

ECOLOGY AND
REGENERATION

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Progress on the Ecology and Silviculture of California Oaks During the Past 17 Years¹

Timothy R. Plumb²

Basic knowledge about the ecological processes and silvicultural requirements of California oaks is essential for their effective management and perpetuation. Interest in ecology and all other aspects of oaks has grown dramatically since the 1979 Oak Symposium (Plumb 1980). But, why has it been so difficult to determine the array of critical factors that control oak population dynamics, establishment, survival, and development into healthy, mature trees? What insight do the papers in this Symposium present? Probably one of the most extensive efforts to date to document ecological variables affecting oak recruitment was presented on blue oak saplings. Although a number of environmental factors that affect blue oak (*Quercus douglasii* Hook. & Arn.) were identified, the bottom line is that sapling recruitment is a long time process affected by a number of interacting variables. Current blue oak basal area and relative tree crown size were reported to be significantly linked to stand dynamics.

To complicate matters even more, we must realize that we are dealing with a diverse group of species; at least nine oak species normally grow to tree size, each with its own set of ecological requirements. Further complicating oak ecology is the propensity for subgenera hybridization. One Symposium paper deals with hybridization among coast live oak (*Q. agrifolia* Née), interior live oak (*Q. wislizenii* A. DC.), and *Q. parvula*. Two other papers deal with interspecific variation, indicating local adaptation between and within local blue oak populations, but there is not yet enough evidence to demonstrate a geographic pattern in either latitude or altitude.

An extremely important feature of oaks trees is their canopies; these have a major impact on the local environment. They affect nutrient cycling, seedling establishment and survival, understory species, forage production and growth, organic matter (on and in the soil), and possibly soil texture. Reports of preliminary work indicate that soil texture under a mixed stand of blue and coast live oaks was coarser and higher in organic matter under coast live oak. Other work reported confirms past evidence that nutrient level under blue oak is several times greater than that of adjacent grassland. Part of the higher nutrient concentration is undoubtedly due to litter and possibly leaching of nutrients from the canopy. But, where lichens are present, new evidence shows that they enhance nutrient cycling fluxes and do not hinder tree growth.

Canopy density likewise affects understory species composition, productivity, and nutrient status. The last two factors are enhanced over grasslands when canopies are open and annual rainfall is less than 50 cm. To the contrary, production under dense canopies is reduced where rainfall is greater than 50 cm. Based on tree mortality and sapling recruitment, blue oak density and canopy cover is decreasing at most of the sites studied. However, in a mixed oak-pine area of the Sierra Nevada foothills, recent longer-than-natural fire-free intervals have resulted in increased oak density.

For oaks to capitalize on the under-canopy nutrients, they should have appropriate root size and distribution. Blue oak root mass was correlated with

¹Presented at the Symposium on Oak Woodlands: Ecology, Management, and Urban Interface Issues, March 19–22, 1996, San Luis Obispo, Calif.

²Professor, Natural Resources Management Department, California Polytechnic State University, San Luis Obispo, CA 93407

tree age, diameter at breast height (dbh), and bole weight. Only 8 percent of the roots were less than 5-10 mm in size, and they were found to be somewhat deeper than grass roots. Oak roots are sensitive to low soil oxygen concentration which is reduced by soil compaction and especially high water content.

In regard to recruitment, canopy shade is more important for coast live oak than for blue oak. Compared to coast live oak, fewer blue oaks were found to emerge, but a much higher percentage of them survive beyond 3 years. In fact, in the southern Sierra Nevada foothills, 10 percent of the blue oak "seedlings" at one site were more than 23 years old. However, the sapling-sized oaks in this area are few in number. On the average, only 15.3 percent of the plots throughout the range of blue oak had saplings present.

Before there can be seedlings or saplings, two basic requirements must be met. One, there must be an adequate seed source, enough to overwhelm herbivory; and two, there must be sustained suitable climatic conditions to promote germination and good root development. Acorn production this year, 1996, was extremely low throughout the state for the 1-year acorn species. Acorn crops of 2-year acorn species were large this year; it will be interesting to see how large their crop will be next year. Work reported at the Symposium indicates that acorn crops are synchronous over 500- to 1,000-km distances. As just noted, the state-wide low acorn crop for 1995-96 bears this out. The assumption is that large-scale weather patterns moderate tree growth and acorn production.

In contrast to the large proportion of oak research in the 1950's and 1960's that was involved in the control of hardwoods, most work since 1970 has been oriented toward promotion of oak recruitment in one way or another. However, total oak management requires the ability to selectively perpetuate or control oaks and other hardwoods. In regard to control, stump treatment of tan oak with undiluted amine of tryclopypyr was reported to be very effective. But, promoting oak recruitment and sustainability is still the major oak challenge today.

Reference

Plumb, Timothy R., technical coordinator. 1980. **Proceedings of the symposium on the ecology, management, and utilization of California oaks**; June 26-28, 1979; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 368 p.