Muick, P. C.; Bartolome, J. R. 1987a. An assessment of natural regeneration of oaks in California. Prepared for: Calif. Dept. of Forestry, Sacramento.

Target species: *Q. douglasii*

Other species: *Q. lobata, Q. agrifolia, Q. wislizeni, Q. kelloggii, Q. englemann, Q. chrysolepis, Q. garryana*

Life stages: all

Origin: natural

Situation: range

Locations: California

Overview: The goals of this report were to examine the status of regeneration for 8 tree oak species and to assess environmental and management factors associated with regeneration. Neither of these ambitious goals was realized. Data collected from an 84-plot subset of the USFS FIA plots provides some data on stand structure, but because mortality and opportunities for regeneration were not assessed, stand structure data does not directly address regeneration. Data collected on management factors, including grazing and fire, are inadequate for identifying relationships of these factors to sapling recruitment or regeneration. Relationships between other site factors (e.g. slope, aspect) and saplings were not analyzed in a valid way. The study does show that for *Q. douglasii*, small seedlings were most likely to be found under canopy whereas saplings were uncommon under canopy.

Methods: Two types of plots are involved in this study. The first type is a subset of the USFS Forest Inventory Assessment (FIA) plots. Although the original FIA plots are based on a stratified random sampling grid, the 84 plot subset was selected on the basis of access, data availability, and geographic region. The number of FIA plots with a given oak species ranged from 41 (or possibly 42; figure 6a and Table 3 do not agree) for *Q. douglasii* to 2 for *Q. engelmanii.* All species other than *Q. douglasii* are represented by 20 plots or less. Plot counts are reduced further in regional analyses, (e.g., between 2 and 20 for *Q. douglasii*), to the point that many sample sizes are too small to be meaningful.

A second group of 36 plots, ("regeneration plots"), was selected based on the presence of regeneration in the plot, particularly of *Q. lobata* and *Q. engelmanii*. Half of these plots were located in southern California. Characteristics of these plots are reported separately from the FIA plot. This biased set of plots does not provide any useful information on factors associated with seedling or sapling recruitment.

In the FIA plots, 3 to 5 circular subplots were sampled. Plot size also varied between .03 and 0.05 ha (.07 to .12 acres) at different locations, depending on tree density. Larger plots (and presumably also more subplots) were specifically used to ensure that additional trees, seedlings, and/or saplings would be included (p. 11); 10/84 FIA plots and 6/35 regeneration plots included the larger subplots. Consequently, reported tree, sapling, and seedling densities are biased upward, i.e., plot densities are inflated relative to the overall densities that existed in the sampled stands.

Mature and juvenile oaks were tallied by size class, using classes that roughly correspond to those used by Bolsinger (1988): trees = 10 cm or more DBH; saplings = basal diameter 1 cm or more and DBH <10 cm; seedlings = < 1 cm basal diameter. Seedlings were subdivided into 3 height classes: <10 cm, 10-30 cm, and >30 cm. Seedlings and saplings were also assigned to origin classes (seed or sprout) and their location relative to overstory canopy was noted.

There are two problems with the data on small seedlings (<30 cm). The assignment of these seedlings to seed or sprout classes is dubious at best, despite the authors' contention that this could be determined by feeling for the attachment point of the old cotyledons. At the time of the survey, the persistent nature of many oak seedlings was not widely recognized. The authors erroneously characterize seedlings as "ephemeral", which undoubtedly influenced the evaluation of resprouting status. Furthermore, because viable oak seedlings may defoliate and/or die back to ground level during mid to late summer, small seedlings would be located with different efficiencies at different times of the year. Field surveys were conducted June - November 1984 and July - December 1985, so substantial differences in seedling populations between plots could be due to the date that a plot was surveyed.

Overall tree, shrub, grass, litter, and bare ground estimates were recorded for each subplot. In addition, observations on grazing, signs of past fire, wood cutting, and wildlife use were noted. These plot history observations are of minimal value, due to the difficulty of assessing past management impacts based on a single observation. In particular, the current presence or absence of livestock provides almost no information on grazing impacts over time. Likewise, the presence or absence of fire evidence gives no information on the timing, frequency, or intensity of past fires, and as shown in various studies, light fires may not leave visible scars on mature oaks. Consequently, relationships (or the lack thereof) between the site variables and seedling or sapling densities are not meaningful.

Analyses for factors related to seedling and sapling presence are inefficient at best, and in some cases are clearly not valid. The use of t-tests to determine whether continuous explanatory variables differed between plots with and without saplings is not valid. It violates several underlying assumptions of the analysis and is subject to excessive bias from outlying observations. The authors used only univariate statistics to look at the effects of plot variables, and did not consider whether any of the explanatory variables might be correlated.

Findings/assertions

Effect of livestock grazing on oak sapling presence. Based on their data for *Q. douglasii*, the authors asserted that the nearly ubiquitous presence of livestock grazing on plots with and without saplings refutes "a prevailing belief that livestock grazing precludes oak regeneration". Their data do not support this assertion because the survey provides no information on the relationship between sapling recruitment and grazing. Given that the sapling size class included oaks up to 10 cm DBH, detected "saplings" could have been recruited at virtually any time during the 50 to 100 years prior to the survey. As noted above, the evaluation of grazing is limited to detectable presence of livestock at the time of the survey, which has no real relevance to the recruitment process that gave rise to the observed saplings.

Fire effects. This study also provides no information about the effects of fire on regeneration. The fire data is both unreliable and lacking in any time frame that could be meaningfully related to past recruitment. The authors make no assertions about fire effects on regeneration.

Regeneration. The authors infer the adequacy of regeneration by species and region based on the ratio of saplings (up to 10 cm DBH) to trees (>10 cm DBH) in the FIA plots. However, only three of the species x region ratios are based on 10 or more plots; most (20/29) of the ratios reported in Table 9 are based on 1 to 3 plots (one is apparently an error, based on no plot). Furthermore, the ratios between the broad sapling size class and the tree class do not account for past or future mortality or opportunities for recruitment within the plot. Finally, as noted above, the data are biased by the expansion of selected plots to include saplings. Hence, these widely cited data do not provide meaningful information about the status of oak regeneration. The authors conclusions on the inadequacy of regeneration in blue oak are well founded, and may be supported by field observations if not by the data presented.

Relation of canopy to regeneration. Probably the most meaningful results of the study are the data on the spatial distribution of seedlings and saplings relative to tree canopy. For all species, almost all seedlings were located under canopy or near the canopy edge. Compared with seedlings, saplings were more likely to be found in open positions. The tolerance of saplings for the understory varied by species, with *Q. douglasii* having generally intolerant saplings (16% of total under canopy) and Q. agrifolia having highly tolerant saplings (73% under canopy).

Sapling populations. Sapling population trends are somewhat obscured by the reporting of averages. For blue oak, the best represented species in the survey, a third of the FIA plots did not contain saplings, and another third of plots contained only 1 or 2 saplings (i.e. 66% of the plots contained trees up to 10 cm DBH). Sapling populations varied widely between sites; one plot contained 97 saplings. The inclusion of such outliers in the averages greatly biases overall reported averages. Only 30% of the saplings were less than 1.4 m tall, but there is no breakdown on the number of plots that contained these smaller (and presumably younger) saplings.

The percent of FIA plots with saplings was 39% (7/18) for *Q. kelloggii* and 23% (3/13) for *Q. garryana*. The other species are either inadequately represented and/or the incidence of plots with saplings is unclear (e.g., for *Q. wislizeni* saplings are reported on 17 plots, although only 13 plots are reported in Fig. 6b and 13). Due to the wide spread in tree ages represented in the sapling classes for the various oak species, the relevance of these sapling counts is unclear.

Related publications

Muick, P. C. and Bartolome, J. 1986. Oak regeneration on California's hardwood rangelands. In: Transactions, Western Section of the Wildlife Society 22:121-125.

This paper presents preliminary results of the data included in the report. Data on *Q. agrifolia* sapling distribution relative to canopy in this paper differ from that in Muick and Bartolome (1986).

Muick, P. C. and Bartolome, J. 1987b. Factors associated with white oak regeneration in California. In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. In: Proceedings of the symposium on multiple-use management of California's hardwood resources; November 12-14, 1986; San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; pp. 86-91.

This paper presents a condensed version of the information presented in (Muick and Bartolome 1986).