Oak reforestation on California rangelands: A review of opportunities and challenges

Amber Kerr, UC Berkeley <akerr@berkeley.edu>

North American Agroforestry Conference, June 28 - July 2, 2021 (online)

Introduction

Rangeland is California's dominant land use type, accounting for about 50% of the state's land area (Figure 1). The most productive and important rangeland vegetation types in California are **annual grassland** (<10% canopy cover) and **oak woodland** (>10% canopy cover); the large majority of this area is **privately owned**. Grasslands, shrublands, and oak woodlands naturally occur in a mosaic in California (Tyler et al., 2007), depending on subtle differences in soil, topography, grazing pressure, fire frequency, and other factors.

Starting with the 1849 Gold Rush, **intentional oak clearing became widespread** (Mensing, 2015). Throughout the Central Valley, Sierra Foothills and Coast Ranges, oaks were felled for firewood, timber, and to open up land for agriculture and grazing. Data are insufficient to estimate this loss quantitatively, but vast tracts of **oak woodland became grassland**, and grassland with scattered trees (savanna) lost its trees entirely.

Recognition of oaks' value

Starting in the late 1990s and early 2000s, range managers' **attitudes toward oaks became more favorable**. The effect of scattered oaks on rangeland forage can be slightly positive or slightly negative, but their beneficial effects in providing shade for cattle (Figure 2), wildlife habitat, erosion control, and aesthetic beauty are widely recognized by ranchers. Intentional felling of oaks is now uncommon, and up to one-third of range managers of with oak woodlands on their property report intentionally planting oaks (Huntsinger et al., 2010).

However, such efforts are still at a small scale, and **natural regeneration of oaks is almost negligible** – possibly due to competition from invasive annual grasses, though much debate remains (Tyler et al., 2007). These "missing oaks" represent a potential opportunity for habitat restoration, range improvement, and carbon sequestration, but the challenges are considerable.

Challenges to oak establishment

Oaks are **extremely long-lived trees**; average age of a stand may be 150 years or more, and individual ages of 300 to 400 years are common (Garrison et al., 2002). Thus, oak stands can persist with **extremely low and uneven recruitment**. Under natural conditions, recruitment is limited by browsing; seed predation; fires; understory competition; and drought. Only in optimal conditions (a "mast" year with abundant acorns; efficient burying by jays; excellent rainfall) will many acorns germinate and survive their first year.

Oak reforestation projects, therefore, must **improve upon natural conditions** to have any chance of success. At a minimum, the following are required: (1) **Deep planting and good soil preparation** for acorns or seedlings. (2) **Protection from browsing** by deer and cattle until trees are above browse height. (3) **Mulching or herbicide to prevent weeds** for the first few years. (Watering has shown mixed results, and fertilizer is unhelpful.) Lack of resources to follow these guidelines often results in total project failure (Figure 3).

Success is further enhanced by paying close attention to **landscape position** (Figure 4), as oaks naturally tend to grow in valleys, watercourses, and sheltered outcrops. **Local species and germplasm** should be used wherever possible, and **planting season** is essential: oaks should be planted early in the wet season (November – December). Late-planted oaks (February-March) rarely survive. Of special concern is the fact that historical oak cover is not well-documented, so it is not always possible to determine whether a project would truly be **reforestation** or whether it would be **afforestation**.

Carbon sequestration and role of carbon finance

Due to the high cost and infrastructure requirements of successful oak establishment, it is conceivable that **carbon finance could help accelerate** oak canopy cover increase on California rangelands. However, oak reforestation (or afforestation) projects entail special concerns due to the **highly variable conditions** on California rangelands and the **slow growth** of most oak species under field conditions. Carbon finance may be good for oaks, but **oaks may not always be the most attractive project** for carbon finance.

California oaks (e.g., *Quercus agrifolia*, coast live oak) are not commercial timber species. Accordingly, **little information is available about their allometry and biomass accumulation** over time. What little information exists highlights their slow growth (e.g., 0.7 inches diameter increase per decade; Garrison et al, 2002) and the problem that growth can greatly depend upon species, location, and conditions (Karlick and Chojnacky, 2014).

A high **priority for research** would be developing a **database** of allometric relationships and size-age relationships for California's **major oak species**, allowing quantitative estimates for potential carbon removal over time. Any such estimate must account for high mortality rate of oak seedlings even under the best possible conditions. Nevertheless, potential benefits for ecosystems and range managers make oak reforestation **worthy of attention at a larger scale**.

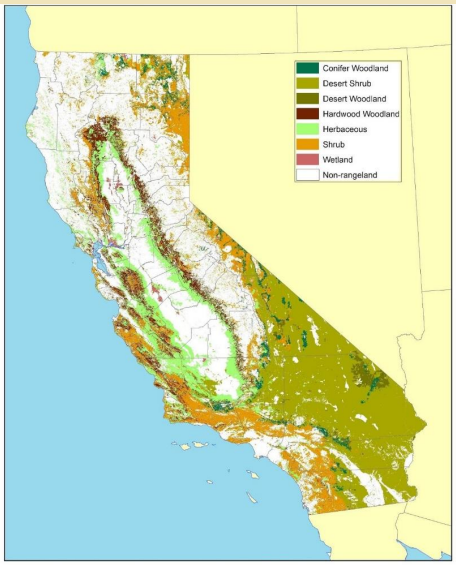

Figure 1. Rangeland vegetation types in California (Balachowski et al., 2017). The two most economically important types are annual grasslands (lime green) and oak woodlands (dark brown).

Figure 2. Black Angus cattle rest in the shade of mature blue oaks (*Quercus douglasii*) on a hot afternoon at Del Valle Regional Park, Livermore, CA (10/20/2020). Photo by A. Kerr.

Figure 3. Failed blue oak restoration at Del Valle Regional Park, Livermore, CA. (L) A seedling is dying after browsing, drought, and competition from weeds. (R) Empty tree tubes indicate that seedlings never grew, likely due to lack of water. (10/18/2020). Photo by A. Kerr.

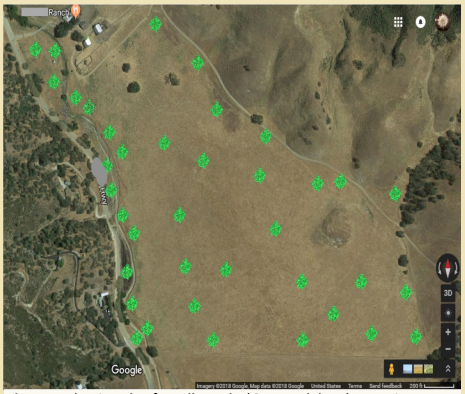

Figure 4. Planting plan for valley oaks (*Quercus lobata*) at a private ranch in central California. Courtesy of Sheila Barry.

References

Balachowski, J., P. Alvarez, A. Kerr, J. Reyes, A. Xides, H. Choe, C. Peters, J. Brown, and L. Roche. (2017). *Climate Vulnerability Assessment of California Rangelands*. U.S. Department of Agriculture: 71 pp.

Garrison, Barrett A.; Otahal, Christopher D.; Triggs, Matthew L. (2002). "Age structure and growth of California black oak (Quercus kelloggii) in the central Sierra Nevada, California." In: Standiford, Richard B., ed. *Proceedings of the Fifth Symposium on Oak Woodlands: Oaks in California's Challenging Landscape*. Gen. Tech. Rep. PSW-GTR-184.

Huntsinger, Lynn; Martin Johnson, Monica Stafford, Jeremy Fried (2010). "Hardwood Rangeland Landowners in California from 1985 to 2004: Production, Ecosystem Services, and Permanence." *Rangeland Ecology and Management* 63(3), 324-334.

Karlik, John F., and David C. Chojnacky (2014). "Biomass and carbon data from blue oaks in a California oak savanna." *Biomass and Bioenergy* Volume 62, March 2014, Pages 228-232.

Mensing, Scott. 2015. "The paleohistory of California oaks." In: Standiford, Richard B.; Purcell, Kathryn L., eds. *Proceedings of the seventh California oak symposium: managing oak woodlands in a dynamic world*. Gen. Tech. Rep. PSW-GTR-251.

Tyler, Claudia M.; Dennis C. Odion, and Ragan M. Callaway (2007). "Dynamics of woody species in the California Grassland." Ch. 14 in *California Grasslands: Ecology and Management*. Berkeley, CA: University of California Press.