California FORESTRY Note

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RAILROAD GULCH: A SILVICULTURAL DEMONSTRATION OF UNEVEN-AGED MANAGEMENT ALTERNATIVES

A PROGRESS REPORT

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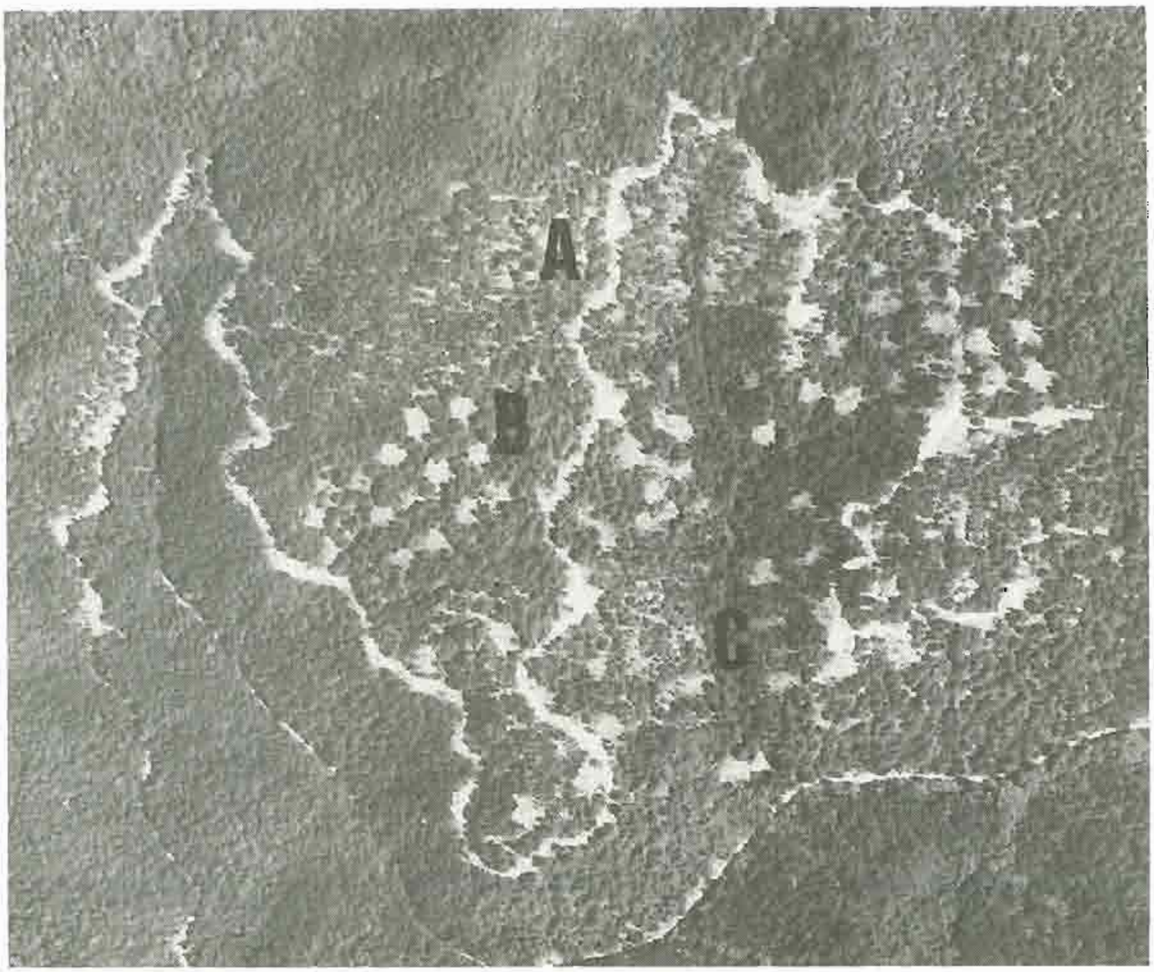

Figure 1. Aerial photo of study area 6 months after harvest. At "A", individual-tree selection was used. At "B", group selection was used. "C" is in an area where a combination of the two was used. Scale: 1 inch = 1,000 feet.

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INTRODUCTION

In 1981 the California Department of Forestry implemented a program to fund selected research and demonstration projects on California's state forests. The funds for this program came from the state's "Forest Resource Improvement Fund" (FRIF), which is generated from state forest timber sale revenues. The primary criterion for selection of funded projects was the "demonstration values and statewide application of study results to land management problems of small forest landowners." Other funding considerations included the project's significance to current forest practice and water quality concerns, and the potential for increasing forest land productivity.

Among the first projects selected for FRIF funding was a proposal by Dr. John A. Helms, Associate Professor in the Department of Forestry and Resource Management, University of California at Berkeley. Entitled "The Effect of Silvicultural System and Stocking Level on Productivity, Costs, and Site Disturbance," this project was implemented in 1982-83 as the Railroad Gulch Silvicultural Demonstration. The study was designed to evaluate alternative silvicultural prescriptions for uneven-aged forest management in the redwood/Douglas-fir region of northern California. By documenting differences in long-term productivity resulting from several different management strategies, specific quantitative information will eventually become available to help guide decision making by small private forest landowners. In addition, the 270-acre Railroad Gulch Silvicultural Demonstration area will serve as an ongoing field laboratory where observations can be made on forest growth and site response to a wide range of silvicultural treatments.

This paper summarizes the general approach and initial findings of the study, which are documented more fully in the Final Report to the California Department of Forestry (Helms 1984).

OBJECTIVES

The three specific objectives of the study are:

1. To quantify the relationship between level of stocking and stand growth.

2. To evaluate financial costs and benefits of alternative silvicultural strategies.

3. To quantify the effects of alternative silvicultural prescriptions on understory growth and soil surface displacement.

STUDY AREA

The study is located on the Jackson Demonstration State Forest in Mendocino County, California. The harvested area is in the headwaters of Railroad Gulch, a tributary to Big River, which enters the ocean at the town of Mendocino, five miles to the southwest. Elevations range from 180 to 880 feet and slopes range from 0 to 80 percent.

Soils on the upper slopes are Van Damme clay loams (clayey, vermiculitic, isomesic typic tropohumults). The Irmulco-Tramway complex (fine-loamy, mixed, isomesic, ultic tropodalfs) predominates on the steeper side slopes (USDA Soil Conservation Service 1986).

The area was logged once previously, about 1918, and subsequently burned annually for several years to allow cattle grazing. Then in 1924, burning was suspended and much of the area was planted to redwood (Sequoia sempervirens) on an eight-foot spacing (Ellis 1925). By 1983 vegetation consisted of scattered redwood sprout clumps intermixed with some surviving hand-planted redwood, as well as volunteer Douglas-fir (Pseudotsuga menziesii) and grand fir (Abies grandis). Large numbers of tanoak (Lithocarpus densiflora), a vigorous hardwood sprouter and prolific seeder, had also invaded the stand. Probably as a result of the stand's fire history, tanoak was the most abundant species in 1983, with 140 stems per acre greater than four inches diameter breast height (dbh).

This area was chosen for the project because of its accessiblity to the public for demonstration purposes and because the low to medium quality of the site is representative of many small private ownerships in the redwood region.

STUDY DESIGN

One 10-acre and thirteen 20-acre treatment blocks were established (Figure 2). The 10-acre block and one of the 20-acre blocks were established as controls, and the remaining twelve blocks received various harvest treatments (Table 1). Block size was chosen to provide an adequate area for demonstration of alternative uneven-aged stand structures.

The twelve harvested blocks are being used to demonstrate combinations of four intensities and three methods of harvest. Specifically, harvest intensity was varied by removing approximately 20, 30, 40, and 50 percent of the preharvest basal area. For each level of residual growing stock, three methods of removal were used: individual-tree selection, group selection, and a combination prescription consisting of group selection with thinning between the groups. The three methods were chosen to create quite different stand structures. They vary in difficulty of implementation, and in the resulting growth and development of trees, sprouts, and understory.

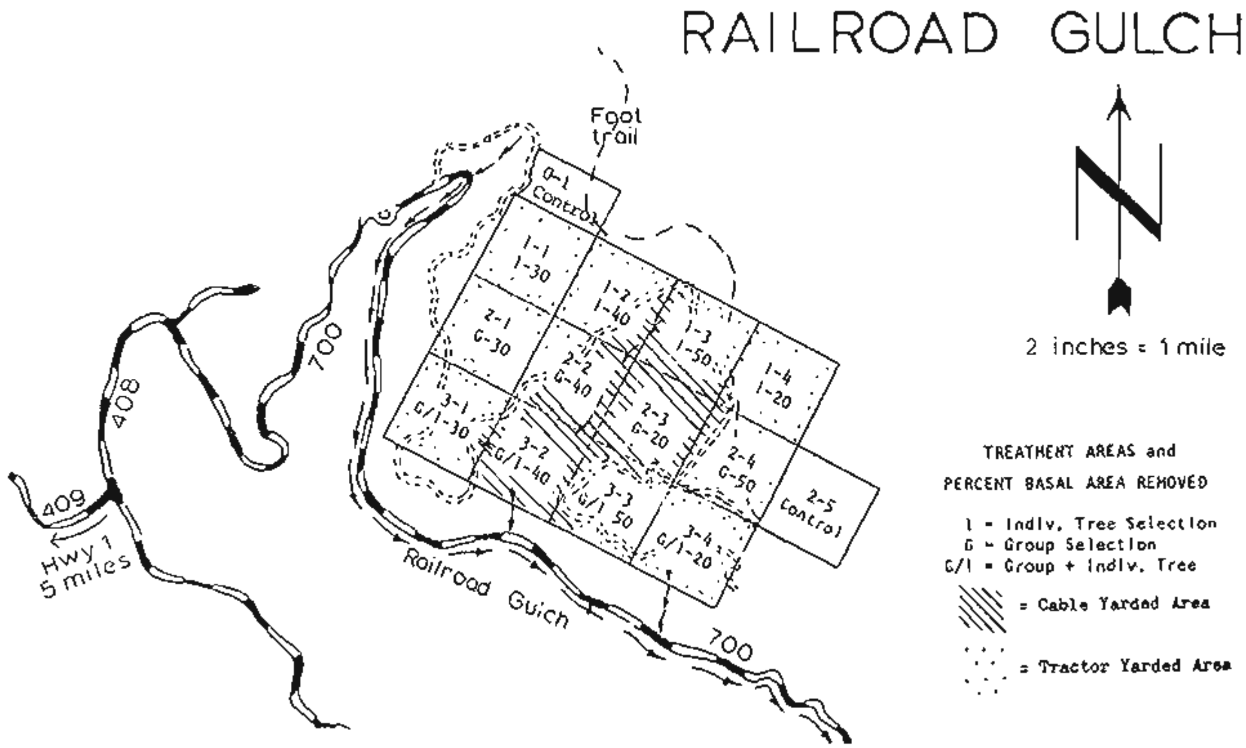

Figure 2. Treatment block layout. Number following letter symbol refers to the percentage of basal area removed.

Table 1. Treatment block characteristics.

Prescription	Treatment Block	Basal Area Removed (% of existing)
Control	0-1	--
	2-5	--
Individual Tree Selection	1-1	30
	1-2	40
	1-3	50
	1-4	20
Group Selection	2-1	30
	2-2	40
	2-3	20
	2-4	50
Group And Individual Selection	3-1	30
	3-2	40
	3-3	50
	3-4	20

Inventory System

A random systematic inventory scheme was used. Twenty permanent circular tenth-acre plots were established in each treatment block prior to logging, resulting in a ten percent sampling intensity. The center of each permanent plot was marked using a three-foot rebar stake with an attached aluminum identification tag marked with treatment block and plot number. In each plot, distances and bearings were measured to three reference trees, thus ensuring relocation of plot centers following logging disturbance (Kennedy 1983).

Within each plot all conifers ≥ two inches dbh and all hardwoods ≥ four inches dbh were assigned a number, tagged, and measured. Measurements included dbh, live crown ratio, and five- and ten-year radial growth at breast height. Height to the nearest foot was measured on eight trees per plot using a clinometer. A total of 260 permanent plots and 8,000 tree records were established. Table 2 summarizes stand characteristics by treatment block.

A computerized redwood growth model known as CRYPTOS (Krumland and Wensel 1982) was used for inventory analysis and projection of growth following treatment. Use of the collected data for input for this model is described in detail by Kennedy (1983).

Table 2. Inventory summary by Treatment Block.

Treatment Block	dbh (in)	Trees /ac	BA (ft^2/ac)	Volume (bd ft/ac)	Site (50 yr) DF	Site (50 yr) Rdwd	Area (ac)
1-1	15.2	234	293	57,630	142	121	21.8
1-2	17.4	218	362	68,840	134	109	20.0
1-4	15.3	253	323	57,360	137	115	18.9
2-1	16.4	240	350	49,160	118	93	20.1
2-2	14.7	194	230	38,200	136	112	18.7
2-3	16.0	224	312	79,020	148	123	17.8
2-4	16.0	231	324	47,560	121	97	21.4
2-5	15.1	223	277	48,690	136	110	20.0
3-1	17.8	181	315	55,620	126	102	21.2
3-2	13.5	187	187	26,650	129	103	20.6
3-3	16.6	167	233	51,410	140	120	20.4
3-4	13.9	198	209	22,090	117	87	21.9
Average	15.8 ±1.2	210.9 ±24.7	286 ±54	50,210 ±15,200	132	108	

On every permanent plot, height and breast-height age of two dominant redwood sprouts and two dominant Douglas-fir were measured for site determination (Krumland and Wensel 1977). If one species was absent then additional site trees of the other species were measured.

Within each treatment block six to eight permanent photo points were established prior to logging. Subsequent photos will record the development of vegetation over time.

Following logging, three 0.01-acre plots were established in each treatment block to assess disturbance to ground cover and to record presence, abundance, and cover of understory species.

RESULTS

Harvest

Volume estimates from the preharvest inventory indicated an average conifer volume of 50,000 board feet per acre. Stocking was highly variable, however, and volume estimates by 20-acre treatment block ranged from 22,000 to 79,000 board feet per acre (Table 2).

Road construction and harvest were completed in 1983. A total of 3.5 million board feet was harvested, for an average of about 15,000 board feet per acre. Overall conifer basal area was reduced by about 30 percent and species composition was maintained at preharvest levels. Unfavorable market conditions precluded harvest or treatment of hardwoods.

Table 3 shows the differences between the percent of basal area designated for removal and the percent of basal area actually harvested. Four main factors account for these differences:

1. Difficulty in marking to precise target levels.

2. Preharvest allowance for removal of seven percent of the volume due to logging damage. This figure was only an estimate, and may or may not have occurred.

3. Trees marked but not felled due to felling difficulties, such as interlocked limbs in redwood clumps.

4. Estimates of basal area harvested were based on re-examination of permanent plots after harvest. This approach is not well-suited to evaluating group selection blocks because of the varying proportion of permanent plots which occurred either in the harvested, or non-harvested, portion of the stand.

Table 3. Comparison of desired and actual harvest levels

Treatment Block	BA before harvest (ft^2/ac)	BA after harvest (ft^2/ac)	Percent BA removed	Desired Cut (%)
1-1	293	176	40	30
1-2	362	191	47	40
1-4	323	261	19	20
2-1	350	261	25	30
2-2	230	156	32	40
2-3	312	256	18	20
2-4	324	161	44	50
3-1	315	180	36	30
3-2	187	117	37	40
3-3	233	136	41	50
3-4	209	121	24	20

Group Selection vs. Individual Tree Selection

a) Harvesting

Observations of the three methods of tree removal were made by Cole and Parrish (1984). They found that group selection worked well in areas that were tractor yarded. Due to the concentrated nature of logs, skid trail routing was simplified, and ground disturbance and damage to residual trees were less than for comparable intensities of individual-tree selection. In cable yarded areas, however, the use of group selection reduced productivity, as it is difficult to yard logs from groups that are some distance downslope from landings without damaging trees in unmarked areas between the groups.

Of the three methods of tree removal, the combined "individual-tree and group selection" option seems to profit from the primary advantages of the two approaches while avoiding their most serious drawbacks. Under this option judicious marking of individual trees between the groups can be used to capture mortality and remove lower quality trees while simultaneously facilitating logging. This latter step is achieved, however, only when markers take into account skid trail and cable corridor routing. Presumably this will be easier after the initial entry, once roads, landings, and major skid trails have been constructed. At that time logistical requirements can be more easily visualized. Experienced tree markers can anticipate such problems as inadequate cable corridors, and can select trees for removal between the groups in such a manner as to accommodate the logging system as well as to achieve desired residual growing stock levels. With subsequent entries, as the stand comes under increasingly intensive management, this flexible strategy promises to provide better overall control of stocking and growth than either individual-tree or group selection alone.

b) Regeneration

In the first year following harvest, biological differences between harvest methods were also apparent. For example, redwoods seemed to sprout in higher numbers and with greater vigor in the small openings created by group selection. Counteracting this, however, sprouts seemed to suffer greater wildlife depredation in the group selection areas than in nearby individual-tree selection areas of comparable intensity. This is probably due to the creation of better deer habitat resulting from increased regeneration and edge effect. The long-term growth effects of these two counteracting phenomena remain to be evaluated.

In the two years after harvest almost no seedling regeneration has been observed in any of the treatment blocks.

FINANCIAL ANALYSIS AND REGULATION

In general, a small-woodland owner has the choice of either a heavier initial cut, which raises more capital but results in lower yields and income in subsequent harvests, or a lighter initial cut, which raises less capital but results in greater yields and income in subsequent harvests.

A comparison of present net worth (PNW) was made to evaluate the various treatments. Table 4 compares PNW for each prescription, both for the period of conversion and for the subsequent regulated stand. The aggregate PNW is the net of the PNW of a series of entries to conversion, and that of a perpetual series of entries in the regulated state. Table 4 shows that the highest aggregate PNW values were found for treatments 2-4 (group selection, removing 50% of existing basal area), 1-1 (individual-tree selection, removing 30%), and 3-3 (group selection plus individual-tree selection, removing 50%). To summarize, the study has shown that the financial attractiveness of treatment increases with low residual stocking, heavy initial harvests, and short conversion periods.

Using the CRYPTOS simulator with a ten-year re-entry cycle to harvest periodic growth, it was estimated that the time required to convert the units of this study to a fully-regulated state varied from 30 to 120 years, depending upon initial stand heterogeneity and complexity of silvicultural prescription.

Table 4. Present net worth for each prescription in 1983.

Treatment Block	Volume after 1983 harvest	Length of conversion	PNW for converting to regulation		PNW for regulated stand		Aggregate PNW	
	MBF/acre	years	$/acre	rank	$/acre	rank	$/acre	rank
1-1	41.5	30	2100	3	1060	2	3160	2
1-2	46.9	40	1891	4	447	3	2338	4
1-4	46.5	20	-2431	10	2232	1	-199	9
2-1	35.5	110	-551	9	10	10	-541	10
2-2	26.3	60	923	6	91	5	1014	6
2-3	63.2	90	-2586	11	31	8	-2555	11
2-4	23.8	70	3168	1	40	7	3208	1
3-1	33.7	100	1632	5	12	9	1644	5
3-2	19.4	60	618	7	82	6	700	7
3-3	32.7	60	2500	2	110	4	2610	3
3-4	15.7	100	557	8	8	11	565	8

FUTURE WORK

Any silvicultural analysis based on a single entry is of limited value. Theoretical prescriptions can be made with the aid of simulation models such as CRYPTOS, but such projections can be validated only by collecting time-series data. The Railroad Gulch Silvicultural Demonstration has established an excellent base for future evaluation of the effects of alternative prescriptions on growth and yield. The project has also provided baseline data for the future analysis of understory vegetation and recovery of areas disturbed by timber harvest activities.

Additionally, the project area now serves as an ongoing "field station" for the demonstration of alternative silvicultural prescriptions and harvesting methods. A short foot-trail has been installed and a summary brochure is being prepared to facilitate the transfer of information to landowners and forestry professionals. The various stand structures created in 1983 also permit qualitative comparisons of related values such as post-harvest plant succession, wildlife habitat, aesthetic impact, and watershed protection.

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