The SMC "Type III" Plantation Network – Holder 1A Site

Introduction. Establishment of the Stand Management Cooperative's Type III installations occurred from the late 1980s to the early 1990s providing a regional network of plots, from southern Oregon to northern Vancouver Island, BC, Canada, and the Cascade foothills to the Pacific Coast. There are 22 locations across this region of the Pacific Northwest and form an exclusive "cradle to grave" cooperative regional study. The Type III installations allow examining the effects of planting density on stand dynamics, tree and stand growth and productivity, and tree and wood quality. With a larger than typical spatial range and measurements stream over the life of the stands, data from these installations provide information about the effects of initial planting density in combination with pre-commercial thinning or pruning, and the longevity thereof. The Type III installations represent a 1990's decadal cohort of plantations.

Experimental Design & Treatments. The Douglas-fir portion of the Type III trials consists of 21 active sites in which the six basic planting densities are arranged in a randomized complete block statistical design. Planting stock types vary somewhat from site to site, including 1-1, 2-0, and 2-1, as well as varying site preparation techniques. Varying stock types and site prep techniques were permitted in order to maximize landowner participation and minimize installation establishment difficulty and other logistical constraints. Each site contains a single replicate of the six basic spacings. Auxiliary treatment plots (pruning and thinning) were installed at many of the Type III Douglas-fir sites following a randomized incomplete statistical block design.

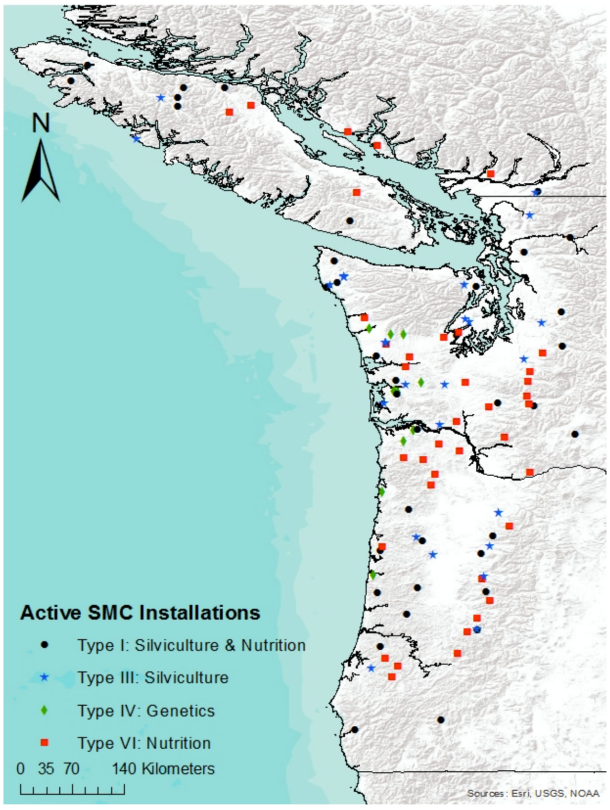
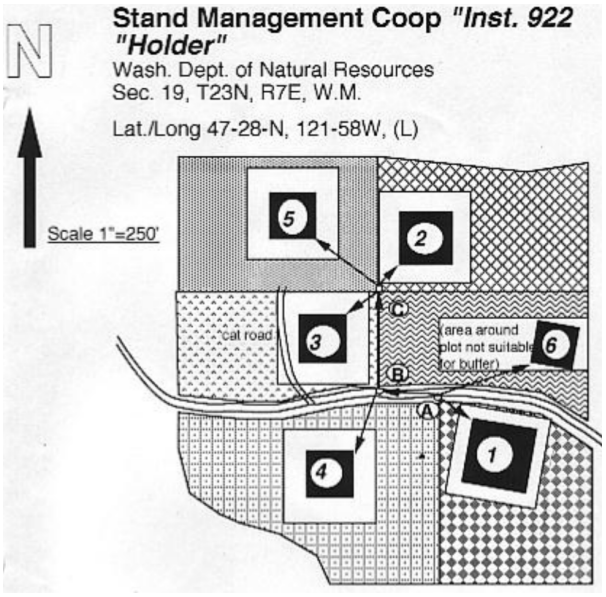


Figure 1: Location of active SMC installations by project. See website for further details on installation types and locations.



The Holder 1A (922) Site. The Holder 1A site has an altitude of 1300 feet. There is minimal slope of about 3%, so technically the aspect is 180°, due south. Soil type is Tokul, the state soil of Wahington. The site index as estimated from the soil survey manual is 130 ft at 50 yr b.h. age (King). The site was planted with 2-0 seedling stock in winter of 1990. The six (6) plots were established in winter of 1994, so by the end of the growing season, the stand was 7 yrs. from seed. The latest measurements were taken in 2018 at age 28 years. The physical arrangement of plots at this site is displayed in the Figure above.

Early Findings. The Crossover effect: Highest densities noted to have greatest mean height. Larger diameter in top 100 trees.

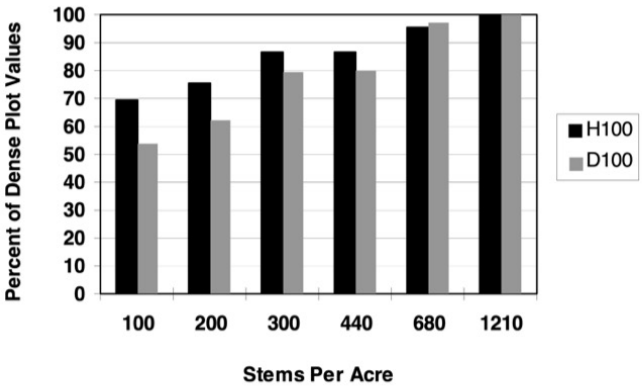


Figure 3. H100 and D100 for pure Douglas-fir stands aged 7 to 9 years from seed.

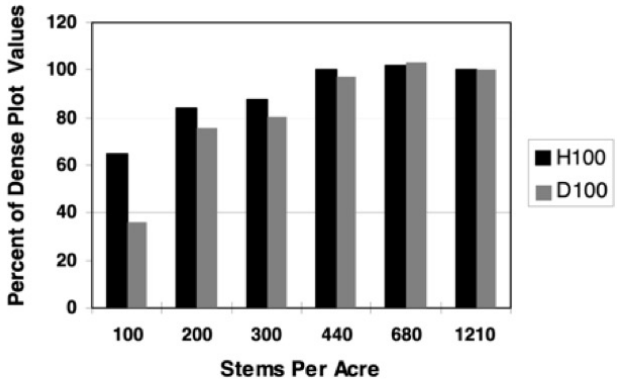
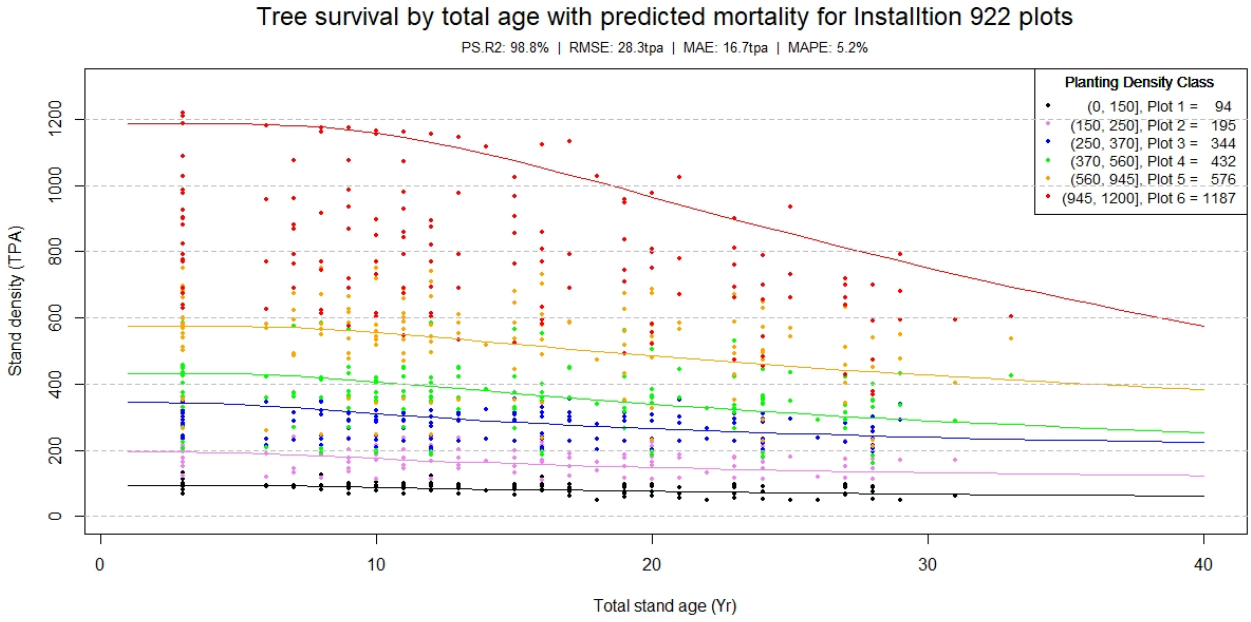


Figure 4. H100 and D100 for pure western hemlock stands aged 7 to 9 years from seed.

These results were corroborated by Scott (Scott et al. Planting density and tree-size relations in coast Douglas-fir. Can. J. For. Res. 28:74-78).

Results to Date. Relevant stand statistics for the last two measurements on record (2014 and 2018 when the stand was 26 and 30 years from seed) appear in the table below.

Plot Num.	Age (yr.)	Trees / ac.	QMD (in.)	Height (ft)	BA (sq.ft)	Vol. (cu.ft/ac)	BF (6"top)	VBAR
1	26	48	12.1	65	38.2	996	2000	52.36
1	30	44	13.3	77	42.7	1330	3000	70.26
2	26	118	11.0	64	77.6	2104	5000	64.43
2	30	103	12.1	76	81.9	2588	7000	85.47
3	26	237	10.0	71	128	3782	9000	70.31
3	30	181	10.8	78	116	3739	10000	86.21
4*	14	383	5.9	41	71.8	1238	0	0.00
4*	26	291	9.7	71	149.1	4367	9000	60.36
4*	30	243	10.5	78	147.4	4784	12000	81.41
5	26	256	9.1	74	115.3	3672	8000	69.38
5	30	160	10.4	77	94.2	3094	8000	84.93


Tree survival by total age with predicted mortality for Installtion 922 plots
PS.R2: 98.8% | RMSE: 28.3tpa | MAE: 16.7tpa | MAPE: 5.2%
Planting Density Class
(0, 150], Plot 1 = 94
(150, 250], Plot 2 = 195
(250, 370], Plot 3 = 344
(370, 560], Plot 4 = 432
(560, 945], Plot 5 = 576
(945, 1200], Plot 6 = 1187
Stand density (TPA)
0
200
400
600
800
1000
1200
0
10
20
30
40
Total stand age (Yr)

Douglas-fir PCT Yield

Background

This fact sheet demonstrates the application of three of the seven Douglas-fir yield models detailed in SMC Working Paper 7: *Yield models for SMC Type I plots thinned precommercially: ages 35-60.* A Pre-commercial thinning is a stand-level treatment that removes less-competitive trees in favor of remaining crop trees. Whether or not a particular application is pre-commercial will depend on site quality, volume of material removed, and proximity to infrastructure. The method of thinning discussed here is *uniform thinning*, a strategy[1] that maximizes the abover-ground growing space per tree.

Basal area yield among stands thinned uniformly is no different than for untreated stands across the observed range of treatment age when treatment intensity (expressed as proportion removed) is no greater than 50%. Additionally, the expected mean diameter is significantly larger whenever intensity is greater than 20%. The highest basal area yields are achieved when treatment age is greater than 10 years and treatment intensity is moderate, near 40%. When thinned, mean diameter becomes a function of intensity and is insensitive to treatment age, with progressively larger diameters expected at progressively higher treatment intensities.

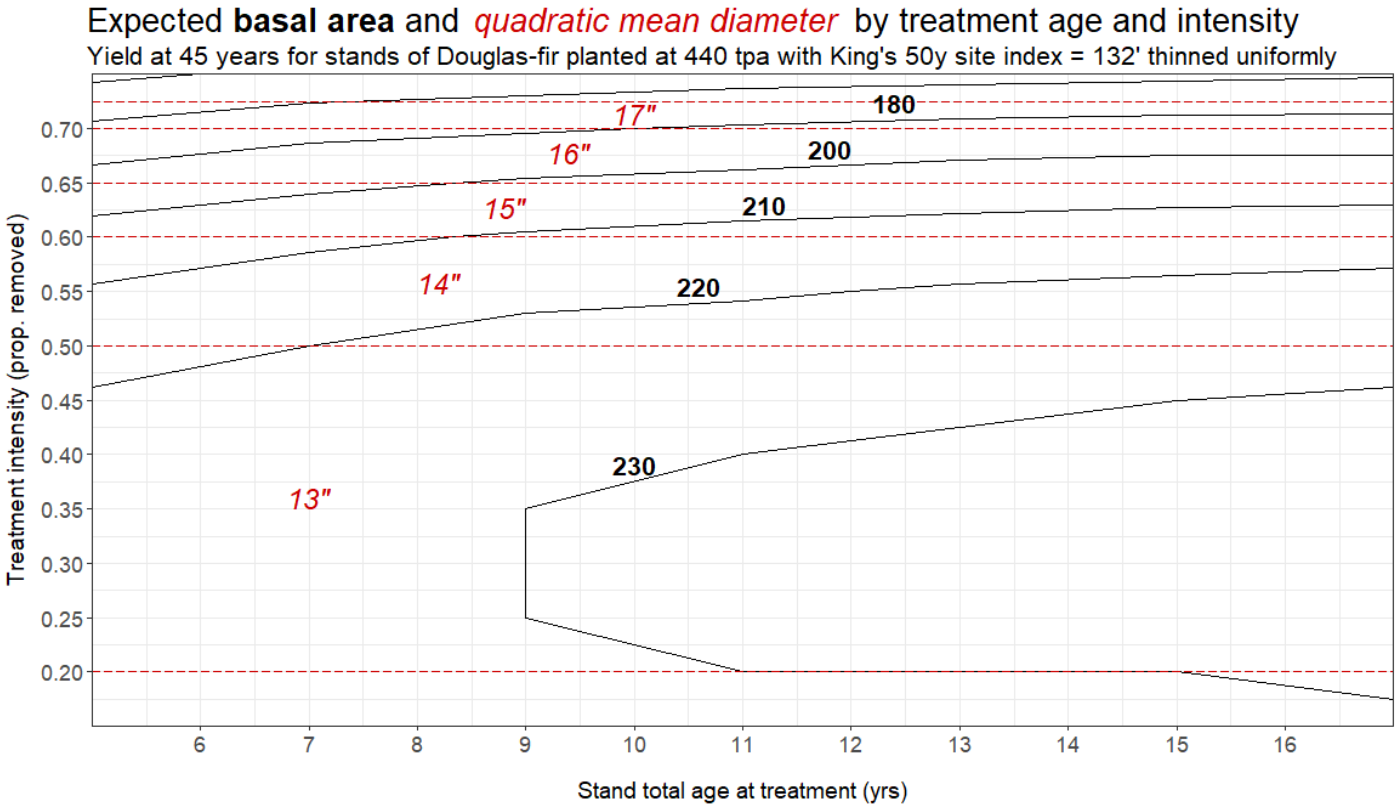


Figure 1: When comparing predicted yield at two different pairs of density/site coordinates, differences in basal area less than 25 square feet are not significantly different, and differences in quadratic mean diameter less than 1.3 inches are not significant statistically.

[1]Reukema, D.L. 1975. Guidelines for precommercial thinning of Douglas-fir. USDA-FS General Tech. Report. 30, 10 p.

While the differences are not statistically significant, expected board foot yields on thinned stands are larger across the observed range of treatment ages with treatment intensities up to 55%. Even at the highest treatment intensities, volumes are not significantly smaller than unthinned stands. The greatest gains are expected when stands are thinned between 11 and 13 years total age at intensities between 40% and 45%. The particular combination of treatment age and intensity may be selected for operational efficiency and/or desired product mix at the time of harvest.

Application

Figures 1 and 2 are calibrated to a planting density of 440 trees per acre and a (Kings's 50-year) site index of 132'; each is the median value from the analysis dataset. To apply, identify the intersection point of a desired treatment age (APCT) and proportion removed (PRM) in Figure 1 on the reverse side: this maps to the expected basal area and quadratic mean diameter at 45 years. Then, find the intersection of the same APCT and PRM values in Figure 2 below to determine the expected BF6 percent volume differential compared to an untreated stand. For Example, removing 45% of stems at age 11 is expected to yield approximately 225 square feet of basal area with a mean diameter of 13" at 45 years (Figure 1). The BF6 volume of that same stand would be approximately 7% greater than an unthinned stand at 45 years (Figure 2). One effect of treatment is to shift the distribution of volume towards higher grades (#2, #3 sawlogs) from lower grades (#4, pulp); differences in stand value (which vary over time and by location) may justify financially treatments that yield lower volumes overall.

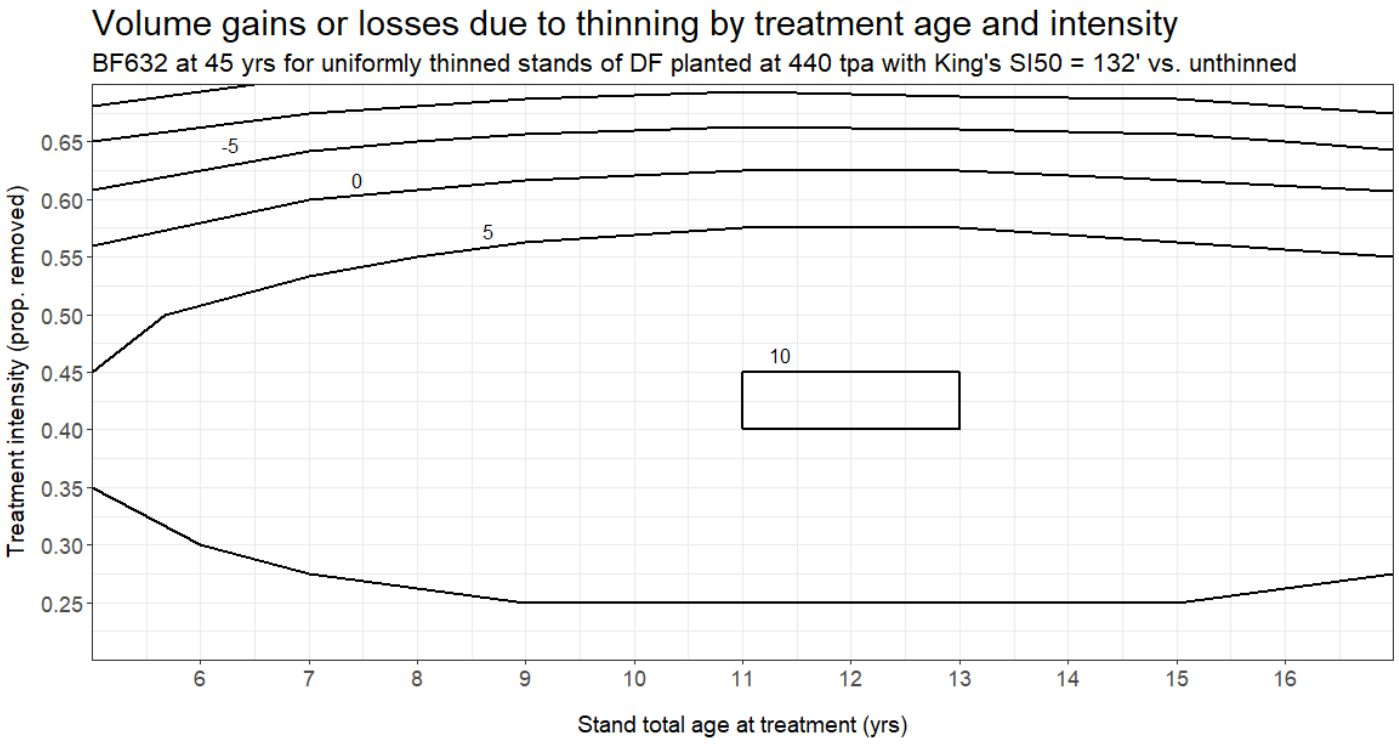


Figure 2: Only differences greater than 16 percent are significant statistically; subtract 16 from nominal value to get the expected net difference in yield. Differences within 16 percent of 0 should be considered not different from untreated stands.

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Douglas-fir BST Yield

Background

This fact sheet demonstrates the application of three of the seven Douglas-fir yield models detailed in SMC Working Paper 7: *Yield models for SMC Type I plots thinned precommercially: ages 35-60.* A Pre-commercial thinning is a stand-level treatment that removes less-competitive trees in favor of remaining crop trees. Whether or not a particular application is pre-commercial will depend on site quality, volume of material removed, and proximity to infrastructure. The method of thinning discussed here is *best-tree selection*, a strategy where a tree's relative dominance over its immediate competitors is the primary criteria for retention. This may result in an uneven spacing within the stand.

While basal area yields are not significantly different than untreated stands across the observed range of treatment ages and intensities when selecting for best-trees, expected mean diameter is significantly larger when treatment intensity is greater than 20%. When thinned, mean diameter becomes a function of intensity and is essentially insensitive to treatment age, with progressively larger diameters expected at progressively higher treatment intensities; additionally, mean diameter increases faster than for uniform spacing as treatment intensity increases (see Fact Sheet 7). The largest basal area yields are achieved at any observed treatment age with an intensity between 30% and 40%.

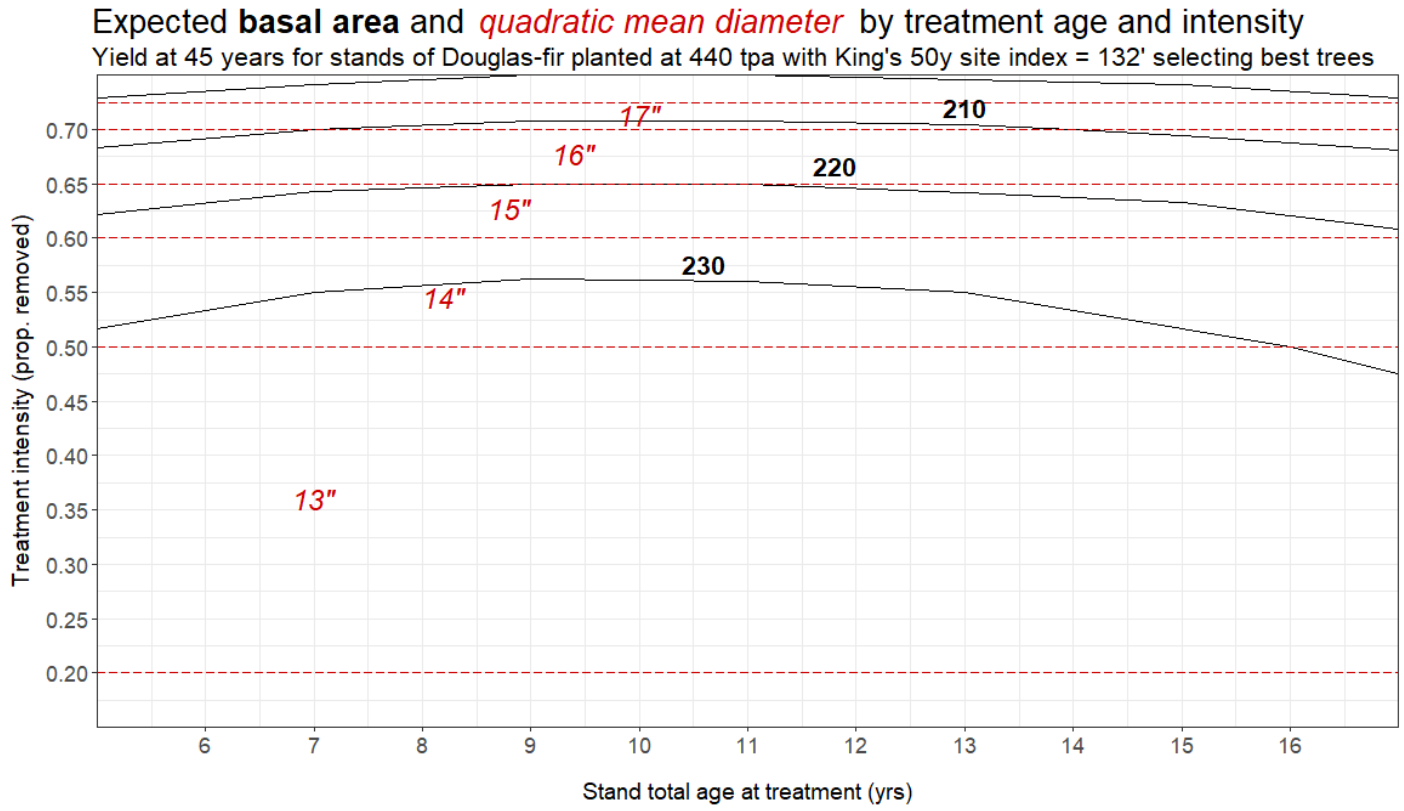

Figure 1: When comparing predicted yield at two different pairs of density/site coordinates, differences in basal area less than 25 square feet are not significantly different, and differences in quadratic mean diameter less than 1.3 inches are not significant statistically.

In contrast to uniform thinning, expected board foot yields on thinned stands are significantly larger than for unthinned stands when treatment age is greater than 8 years and treatment intensity is between 45% and 55%. Even at the highest treatment intensities, volumes are no different than for unthinned stands. The greatest gains are expected when stands are thinned between 13 and 17 years total age at intensities between 45% and 50%. Later treatment ages benefit best-tree selections as stands may be expected to have developed a greater degree of stratification between (co-)dominant, intermediate, and suppressed trees.

Application

Figures 1 and 2 are calibrated to a planting density of 440 trees per acre and a (Kings's 50-year) site index of 132'; each is the median value from the analysis dataset. To apply, identify the intersection point of a desired treatment age (APCT) and proportion removed (PRM) in Figure 1 on the reverse side: this maps to the expected basal area and quadratic mean diameter at 45 years. Then, find the intersection of the same APCT and PRM values in Figure 2 below to determine the expected BF6 percent volume differential compared to an untreated stand. For Example, removing 45% of stems at age 11 is expected to yield approximately 230 square feet of basal area with a mean diameter between 13" and 14" at 45 years (Figure 1). The BF6 volume of that same stand would be approximately 17% greater than an unthinned stand at 45 years (Figure 2). This result would be both significantly larger than unthinned stands, and 10% greater than stands thinned uniformly.

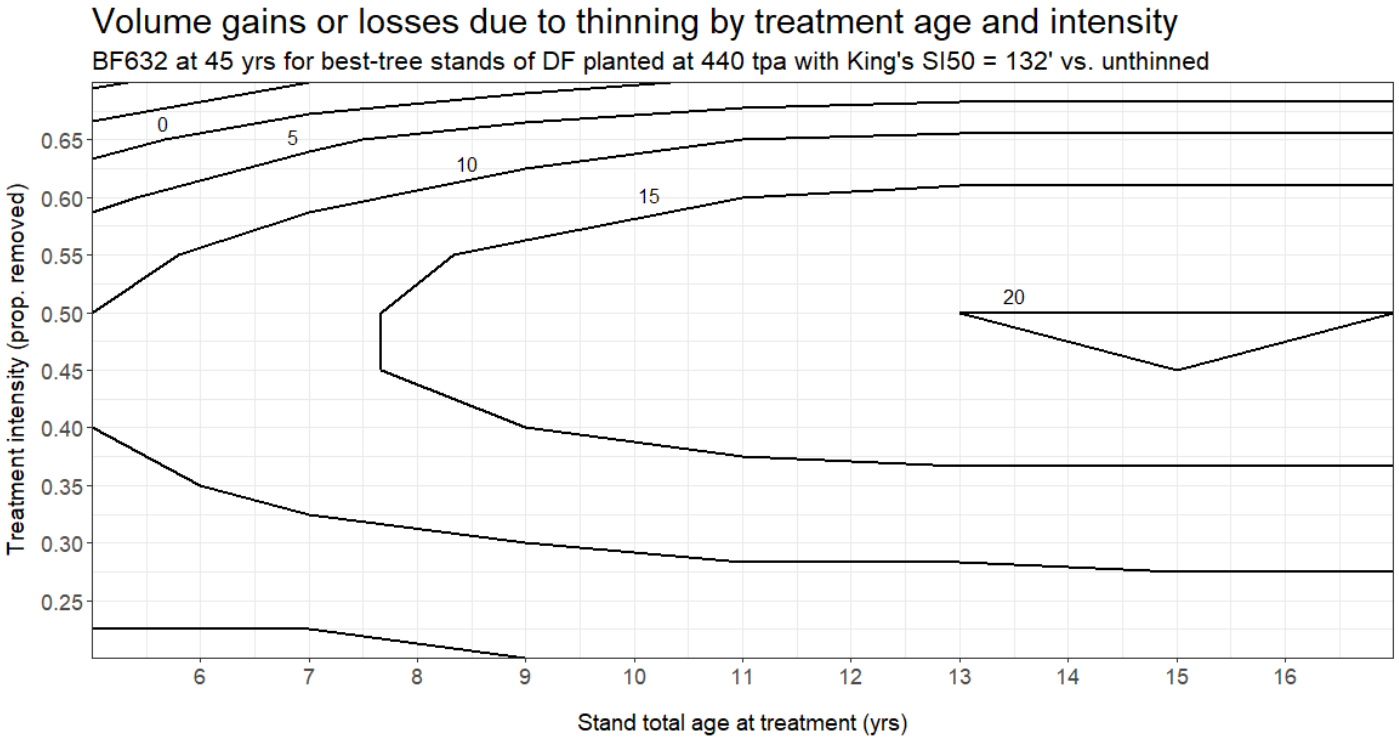

Figure 2: When comparing predicted yield at two different pairs of density/site coordinates, differences in basal area less than 25 square feet are not significantly different, and differences in quadratic mean diameter less than 1.3 inches are not significant statistically.

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