Research

UNIVERSITY OF CALIFORNIA
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LAND IMPROVEMENT THROUGH OAK TREE CONTROL

Information has been secured and disseminated during the 1955-1957 period on control of oaks by chemical, mechanical, fire, and combinations of these means: on forage production and composition in oak areas: and on hydrologic factors in oak areas.

METHODS OF OAK CONTROL

Chemical treatment alone has been applied using the cut-surface method. Chemical has been combined with mechanical in treating stumps of trees sawed down for firewood or to burn in the field. Mechanical control alone has been with bulldozers. Fire was used with mechanical means in an area where trees had been cut down with a chain saw and left to dry.

STUMP TREATMENT

Two trials were established in early 1955, one with C. M. Newell, near Lincoln, and one with Graham Cranston, 8 miles north of Auburn. W. A. Harvey and Oliver Leonard cooperated. In both instances, stumps were treated immediately after cutting. Two treatments were used: painting the entire top of the stump with undiluted 2,4-D Amine and spraying the entire stump with a mixture of 1 gallon of brush killer (2,4-D plus 2,4,5-T) and 24 gallons diesel oil.

The Newell plot was in a very thick stand of second growth live oak, and the trees were cut up and made into firewood. The Cranston plot was in a stand of average density, consisting primarily of blue oak, but with some live oak mixed in. The trees were cut down, mechanically piled, and finally burned.

Estimates of per acre costs follow. Plots were smaller than one acre, but estimates were projected to a per acre basis. Cost estimates are based on the following charges:

Labor	$1.00 per hour
Saw	.10 per hour
Tractor	1.00 per hour
Diesel Oil	.15 per gallon
Brush Killer	9.00 per gallon
2,4-D Amine	3.50 per gallon

	Newell 2/3/55		Cranston 3/4/55	
	Brush Killer Treatment	Paint Stump	Brush Killer Treatment	Paint Stump
Labor (@ $1.00/hour)				
Falling and treating	$ 27.30	$ 20.00	$ 20.00	$ 24.30
Clean up	109.00	107.00	22.70	22.90
Total Labor	$136.30	$127.00	$ 42.70	$ 47.20
Equipment Use				
Saw @ 10¢/hour	$ 4.10	$ 3.67	$ 1.00	$ 1.22
Tractor @ $1.00/hour	13.70	13.30	14.00	12.90
Total Equipment	$ 17.80	$ 16.97	$ 15.00	$ 14.12
Material				
Diesel @ 15¢/gallon	$ 6.83	$ -	$ 3.84	$ -
Chemical	16.20	11.55	9.90	6.30
Total Material	$ 23.03	$ 11.55	$ 13.74	$ 6.30
Total Estimated Costs per Acre	$176.13	$155.52	$ 71.44	$ 67.62
Wood Cut (cords)	13.7	13.3	-	-
Return for wood if sold @ $20.00/cord	$274.00	$266.00	-	-
Return for wood minus clearing costs	$ 97.87	$110.48	-	-

In comparing the two tests, it can be seen that the "hand clearing" as at Cranston's, was prohibitive in cost. Somewhat similar costs would have been experienced at Newell's if wood had not been made from the trees. The density of stand has a bearing on costs, particularly in regards to falling labor and material use. Clean up time would also be affected, but is not shown in this comparison because of different methods used by the two cooperators.

Labor and material use in relation to tree stand is shown below, on a per acre basis.

	Newell 2/3/55		Cranston 3/4/55	
	Brush Killer Treatment	Paint Stump	Brush Killer Treatment	Paint Stump
Number of trees	687	760	413	357
Range in diameter	1-18"	1-14"	1-12"	1-8"
Average diameter	5.8"	5.1"	3.8"	4.3"
Total inches of diameter	3986	3855	1580	1530
Time to fall and treat	27.3 man hrs.	20 man hrs.	20 man hrs.	24.3 man hrs.
Time to fall and treat/100" diameter	.68 man hrs.	.52 man hrs.	1.27 man hrs.	1.59 man hrs.
Time to clean up	109 hours	107 man hrs.	22.7 man hrs.	22.9 man hrs.
Use of saw to cut	13.7 hrs.	10.0 hrs.	10.0 hrs.	12.2 hrs.
Use of saw to clean up	27.3 hrs.	26.7 hrs.		
Use of tractor to clean up	13.7 hrs.	13.3 hrs.	14.0 hrs.	12.9 hrs.
Material use	54.5 gals. diesel; 1.8 gals. brush killer	3.3 gals. 2,4-D	25.6 gals. diesel oil; 1.1 gals brush killer	1.8 gals. 2,4-D
Material use per 100" diameter	1.37 gals. diesel; .045 gal. brush killer	.085 gal. 2,4-D	1.62 gals. diesel oil; .070 gal. brush killer	.118 gal. 2,4-D

It is of interest to note the difference in time required to fall and treat on the two ranches. Falling on the Newell ranch was done with a circular saw mounted on wheels. This appears to be a somewhat slow operation, but is very steady. A chain saw was used at Cranston's, and although it cut very fast, an excessive amount of time was taken by minor repairs and adjustments.

Results of treatment on both plots are excellent.

The Cranston plot, primarily blue oak, showed a small amount of sprouting the first summer following treatment. One year after treatment, on March 12, 1956, the only sprout found was one of live oak in the brush killer treatment. On November 13, 1956, only sprout found was of blue oak in the brush killer treatment. In September and November 1957, no sprouts could be found. Thus 100% control of sprouting was achieved.

The Newell plot, primarily live oak, showed 3 live oak sprouts and one blue oak sprout in the brush killer treatment on March 7, 1956, 13 months after treatment. Here control was 97%. 2,4-D treatment (paint stump) showed 5 live oak sprouts, a control of 96%. By November 13, 1956, additional sprouting had taken place to where control was down to 90% in the brush killer area and down to 86% in the paint stump plot. Additional observations made December 5, 1957 showed control to be 89% on brush killer spray and 87% on 2,4-D paint stump. All living sprouts but one are live oak.

It must be remembered that all sprouts were left alone. Followup treatment, which would have been simple to accomplish, was withheld to see if sprouts would die over a long period after treatment. Although there are still live sprouts, they are growing at a slower rate than normal.

An additional test, on a larger area, was established on February 1, 1957, at the Newell ranch. This was designed primarily to check material use and prevention of resprouting, although some rough estimates of labor were also secured. Informal tests and observations, together with information from other counties, indicated the possibility of painting 2,4-D amine on only the outside 30-50% of the stump surface rather than covering the entire surface. Even though this method of painting was used, material usage per 100 inches of diameter was essentially the same as in the previous tests.

Plot size was surveyed and found to be 1.35 acres. Cost estimates for labor, equipment, and material per acre and per 100 inches of diameter follow.

ESTIMATED COSTS
CLEARING AND PAINTING STUMPS
C. M. NEWELL
FEBRUARY 1, 1957

	Per Acre	Per 100" Diameter
Labor ($1.00/hour)	$26.11	$1.00
Falling and treating		
Clean up	74.10	2.83
Total Labor	$100.21	$3.83
Equipment Use		
Saw (10¢ per hour)	$ 1.55	$ .06
Tractor ($1.00 per hour)	11.10	.42
Total Equipment	$12.65	$ .48
Material Cost		
2,4-D Amine ($3.50/gallon)	$ 9.10	$ .35
Grand Total	$121.96	$4.65
Wood Cut		
2.22 cords @ $20.00/cord	$44.40	$1.69
Net Cost to Producer	$77.56	$2.96

From this and the earlier Newell tests, it can be seen that the amount of fire-wood made from a given area has considerable bearing on the labor cost and the so-called net cost of clearing. In this test, much of the wood was too small or in other ways undesirable for further handling.

Stand Density, size of trees, and other pertinent information is in the following table.

STAND, LABOR, AND MATERIAL USE
CLEARING AND PAINTING STUMPS
C. M. NEWELL
FEBRUARY 1, 1957

	Total	Per Acre
Number of trees	775	574
Blue oak	450	333
Live oak	325	241
Range in Diameter	2-21"	2-21"
Average Diameter	4.6"	4.6"
Total Inches of Diameter	3,538"	2,621"
Time to fall and treat	35.24 hours	26.11 hours
Time to fall and treat/100" diameter	1.0 hours	1.0 hours
Time to clean up	100 hours	74.1 hours
Use of saw to cut	15.0 hours	11.1 hours
Use of saw to clean up (est.)	6.0 hours	4.4 hours
Use of tractor to clean up (est.)	15.0 hours	11.1 hours
Material use (2,4-D Amine)	3.5 gallons	2.6 gallons
Material use per 100" diameter	.099 gallons	.099 gallons

Control of resprouting, to date, is excellent. On December 5, 1957, control of resprouting on blue oak was 99.1%, and live oak control was 99.4%. Control on the total plot was 99.2%. All sprouts, totalling only six, were extremely weak.

A summary of the five plots, showing stand density, tree size, and material use on both a per acre and per 100" diameter follows. Apparent control of resprouting is also included. The records are based on actual treatment of 1,127 stumps.

STUMP TREATMENT 1955-1957
STAND, MATERIAL USE, CONTROL, COSTS

	NEWELL 1955				CRANSTON 1955				NEWELL 1957		OVER-ALL			
	Brush Killer & Oil Spray		2,4-D Amine Paint		Brush Killer & Oil Spray		2,4-D Amine Paint		2,4-D Amine Paint		Brush Killer & Oil Spray		2,4-D Amine Paint	
	Per Acre	Per 100" Diameter	Per Acre	Per 100" Diameter	Per Acre	Per 100" Diameter	Per Acre	Per 100" Diameter	Per Acre	Per 100" Diameter	Per Acre	Per 100" Diameter	Per Acre	Per 100" Diameter
Number of stumps	687		760		413		357		574		550		564	
Range in Diameter, inches	1-18		1-14		1-12		1-8		2-21		1-18		1-21	
Total Diameter, inches	3,986		3,855		1,150		1,530		2,621		2,783		2,669	
Average Diameter, inches	5.8		5.1		3.8		4.3		4.6		5.1		4.7	
Material Use														
Brush killer, gallons	1.8	.045			1.1	.070					1.45	.052		
Diesel oil, gallons	54.5	1.37			25.6	1.62					40.1	1.44		
2,4-D Amine, gallons			3.3	.085			1.8	.118	2.6	.099			2.6	.097
Apparent Control,%	89.4		86.8		100		100		99.2		92.5		97.7	
Labor, hours	136.6	3.42	127.0	3.29	42.7	2.70	47.2	3.08	100.21	3.83				
Saw, hours	41.0	1.03	36.7	.95	10.0	.63	12.2	.80	15.5	0.6				
Tractor, hours	13.7	.34	13.3	.35	14.0	.89	12.9	.84	11.1	0.42				
Labor cost, $	136.30	3.42	127.00	3.29	42.70	2.70	47.20	3.08	100.21	3.83				
Saw cost, $	4.10	.10	3.67	.10	1.00	.06	1.22	.08	1.55	.06				
Tractor cost, $	13.70	.34	13.30	.35	14.00	.89	12.90	.84	11.10	.42				
Material cost,														
Brush Killer, $	16.20	.41			9.90	.63					13.05	.47		
Diesel oil, $	6.83	.17			3.84	.24					6.02	.22		
2,4-D Amine, $			11.55	.30			6.30	.41	9.10	.35			9.10	.34
Total costs, $	176.13	4.42	155.52	4.03	71.44	4.52	67.62	4.42	121.96	4.65				
Wood Return, $	274.00	6.87	266.00	6.90	0	0	0	0	44.40	1.69				
"Net" cost, $	+97.87	+2.46	+110.48	+2.87	71.44	4.52	67.62	4.42	77.56	2.36				

The preceding table did not show labor or other costs, other than material costs, in the "over-all" records. Even with standardizing records to a basis of 100 inches of diameter, labor and subsequent costs are highly dependent on the method of handling the trees after they are cut down.

The summary table indicates a number of things.

1. Resprouting can be successfully controlled by both chemical treatments.
2. Cost of chemical treatment is not excessive, nor is it cheap.
3. Costs of spraying stumps with a brush killer-oil spray are about double that of painting 2,4-D amine on the stumps.
4. Time consumed and costs experienced in this method of clearing are excessive unless the trees may be made into wood products that can be sold.
5. Total costs per acre cannot be predicted or estimated without considering the density and size of trees, the method of clearing, and the disposition of the trees.
6. Material usage and material costs varied, but are close enough to make predictions in other areas regardless of the clearing method and tree disposition factor.

Further observations indicate some problems with commercial woodcutters. Material was supplied to one professional woodcutter with the hopes of securing additional information. Trees are not cut with a horizontal cut in all cases; therefore, it is difficult to paint sufficient quantities of 2,4-D to give effective results. Trees treated in this manner have been observed to resprout vigorously. Treating stumps is an additional bothersome chore to the woodcutter; so, treating may be done carelessly and ineffectively. Even though some control was achieved, the lower the per cent control the higher the cost becomes.

Additional materials were tried on December 11, 1956 at the Newell ranch in cooperation with Oliver Leonard. Materials used were ACP-M-103-A and ACP-M-177, with 2,4-D as a check. Both blue oak and live oak stumps were treated. Observations on December 5, 1957, did not show improvement over 2,4-D amine. Trees were primarily second growth, with clumps being cut for the most part, although some single stumps were also treated. Partial results of these tests follow.

	ACP-M-103-A	ACP-M-177	2,4-D Amine
No. of Clumps or Single Stumps Treated	18	26	15
Live oak	12	11	6
Blue oak	6	15	9
Total Cuts Treated	83	83	41
Live oak	70	57	29
Blue oak	13	26	12
Number of Clumps with Live Sprouts	5	4	0
Live oak	5	1	0
Blue oak	0	3	0
Per Cent of Clumps with No Live Sprouts	72	85	100
Live oak	58	91	100
Blue oak	100	80	100

Although there was wide variation in the amounts of material applied per inch of diameter, there is no relationship of sprouting to dosage. Four live oak clumps, two treated with the 103 and two with the 177 chemical, received a soda treatment on top of the chemical. There are no live sprouts on these clumps.

A more critical analysis of these results should be made in another year. Control should be considered on the actual number of stumps as well as on the number of clumps.

CUT SURFACE METHOD

The first trial was established on March 4, 1955 on the Cranston Ranch in cooperation with W. A. Harvey and Oliver Leonard. One acre was involved, consisting almost entirely of blue oak. Results were so encouraging as far as control and costs were concerned, two larger tests were established to more accurately measure costs. One trial, with L. A. Gunther near Camp Far West consisted of 12.7 acres and was established March 8, 1956. The other, at the Files Ranch northeast of Lincoln, measured 13.1 acres and was established on April 13 and 20, 1956.

A summary of stand, labor, material, and cost records of the three trials is in the following table. These records are based on actual treatment of 3,139 trees.

CUT SURFACE TREATMENT, 1955-57
STAND, LABOR, MATERIAL, AND COST

	CRANSTON 1955		GUNTHER 1956		FILES 1956		OVER-ALL	
	Per Acre	Per 100" Diameter	Per Acre	Per 100" Diameter	Per Acre	Per 100" Diameter	Per Acre	Per 100" Diameter
Number of trees	130		118		115		121	
Range in diameter, inches	1-30		2-51		1-49		1-51	
Total inches of diameter	902		964		868		911	
Average diameter, inches	6.9		8.2		7.5		7.5	
2,4-D Amine used, gallons	.42	.047	.46	.048	.53	.061	.47	.051
Labor to cut and treat, hours	1.50	.17	1.42	.15	2.21	.25	1.71	.19
Labor Cost, $	1.50	.17	1.42	.15	2.21	.25	1.71	.19
Material Cost, $	1.48	.16	1.62	.17	1.85	.21	1.65	.18
Total Cost, $	2.98	.33	3.04	.32	4.06	.46	3.36	.37
	Per Tree		Per Tree		Per Tree		Per Tree	
Labor, minutes	.69		.72		1.15		.85	
Material, cc	12.3		14.9		17.4		14.9	
Labor cost, cents	1.15		1.20		1.92		1.42	
Material cost, cents	1.14		1.37		1.61		1.37	
Total cost, cents	2.29		2.57		3.53		2.79	
No. trees treated per hour of labor	87		83		52		74	
Inches of diameter treated per hour of labor	601		679		393		558	

The preceding records show a remarkable similarity in results between the Cranston and Gunther plots. Both plots were similar in respect to gentleness of slope, very few second growth clumps, and very little underbrush. The higher costs on the Files plot are believed to be due to a number of factors; including steeper slopes, more second growth clumps, the oaks had leafed out, and poison oak had leafed out.

Per cent kill is excellent. The Cranston plot showed 100% kill in September, 1957. Since then, the trees were cleared by a bulldozer. On the Gunther and Files plots only an estimated five per cent or less of the trees are showing any signs of life. Final per cent kill will be determined when the trees leaf out in the spring of 1958.

These records add proof to the idea that the cut surface method is an excellent one for killing oak trees. Advantages are:

1. Low cost. Costs are even lower if only the out-of-pocket cost for material is considered.
2. It is easy. No special skill required.
3. No special or expensive equipment is needed.
4. It is relatively fast: two men can treat one or two acres per hour.
5. The job can be done sporadically, using short or long periods of available time through several months (November-May).

Additional materials were tried at the Files Ranch on December 11, 1956, in cooperation with Oliver Leonard. Forty-four trees, or clumps, totalling 67 individual stems, were treated. The test was designed primarily for live oak. Thirty-seven of the trees or clumps and 70 of the stems were live oak; 6 trees and 6 stems were blue oak: and 1 tree and 1 stem was Digger pine.

Material used were ACP-M-103-M and ACP-M-177. 2,4-D amine was used on four live oak trees.

A summary of observations, as of December 5, 1957, is below.

	Material		
	ACP-M-103-M	ACP-M-177	2,4-D Amine
Number of trees or clumps treated	21	19	4
Live oak	19	14	4
Blue oak	2	4	0
Digger pine	0	1	0
Number of trees or clumps showing signs of life	17	15	0
Live oak	16	13	0
Blue oak	1	1	-
Digger pine	-	1	-

Even though the number of dead trees is quite small to make comparisons, it appears that the % kill was not correlated to the rate of dosage.

With each of the ACP materials, four of the trees received only one axe cut and a relatively small dose of material in relation to the tree's total diameter. All eight trees so treated show signs of life.

Three trees were treated with soda in addition to ACP-M-103-M. All three trees show signs of life.

Time of treatment is said to be influenced by the amount of available moisture in the soil, with treatment losing effectiveness during the dry summer months. One test on the Newell Ranch included trees treated on May 27, July 1, and August 6, 1955.

Observations of the May treated trees eleven days after treatment showed the blue oak with practically all the leaves dry, the live oak with little or no symptoms, and the water oak with partial symptoms. Other observations showed blue oak trees to exhibit severe damage 13 and 14 days after treatment.

As of January 8, 1958, the per cent kill appeared to be 100% under all timing conditions. It is recognized that the test area is wetter than normal. It also appears that a conscientious job of properly treating trees will provide better than expected control during the "off season".

Cleaning up an area treated by the cut surface method has not been experienced in Placer County as yet. At least, not in a planned program. The one acre 1955 plot at Cranston's was pushed over and cleared by a bull dozer in the process of clearing a large acreage surrounding the plot. No observations were made of the clearing process and no records were kept.

It is assumed that a simple way to clean up the area will be to allow the dead trees to fall and then clean up the mess with a controlled fire. Observations in other areas indicate this may be done in two to five years after treatment.

The Cranston plot, after 31 months, showed only a small number of small trees fallen. No larger trees had fallen, although many branches had broken off and fallen to the ground. The Files and Gunther plots, after 21 months showed similar results. It appears that a minimum of three to four years will be required before enough trees have fallen to make a clean up fire worthwhile.

INCREASED FEED PRODUCTION

The principle reason for clearing oaks, from the stockman's viewpoint, is to increase feed supplies, and possibly to increase stock water supplies.

With assistance from range specialists, the treated area of the Files Ranch, and a similar untreated area adjacent to the plot, were sampled by the point-step method to determine the density of ground cover and the botanical composition of both areas. Results of the sampling follow. Date of sampling was February 27, 1957.

CHANGES IN DENSITY AND BOTANICAL COMPOSITION OF FORAGE

	Untreated			Treated		
	N	W	Ave.	N	W	Ave.
% Ground Cover Density	23	47	35	60	80	70
Botanical Composition						
% Annual grass	34	28	31	46	48	47
% Broadleafed Fillaree	0	22	11	0	34	17
% Red Stem Fillaree	18	8	13	6	6	6
% Bur Clover	6	14	10	6	4	5
% Other Forbs	42	28	35	42	8	25

N = North facing slope W = West facing slope

It can be seen that the density of ground cover in the treated area was twice the density found in the untreated area. An increase in annual grasses was primarily responsible. It was also quite obvious that the forage was considerably taller in the treated area.

Further observation on February 27, 1957 showed a distinct demarcation in forage growth in a line between treated and untreated trees. The increase in growth under treated trees was extremely striking and easy to observe. To more accurately determine differences in production, eight exclosures, varying in size from 300 to 1600 square feet were established; four in the plot and four in similar spots of the untreated area.

Strips of each exclosure were harvested on May 28, 1957. Green weights were secured in the field and samples were taken for laboratory analysis. Results of the harvesting and laboratory work are below.

	Treated	Control	Difference from Treatment	Treated as % of Control
Green Wt. per Acre, lbs.	4,372	804	+ 3,568	544
Dry Matter, %	31.90	34.55	- 2.65	92
Dry Matter per Acre, lbs.	1,395	278	+ 1,117	502
Nitrogen, %	1.02	1.22	- 0.20	84
Protein, %	6.38	7.63	- 1.25	84
Phosphorus, %	.299	.346	- .047	86
Nitrogen per Acre, lbs.	14.23	3.39	+ 10.84	420
Protein per Acre, lbs.	89.0	21.2	+ 67.8	420
Phosphorus per Acre, lbs.	4.17	.96	+ 3.21	434

Both green weight and dry matter production per acre were five times greater in the treated area. Nitrogen and phosphorus production were four times greater in the treated area. The per cent of these two elements in the forage appeared somewhat lower, although the difference was not significant. Moisture content of the forage was approximately 2½% higher in the treated area.

Palatability seems to have been affected, and quite rapidly. The plot was in an area seldom grazed by the cattle. Within three weeks after treatment, cattle were grazing the area heavily. Heavy grazing was also the rule in the 1956-57 season and in the fall of 1957.

There is no question that feed production was greatly increased. The increase was probably due to both greater growth and a more dense stand. The actual reason for increased production is unknown. Many theories have been proposed, but there is no proof for any.

Similar differences in feed production in the same area have been observed since October 22, 1957. Rains of September 27 started the grass and it appears that results of the 1957-58 season will be similar to 1956-57.

There has been some question as to whether the increased production in cut surface areas is any different than would be experienced from complete removal of the trees as in a wood-cutting operation. No actual records have been kept, but a few observations indicate that the increase in feed production is greater in areas treated by the cut surface method.

OTHER METHODS

Mechanical means, primarily bulldozer, have been used for many years. No accurate cost records have been kept. Informal quotations indicate a price range of from 15-25 dollars per acre. Thus, the cleared land must be subject to some type of improvement in order to justify this type of clearing.

One operator cleared a considerable acreage with a D-9 Caterpillar. Land was cleared at the rate of approximately three acres per hour of running time. Contract prices are not established in the area for a D-9, but it is felt that this cost may be in the neighborhood of $10.00 per acre. Generally, the experience in oak areas is that the bigger the equipment the greater the cost per hour and the lesser the cost per acre.

This same operator hooked a length of chain (weighing 60 lbs. per 12" link) between a D-8 Cat and the D-9 Cat. In satisfactory going, they cleared seven or more acres per hour with this method.

Fire has been used locally to only a minor extent. Burning oak lands, with the fuel high off the ground, has not proven too successful. Complete burns have been difficult, if not impossible, to secure. It is felt that knocking down or crushing the oaks, allowing them to dry for several months or a year, and then burning will provide not only a complete burn but also a good ash for reseeding. A test of this procedure has been established on the old W. W. Ridinger Ranch in cooperation with Warren Hardin.

Girdling has also been practiced in the county, although no formal plots have been carried out. Different growers indicate oaks take 2 - 4 years to die after girdling. It is believed that girdling takes more time than using the cut surface method. Observations have been made on the Munson Church Ranch since 1954 on blue oak that had been girdled in 1952. By the fall of 1954 the trees were 99-100% dead, with no branches fallen. Some small branches and tops started falling in 1955. By 1956 all the tree tops and small branches had fallen down, but none of the main trunks and largest limbs had fallen. Observations on December 10, 1957, 5½ years after girdling, found the entire tree starting to fall, with many completely down.

Even though chemical treatment can be successful to prevent resprouting, mention should be made that local experience over many years has shown that goats, under proper management, are extremely effective in controlling sprouts.

The possibility of using oaks as a source of pulp was mentioned in the original project. This possibility may become a reality sooner than expected. A paper products concern is expecting to make soon a commercial test of 1200 cords of oak wood. Some of the wood is being supplied by Placer County people. Such an outlet will give further impetus to range improvement. The local work and determinations of satisfactory stump treatment will have wider demand and use.

EXPERIMENTAL WATERSHEDS

DEVELOPMENT

Stream gaging stations and settling basins were constructed on two watersheds in the summer of 1956. Two standard rain gages and one recording gage were installed, as well. A third watershed was put under control in the summer of 1957.

Watershed	Acreage (est.)	Proposed Treatment
Placer A	59.2	None
Placer B	34.0	Chemical
Placer C	15.5	Bulldozer

SOIL SURVEY

A detailed soil survey was made of all areas by Rodney J. Arkley, Department of Soils and Plant Nutrition, Berkeley. The survey shows that the soils are quite uniform throughout the three watersheds. Principle soils involved are Auburn, Exchequer, and a minor amount of White Rock. His detailed summary follows.

PLACER COUNTY -- STUDY OF SOILS IN 3 WATERSHEDS

Statistical analysis of soil depth.

Water-shed	Acres	Av. Depth Inches	Standard Deviation s	Standard Error E	Unbiased s^2	Number of Samples	% Auburn	% Exchequer	% White Rock
A	59.2	21.5	6.24	1.27	40.7	24	67	16.7	16.7
B	34.0	21.5	8.60	2.22	79.6	15	40	53	7
C	15.5	18.3	7.45	1.79	45.0	13	54	31	15
ABC		20.7	7.02	.97					

Comparisons btw watersheds	Standard Error of Difference E_d	Difference D	D/E_d	F_x	$F_{5\%}$	$F_{1\%}$
A-B	0	0	0	1.96	2.17	2.93
A-C	2.19	3.2	1.46	1.10	2.51	3.80
B-C	2.85	3.2	1.12	1.77	2.64	4.05

Since D/E_d is smaller than E_d in all comparisons, there is no significant difference between the average depths on the 3 watersheds.

Since the F test shows F_x less than F at both the 5% and 1% level, it can be assumed that there is no significant difference between the frequency distributions of soil depth on the three watersheds.

Thus the average depth of the combined watersheds may be used for all computations.

In Addition, Dr. Arkley ran laboratory analyses on soil samples for pH and moisture constants. The results are interpreted to mean that rainfall must be 5.4 inches in excess of evapotranspiration before much runoff can be expected, provided that rainfall is not more rapid than infiltration. Inspection of the rainfall and and runoff records will reveal that 7.12" of precipitation was recorded from October through February 22, 1957, and runoff started the week beginning February 22. The Auburn soils average about 2.3 inches of available water per foot and the Exchequer 2.85. The detailed lab report follows.

Sampled:
April 1957
R. J. Arkley

Analysis:
G. Drumm
Jan. 3, 1958

Soil Type	No.	Depth	Moist. Equivalent	1/3 atm. H2O	15 atm. H2O	1/3 = 15 atm. ratio	pH	1/3 - 15 atm. in %	1/3 - 15 atm. in. of H_2O*	
Exchequer	BE-1	0-12"	19.0	22.4	5.64	4.0	5.9	16.8	2.8	
Auburn	BA-1	0-12	18.0	20.5	6.14	3.3	6.4	14.4	2.4	
	BA-2	12-25	19.2	22.1	8.32	2.7	6.4	13.8	2.5	6.3
	BA-3	25-33	18.3	21.0	8.39	2.5	6.3	12.6	1.4	
Exchequer	CE-1	0-12	19.7	22.8	6.34	3.6	6.3	16.5	2.9	
Auburn	CA-1	0-7"	17.7	20.8	6.53	3.2	5.6	14.3	1.4	
	CA-2	7-27	18.9	21.8	8.73	2.5	6.2	13.1	3.7	6.7
	CA-3	27-35	22.2	25.1	10.8	2.3	6.2	14.3	1.6	

* Calculated on the basis of the assumption: bulk density = 1.40

Sample numbers refer to samples indicated on map of EXPERIMENTAL WATERSHED

Placer County, Sec. 17, 18 T13 N, R 17 E.

FORAGE DENSITY AND COMPOSITION

Eight transects were established on each of the three watersheds. The transects were point-stepped February 27, 1957, to determine density of ground cover and its botanical composition. The striking point is the almost total lack of ground cover. This is a total lack in the thickly wooded areas, with the low density rate reflecting forage in small clearings and in areas of less dense trees. The percentage of total grasses and total forbs are reasonably close in all three watersheds. The detailed report is in the following table.

WATERSHED MANIPULATION STUDY
PLACER COUNTY

	A	B	C
Total Herbaccous ground cover (Density)	5.5	5.0	9.0
Botanical Composition:			
Annual grasses	29.5	35.0	30.5
Trifolium spp.	2.5	9.0	7.0
Erodium botrys	-	2.0	1.5
Total	2.5	11.0	8.5
Brodiaea spp.	28.5	21.5	9.5
Galium spp.	8.0	12.5	6.5
Other forbs	31.5	20.0	45.0
Total Undesirable forbs	68.0	54.0	61.0
Total grasses	29.5	35.0	30.5
Total forbs	70.5	65.0	69.5

Sampled: 2/27/57

Additional point-stepping was done on June 4, 1957. The results are in the table below. It is not considered that this is a reliable indication of forage density and composition. The late date, with much forage totally dry, did not permit accurate determinations.

		Watershed A	B	C
Density		3.75%	2.50%	4.63%
% of				
	Grass	47.5	60.8	39.2
	Clover	1.7	1.7	13.6
	Forbs	50.8	37.5	47.2
	Brodiaea	1.7	1.7	4.8
	Geranium	5.8	3.3	2.4
	Other forbs	43.3	32.5	40.0

PRECIPITATION AND RUNOFF

Records of precipitation and runoff were kept continuously on watersheds A and B from the week ending November 1, 1956 through the month of May, 1957. This season was considered to be a "half-dry" year. Total precipitation was 21.12 inches, where 25 inches were expected. Of particular interest was the distribution of rainfall. A comparison of the per cent of the annual precipitation over various months on the watersheds and at Auburn, some 10 miles distant (airline) is of interest. Precipitation records at Auburn date back to 1871-72.

Per Cent of Seasonal Total Precipitation

	Auburn	Watersheds
October	5.2	9.4
November	10.4	0.0
December	17.1	4.5
January	19.0	13.8
February	18.0	28.3
March	15.3	18.4
April	8.7	11.1
May	3.8	14.5
June and September	2.5	Not recorded

The following table gives detailed precipitation and runoff records. No runoff was recorded until the last week of February. Runoff was not constant in either watershed, but was intermittent until the week ending May 20. Recorded runoff totals amounted to .838% of the precipitation on watershed A and .388% on watershed B. This appears to be an extremely low runoff rate. At least, there is little room for reducing runoff rate by clearing this land.

PLACER COUNTY
PRECIPITATION & RUNOFF RECORD
(1956-57)

	RAINFALL		RUNOFF A		RUNOFF B	
Week Ending	Inches	Monthly Total	Inches	Monthly Total	Inches	Monthly Total
	10.31	1.98		0		0
11-1-56	1.98		0		0	
12-10-56	.93		0		0	
12-17-56	.03		0		0	
	12-31	.96		0		0
1-2-57	.04		0		0	
1-7-57	.04		0		0	
1-14-57	1.58		0		0	
1-21-57	1.21		0		0	
1-28-57	.04		0		0	
	1-31	2.91		0		0
2-4-57	.19		0		0	
2-8-57	.77		0		0	
2-15-57	.22		0		0	
2-22-57	2.09		0		0	
2-27-57	2.71		.047		.037	
	2-28	5.98		.047		.037
3-4-57	1.14		.034		.026	
3-11-57	1.18		.072		.014	
3-18-57	.96		.005		.001	
3-27-57	0.00		0.00		0.00	
	3-31	3.89		.113		.040
4-1-57	.61		.001		0	
4-8-57	0.00		0.00		0	
4-15-57	.97		.003		0	
4-22-57	1.37		.011		.005	
4-29-57	0.00		0		0	
	4-30	2.34		.013		.005
5-6-57	.69		.002		0	
5-13-57	.32		.0		0	
5-20-57	2.00		.002		0	
5-27-58	.05		0		0	
	5-31	3.06		.004		
Totals	21.12	21.12	.177	.177	.082	.082

More detailed and professional interpretations of hydrologic factors will be made by R. H. Burgy at the appropriate time.

EXTENSION EDUCATION

During 1955-57 one or more activities of this project have been shown at eight different formally organized field meetings with 287 in attendance, and on several informal visits with one or more local people. Further discussions on a formal basis have taken place at seven indoor meetings attended by 177 people, and informal mention or discussion has taken place at many other meetings. 106 farm calls have been made where the project has been the primary purpose of the call; and further discussion has taken place on scores of other calls. Telephone and office calls add more contacts. Several news items and two feature stories have been used locally; one feature story by another writer appeared in a farm magazine; and many references have been made on radio. Usage of the material on TV programs is unknown.

SUMMARY

1. Blue oak and live oak stumps can be successfully treated with chemicals to prevent resprouting.
2. Brushkiller and oil sprays or 2,4-D amine painting are both effective, with 2,4-D amine painting being the more economical method.
3. Other materials tried to date for stump treatment appear to be no better than those above.
4. Blue oak, live oak, and digger pine can be effectively killed by the cut surface method.
5. Costs of cut surface treatment (no clean-up) ranged from three to four dollars per acre, depending on type of trees treated, density of stand, size of trees, slope, amount of second growth, and condition of the underbrush.
6. Feed production can be greatly increased where oaks are removed.
7. Mechanical clearance is successful, though relatively costly.
8. Fire without suitable advance preparation is not an effective tool for oak removal.
9. Girdling successfully kills oak and digger pine, though it is more time consuming and takes a longer time for the trees to die than in the cut surface method.
10. Goats are an exceptionally good tool to control resprouting from either stumps or after a fire.
11. A market exists for a certain amount of oak to go into domestic wood use and into charcoal production. A market may develop for the use of oak in the pulp industry.
12. Three experimental watersheds have been established to measure hydrologic factors related to manipulation of the vegetative cover.
13. The above area has been surveyed to determine soil types and vegetative cover.
14. Precipitation and runoff records of two watersheds in the 1956-57 season indicated a low runoff rate.

ACKNOWLEDGEMENTS

The project has been one involving a large number of people. Cooperation and assistance from all has been excellent. Such relationships have made the project a most pleasant one.

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R. H. Burgy is in charge of the over-all experimental watershed phase of the project.

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To all, a word of thanks.

Walter H Johnson

Walter H. Johnson
Farm Advisor
Placer County