

MANAGING WESTERN WHITE PINE PLANTATIONS FOR MULTIPLE RESOURCE OBJECTIVES

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ABSTRACT

Western white pine (*Pinus monticola* Dougl. ex D. Don) continues to be one of the most important coniferous tree species growing in Northern Rocky Mountain forests. Because large wildfires occurred early in the 1900s, many plantations of western white pine with varying levels of resistance to blister rust (*Cronartium ribicola* Fisch.) were established. Thinning these stands cannot only produce high value lumber products, but can maintain other resource values important to sustaining forest ecosystems. In 1982, a 53-year-old western white pine plantation was thinned to three different spacings, one portion was clearcut, and one portion remained as an untreated control using a randomized complete block experimental design. Ten years after treatment, except for trees in the widest spacing, diameter growth response was minimal. Up to 20,000 western white pine regenerated per acre (49,421/ha) in the thinnings. Even if only a small portion (i.e., 5%) of these seedlings were rust-resistant, the future stand will be well stocked. Western white pine regeneration in the clearcut exceeded 5,500 trees per acre (13,591/ha) and were the tallest found in any of the treatments. If the stands initiated by the thinnings are allowed to develop, they will have a variety of structures and attributes ranging from large trees, snags, and downed-logs, to high-value commercial products.

Keywords: Thinning, shelterwood, stand growth, wildlife, snags, blister rust, regeneration

INTRODUCTION

Western white pine continues to be one of the most important coniferous tree species growing in Northern Rocky Mountain forests. The species has high commercial value for lumber, and was extensively harvested in the early 1900s for construction materials and for the production of matches (Anderson 1935). The species is fast growing, resistant to root disease, and it occupies the early seral stage in many Northern Rocky Mountain forests (Graham 1990).

In the early 1900s large areas of the Inland Northwest were burned by wildfires (Wellner 1970). On many of these areas western white pine plantations were established using seedlings grown from wild seed collections. In the 1920s, blister rust was introduced into the Northern Rocky Mountains; it has since

infected many forest stands, decreasing the abundance of western white pine (Mielke 1943; Ferguson et al. 1986). Because of losses caused by blister rust and the lack of disease-resistant planting material, large amounts of western white pine were harvested during the 1960s through the early 1970s, and only small areas were regenerated with western white pine.

Even with the reduced emphasis on regenerating and managing western white pine during the past 30 years, many stands throughout northern Idaho still contain young to mid-aged, rust-susceptible western white pine. Stands dominated by western white pine have a wide range of rust resistance and a variety of species compositions and structures; they may yet play an important role in Northern Rocky Mountain forest ecosystems. Not only does western white pine have high commercial value, but it is an aggressive, fast growing, seral species capable of quickly restocking sites after disturbance. In spite of high blister rust-susceptibility, many young and mid-aged stands of western white pine in northern Idaho, could be developed through management into forests having many resource values.

Large trees, snags, coarse woody debris, and downed logs are all recognized as important components of functioning forest ecosystems (Thomas et al. 1979; Maser and Trappe 1984; Harvey et al. 1987; Reynolds et al. 1992). Moreover, wildlife, aesthetics, and ecosystem sustainability are becoming increasingly important in forest management. Traditional silvicultural practices designed to optimize growth and development of western white pine for lumber production can also be used to address these emerging issues. When these practices are employed, plantations and natural stands containing western white pine have the potential to develop many of the components important for sustaining forest ecosystems.

In 1982, a commercial thinning study was established in a portion of the Cathedral Peak western white pine plantation on the Wallace Ranger District of the Idaho Panhandle National Forests. Originally, the study was designed to compare the growth and development of young western white pine plantations thinned to different spacings. But, because of the abundant western white pine regeneration, the presence of blister rust, and the dynamics of forest growth, the study was also able to provide alternatives for managing western white pine plantations to produce more than just timber products.

MATERIALS AND METHODS

The study area is near Cathedral Peak in the heart of the Coeur d'Alene mountains above the Coeur d'Alene River at an approximate elevation of 4,000 feet (1,219 m). The study site is on a

gentle (20%) north-facing slope. The habitat type is western hemlock (*Tsuga heterophylla* (Raf.) Sarg.)/(*Clintonia uniflora* (Schult.) Kunth.) (Cooper et al. 1991). The area burned in 1910 and again in 1919. Because of the double burn, the site was devoid of most vegetation and when the western white pine was planted in 1924, it had little competition from other conifers or shrubs. The site is excellent for growing western white pine, with a site index of 75 (base age 50, Haig 1932). At age 23, the plantation had 900 trees per acre (2,224 trees/ha) with an average diameter of 4.2 inches (10.7 cm) (Boyd and Deitschman 1964).

In 1982, three replications of four treatments and a control were randomly installed. The treatments included: thinnings to spacings of 15 x 15 feet (4.6 x 4.6 m); 20 x 20 feet (6.1 x 6.1 m); 25 x 25 feet (7.6 x 7.6 m); and a clearcut. The uncut control was naturally spaced at about 12 x 12 feet (3.7 x 3.7 m). Within each replication, five 0.2-acre (809 m²) treatment units were established. After the trees were harvested, the residual trees were tagged and their diameter was measured at 4.5 feet (1.4 m) from the ground (diameter breast height). At 5-year intervals plots were revisited and tree d.b.h. and mortality recorded. In 1992—10 years after the initial measurements—the quantity, height, and species of regeneration were tallied. Regeneration was sampled using three randomly located, 0.03-acre (13.5 m²) plots per treatment within each replication.

Data were analyzed as a randomized complete block design using Scheffe's multiple range test to separate the means. The residual trees and regeneration in each treatment were projected 100 years into the future using the Stand Prognosis Model (Wyckoff et al. 1982). No additional regeneration was allowed in the projections.

RESULTS AND DISCUSSION

The volume of material removed from the 58-year-old plantation during the 1982 thinning ranged from 150 cubic feet per acre (11 m³/ha) in the 15 x 15-foot spacing, to over 550 cubic feet per acre (38 m³/ha) in the clearcut (Figure 1). The amount and size of material needed to make a thinning commercially viable is highly variable and site specific. If stocking control is needed to maintain healthy forests, or maintain other resource values, the cost of creating the desired forest structure may have to be borne by more than the value of the timber extracted.

Blister rust has killed western white pines since the plantation was established. Boyd and Deitschman (1964) reported that at age 23, 900 trees per acre (2,224 trees/ha) existed; by 1982 just 247 trees per acre (610/ha) were alive, representing an annual mortality rate of 2.1%. By 1992 annual mortality in the plantation was 5.4% in the 12 x 12-foot spacing (untreated) and 3.9% in the 25 x 25-foot spacing. Because heavily infected trees were removed during harvest, lower mortality rates occurred in the thinned stands.

As Foiles (1972) and Deitschman (1966) observed in wild stands, western white pine does not respond much to increased growing space after age 30. The results of this plantation study showed similar results. Comparison of stem diameters showed

no significant difference among spacings, but annual diameter growth for the 10 years after harvest, western white pine in the widest spacing was significantly ($P < 0.05$) greater than the control (Table 1). As Deitschman (1966) noted, to have any response to thinning beyond age 30, western white pine must be widely spaced, which sacrifices growing space. Even though significant differences in diameter were not detected up to 10 years after harvest, the trend was for larger trees to occur in the wider spacings. This was reflected in the 20 x 20-foot spacing where, even with a 42% decrease in the number of western white pine, basal area only decreased 11%. Because western white pine dominated the stands, the trends in stand and tree growth remained the same even when the few individuals of other species were added to the analysis.

In the absence of blister rust, western white pine could easily be managed using natural regeneration methods. Even with minimal soil disturbance, western white pine aggressively reproduced in all harvest units. In the undisturbed stand, with no forest floor disturbance and the only canopy openings caused by tree mortality (primarily caused by blister rust), 2,500 trees per acre (6,177/ha) of western white pine and another 900 grand fir (*Abies grandis* (Dougl. ex. D. Don) Lind.) per acre (2,224/ha) were regenerated (Table 2). The shelterwoods created by thinnings produced up to 20,000 western white pine per acre (49,421/ha), and up to nearly 3,000 trees of other species per acre (7,413/ha). The stands created by the thinnings produced sufficient and diverse stocking with large trees of varying sizes in the overstory.

Natural seed sources traditionally provided adequate western white pine regeneration after clearcutting (Haig et al. 1941). This study showed similar results. The striking feature of seedlings in the clearcut was their height. Western white pine regeneration in the clearcut was 6.5 times taller than in the uncut stands, 3.5 times taller than the 15 x 15-foot and 20 x 20-foot spacings, and 2.5 times taller than those in the 25 x 25-foot spacings (Table 2). Lodgepole pines (*Pinus contorta* Dougl. ex Loud.) were tallest only in the 15 x 15-foot spacing and the clearcut.

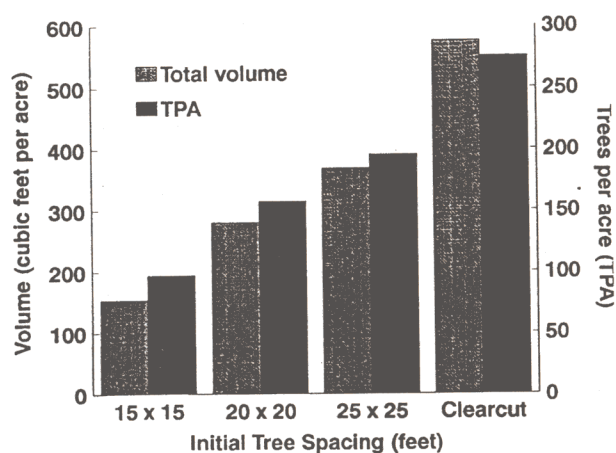


Figure 1.—The mean total volume and trees per acre removed during harvesting for each of the residual spacings and the clearcut.

Table 1.—Tree and stand characteristics of western white pine and all species combined for three different spacings and a control.

¹Initial Spacing	²Dbh			³Growth	⁴Basal area			⁵Trees per acre		
	1982	1988	1992		1982	1988	1992	1982	1988	1992
	-----inches-----				square feet per acre					
Western white pine										
12 x 12	⁶10.1a	11.6a	12.4a	0.15a	145.0a	103.1a	97.5a	247a	137a	113a
15 x 15	10.5a	11.7a	12.3a	.17ab	102.0ab	73.5ab	70.1ab	158ab	92b	77b
20 x 20	10.7a	12.8a	13.5a	.17ab	73.4b	67.7ab	65.5b	107b	73bc	62bc
25 x 25	11.0a	12.4a	13.1a	.21b	55.4b	50.6b	46.7b	78b	56c	47c
All species										
12 x 12	10.6a	11.8a	12.6a	0.13a	165.2a	123.5a	118.6a	275a	163a	137a
15 x 15	11.0a	13.3a	13.1a	.13a	116.8ab	90.6ab	89.5ab	178ab	111b	97ab
20 x 20	11.4a	13.1a	13.8a	.20a	81.6bc	76.9b	73.7ab	118ab	83bc	72bc
25 x 25	11.4a	12.8a	13.6a	.18a	55.9c	51.5b	47.5b	80b	58c	98c

¹ Approximate initial (1982) spacing in feet. The 12 x 12-foot spacing is the untreated control.² Dbh = Diameter at breast height (4.5 ft).³ Growth = Mean annual diameter growth (1982-1992).⁴ Ba = Basal area.⁵ Tpa = Trees per acre.⁶ Different letters indicate significant ($P < 0.05$) differences among initial spacings.

Table 2.—The amount of regeneration by species and the height of regeneration for the various spacings and the clearcut.

¹ Initial Spacing	White pine		Lodgepole		Douglas-fir		Grand fir		² Cedar/Hemlock	
	Trees/acre	³ Ht	Trees/acre	Ht	Trees/acre	Ht	Trees/acre	Ht	Trees/acre	Ht
		ft		ft		ft		ft		ft
12 x 12	⁴ 2,500a	0.5a	-	-	-	-	900a	0.6a	-	-
15 x 15	19,600b	.8a	200a	4.8a	-	-	1,567a	1.2a	550a	0.5a
20 x 20	13,333b	.9a	100a	1.3b	100a	1.7a	1,933a	.8a	-	-
25 x 25	20,933b	1.2b	-	-	267a	2.1a	2,933a	1.1a	150b	2.5b
Clear Cut	5,633a	3.3c	150a	3.4a	100a	1.4a	167b	1.6a	-	-

¹ Approximate initial thinning spacing in feet. The 12 x 12-foot spacing is the untreated control.² A combination of both western redcedar and western hemlock regeneration.³ Ht = Height.⁴ Different letters indicate significant ($P < 0.05$) differences among initial spacings.

In all of the stand treatments, western white pine dominated the regeneration (Figure 2). In the thinnings the effect of the overstory was evident, with more shade-tolerant species regenerating, especially grand fir. Even though the site was a western hemlock habitat type, only a small amount of western hemlock or western redcedar (*Thuja plicata* Donn ex D. Don.) regenerated, because seed was unavailable due to the size of the burned area and the repeated wildfires before the plantation was established.

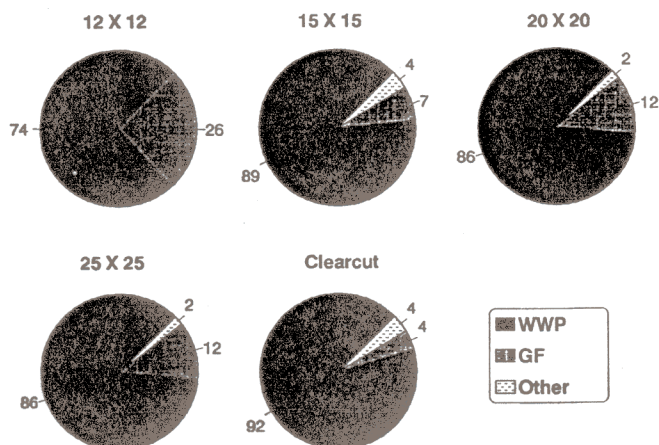


Figure 2.— Species composition (percent) 10 years after harvest for each of the spacings and the clearcut. Spacings are in feet. The 12 x 12-foot spacing was the uncut control. WWP = western white pine, GF = grand fir, Other = the sum of western larch, Douglas-fir, western hemlock, western redcedar, and lodgepole pine

After the 1982 harvest and subsequent regeneration, the different spacings had variable stand structures. By projecting these stands 100 years into the future using the Stand Prognosis Model, western white pine will dominate the stands. Even with no additional regeneration and an annual mortality rate of about 4% per year, western white pine was projected to be the most abundant species in the clearcut (Wyckoff et al. 1982) (Figure 3).

The abundant western white pine produced by the treatments in this study offer an excellent opportunity for mass selection of trees for blister rust-resistance. Hoff et al. (1976) reported over 19% of natural regeneration is rust-resistant in stands suffering high losses from blister rust. With nearly 20,000 western white pines regenerating per acre (49,400 trees/ha) in the thinnings, even if the resistance level were only 5%, there would still be 1,000 rust-resistant trees per acre (2,470 trees/ha). Therefore, the Prognosis Model's projection of 50 to nearly 700 western white pines per acre (124 to 1,729 trees/ha) would surviving for 100 years is very realistic (Figure 4). In fact, the actual numbers could be higher.

The stand structures would be quite diverse 100 years after these thinnings. Tree density would be variable, but the basal area among spacings should remain relatively constant (200 - 250 square feet per acre, 46 - 57 m²/ha). The original control (12 x 12-foot spacing) would be dominated by large mature trees with an understory of small trees. As the spacings widened during the years after thinning, the number of large trees would diminish and more regeneration would survive (Figure 4).

At 100 years after thinning the largest trees would be over 30 inches (76 cm) in diameter at breast height (Figure 5). These large trees, and resulting snags that were continually being recruited because of blister rust, would provide excellent habitat for many small animals and birds. Snags would be present in various diameters, heights, and stages of decay. These snags would eventually fall, providing organic material for the forest floor and provide bird, mammal, and insect habitat (Reynolds et al. 1992). Also, depending on management objectives, the various forest structures could provide abundant deer, elk, and bear habitat. Also, because many of these types of stands occur along stream courses, streambank cover would continually be available, as would continual recruitment of coarse woody debris for streams.

As stated earlier, the study area is an excellent site for growing trees, with about 10,000 cubic feet per acre (700 m³/ha) of material potentially produced in the clearcut 100 years after harvest. Large volumes of high-value big trees and a second story of midsized western white pine would also be produced in the other spacings.

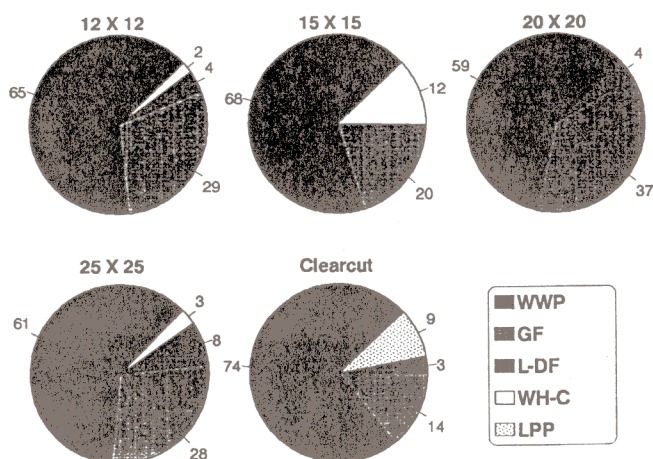


Figure 3.— Predicted species composition (percent) for each of the spacings and the clearcut 100 years after harvest. Spacings are in feet. The 12 x 12-foot spacing was the uncut control. WWP = western white pine, GF = grand fir, L-DF = the sum of western larch and Douglas-fir, WH-C = the sum of western hemlock and western redcedar, and LPP = lodgepole pine.

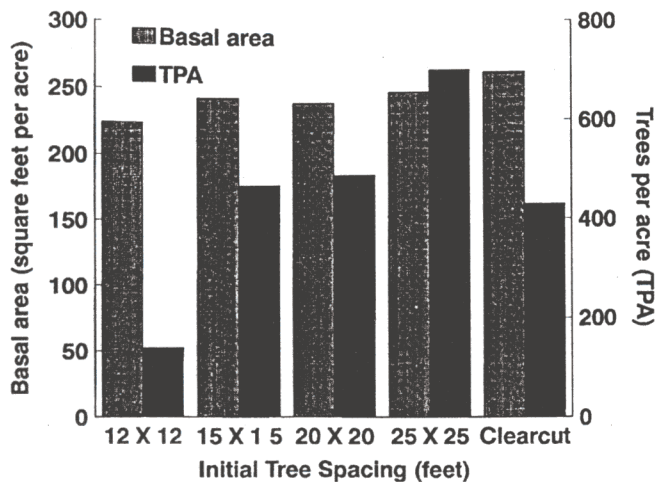


Figure 4.—Predicted basal area and trees per acre 100 years after harvest for each of the spacings and the clearcut. The 12 x 12-foot spacing was the uncut control.

SUMMARY

Neither natural stands nor plantations of western white pine respond vigorously to thinning after age 30. This study, as well as those of Foiles (1972) and Deitschman (1966), show that growth dynamics are set early in the life of western white pine. Because of the past fire history, little or no competition from other tree species occurred at the study site. This may not be the case in other stands; competition could be severe and stands may have to be cleaned or weeded in addition to being thinned to create similar stand structures in other circumstances.

The young and mid-aged naturally and artificially regenerated western white pine stands throughout the Inland Northwest provide many management options. Without some type of density control, these stands are likely to become overstocked with shade-tolerant species and become candidates for insect and disease attack, creating the conditions for another forest-replacing fire.

In these types of stands, a variety of structures could be created in a landscape using a variety of thinnings, shelterwoods, and clearcuts mimicking all types of naturally occurring conditions. Old-growth attributes such as large trees, snags, and downed logs that are important for productivity and for many wildlife species and for scenic values can be created using these methods. In addition, managing stands with thinnings or shelterwoods can provide commercial products from small pole-sized material to large, high-value, western white pine saw timber.

Another important consequence of managing stands for large quantities of natural western white pine regeneration is mass selection for rust-resistant trees. Heavy regeneration of western white pine could easily supplement the use of rust-resistant planting stock created through breeding programs and would help expand the region's genetic base. Mass selection for rust resistance can be accomplished in many areas where planting

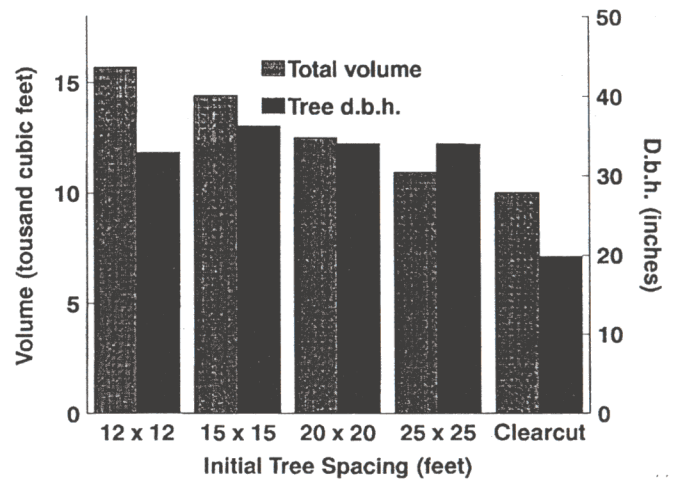


Figure 5.—Predicted diameter at breast height (d.b.h.) of the largest tree in the stand and the total stand volume 100 years after harvest for each of the spacings and the clearcut 100 years after harvest. The 12 x 12-foot spacing was the uncut control.

could be costly or where commercial harvesting may not be possible.

Even though western white pine dominated these stands, grand fir, lodgepole pine, western hemlock, western red cedar, Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) and western larch (*Larix occidentalis* Nutt.) were all present. Thus, stands created by thinning could have variable compositions and structures to meet multiple resource values.

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