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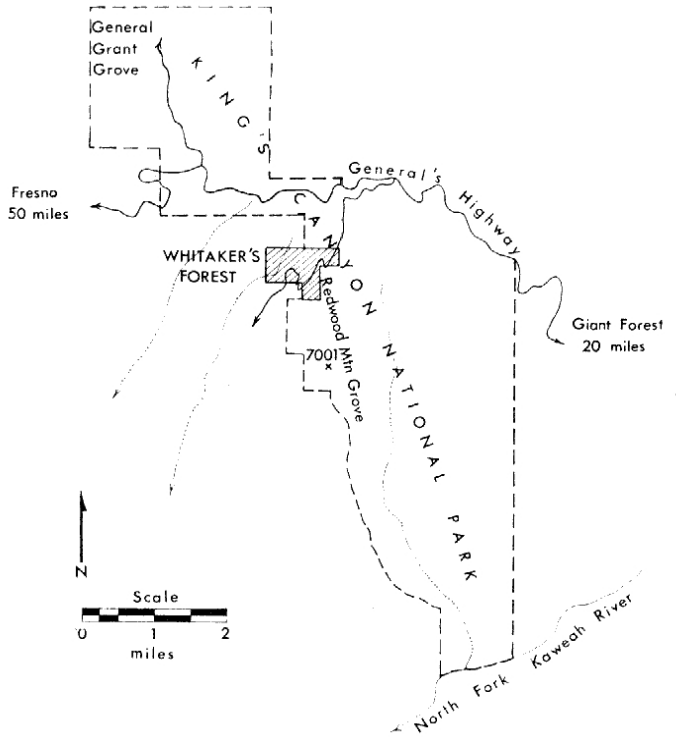

Fuel Conditions and Fire Hazard Reduction Costs in a Giant Sequoia Forest

H. H. Biswell. R. P. Gibbens and Hayle Buchanan
Photographs by R. P. Gibbens; map by James K. Agee

IN RECENT PERIODS as long as 100 years, California's groves of giant sequoia have been protected from destructive forces – including the fires which were once an integral part of their environment. There is today a growing concern that such protection, while of vital importance, is not of itself an adequate substitute for natural habitat conditions. Plant successions are changing conditions within the groves the understory shade-tolerant trees, chiefly white fir, are increasing in number; and large amounts of debris are accumulating.

With the steady increase in fuel buildup, irreplaceable giants are faced with an ever-increasing threat to their existence because even modern fire-fighting equipment and technology are not totally effective in suppressing wild- fires in such areas. The fire-scarred trunks of giant sequoias attest to their ability to

survive repeated ground fires. However, the sequoia trees may not withstand crown fires which are sure to occur if a fire burns uphill through the heavy fuel accumulations and understory trees during the dry season. Protection from wildfire is vital, but it is apparent that steps must be taken to insure a fire of relatively 3ow intensity, if one should occur.

Investigations of ways to reduce fuels and improve esthetic values in giant sequoia groves are under way on Whitaker's Forest, a 320-acre forest owned by the University of California. Whitaker's Forest lies on the western slope of Redwood Mountain in Tulare County and adjoins the magnificent Redwood Mountain grove of giant sequoias in King's Canyon National Park. Plant successions following logging of Whitaker's Forest in the 1870's have resulted in the development of extreme fire hazards. Dense stands of incense cedar, Scouler willow, second-growth sequoia, and white fir became established following the logging, which removed most of the pines and about half of the original stand of giant sequoias.

In the dense second-growth stands, many of the incense cedars which became established following the logging disturbance of the 1870's have succumbed to competition and are now dead, but still standing. For example, on a photo plot of 33 x 33 feet there were 19 dead trees, the equivalent of 760 per acre. These dead trees help form a fuel bridge between the ground and the overhead canopy. Another fuel type which is characteristic of the second-growth stands is Scouler willow debris. This formerly abundant species grew in dense clones which have now been shaded out and killed. The slowly decaying stems form dense tangles of fuel. Much heavy debris from limbs and fallen trees of other species is found on the ground also. Such accumulations are especially prevalent where the relatively short-lived white fir stands are approaching maturity, or have succumbed to disease or insects.

Understory trees are found in great numbers on Whitaker's Forest as well as in many other giant sequoia groves. These trees, principally the shade-tolerant white fir, have increased steadily in numbers since the inception of protection from fires. Now they frequently form a continuous mass of fuel from the ground to near the tops of the tallest trees. Where these trees have grown high in the understory, with heavy debris accumulation below, serious fire hazards exist. Bear clover and manzanita occur as understory to pines on drier sites on Whitaker's Forest. When these shrubs are draped with pine needles they form a very flammable fuel.

In 1964 a manipulation program was started on Whitaker's Forest with the cooperation of the California Division of Forestry and its Miramonte Conservation Camp. A "minimum" treatment has been applied to about 60 acres. This treatment consists of the removal of understory white fir and incense cedar trees between one and 11 feet tall, cutting of dead standing trees, and removal of heavy debris on the ground.

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Above: a tangle of debris from dead clones of Scouler willow creates high fire hazard. Dense understory of white fir shown in back-ground also adds to likelihood of disastrous fire. Base of large second-growth giant sequoia appears at right, a white fir trunk at left.

At right: heavy fuels from white fir debris have accumulated near a mature giant sequoia. Decadent stands of white fir are found in many groves of Sequoia gigantea

Below: views of a one-tenth acre test plot before (left) and after (right) clearing. Dense understory stand of white fir and incense cedar blocks view of mass of Scouler willow debris on ground in left-hand photo. Hazards were greatly reduced and vistas opened up by treatment, as seen in right-hand photo.

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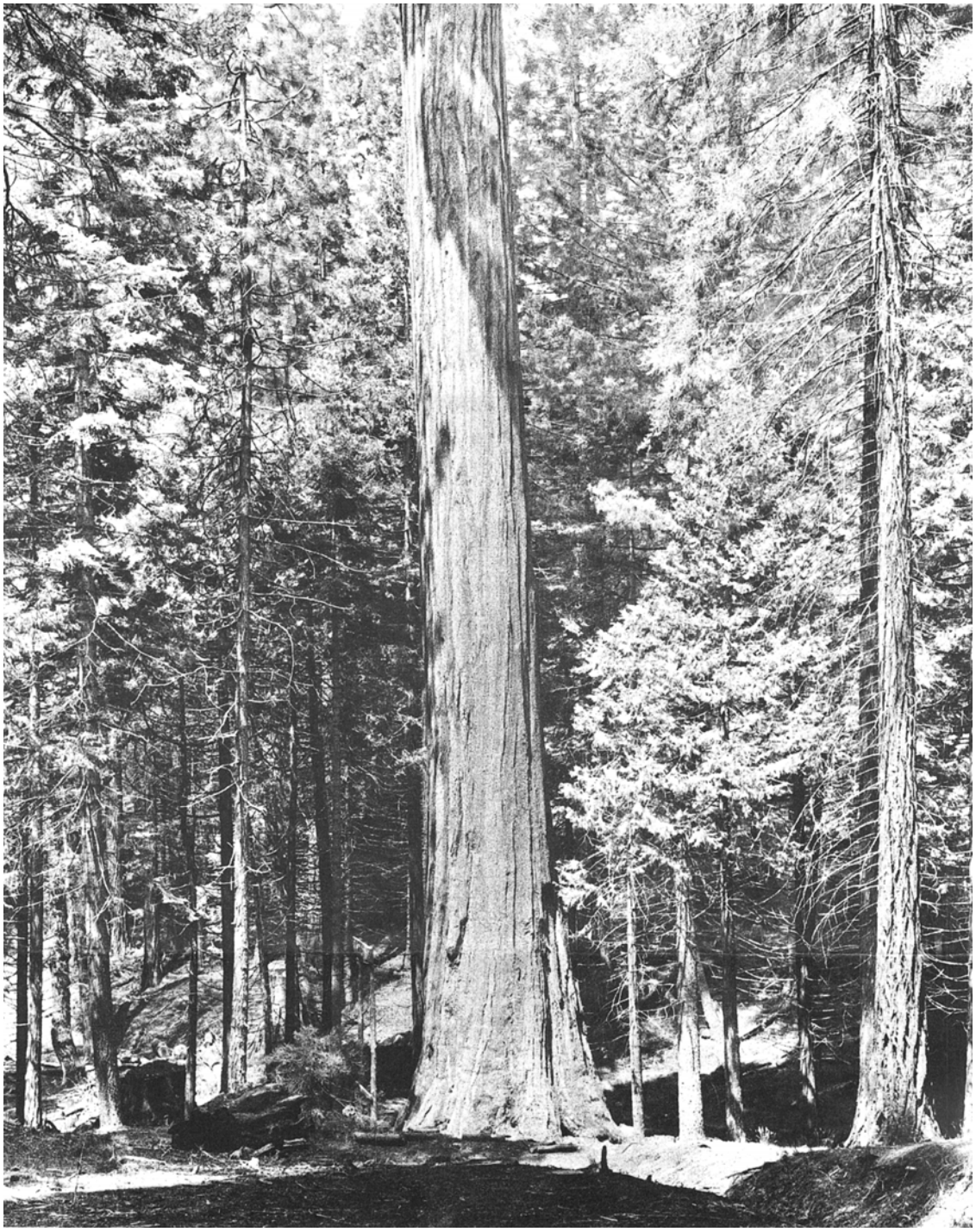

Above, the result of understory manipulation to reduce wildfire hazards and to improve esthetic value of giant sequoia at the University of California's 320-acre Whitaker's Forest adjacent to King's Canyon National park.

MATERIALS REMOVED, LABOR REQUIRED, AND CALCULATED COSTS OF MANIPULATION ON FOUR TENTH-OF-AN-ACRE PLOTS IN SECOND-GROWTH GIANT SEQUOIA.

Material removed	Plot 1	Plot 2	Plot 3	Plot 4
Number of live trees cut	41	125	93	119
Number of dead standing trees cut	17	55	36	112
Total trees cut	58	180	129	231
Estimated weight of dead material (lbs)	3,225	3,965	5,070	1,770
Estimated weight of live material (lbs)	20	1,235	730	1,600
Total weight of material burned	3,245	5,200	5,800	3,370
Man-hours of labor				
Man-hours required to cut standing trees* (with chain saw)	0.42	0.83	1.33	1.50
Man-hours required to buck up material (with chain saw)	1.67	0.84	1.67	0.74
Man-hours to pile material on fires	1.30	1.96	1.43	1.45
Man-hours to tend fires and complete burning	0.37	0.97	0.45	0.47
Total man-hours	3.76	4.60	4.88	4.16
Number of fires built on plots	7	9	5	7
Calculated costs (Labor at $2.38 per hour, chain saw at $2.00/hr.)				
Labor to cut standing trees	$1.00	$1.98	$3.16	$3.57
Chain saw costs for standing trees	0.84	0.84	1.32	1.50
Total thinning costs	$1.84	$2.82	$4.48	$5.07
Labor for bucking up material	3.97	2.00	3.97	1.76
Chain saw costs for bucking up	1.68	0.84	1.68	0.74
Total bucking up costs	$5.65	$2.84	$5.65	$2.50
Labor for piling material	3.09	4.66	3.40	3.45
Labor for tending fires	0.88	2.31	1.07	1.12
Total costs (supervisory costs not included)	$11.46	$12.63	$14.60	$12.14
Cost per ton of material removed	7.07	4.85	5.03	7.23

*A two-man crew on chain saw with the exception of cutting standing trees on plot 1 where only one man was needed.

The material is disposed of by burning in small piles below the canopy of larger trees in the fall and spring months when the danger of wildfire is minimal. Large amounts of material have been removed and the continuous vertical distribution of fuels broken up by this treatment. Because the treatment does not appreciably affect those trees in dominant- or subdominant-crown classes, the composition of the forest is not changed significantly for the present.

In the second phase of the manipulation (yet to be done) it is planned to remove some of the intermediate sized incense cedars and white fir (which seeded in following the logging of the 1870's) growing within about six feet of sequoias. This will not be a thinning to promote growth of incense cedars and firs; rather, the purpose will be to reduce competition to – and open up views of – the sequoias and to further reduce fire hazards.

At a later date prescribed burning will be tested in the different types of fuels on the forest floor. These treatments are designed to result in more pines inn the forest and fewer incense cedars, and to restore plant patterns and successions

that prevailed in the primitive condition before the white man intervened. Increasing the reproduction of giant sequoia is not a special objective of the manipulation on this forest, although some may result from the disturbances. The forest is well stocked with second-growth redwood, far more than are necessary to replace those which were logged off.

To determine the man-hours of labor required to perform the minimum treatment, four tenth-of-an-acre plots were marked off for manipulation. Plots were selected where debris, dead trees, or understory trees were fairly representative of maximum conditions encountered. A careful record was made of the time required to perform each step in the manipulation operation. Weight of material to be burned was estimated, after a period of training with scales.

The results obtained are presented in the table above. Assuming a labor cost of $2.38 per hour and chain-saw cost of $2.00 per hour, the calculated cost ranged from $114 to $146 per acre. This does not include costs of supervision, etc. These figures approach the maximum cost since few areas would have more material to dispose of. The average amount of fuel removed from the four plots was 44,040 pounds per acre. The average number of trees cut per acre was: living, 945; dead, 550.

While the cost of treatment appears high, it should be borne in mind that the manipulation removed 80 years' accumulation of debris and lowered the fire hazard conditions for many years to come. Also, there has been an improvement in esthetic values. No monetary value can be placed on giant sequoias because they are a priceless heritage to be preserved at almost any cost.

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