Cost of Tree Removal Through Chemicals[1]

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Highlight

Four things must be known to estimate cost of chemical tree treatment: labor performance rates, quantity of material, wage rate, and unit cost of material. Labor and material requirements are related to tree diameter, stand density, and species treated.

Density of tree cover is a major determinant of forage production in woodland-grass ranges. Heavily wooded areas support only a sparse herbaceous understory of less desirable forage species; whereas, open woodlands with widely scattered trees may be as productive as open range. Thus, removal of trees from denser areas may result in both improved forage quality and increased forage production. Murphy and Crampton (1964) reported that forage yield under chemically treated blue oak *(Quercus douglasii)* at Hopland exceeded that of open ground the growing seasons following treatment. Natural revegetation may be relied on or seeding with desirable forage species may be carried out to vegetate cleared areas. Although trees may be removed by felling or by the use of bulldozers, these methods are, under certain conditions, prohibitive in cost. Estimated costs of $80 to $200 have been reported by the California Agricultural Extension Service (Berry, et al., 1955). Accordingly, much attention has been focused on the use of chemicals as a more economical method of removing trees (Johnson, et al., 1959 and Leonard, et al., 1956).

This article is concerned with the cost of chemical tree treatment based on data collected at the University of California's Hopland Field Station in southeastern Mendocino County between December 1959 and April 1960. Four 1-acre plots of densely wooded grass range were treated with 2,4-D applied by injector-type applicators. The diameter, species, treatment time, and moving time between trees were recorded for each plot and regression analyses of these data provided estimates of the influence on treatment and moving time of species, diameter of trees, and density of stand.

Material and Labor Costs

Costs of such treatment include chemical materials and labor. Per acre costs for materials vary with the type and concentration of chemicals used as well as with the number and diameter of trees treated. The use of 2,4-D at the rate of 0.075 ounce of actual chemical per inch of diameter has proved to be effective for most of the trees and larger shrubs in woodland grass areas (Leonard, et al., 1956).

Per acre costs for labor include time spent in actual application of chemicals,[2] in moving between trees, and in mixing chemicals and filling chemical applicators. In addition, there is time wasted or lost. Regression analysis indicates that the diameter and species of trees treated largely influence the time necessary for actual chemical application (Table 1). First, the data indicate that treatment time for all species increases linearly with increases in the diameter of trees treated. Second, by holding diameter constant, it is clearly evident that there are significant differences in treatment time between species, arising from their individual growth habits. For example, blue oaks and small diameter black oaks are quickly treated because they have relatively thin bark and isolated main stems.. Large diameter black oaks, however, have long treatment times because their thick and spongy bark not only impede penetration to the cambium layer but also clog the chemical ports of the injector tool. Live oaks and madrones also have long treatment times because they grow in clumps with as many as 8 main stems coming from a limited base area. And, during the treatment of any one stem, adjacent stems obstruct and thus prolong frilling and applying chemicals. (Thick bark on large diameter live oaks make treatment additionally time consuming.) Manzanitas have long treatment times because they often grow low and parallel to the ground, making treatment on the undersides of the main stems a slow process.

Additional regression analysis indicates that the time spent moving between trees varies with density, that is, the number of stems per acre (Table 2). As one would expect, moving time increases linearly with increases in the number of trees treated per acre, that is, with increased

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[1]*Giannini Foundation Paper No. 254.*

[2]*Includes making axe frills and applying chemicals or using injector-type applicators.*

Table 1. Labor time for chemical application in seconds per tree.

Species	Diameter of trees — inches 4	5	6	7	8	9	10
Blue oak	11.7	14.3	17.0	19.6	22.3	25.0	27.6
Black oak	12.9	19.0	25.1	31.2	37.2	43.3	49.4
Live oak	23.5	30.1	36.7	43.3	49.9	56.5	63.1
Madrone	28.2	31.8	35.5	39.1	42.7	46.3	50.0
Manzanita	25.3	31.3	37.3	43.3	......	......	......

density. However, moving time does not increase proportionally with density. For example, as the number of trees per acre increases five times the moving time increases only three times.

The labor required in mixing chemicals and filling applicators, including lost or wasted time, averaged about 35 percent of the total labor time per acre.

Effect of Species, Diameter, and Density

Relationships between tree species, diameter, and total per acre costs are indicated in Table 3. For all species, estimated per acre costs increase with increases in the diameter of trees treated. For small diameters, total per acre costs of treating live oaks, madrones, and manzanitas are consistently higher than those for treating blue oaks and black oaks of comparable diameters. However, at large diameters, per acre costs of treating black oaks approach those for treating large diameter, live oaks, madrones, and manzanitas. These cost estimates are based on a density of 120 trees per acre, labor costs at $1.50 per hour, 2,4-D applied at a rate of 0.075 ounce per inch of tree diameter at a cost of $1.05 per pound.

The effect of tree density on cost of treatment is illustrated in Table 4. Estimated per acre cost of treating blue oaks of the same average diameter increases from $2.45 when 50 trees are treated to $7.20 when 150 trees are treated Table 4, part A). This increase in cost results from the longer time spent moving between trees in the denser stand and from the greater cost of materials used in treating the larger total diameter of the denser stand. The cost of treating 50 blue oaks with average diameter of 20 inches is $6.63 while the cost of treating 150 blue oaks with average diameter of 6.6 inches (holding total diameter of all trees the same) costs $6.85 (Table 4, part B). Theoretically, the cost of materials in both treatments is the same since the total diameters treated are identical. Granting this, the difference in cost of treatment results mainly from the increased moving time within the denser stand.

Discussion

In summary, four things must be known to estimate the cost of chemical tree treatment: labor performance rates, quantity of material used, the wage rate, and the unit cost of the material used. Wage rates and material costs are generally easily ascertained. Labor performance rates and material requirements have been shown to be determined by diameter of trees treated, the density of the stand, and the species and are typically estimated in terms of hours and gallons per acre respectively. No allowance for variation in labor productivity has been incorporated in the cost estimates included in Tables 3 and 4 though this additional variable can be easily introduced.

As is often the case with other

Table 2. Effect of number of trees treated on moving time.

Number of trees treated per acre	Moving time in minutes per acre[1]
50	5.5
100	8.1
150	10.7
200	13.3
250	15.9

[1] Moving time in minutes (Y) as a function of number of trees treated (X) on the Hopland experiment can be expressed as $Y = 2.95 + 0.052\,X$; $r = 0.86$; $t = 8.305$.

Table 3. Cost per acre for chemical tree treatment by species and diameters[1]

Diameter of trees treated	Total per acre cost of treatment: Blue oak	Black oak	Live oak	Madrone	Manzanita
	(Dollars)				
3	2.69	2.54	3.22	3.74	3.60
5	4.23	5.15	5.34	5.41	5.35
7	5.77	6.95	7.37	7.09	7.07
9	7.30	8.75	9.43	8.75	......
11	8.85	10.56	11.50	10.42	......

[1] These estimated costs are based on the following conditions: density of 120 trees per acre, labor at $1.50 per hour, and 2,4-D applied at a rate of 0.075 ounce per inch of tree diameter at a cost of $1.05 per pound.

Table 4. Effect of number of trees per acre and average tree diameter on costs of chemical treatment of blue oak.

Blue oak trees per acre	A: Average diameter	A: Total diameter	A: Cost of treatment	B: Average diameter	B: Total diameter	B: Cost of treatment
(Number)	(Inches)		(Dollars)	(Inches)		(Dollars)
50	7	350	2.45	20.0	1,000	6.63
75	7	525	3.65	13.3	1,000	6.68
100	7	700	4.85	10.0	1,000	6.75
125	7	875	6.00	8.0	1,000	6.80
150	7	1,050	7.20	6.6	1,000	6.85

types of range improvement practices, little information is available on which to base expectations of increased grazing capacity following tree removal. Darrow and McCully (Darrow, et al., 1959) report a fivefold increase in forage production with complete treatment and a twofold increase with partial treatment. Average yields per acre of oven dry forage, for 3 years after treatment, increased from 222 pounds to 504 and 1,290 pounds for partial and complete treatment, respectively. Following the treatment of a stand of blue oaks with 2,4-D Johnson et al., (1959) report that density of herbaceous vegetation increased from 35 percent to 70 percent and contained a higher proportion of desirable annual grasses. And, average production of dry matter per acre increased from 278 pounds to 1,409 pounds. Similarly, although forage production was not measured, visual observations on the Hopland plots show pronounced increases in the quantity of forage grasses (Figure 1).

Tree removal, as a type of range improvement, yields no significant change in season of use where increased production is through natural revegetation. However, observations do indicate that green forage under a tree canopy is available earlier as well as later than the forage in open areas. Thus, while forage production was not measured in connection with data reported here, it seems that although total forage production can be increased by complete tree removal, leaving a few trees may result in a somewhat longer grazing season on green feed.

FIGURE 1. *Left:* Two different sections prior to treatment in December 1959. *Right:* Same sections, respectively, in January 1963, three years after treatment. Note increase in understory vegetation.

Summary

Density of tree cover, a major determinant of forage production in woodland-grass ranges, can be changed by chemical treatment of individual trees. Labor and materials costs, the essential cost components, are determined by the quantity of labor and materials used and their prices. Labor and material requirements are functionally related to diameter of trees treated, density of stand, and species treated. Therefore, costs per acre to treat trees can be related to these same variables and, additionally, to the prevailing wage rates and cost of chemical material used.

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