

Thinning Interior Live Oak in California's Southern Sierra Nevada¹

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Abstract

This study describes a thinning and resprout control study in Madera County. The study site was a dense, 40-year old interior live oak stand (*Quercus wislizeni*) that originated from resprouting, with 100 percent canopy cover. Tree thinning was initiated in 1998 in cooperation with the local Resource Conservation District to evaluate thinning treatment to reduce first risk and to increase forage production. Three thinning treatments were evaluated: (1) thin one-third of the standing tree basal area (resulting in a post-thin basal area of 46 square feet per acre); (2) thin two-thirds of the standing tree basal area (resulting in a post-thin basal area of 27 square feet per acre); and (3) control/no thin (basal area of 73 square feet per acre). Because interior live oak is such a prolific sprouter, half of the thinned plots were treated with herbicides to prevent resprouting and to retain the open canopy structure. Canopy cover, diameter and height growth, and acorn production were monitored over a 13-year period. Periodic annual increment for basal area and volume was not significantly affected by the thinning treatment. Individual tree DBH growth was significantly increased with the thinning. 13 years after the thinning, the 1/3 treatment had virtually identical volume to the control, although the 2/3 thinning treatment had significantly less volume per acre. The sprout control treatment had no significant effect on the overstory tree growth, although a more open understory was maintained by controlling resprouting. Individual tree acorn production was significantly increased as a result of the thinning treatments. Thinning appears to be a promising management tool to diversify stand structure in dense live oak stands in the Southern Sierra, increasing economic value for livestock use and reducing wildfire risk.

Key words: interior live oak, oak thinning

Introduction

Interior live oak (*Quercus wislizeni*) is widespread in California, occurring on 16 percent of California's oak woodlands (Waddell and Barret 2005). It is characterized by a vigorous sprouting capacity (Fryer 2012, Plumb and McDonald 1981). It is well-adapted to fire, and shows a rapid response to top-killed fire damage (Plumb and Gomez 1983).

The rapid regrowth of interior live oak results in very high density canopy cover classes following wildfire, which has a negative effect on forage production, water yield, and some wildlife species (Fryer 2012). Interior live oak is predominantly found on private lands (78 percent of the total cover type), making multiple use management and economic livelihood of private owners a key component of long term conservation (Waddell and Barrett 2005).

Dense stands of interior live oak are widespread throughout the Sierra Nevada foothills. To date, there have been no investigations of the effects of thinning on interior live oak stand characteristics. Bonner and other (2008) have shown promising results with thinning of coast live oak (*Quercus agrifolia*), a coastal live

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oak with similar silvical characteristics to interior live oak. This suggests that there could be positive effects on stand structure from thinning treatments.

Methods

The Coarsegold Resource Conservation District (RCD) has had an active program to reduce impacts from catastrophic wildfires on a diverse array of wildland vegetation types, and provides technical assistance and support for cost-share payments to landowners with appropriate silvicultural and restoration strategies. They requested the assistance of the University of California to develop thinning recommendations on interior live oak to guide landowner actions.

A study site on a private ranch was selected near the town of North Fork, California in Madera County. The study site was at an elevation of 579.12 m (1900 ft), and was seasonally grazed as part of a cow-calf operation. The study site had developed from a rangeland clearing 40 years earlier. The overstory interior live oak canopy cover was close to 100 percent. The stand has a very high fire risk, and had no forage production due to the heavy shading of the understory. The area was representative of large acreages of similar, dense interior live oak stands in the Southern Sierra.

The study was designed with two thinning levels (thin one-third, and two-thirds of the basal area), and an unthinned control. There were 6 replications of each thinning level. Each replication was 0.1 acres in size. On half of the replications, the stumps were treated with herbicides (glyphosate), to prevent resprouting of the cut stumps. The trees were harvested in the winter of 1998. Trees were selected for harvest to accomplish the basal area retention goals for each treatment. The herbicide treatments were applied at the time of harvesting. Rings of the harvested trees were counted, and the stand age of 40 years was confirmed. Table 1 below shows the summary statistics of the study site.

Table 1—General summary statistics for interior live oak thinning treatment in Madera County, California (standard errors shown in parentheses)

Treatment	Basal area (sq. ft./ac)	Volume (cu. ft./ac)
Control	95.3 (5.6)	1876 (306)
Thin 1/3	48.5 (2.5)	1387 (167)
Thin 2/3	26.8 (1.5)	769 (103)

Data was collected on all residual trees in the study area in 1998, 2002 and 2010. At each measurement, diameter at breast height (1.37 m, DBH) and total height was calculated. From these figures, merchantable volume to a 5.08 cm (2 inch) small end diameter was calculated, using the volume equations in Pillsbury and Kirkley (1984).

Crown radius of all residual trees was taken in two directions in 2010 to calculate overstory canopy cover percent. The canopy radius of the resprouting cut stumps was also measured in two directions in 2010 to calculate the understory canopy cover percent.

Acorn production was evaluated in 2000, 2001 and 2003 on all residual trees using the visual estimation methodology described by Graves (1980). All trees were placed into one of the four classes described by Graves (Class 1 = no acorns; Class 2 = acorns visible on close exam; Class 3 = acorns readily visible, don't cover entire tree; Class 4 = acorns readily visible, cover entire tree).

Results

Volume and basal area growth

Figures 1 and 2 show the 13-year total volume and basal area per acre for the three treatments. The one-third thinning treatment had virtually the same volume as the unthinned control after 13 years. Both the one-third and two-thirds thinning treatments were growing at an increasing rate in both volume and basal area, while the control growth was decreasing over the study period. The replications with stump sprout control were combined with those without herbicide treatment, since understory treatment had no significant effect on volume or basal area. Expressed as a compound annual growth percent, the two-thirds thinned treatment grew at 5.1 percent, the one-third thinned treatment grew at 3.8 percent, and the unthinned control grew at 1.7 percent.

Table 2 compares the 13-year periodic growth per acre and for individual trees. There was no significant difference in per acre volume or basal area periodic annual growth, although the one-third treatment had the highest numerical growth rate. Individual tree DBH growth was significantly higher in the two-thirds thinning treatment, growing over 4.5 times faster than the unthinned control.

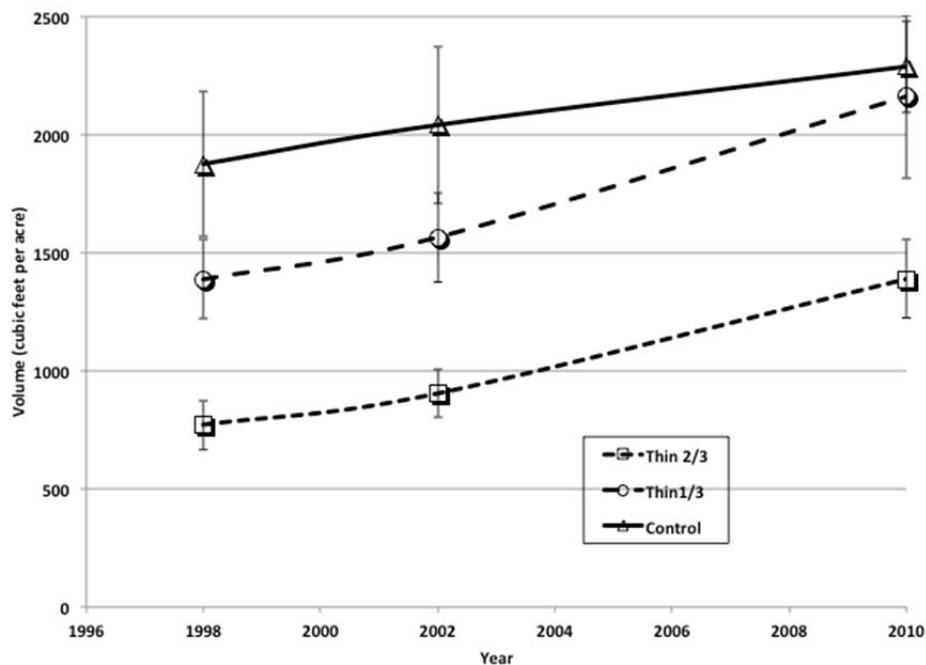


Figure 1—Volume per acre for interior live oak thinning treatments from 1998 through 2010.

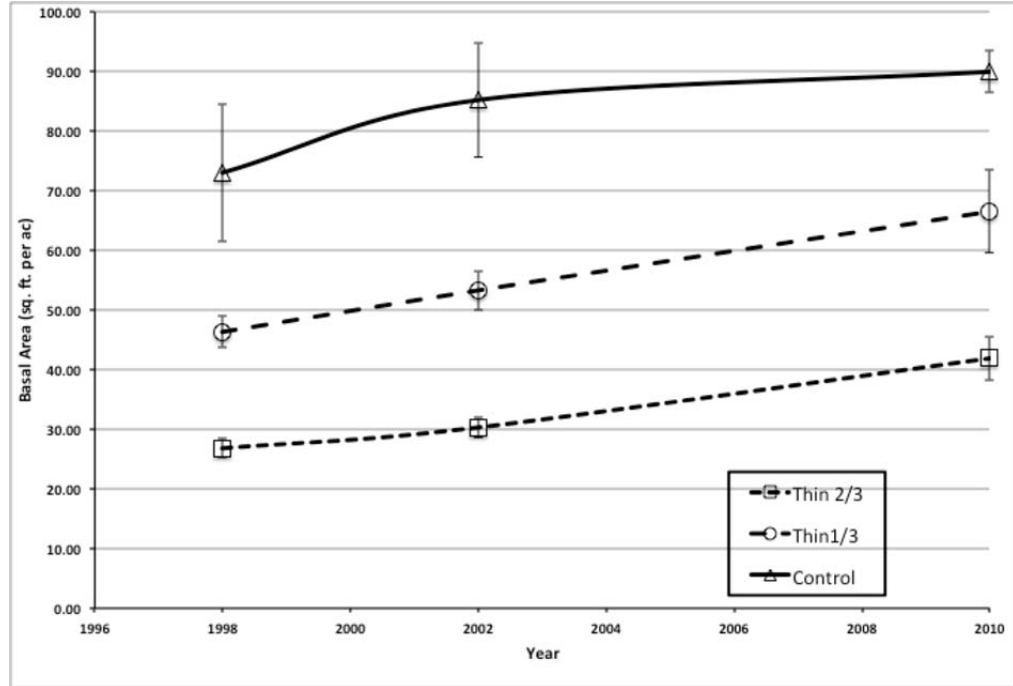


Figure 2—Basal area per acre for interior live oak thinning treatments from 1998 through 2010.

Table 2—13-year changes in periodic annual increment and per tree measurements (means with different letters are significantly different at the 0.05 level)

Treatment	Vol. growth (cu.ft./ac/yr.)	BA growth (sq.ft./ac/yr.)	DBH growth (inches/tree/yr.)
Control	59.9	1.3	0.03 A
Thin 1/3	78.5	1.4	0.08 AB
Thin 2/3	51.7	1.2	0.14 B
Significance	N.S.	N.S.	Sign. 0.05

Overstory and understory crown cover and sprout growth

Figure 3 shows the overstory and understory crown cover after 13 years. The overstory cover was significantly affected by thinning intensity, and the understory cover was significantly affected by the stump herbicide treatment. Stump herbicide treatment did not affect the overstory cover, except for the two-thirds thinning, which had a 20 percent greater canopy cover when the stump were treated. The amount of understory cover was not affected by the thinning intensity. Table 3 shows the effect of thinning on sprout height and cover. The treated stumps had smaller canopy cover and very short sprout heights. The untreated stumps had sprouts of 1.83 to 2.44 m (6 to 8 ft) in height, and a cover of 12 to 16 percent, showing that thinning without stump treatment results in a significant ladder fuel and high fire risk, while thinning with sprout control had reduced fire risk.

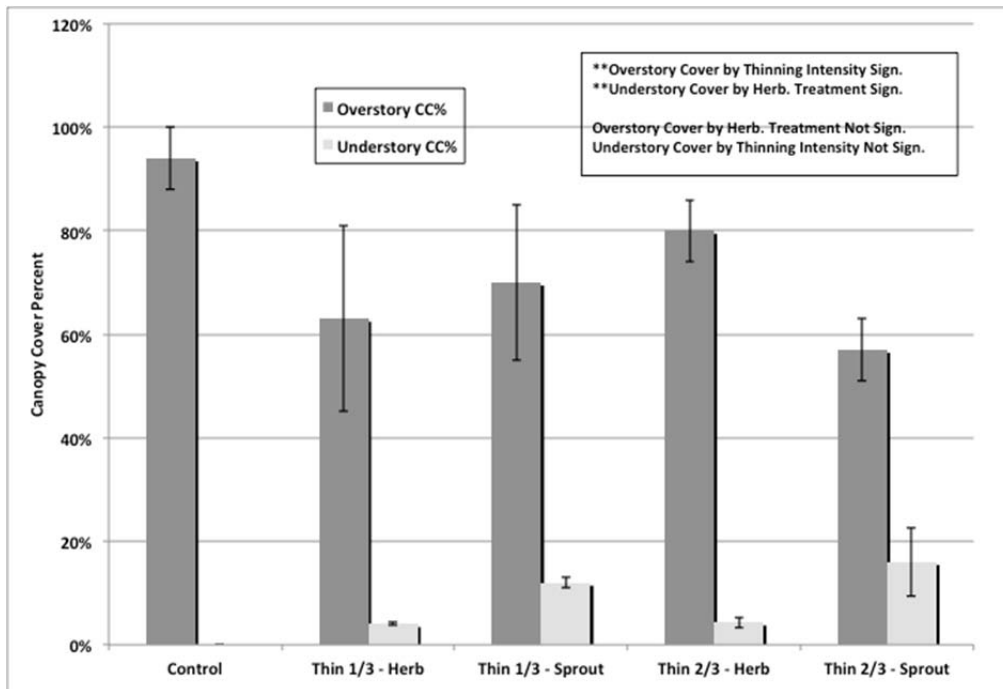


Figure 3—Overstory and understory canopy cover in 2010 by thinning and stump treatments.

Table 3—13-year sprout height and understory canopy cover by thinning treatment

Treatment	Sprout height (ft.)	Sprout cover (pct.)
Thin 2/3 basal area		
No sprout control	8.4	16 pct.
Sprout control	<1	4 pct.
Thin 1/3 basal area		
No sprout control	6.1	12 pct.
Sprout control	<1	4 pct.
Significance	Sprout control sign. at 0.01; thin intensity N.S.	Sprout control sign. at 0.01; thin intensity N.S.

Acorn production

Figure 4 shows the probability of acorn production for the unthinned control and the two thinning intensities. For the 3 years sampled (2, 3 and 4 years after the thinning), there was a significant treatment effect from the thinning on the probability that a tree would have acorns (Class 2, 3 or 4). It will be necessary in future studies to determine if this has an impact on per acre acorn production, since thinning reduces the number of trees per acre and canopy cover.

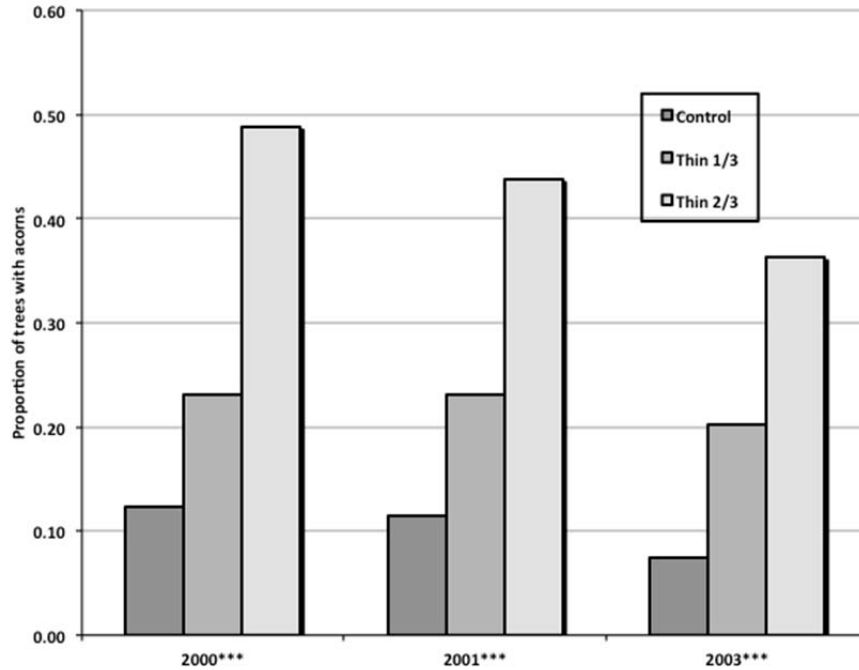


Figure 4—Proportion of trees with acorns for the three thinning treatments. Significance evaluated with Chi-square analysis. *** denotes significant at 0.01 level.

Discussion

This study was useful in describing changes in interior live oak stand structure after thinning and sprout control. Over the 13 years in the study, there were no significant stand level growth differences from the thinning treatments, although the one-third thinning level had reached the same per acre volume level as the unthinned control.

The most significant stand level thinning impact is in individual tree growth. The two-thirds thinned stands were growing on average over four times greater than the unthinned stand. Over time, we would expect the thinned stands to have larger individual trees, that approach the unthinned stand in canopy cover and per acre volume. The thinning also significantly increased the probability of acorn production.

This study was designed to evaluate if thinning reduced the fire risk for landowners with interior live oak. This showed that thinning alone resulted in significant resprouting of the residual stumps, causing high risk of catastrophic wildfire from fuel ladders. Herbicide treatment of the residual stumps maintained a very low level of understory fuel ladders. It will be important for any fuel thinning to reduce the overstory crown cover, as well as treating the stumps in order to reduce fire risk.

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References

- Bonner, L.E.; Pillsbury, N.H.; Thompson, R.P. 2008. **Long-term growth of coast live oak in three California counties – 17-year results.** In: Merenlender, A.M.; McCreary, D.D.; Purcell, K.L., tech. eds. Proceedings of the sixth symposium on oak woodlands: today's challenges, tomorrow's opportunities. Gen. Tech. Rep. PSW-GTR-217. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 69–78.
- Graves, W.C. 1980. **Annual oak mast yields from visual estimates.** In: Plumb, T.R., tech. coord. Proceedings of the symposium on the ecology, management, and utilization of California oaks. Gen. Tech. Rep. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 270–274.
- Pillsbury, N.H.; Kirkley, M. 1984. **Equations for total, wood and saw-log volumes for thirteen California hardwoods.** Research Note PNW-414. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 51 p.
- Plumb, T.R.; Gomez, A.P. 1983. **Five southern California oaks: identification and postfire management.** Gen. Tech. Rep. PSW-71. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 56 p.
- Plumb, T.R.; McDonald, P.M. 1981. **Oak management in California.** Gen. Tech. Rep. PSW-54. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 12 p.
- Fryer, J.L. 2012. *Quercus wislizeni*. In: Fire Effects Information System. [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). <http://www.fs.fed.us/database/feis/plants/tree/quewis/all.html>. (06 February 2015).
- Waddell, K.L.; Barrett, T.M. 2005. **Oak woodlands and other hardwood forests of California, 1990s.** Res. Bull. PNW-RB-245. Portland, OR: U.S. Department of Agriculture Forest Service, Pacific Northwest Experiment Station. 94 p.