Cleaning to Favor Western White Pine—Its Effects Upon Composition, Growth, and Potential Values

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THE MANAGEMENT OF western white pine (*Pinus monticola*) requires the production of a high proportion of valuable white pine crop trees in order to defray the costs of protection from blister rust. Current average selling prices of lumber give white pine about $50 per m.b.f. advantage over western larch (*Larix occidentalis*) and Douglas-fir (*Pseudotsuga menziesii*), the next most valuable species common to the type. On the average site, yielding 50 m.b.f. per acre at 120 years of age, a 10 percent difference in white pine volume would amount to $250 per acre.

Unfortunately, the forester cannot depend upon nature to provide composition that is good from a financial standpoint. Occasionally nearly pure stands of white pine are found, but they are exceptional. Ecologically white pine is a seral tree growing with a number of other species. It generally reproduces quite well, but can be suppressed by faster growing intolerant species or advanced reproduction of more tolerant species, all of which reproduce more abundantly than white pine (*2*). Western larch, a very common associate, and lodgepole pine (*Pinus contorta*) outstrip white pine in height growth by 1½ times during the first 30 years of a stand's life. Larch retains some height advantage until maturity. Lodgepole pine slows down by the 50th year and is soon overtopped by white pine. Grand fir (*Abies grandis*) height growth is equal to that of white pine during this period, and Douglas-fir growth nearly equals that of white pine. Ordinarily western hemlock (*Tsuga heterophylla*) grows much more slowly than white pine, but on north aspects and under a partial overwood both hemlock and grand fir equal or outgrow white pine.

During the first 30 years of the life of white pine stands, the composition of the mature stand is formed from the diverse reproduction that survives the regeneration period. Growth and yield studies in the white pine type show that stand composition does not change materially between the 30th year and the rotation age of 120 years (*3*). Cleaning to improve stand composition has its best chance of success at the least cost during the early portion of this formative period. Undesirable species can be removed with the least effort, and desirable crop trees can be given a full measure of growing space before competition and age reduce their tolerance and vigor.

Two cleanings were made in 1935 in stands typical of many reproduced areas of the Inland Empire. Both of these stands were approximately 30 years old at the last remeasurement of the tests; so their composition should be fairly well established. The stands were cleaned by CCC labor using hand pruners. The cleanings required from one to four man-days per acre.

Prior to remeasurement of the plots 20 years after treatment, stand composition was judged on the basis of milacre quadrat stocking. This was necessary because of the difficulty of determining crown classes in juvenile stands. In using this measurement method, the tallest tree on each quadrat was considered the dominant tree for that unit, and the sum of these unit dominants was considered the dominant stand. The percentage of these stocked quadrat units on which western white pine was the dominant tree was the measure of the effectiveness of cleaning in improving composition. Twenty years after cleaning, the crown classes were sufficiently discernible so that conventional stand tallies by crown classes were made.

Kaniksu Study

This study is located in the Upper West Branch Drainage of Priest River in the Kaniksu National Forest, Idaho. It tests the development of well stocked white pine when released from a competing stand composed primarily of western larch and lodgepole pine. The stand originated after the old growth was burned in 1926. Stand density on the study plots ranged from 9,000 to 21,000 trees per acre, with an average of 13,000.

The plots were located on a level bench. The soil is clay loam in texture to a depth of about 2 feet underlain by a clay hardpan.

The test was established in 1935 when the stand was eight years old and consisted of three 0.4-acre plots treated as follows:

Heavy cleaning.—All trees higher than 0.5 foot except white pine and redcedar were cut.

Moderate cleaning.—All white pine and cedar trees were left. Larch trees within 8 feet of a white pine were removed and Engelmann spruce (*Picea engelmannii*) and Douglas-fir trees were cut only when crowding white pine. In the absence of white pine, smaller larches were left and given an 8-foot spacing.

Check.—Uncleaned.

On a milacre stocking basis, moderate cleaning increased the proportion of white pine in the dominant stand from 1 percent before cleaning to 45 percent after cleaning. On the heavily cleaned plot the increase was from an initial 9 percent to 70 percent. Cleaning reduced the densities of the trees taller than 0.5 foot by approximately 70 percent on both the moderately and heavily cleaned areas,

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TABLE 1.—PROPORTION OF WHITE PINE IN THE KANIKSU NATIONAL FOREST CLEANING PLOTS 20 YEARS AFTER TREATMENT

Treatment	White pine in total stand	White pine in dominant stand		White pine in largest 200 trees per acre	
		Number stems	Cubic volume	Number stems	Cubic volume
	Percent				
Heavy cleaning	19	61	76	81	86
Moderate cleaning	22	30	39	40	45
Uncleaned	6	0.5	0	0	0

and left cleaned stands of about 2,800 stems per acre.

Results. — Composition results from this study at the end of the fourth and ninth years after cleaning have been reported by Wellner (*4, 5*). During this period larches shorter than 0.6 foot in height grew rapidly enough to overtop many of the white pines that had been placed in a dominant position by cleaning. Nevertheless the white pine, having less competition, showed great changes in its development after being released. After four years the pines on the weeded plots were stocky with dense blue-green foliage as compared to the slender sparse dark green foliage on pines in the uncleaned plots. Weight of foliage per seedling, on an ovendry weight basis, as well as stem diameter, was half again as great on the weeded plots as on the unweeded. No differences in pine height growth during the first four years were apparent, but by the end of the ninth year the average height of white pine on the heavily cleaned plots was nearly three times that on the check plot, while the pines on the moderately cleaned plots were nearly twice as tall as their unweeded contemporaries.

Measurements made 20 years after cleaning show that in spite of the rapid response of small residual larch seedlings left, desirable composition has been maintained (Table 1). In terms of the total stand, cleaning has had only a small effect on white pine composition. Approximately 20 percent of the total number of stems are white pine in the cleaned stands compared to 6 percent in the check stand. In terms of the percentage of white pine in the dominant crown classes, cleaning has been very effective. On the check plot larch and lodgepole pine have maintained their original height superiority with the result that white pine constitutes less than 1 percent of the dominant stand by number of stems and by cubic volume. The dominant stand on the heavily cleaned plot is high value white pine: 61 percent of the stems and 76 percent of the volume. Improvement in composition has been only about half as effective in the moderately cleaned stand, where 30 percent of the dominant trees and 39 percent of the dominant volume are white pine.

Judging the effects of cleaning by an analysis of composition of the dominant stand was somewhat complicated because of the disproportionate number of trees per acre rated as dominant or codominant on the various treatments. Therefore the same proportions were calculated for the 200 largest trees per acre. The effects of cleaning upon composition of the potential crop are even more striking when the stands are so analyzed. Of these 200 trees per acre, 81 percent of the trees and 86 percent of the volume are white pine on the heavy cleaning as compared to 40 and 45 percent, respectively, under moderate cleaning. The check plot had no white pine in the 200 largest trees per acre. Thus it appears that cleaning has actually been more effective than might be indicated by a compositional analysis of the dominant stand.

Although the primary objective of cleaning is to improve species composition, the reduction in stand density that results from cleaning can promote additional benefits. As was stated earlier, the cleaning operation on these plots resulted in a 70-percent reduction in stocking of the stand above one-half foot in height. What effect did this reduced stocking have on stand volume and tree size? The total stand volume on the check plot 20 years after treatment was 917 cubic feet compared to 949 cubic feet on the moderate cleaning and 1,271 on the heavy cleaning. Measurements of the 200 largest trees per acre showed greater differences: 355 cubic feet on the check plot, 402 cubic feet on the moderately cleaned plot, and 623 cubic feet on the heavily cleaned stand. These differences reflect the differences in the average diameters of the 200 largest trees, which increase by approximately 0.5 inch for each degree of weeding.

Deception Creek Study

This set of nine plots, located on the Deception Creek Experimental Forest, was established in a 16-year-old stand composed primarily of grand fir, western hemlock, and western white pine. The stand originated from a 1916-1918 seed tree cutting. Hemlock and grand fir had been girdled at the time of logging so as to leave a white pine seed tree stand. Seed trees were removed in 1935 when the stand was cleaned. This stand is situated on a middle and lower slope with a northerly aspect. The soil is a residual stony loam with loessal admixture, about 2 feet deep, underlain by fractured quartzite.

The study consists of three blocks of three 1/10-acre plots, two cleaned and one uncleaned in each block. White pine reproduction was well distributed on the plots and averaged 1,300 seedlings per acre with a milacre stocking of 74 percent. The number of white pine seedlings ranged from 750 to 3,200 per acre and the stocking from 62 percent to 85 percent. Only 21 percent of the stems were white pine on the average; the remainder were largely advanced hemlock and grand fir in a dominant position with respect to the white pine. Larch, cedar, and Douglas-fir were minor components of the stand.

The cleaning removed an average of 76 percent of the original stand above 0.5 foot in height, leaving the best white pine seedlings spaced at a minimum of 4 feet. The proportion of white pine was raised from 21 to 81 percent. Practically all seedlings other than white pine were cut unless they were needed to provide good crop tree distribution in the absence of pine. Fifty-four to 80 trees were marked as crop trees on each plot. Nearly pure stands of white pine crop trees were left on blocks A and C, but on block B, 20 percent of the "crop trees" were grand fir.

Results. — Twenty years after cleaning, white pine had maintained the original advantage given to it in the cleaning operation (Table 2). The present proportion of white pine in the dominant stand (78 percent) closely approximates the proportion that was left by the cleaning operation (81 percent). Ingrowth and seeding in of more tolerant species has reduced white pine to 31 percent of the total number of stems but has not affected the dominant stand. For the complete set of plots, cleaning has resulted in nearly a 3-fold increase in the proportion of white pine in the 200 largest trees per acre.

Cleaning has not resulted in any improvement in total stand volume. The uncleaned stands have a slight superiority in total volume 20 years after cleaning, but there is no difference in total dominant stand volumes. However, white pine volume is greatly superior on the cleaned areas, averaging 1,057 cubic feet per acre as compared to 320 cubic feet per acre on the uncleaned stands. Thus, cleaning has effected more than a 2-fold increase in white pine volume.

The trees originally marked as "crop trees" on the cleaned plots were superior to equivalent "crop trees" on the check plot (Table 3). Crop tree volumes on the cleaned plot averaged 231 percent more than on the check; average diameters were 61 percent greater, and heights were 24 percent greater. In addition, mortality, caused principally by snow breakage, has been much lighter in the cleaned plots.

Analysis of the volumes and sizes of the 200 largest trees per acre shows much the same treatment influence as on the Kaniksu plots. The volume of the 200 largest trees on the cleaned plots averaged 762 cubic feet as compared to 573 cubic feet on the check. The average diameter of the largest trees was one-half inch greater on the cleaned stand (5.8 inches on the cleaned vs. 5.3 on the check).

TABLE 2.—WHITE PINE COMPOSITION 20 YEARS AFTER CLEANING, DECEPTION CREEK PLOTS

Treatment	White pine in total stand	White pine in dominant stand: Number stems	White pine in dominant stand: Cubic volume	White pine in largest 200 trees per acre: Number stems	White pine in largest 200 trees per acre: Cubic volume
	Percent				
Block A					
Cleaned	32	91	94	95	97
Check	10	24	27	30	32
Block B					
Cleaned	34	48	73	65	65
Check	18	19	14	15	8
Block C					
Cleaned	28	94	99	100	100
Check	13	25	27	25	27
Mean all blocks					
Cleaned	31	78	89	87	87
Check	14	23	23	23	22

Discussion

Cleanings have long been advocated in the western white pine type because they seemed to promise great improvement in stand value at low expense (*1, 4, 5*). Like planting, pruning, blister rust control, and precommercial thinnings, cleanings must be made at a dead weight expense and should yield benefits in excess of their original cost.

Davis (*1*), in estimating the possible future benefits of the Deception Creek cleanings, anticipated an increase of 25 percent in white pine volume at maturity. Twenty years later measurement shows that these cleanings have resulted in white pine compositional improvement of 66 percent, far in excess of what was thought possible. In view of the negligible changes in composition that normally occur in white pine stands after the 30th year, it seems reasonable to assume that the present proportion of white pine will be maintained until the harvest age.

By applying the $250 per acre valuation for each 10 percent increase in the proportion in white pine volume yields, a final increased valuation of $1,650 per acre might result from the cleaning operation. Present-day cost of this cleaning at 1.5 man-days per acre would be about $30 per acre.

Cost and benefit values for the Kaniksu stands are comparable to those on the Deception Creek cleanings. The heavy cleaning today would cost about $60 per acre (3 man-days), and final increased valuation might amount to $1,900 per acre. The moderate cleaning would now cost about $40 per acre (2 man-days); final increased valuation might be about $975 per acre.

These potential benefits result from improvement in composition only. Should the cleaning, through an early reduction in stand density, promote greater diameter growth on the crop trees, as has been indicated, some additional benefit might be realized.

Where cleanings can materially increase the amount of western white pine in the stand, as they did in the Kaniksu and Deception Creek tests, they should aid mate-

TABLE 3.—"CROP TREE" STAND ON CLEANED AND CHECK PLOTS 20 YEARS AFTER CLEANING

	Volume	Average d.b.h.	Height	Mortality (20-year total)
	Feet	*Inches*	*Feet*	*Percent*
Cleaned	898	4.2	25.6	29
Check	271	2.6	20.6	47

rially in defraying the costs of protecting white pine from blister rust.

Summary

Results of two cleanings to favor western white pine show that: (1) compositional improvements have been maintained at a high level during the 20 years since cleaning; (2) improvement in size and volume of potential crop trees resulted from the reduction in stand densities; and (3) similar cleaning operations under current economic conditions should yield substantial economic benefits.

Literature Cited

1. DAVIS, KENNETH P. 1942. Economic management of western white pine forests. U. S. Dept. Agric. Tech. Bul. 830, 77 pp., illus.
2. HAIG, IRVINE T., KENNETH P. DAVIS, and ROBERT H. WEIDMAN. 1941. Natural regeneration in the western white pine type. U. S. Dept. Agric. Tech. Bul. 767, 98 pp., illus.
3. WATT, RICHARD F. 1956. Site index and species changes, mortality, and normality trends in second-growth western white pine stands. (Unpublished manuscript, Intermountain Forest and Range Expt. Sta.)
4. WELLNER, C. A. 1940. Effects of cleaning in a reproduction stand of western white pine and associates. Northern Rocky Mountain Forest and Range Expt. Sta., Res. Note 4, 5 pp., illus.
5. ————. 1946. Improving composition in young western white pine stands. Northern Rocky Mountain Forest and Range Expt. Sta. Res. Note 43, 6 pp.

Effects of Stock Plant Fertilization Upon Rooting of Cuttings of Picea abies, Pinus resinosa, and Pinus strobus[1]

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IT HAS BEEN SHOWN that Norway spruce (*Picea abies*), red pine (*Pinus resinosa*) and white pine (*Pinus strobus*) may be propagated by cuttings and that the rooting of the cuttings is usually improved by treatment with root inducing substances (*1*). It has been further shown that cuttings taken in November root better than if taken in late winter, and better if taken in December than if taken in spring, summer, fall, or later in the winter (*2*). Treatments for 24 hours with solutions of indoleacetic (*5*) and indolebutyric acid (*6*) have failed to improve rooting significantly. Powder dip treatments with indolebutyric acid have caused some injury in many cases (*6*), but rooting was somewhat improved by indoleacetic acid in talc (*4*). November cuttings made with the basal cut above the base of the current season's growth and planted in a mixture of equal parts of sand and peat have rooted about 50 percent without treatment, 82 percent in 10 months after treatment with indoleacetic acid (*6*). Treated cuttings in the same experiment rooted less well in sand.

White pine cuttings, treated or untreated, have not often rooted well if obtained from mature trees, or trees more than 4 years old (*6, 7, 8*). Deuber (*2*) found that small cuttings (lateral twigs) root better than large cuttings (terminal shoots) and that winter is apparently a better time to take cuttings than spring, summer, or fall. Snow (*9*) took cuttings in August and rooted them the following summer. Best results secured were 47.5 percent rooting when the cuttings were treated with indolebutyric acid. Earlier papers by Enright (*3, 4*) reported successful propagation of *Liriodendron tulipifera* and several species of Acer from cuttings with a concentrated-solution-dip treatment with indolebutyric acid and it was decided to study the effects of the same treatment on the conifers herein mentioned.

In this work, special attention was given to (*1*) the effects of fertilizer applications to the stock plants on rooting responses of cuttings taken from those plants, (*2*) the effects of root inducing substances used for treatment of cuttings, and (*3*) the season of the year or stage of growth at which cuttings are taken.

Materials and Methods

All the seedlings used as a source for cuttings in this investigation were grown at the Maryland Forest Tree Nursery, Harmans, Maryland. The seedbeds for growing the parent stock plants were prepared in the usual manner but with the addition of cottonseed meal applied at the rate of 1,000 pounds per acre and a 4-12-4 fertilizer at the rate of 500 pounds per acre. During the early spring of their first year, the seedlings were top dressed with the same materials at the rate of 500 pounds per acre. This top dressing was prepared with a ratio of two parts cottonseed meal for each part of 4-12-4 fertilizer.

Cuttings were taken from the side branches of the trees during their third year of growth. The cuttings taken averaged 4 to 5 inches, and they were prepared with a diagonal basal cut. The cuttings were not wounded because it was found in earlier experiments that the stems became discolored and the cuttings died when the basal portions had been wounded Cuttings were made in July, August, and September and were

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[1]Scientific Article No. A680. Contribution No. 2895 of the Maryland Agric. Expt. Sta. (Department of Horticulture).