CALIFORNIA FIRE SCIENCE CONSORTIUM

JOINT FIRE SCIENCE PROGRAM

Research Brief for Resource Managers

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Influence of conifer encroachment & fire on CA black oak

Cocking, M.I., Varner, J.M., and R.L. Sherriff. 2012. California black oak responses to fire severity and native conifer encroachment in the Klamath Mountains. Forest Ecology and Management, 270: 25-34. https://www.humboldt.edu/geography/documents/Cocking.et.al._For.Ecol.Manag._2012.pdf

California's oak ecosystems are generally fire-prone, relying on frequent, low- to moderate-intensity fire to maintain their open structure and limit competition from fire-sensitive vegetation. Tree and shrub encroachment is common in areas where fire has been excluded, and has become a focal point of many oak management and restoration programs.

However, in spite of a general understanding of the issue and its direct deleterious effects on oak woodlands and savannas, little is known about the long-term or secondary influences of conifer encroachment on oak health and survival. This study explored canopy competition, age structures, and post-wildfire survival in a recently burned, heavily encroached California black oak (*Quercus kelloggii*) woodland, providing critical new insight for the management and restoration of these important ecosystems.

Site description

This study took place near Somes Bar, in the Klamath Mountains of northern California. The climate of the region is Mediterranean, with hot, dry summers and cool, wet winters. Due to frequent natural and cultural ignitions, the low-elevation forests of the study area had a historical fire return interval of 5 to 22 years; however, fire was excluded from the study area throughout the 20th century, and when the area burned in 2008, it was the first time in more than 100 years.

Management Implications

- Conifer encroachment is common in areas that have experienced long fire-free periods. In those areas, conifers and oaks may be similar in size, but oaks are likely much older.
- Competitive pressure from encroaching trees may compromise the ability of CA black oak to survive fire.
- Low-intensity fire in encroached stands may favor larger, fire-resistant conifers and leave oaks vulnerable to overtopping. Thus, high-severity fire may be critical to the persistence of CA black oak.

Methods

Plots were installed in an area that burned in the 2008 Siskiyou Complex, a group of lightning-ignited wildfires. The study area had elevations ranging from 2000 ft. to 2500 ft., and was selected for its variable fire severity and accessibility, and the presence of black oak. Data collection and sampling took place 23 months post-wildfire.

Plots were centered on individual overstory California black oak trees, and data were collected on all trees within a 10-m radius. In each plot, basic plot data (slope, aspect) were recorded, as well as specifics on each tree (dbh, height, live or dead, etc.). Of particular interest were the canopy positions of all trees in relation to black oak crowns, and tree ages, which were determined with tree cores using standard tree-age sampling techniques. Fire effects data were also recorded, including maximum bole char height and whether or not trees were top-killed or completely killed by the wildfire.

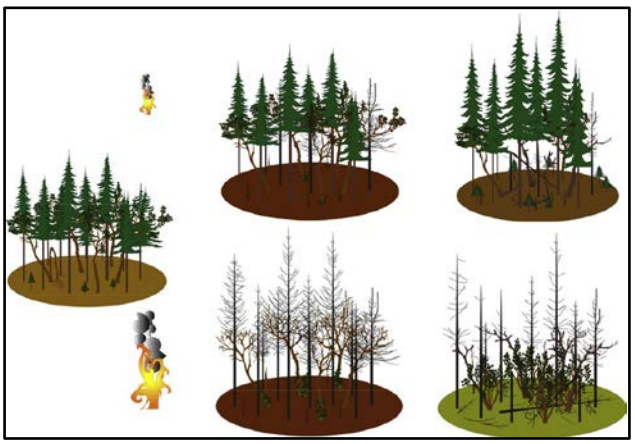
Results

Focal black oaks were often surrounded by Douglas-fir (*Pseudotsuga menziesii*), the most common tree species in all of the plots. The few ponderosa pines (*Pinus ponderosa*) in the plots were significantly larger and taller than other tree species, but there were no significant differences in dbh or height between black oak and Doug-fir. Doug-fir comprised 80% of the emergent trees in the plots, and they made up 92% of trees that were overtopping or piercing black oaks.

Ring counts showed that black oaks were significantly older (ave. 44 years) than the Doug-firs that were piercing their crowns. Piercing trees ranged from 35-104 years old (ave. 67), and pierced oaks ranged from 48-210 years old (ave. 110).

Fire effects were highly variable in the study area, with maximum char heights ranging from 0-33.2 meters and above-ground stem mortality ranging from 0-100%. For black oak, above-ground stem mortality was 71%, but complete mortality (no post-fire resprouting) was only 13%. Of all the species in the plots, black oak suffered the greatest reduction in basal area from the wildfire, whereas Doug-fir suffered the least.

The probability of complete mortality of California black oak increased as the height of Doug-fir increased and as the heat load index decreased. Probability of above-ground mortality of oaks was similar to that of small-diameter Doug-fir; however, larger Doug-fir had much lower mortality rates.



Conceptual diagram of divergent pathways for high-severity (bottom) and low-severity (top) fire in conifer-encroached CA black oak woodlands.

Discussion

Doug-fir invasion has been documented in many oak woodland areas in northern California, and it is especially pronounced in areas where fire has been excluded for extended periods of time. Before it burned in 2008, this study area had not experienced fire in over 100 years; the area's thick Doug-fir understory is testament to this gap in the area's fire history, as are the disparate age structures of California black oak and the relatively young, competing conifers that have filled in low-elevation oak woodlands.

Black oaks in the study site were significantly older than Doug-fir; however, the rapid growth rates and shade tolerance of the conifers have allowed them to pierce and overtop the oaks. This is likely the cause of crown dieback seen on many of the overtopped oaks at the study site, indicating that competition from Doug-fir may reduce vigor in individual black oak trees. This decline in oak health may explain why the probability of complete oak mortality is related more to the height of neighboring Doug-fir trees than to fire intensity. This pattern has been documented for other tree species, and it presents a host of management concerns and challenges.

Conclusion

When we think about oak woodlands and fire in northern California, we often envision a low-severity fire regime, where frequent, low-intensity fires maintain continuous, grass/forb-dominated fuelbeds and open woodlands. Historically, this type of fire regime did predominate in many oak woodlands, including California black oak. However, long fire-free periods and consequent conifer encroachment have affected the role of fire in these ecosystems, and the low-severity fire regimes that once maintained black oak woodlands now favor Doug-fir in the areas where it has become established. Thus, though low-intensity fire is a critical tool in warding off encroachment when encroaching trees are still small, it may prove ineffective once invading conifers have grown larger and more fire resilient. Unless encroaching trees are removed by thinning, high-severity fire—which can top-kill both species but only stimulates a sprouting response in black oak—may be the primary fire-based path toward restoration of black oak dominance in heavily encroached stands.