

The Effect of Land Use Changes on Blue Oak Regeneration and Recruitment¹

Scott Mensing²

Abstract: Lack of blue oak (*Quercus douglasii*) saplings and seedlings throughout much of its range has prompted research into the regeneration status of the species. Our ability to assess whether the current lack of regeneration is a natural pattern or a response to human induced environmental change is limited by lack of data on the history of blue oak establishment. This study presents data on blue oak age stand structure collected from three sites on the Tejon Ranch, in the Tehachapi Mountains. Over half of the trees aged became established during the 1850s, whereas almost no new trees have come in during the last 120 years. The evidence suggests that blue oak regeneration and recruitment has been strongly influenced by changes in fire frequency and human land use.

Blue oak (*Quercus douglasii*) appears insufficient at the present time to replace many existing stands (Muick and Bartolome 1987, Bolsinger 1988). It is unclear whether the present pattern represents a natural cycle, or is a response to environmental change associated with European settlement. Evidence based on age structure studies has identified a period of successful regeneration during the latter half of the 19th century (White 1966, Vankat and Major 1978, McClaran 1986). This paper reports age structure data from three sites on the Tejon ranch, in the Tehachapi Mountains.

Tejon Ranch has been held as a single property since the 1860s, and includes some of the largest undisturbed oak woodlands in the state. Cross-sections were cut from stumps, following a wood-cutting operation. Stumps were cut at or below ground level in order to obtain the oldest possible age (McClaran 1986, Frank Davis pers. comm. 1988). Tree ring analysis of 279 cross-sections showed that 56 percent of all trees sampled became established in 1856 (fig. 1). Prior to 1856, recruitment was relatively continuous, with several new trees becoming established every decade. A noticeable lack of regeneration was found after 1864, with only 3 percent of all trees becoming established since this date. Analysis of fire scars found an increase in numbers of scars in the 1850s and 1860s (fig. 2). Following 1864, there is a distinct decrease in fire scars for a 70 year period.

DISCUSSION

The results seem to indicate three distinct patterns of regeneration and recruitment which coincide with different periods of local land use. The earliest period (pre-1842) predates European settlement and reflects regeneration under aboriginal land use. Regeneration was low, but relatively continuous. Given the inevitable gaps in the record from mortality and heart rot, there appears to have been no regeneration and recruitment problem during the Indian period.

The period between 1843-1865 was one of active European settlement. During this time, new tree establishment was unusually successful. Fires were particularly frequent, and the evidence suggests that the regeneration peak in 1856 is primarily the result of regeneration by sprouting of previously established seedlings and saplings, which had been top-killed by frequent fires. McClaran and Bartolome (1989) have hypothesized that fire temporally concentrates post-fire sprouts. Figure 2 illustrates an increase in fire activity during the 1850s. Almost half of the trees from the 1856 cohort have more than one stem, an indication that they probably originated from sprouts. The strong regeneration peak associated with high fire frequency appears to support McClaran and Bartolome's hypothesis.

Following successful regeneration, browsing may suppress sapling growth and limit recruitment. During the occupation period of Fort Tejon (1854-64), soldiers regularly held hunting parties (Giffen 1942, Crowe 1957). Hunting likely reduced the local deer population thereby reducing browsing pressure. Trees established within one year of a fire have been shown to grow almost twice as fast as other trees (McClaran 1986). Rapid vertical growth of sprouts during a period of reduced browsing may have contributed to tree survival by quickly raising the apical meristem above the browse-line (135 cm).

In 1866, the ranch was consolidated into a single property and commercial livestock grazing was introduced. Fire frequency declined markedly. Relative absence of fire for a 70 year period contributed to survival of the 1856 cohort, and resulted in a dense, even aged stand. Since 1866, there has been a virtual absence of regeneration and recruitment. Lack of new tree establishment may result from intraspecific competition due to an increase in woodland density and canopy cover, an increase in livestock and deer browsing, changes in fire frequency, or competition for soil moisture between seedlings and introduced annual grasses (Gordon and others 1990).

¹ Presented at the Symposium on Oak Woodlands and Hardwood Rangeland Management, October 31-November 2, Davis, Calif.

² Graduate Student, Department of Geography, University of California, Berkeley.

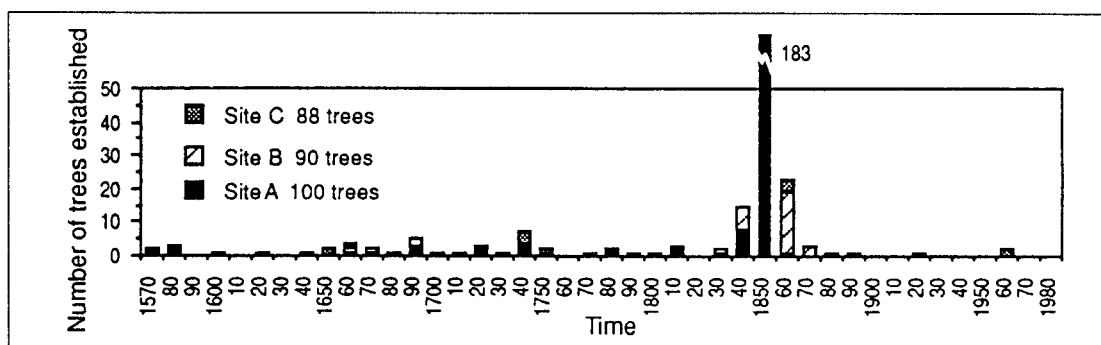


Figure 1—Number of blue oaks established per decade by site on Tejon Ranch, Kern County, California. Of the 183 trees established in the 1850's, 156 date to 1856, including 61 from site "A", 44 from site "B", and 51 from site "C".

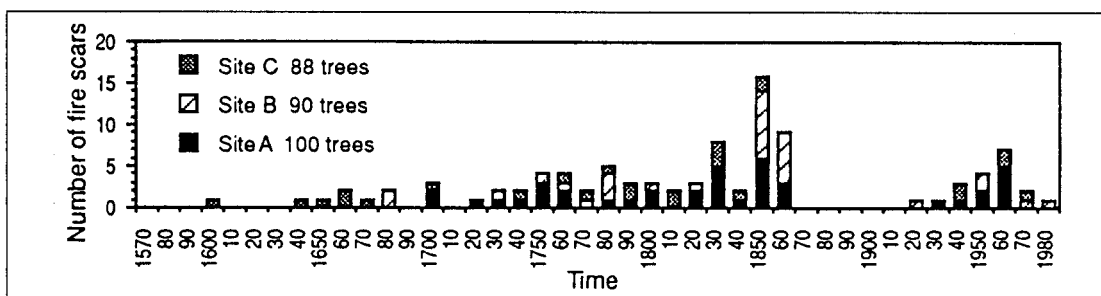


Figure 2—Number of fire scars on blue oaks, per decade, by site on the Tejon Ranch, Kern County, California.

CONCLUSION

During Indian occupation of the area, the woodland appears to have been less dense, with a slow but steady process of replacement, adequate to maintain the woodland. Changes in fire frequency and browsing patterns, associated with European settlement in the mid 19th century, resulted in unusually high rates of regeneration and recruitment. Since the 1860s, the combination of an increase in density, reduction of fire frequency, and the introduction of livestock grazing have resulted in virtually complete suppression of regeneration. Regeneration under the present conditions may require a significant change, such as a large crown fire, changes in grazing practices, or a combination of these and other events. Since these events are largely controlled or influenced by people, future regeneration of blue oaks in these woodlands will be increasingly dependent on land use management decisions.

ACKNOWLEDGMENTS

I thank Don Geivet and the people at Tejon Ranch for permission to conduct research on the Tejon property, and Roger Byrne, Joe McBride, and Theodore Oberlander for constructive comments during the research and writing phases of this project.

REFERENCES

- Bolsinger, Charles L. 1988. The hardwoods of California's timberlands, woodlands and savannas. Resource Bulletin, PNW-RB-148. Portland OR: U.S.D.A., Forest Service, Pacific Northwest Res. Sta. 148p.
- Crowe, Earle 1957. Men of El Tejon. Los Angeles, CA: The Ward Ritchie Press, 165p.
- Giffen, Helen S. 1942. The story of El Tejon. Los Angeles, CA: Dawsons Book Shop.

- Gordon, D.R.; Welker, J.R.; Menke, J.W.; Rice, K.J. 1989. Competition for soil water between annual plants and blue oak (*Quercus douglasii*) seedlings. *Oecologia* 79:533-541.
- McClaran, M. P. 1986. Age Structure of *Quercus douglasii* in relation to livestock grazing and fire. Berkeley: University of California; 119p. Dissertation.
- McClaran, M. P.; Bartolome, J. W. 1989. Fire-related recruitment in stagnant *Quercus douglasii* populations. *Canadian Journal of Forestry*. 19:580-585.
- Muick, Pamela C.; Bartolome, James W. 1987. An assessment of natural regeneration of oaks in California. Final Report. Calif. Dept. For.: Forest and Rangeland Resource Assessment Program.
- Vankat, John L.; Major, Jack L. 1978. Vegetation changes in Sequoia National Park, California. *Journal of Biogeography* 5(4):377-402.
- White, Keith L. 1966. Structure and composition of foothill woodland in central coastal California. *Ecology* 47(2):229-237.