

Variable-Density Thinning in Coast Redwood: a Comparison of Marking Strategies to Attain Stand Variability

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Abstract

Variable-density thinning (VDT) is an emerging thinning method that attempts to enhance stand structural heterogeneity by deliberately thinning at different intensities throughout a stand. VDT may create stands with dense areas, open areas, and other areas that may be intermediate in density. Subsequent stand development forms a more varied structure than is common in many even-aged forest stands. VDT is becoming a treatment of choice in many restoration efforts where even-aged stands are being directed on trajectories towards old forest stand structure conditions because: 1) VDT enhances structural heterogeneity, and 2) a reduction in tree density provides for an accelerated development towards old forest conditions. A primary difficulty in marking VDT treatments is systematically attaining the variability necessary in a VDT prescription. Instead, markers/thinners are seemingly trained to implement a prescription by applying a uniform treatment across a stand that enhances structural homogeneity.

In coast redwood (*Sequoia sempervirens*), VDT has become the primary restoration treatment for young stands within the national and state parks of Humboldt and Del Norte Counties. These stands are young and even-aged developing following clearcutting by previous industrial landowners. VDT is being used to increase structural heterogeneity, increase the proportion of redwood or other conifers, or accelerate development towards old forest structures. Six marking/thinning prescriptions are described that have been used to date to achieve the VDT objectives in coast redwood:

- 1) "Randomized grid – moderate density": 371 tph (150 tpa). Required marker to visualize grid area and randomly assign 0 to 3 trees for each grid area (more fully described in O'Hara et al. 2010). Used in research study to achieve target densities. Post-treatment densities ranged from 346 to 558 tph in three treatment areas (blocks). Labor intensive to use on operational basis.
- 2) "Randomized grid – low density": 185 tph (75 tpa). Same as number 1, but lower target density. Attempted to achieve target restoration density in one treatment. Lower density achieved by marker visualizing larger grid but still randomly assigning 0 to 3 trees to each grid area. Post-treatment densities ranged from 192 to 331 tph (more fully described in O'Hara et al. 2010).
- 3) "Dx rule" – in predominantly coast Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*) stands. Largest Douglas-fir greater than 12.7 cm is identified, diameter in inches is multiplied by 2, and all trees between 12.7 and 24.5 cm are cut within that radius (feet) but not more than 6.1 m (20 ft). Performed on two contrasting sites where resultant densities were 238 and 576 tph. Feasible for thinners to implement without marking and allows heavier cutting of broadleaved trees (more fully described by Keyes et al. 2010).
- 4) "16 x 16 ft" or 4.9 x 4.9 m: Thinning attempted to leave most desirable trees on a 4.9 x 4.9 m (± 1.3 m). Did not cut any redwood stump sprouts and counted a redwood sprout

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- clump as one tree. Easy for thinners familiar with standard precommercial thinning methods. Easy to achieve target density but relatively low variability in spacing (*table 1*).
- 5) “20 x 20 ft” or 6.1 x 6.1 m: Thinning attempted to leave most desirable trees on a 6.1 x 6.1 (± 1.3 m). Similar attributes as “16 x 16 ft” treatment but achieved lower density and greater variability (*table 1*).
 - 6) “Localized release”: Thinners cut 7.6 m (25 ft) circles leaving three best retention trees in any position in circle. Spaces between two circles thinned to 3.7 x 3.7 m spacing. Spaces between three or four circles left unthinned. Did not cut any redwood stump sprouts and counted a redwood sprout clump as one tree. Achieved highly variable spacing (*table 1*) and approximately 112 tph with full exposure. More difficult to implement for thinners.

The coefficient of variation is used to provide a measure of variability for trees per ha between sample plots (*table 1*). Controls represent either unthinned controls for all six methods except Panther Creek where the controls were the pretreatment densities. All six methods resulted in an increase in the coefficient of variation indicating an increase in stand level spatial heterogeneity. O’Hara et al. (2010) also showed increased tree size variability with both the medium and low density treatments with the “randomized grid” method.

Key words: *Sequoia sempervirens*, variable-density thinning, precommercial thinning, intermediate operations, timber stand improvement

Table 1—Coefficient of variation (CV) for the six prescriptions/marketing tools. CV was calculated as the average of block CVs and the number of blocks is shown as the sample size (n). CVs for untreated stands are shown except for Panther Creek which is a pretreatment CV. Other prescriptions share the same untreated stand data.

Prescription	Site	CV treated stands	n	CV untreated stands or before treatment	n
“Randomized grid moderate density”	Mill Creek	0.390	5	0.245	5
“Randomized grid low density”	Mill Creek	0.432	9		
“Dx Rule”	Panther Creek	0.780	2	0.488	2
“16 x 16 ft”	Mill Creek	0.179	5		
“20 x 20 ft”	Mill Creek	0.208	5	0.166	5
“Localized release”	Mill Creek	0.334	5		

References

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