Evaluating Long-Term Ponderosa Pine Seedling Growth Across Densities Using Nelder Plots and the Forest Vegetation Simulator in the Black Hills, South Dakota

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Overview:

- Competition is known to regulate small-tree growth and accurately representing this growth in simulation models is important for developing management plans.
- In 1969, a Nelder plot was established on the Black Hills Experimental Forest to examine the influence of site preparation and planting density had on ponderosa pine seedling growth (fig. 1).
- After 45 years of growth, ponderosa pine seedlings planted at low planting densities had diameters 2.5–3x larger than the most densely planted seedlings.
- Depending on the planting density, the Forest Vegetation Simulator (FVS) underpredicted diameter at breast height (d.b.h.) by 0 to 35%.

Summary:

Management problem: In the Black Hills of South Dakota and Wyoming, establishment of natural ponderosa pine regeneration can be prolific. The density of trees in the early stages of stand development affects their growth and sets the basis for future forest dynamics. Underestimation of growth by simulation models could delay scheduling of precommercial thinning and lead to loss of growth or stand stagnation.

Management need: It is clear that a better understanding of how small tree density influences growth and refining the growth and yield simulation models is needed. This information will lead to better management decision-making such as assessing fuel treatment effectiveness and sustainable harvest scheduling.

Silvicultural Concepts:

- Growth rate of natural or artificial ponderosa pine regeneration is influenced by competition.
- Differences in density dependent growth were apparent at age 12 when comparisons between site preparation methods were examined. At age 12, areas that received herbicide application at time of planting were 3 feet taller and 0.6 to 1.9 inches larger in diameter than the areas which were only scalped.
- The effect of site preparation was no longer apparent by age 45.
- At age 45, d.b.h. at the lower densities were substantially larger; however, height growth was no longer different (fig. 2; table 1).
- High densities of ponderosa pine seedling establishment led to a reduction in growth and stand stagnation.

Management Applications:

- This research provides land managers with rationale to implement precommercial thinning activities to facilitate faster transition from the seedling stage to the sawtimber stage.
- The use of FVS to predict growth of ponderosa pine regeneration was insensitive to density levels and underpredicted tree diameter and height growth at age 12 and 45.
- Table 1 provides planting densities and potential diameter at age 12 and 45 for ponderosa pine seedlings for the Black Hills National Forest across site indices of 55 to 65 base age 100.

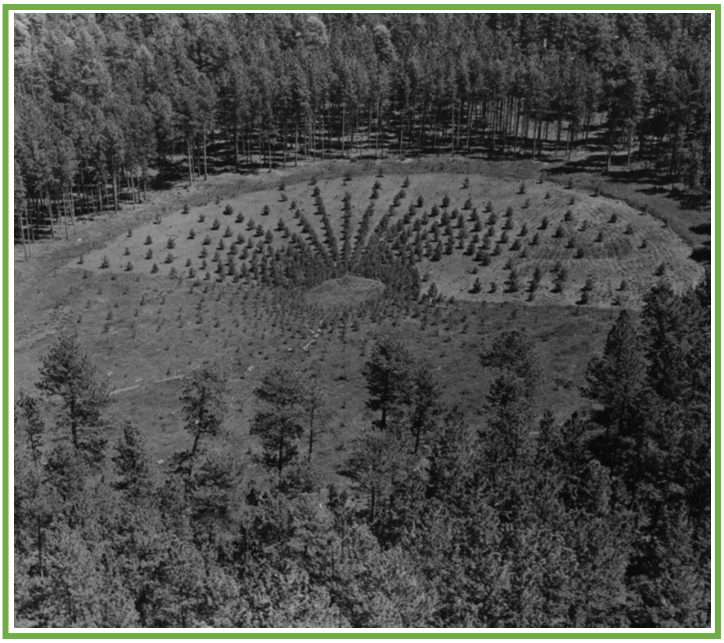

Figure 1—Aerial view of a Nelder plot on the Black Hills Experimental Forest around 1970.

Figure 2—Cross-sections at d.b.h. of the ponderosa pine trees grown at different spacings in the Nelder plots after 45 years.

Table 1—Quadratic mean diameter (QMD) of Black Hills ponderosa pine planted at different spacings at age 12 and 45.

Initial spacing (ft)	Initial trees per acre	QMD (inch) at age 12	QMD (inch) at age 45
19	120	1.4	10.4
16.7	153	1.5	10.8
15.1	194	1.4	10.3
13.1	248	1.4	9.8
11.8	315	1.5	9.3
10.5	401	1.3	8.6
9.2	511	1.6	8
8.2	651	1.4	7.5
7.2	828	1.4	6.6
6.6	1,055	1.4	6.3
5.6	1,345	1.5	5.9
4.9	1,712	1.4	5.2
4.6	2,181	1.4	5.6
3.9	2,780	1.3	4.4
3.6	3,545	1.2	4.0
3	4,507	1.2	4.0