

Juvenile Plantations Exhibit the “Crossover” Effect

In 1991, the Stand Management Cooperative (SMC) Silviculture Project began establishing permanent plots in a series of spacing trials which were planted beginning in 1985. The permanent plots will provide information about the effects of initial spacing on the growth and development of juvenile stands of pure Douglas-fir, pure western hemlock, and 50-50 mixtures of the two species. The geographic scope of the project stretches from western Oregon and Washington northward to coastal British Columbia, Canada. These installations include widely contrasting spacings over a large range of soil and climatic conditions. They are further intended to provide sites for a variety of future research needs, which include understanding growth dynamics, estimating growth and yield, modeling, and studies of wood quality.

As of January 1998, there were 20 Douglas-fir installations, five western hemlock installations, and three with 50-50 mixtures of the two species. Each installation has at least one plot each of six different stocking levels: 100, 200, 300, 440, 680 and 1,210 stems per acre (spa). Five installations have two plots established for each stocking level. Scott, *et al.* (1992) reported that in seven to nine year-old plantations of Douglas-fir, both average total height and average diameter at breast height (DBH) *increased* with increasing density, as measured by percentage of 1,210 spa value. This observation has in recent years come to be known as the “crossover” effect, because the relationship observed between average height (and DBH) and spacing is reversed from expectation (*i.e.*, *smaller* heights and DBH with increasing density), but is destined to “crossover” back to expectation once the trees within each spacing become large enough to begin competing with each other. Several hypotheses attempt to explain this phenomenon. Whatever the reason, important implications for management include knowing the duration of the effect.

Methods

Square, one acre fixed area permanent plots are installed. A measurement sample plot is centrally located within each permanent sample plot. In an effort to keep measurement costs down, the measurement sample plots vary in size from 0.212 acres in the 1,210 spa spacing up to 0.5 acres in the 100 spa spacing. The installations are measured every two years during the dormant (winter) season. All trees within the measurement sample plots are tagged and numbered. Species, total height, and DBH are recorded for every tree. On a sub-sample of 42 trees, crown width, height to lowest live branch, and height to crown base, are measured.

Setting the average total height or DBH of the highest stocking level as 100% and expressing the average size of

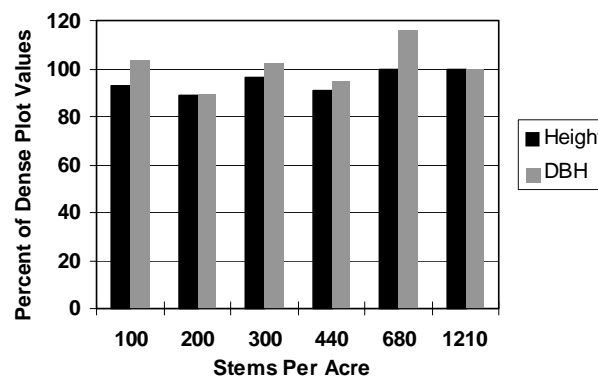


Figure 1. Average height and DBH of all trees, pure Douglas-fir stands aged 7 to 9 years from seed.

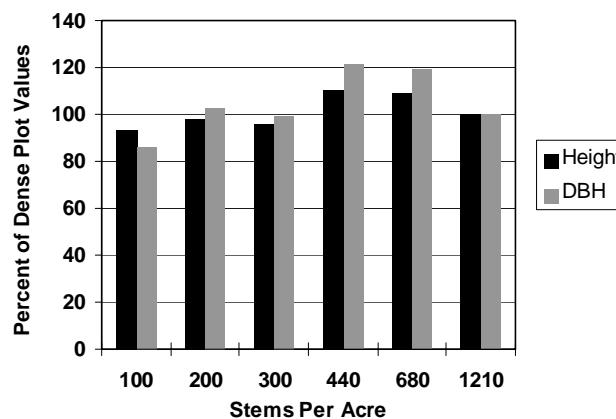


Figure 2. Average height and DBH of all trees, pure western hemlock stands aged 7 to 9 years from seed.

each lower stocking level relative to the highest stocking level as a percent, the relationship between size and density is examined for two stand components (whole stand and 100 largest by DBH) for each species. Multiple comparisons (*t*-tests) to test for significant differences are also performed on the absolute differences in DBH and height between successive pairs of plots.

Results

Considering average total height and average DBH, there appears to be little if any regular relationship with density for Douglas-fir (Figure 1) or for western hemlock (Figure 2) in seven to nine year-old (total age) plantations. The same holds true for three to six year-old and for ten to 13 year-old plantations of both species (not shown).

Perhaps more importantly, however, there is a definite relationship between size and density when size of the “crop” trees only are considered. Figure 3 shows that the average DBH of the 100 largest diametered trees (D100) increases monotonically from widest to narrowest spacing with relative diameters of 54%, 62%, 79%, 80%, and 97% for the 100, 200, 300, 440, and 680 spa stocking levels, respectively. For height (H100) we observe a progression of 69%, 76%, 86%, 86%, and 96% for 100 through 680 spa stocking levels, respectively. Figure 4 shows the observed relationships for western hemlock. For western hemlock there appears to be an optimal stocking level somewhere between 440 and 1,210 spa. Based on the *t*-tests for Douglas-fir, stocking levels 1,210 and 680 spa behave in a statistically similar fashion. The 440 and 300 stocking levels form another group while the 200 and 100 spa levels form the third. For western hemlock there are basically two statistically significant groups: 1,210, 680, and 440 spa formed one group, and the 300, 200 and 100 spa levels formed the other. These trends for both species continue in the ten to 13 year-old age group as well.

Conclusion

Average height and DBH of the 100 largest diametered trees per acre show significant trends with density in plantations as young as three years. Appropriately timed thinnings could possibly maintain or even enhance this size increase. This opportunity, however, depends on the presumption that the 100 largest diametered trees are well distributed throughout the plot and not clumped on one particularly good microsite.

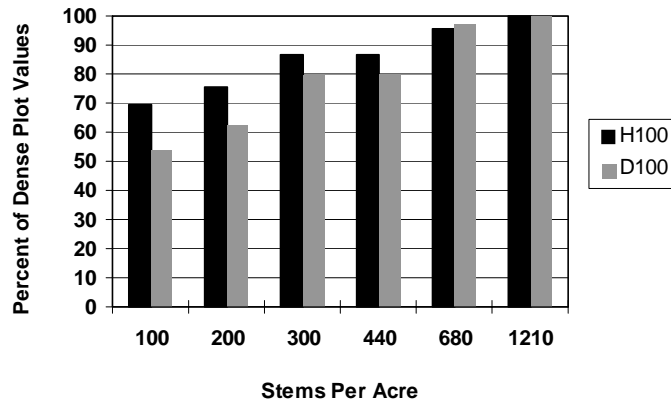


Figure 3. H100 and D100 for pure Douglas-fir stands aged 7 to 9 years from seed.

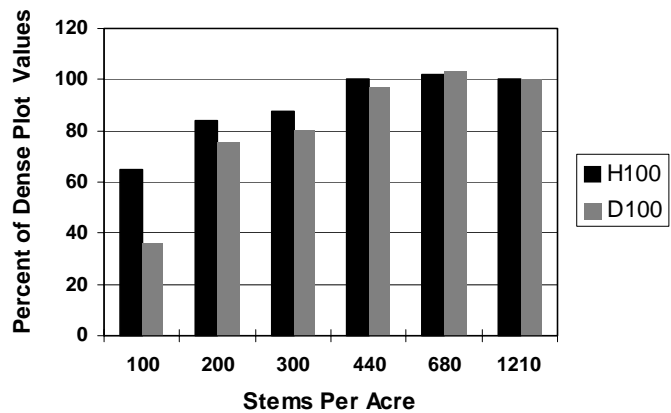


Figure 4. H100 and D100 for pure western hemlock stands aged 7 to 9 years from seed.

Literature Cited

Scott, W., R. Meade, and R. Leon. 1992. Observations from 7 to 9-year-old Douglas-fir variable density plantation test beds. Forestry Research Field Notes, Weyerhaeuser Company, Timberlands Forest Resources R&D, Silviculture- West, Paper #92-2.

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