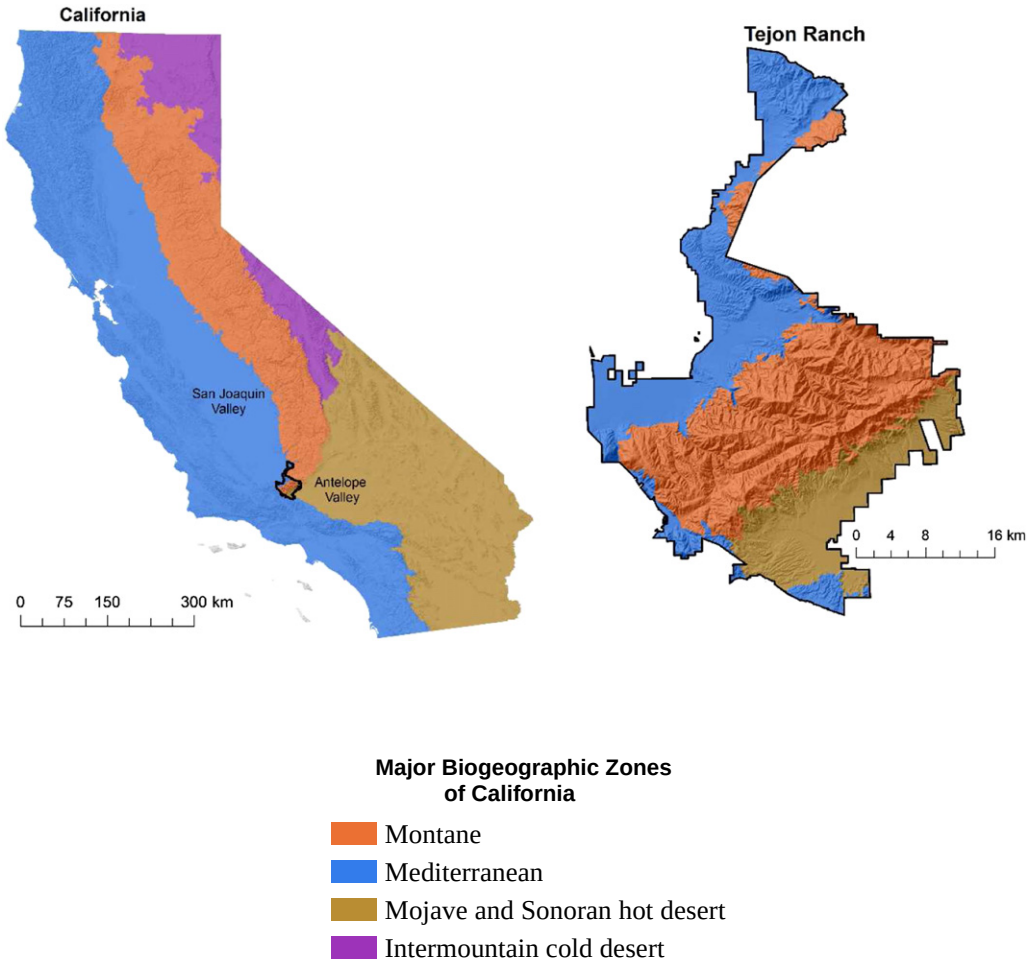

Figure 1. Three of California's four major biogeographic zones converge on Tejon Ranch.[6,18]

world.[1] Recently, anthropogenic nitrogen deposition has increased soil nitrogen, creating more hospitable conditions for exotics.[2]

In Californian annual grasslands, as in other rangeland types worldwide, soils and vegetation vary together across short distances,[3] and rainfall fluctuates greatly over time. Because annual plant production and species composition vary closely with these abiotic factors,[4] annual grasslands behave as persistent nonequilibrium systems, in which abiotic factors govern plant community dynamics more than biotic processes such as grazing do.[5] As a result, management is more likely to be successful if it is tailored within the constraints of abiotic factors such as rainfall events, fire, and particular soils.[6] Accordingly, cataloguing the variation in rainfall and underlying geo-topo-edaphic heterogeneity is critical for understanding the system and making predictions about the influences of management. Ecological sites and state-and-transition models (STMs) are conceptual tools ideally suited to the task.

Generalized State and Transition Models

When we began work in 2008, no official Ecological Site Descriptions had been developed for Tejon Ranch. Therefore, we developed a novel approach guided by the NRCS ecological site philosophy[7,8] but adapted to the immediate needs of the Tejon Ranch Management Plan. Through extensive reconnaissance of the landscape, use of local knowledge, and review of available geologic research and soil surveys, we conceptualized the Tejon grassland landscape as an assemblage of geologic landform classes.[9] We defined a "geologic landform" as a unit of land with a distinct combination of biogeographic region, elevation, slope, geologic material and age, and dominant formative geomorphic process. We hypothesized that each geologic landform class would support a distinct set of soils and vegetation dynamics (historical states, contemporary states and community phases, and probable responses to management) and therefore would form the basis for a distinct ecological site. We tested this hypothesis by establishing 57 permanent, 0.3-ha plots randomly sited in grasslands within strata defined by the geologic landform classes.

First, we assayed the plots' surface chemical and textural soil properties and estimated historical conditions using soil phytoliths[10] and historical accounts.[11] We then resampled the plots for several years on an annual basis during peak live