FURTHER ANALYSES FROM BALDERSTON PLANTATION

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The first project funded by SCIFMRC was to remeasure plots at Balderston Plantation on the Eldorado National Forest. One unusual trait of the Balderston site at 3,200 ft. near Georgetown is the occurrence of two distinctly different soils. The poorer of the two is the Mariposa soil series developed from 200 million year old marine sediments. The more productive is the Cohasset soil series developed on a volcanic mudflow occurring during the Pleistocene some 50,000 years ago.

Balderston was planted with ponderosa pine in 1967 following brushfield clearing by tractor. The experiment I began in 1976 was the first in California to test interactions between brush competition and soil fertility. Treatments were applied before the pines began their 10th growing season. They consisted of retaining or manually removing woody shrubs (manzanita) crossed with three levels of nitrogen fertilization (0, 200, or 400 lbs N per acre). Growth and nutrient changes were measured over 5 years (through plantation age 14) and findings were published. The site lay fallow until winter 1986, when treatments showing superior growth were retreated (further brush removal, fertilization, or thinning as needed). In 2000 we obtained SCIFMRC funding to remeasure the plots. That winter we reestablished plot boundaries and remeasured all trees. Twenty five-year effects of treatment and retreatment on mean stand diameters, heights, and volumes at plantation age 33 were reported in SCIFMRC Progress Report 2000.

Volume Differences. Remeasurements reported in last year's Progress Report showed that stand volumes on the Mariposa soil were 9 times greater where brush had been removed at age 9 than where it had not, and volumes were up to 14 times greater where brush control and fertilization were applied twice. Results from the Cohasset soil were proportionally more modest, although absolute growth was far greater. Standing volumes doubled over 25 years from varying combinations of fertilization, weeding, and thinning on Cohasset. But standing volumes after 25 years give us no clue as to the trend *during* the 25-year period. For insight, I analyzed height growth increment.

Defining the Trend. During remeasurements in winter 2000 we measured every 3rd to 5th tree for past heights at 5-year intervals between 1980 and 2000. From this we could estimate height growth patterns for a variety of height classes in each treatment plot. Averaging the heights of sample trees per plot gave us estimates of plot (stand) averages. We also measured heights for 1987 and 1988 (the 1st and 2nd years following retreatment). From this, heights could be reconstructed for the period covering the life of the experiment, including the period immediately after retreatment.

Procedures. We examined height growth trends for individual trees, plot means, and stand averages by treatment. Stand averages produced trends that fell into five groups of interest (Fig. 1). On the Mariposa soil, plots fertilized once in spring 1976 with 200 or 400 lbs N per acre showed slightly greater height growth than unfertilized, unweeded controls, but the difference of 2 to 3 feet seen by age 5 changed little thereafter. In contrast, plots with early brush control showed consistently greater rates of height growth, with differences widening with time. Weeded plots that were retreated with brush control and fertilization in 1986 (red and orange curves, Fig. 1) showed higher growth rates between 1987 and 2000 than those weeded and fertilized only once (blue curve, Fig. 1). However, all treatments with initial brush control responded similarly regardless of single or multiple fertilization. Mean stand heights for those treatments were twice those of controls.

Trends on Cohasset were similar to those on Mariposa. Fertilization at 200 to 400 lbs N per acre increased mean stand height by an average of 2 to 3 feet where brush was untreated (yellow and white curves). Although differences were not significant statistically, they seem to be widening. Brush control (the red curve) produced stands that averaged 10 feet (60%) taller than controls after 10 years, and this absolute difference has carried to the present.

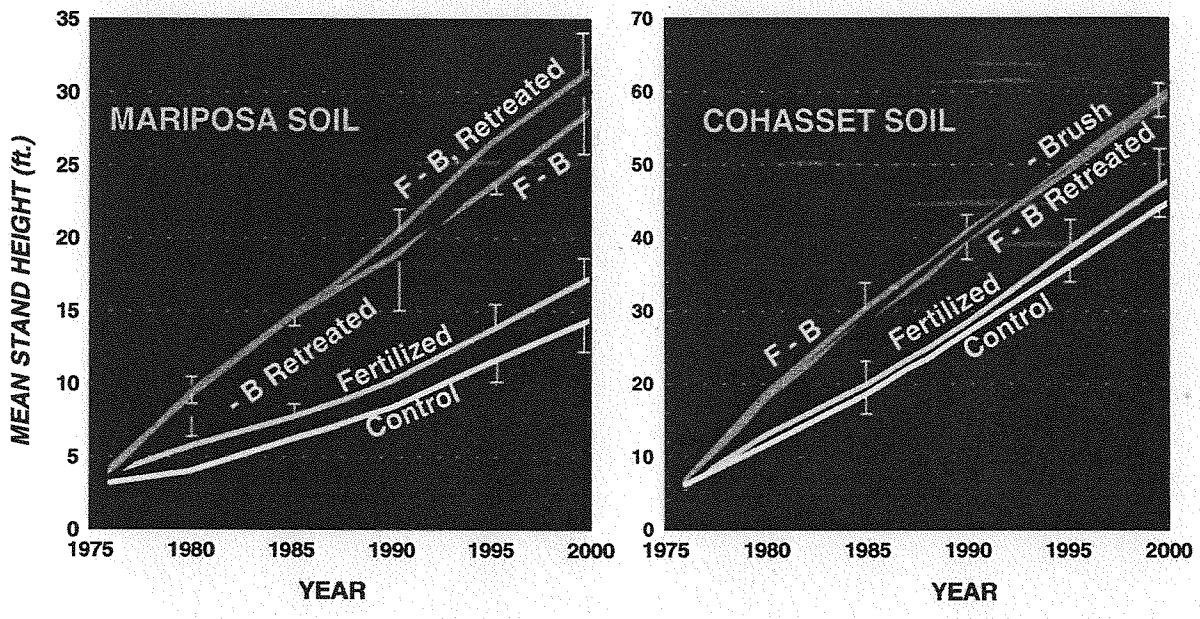

Figure 1. *Trends in mean stand height with time on the Mariposa and Cohasset soil series (F = fertilization, -B = manual removal of brush). Treatments with nearly identical trends were combined, and no distinction was seen between initial fertilization rates of 200 and 400 lbs. N per acre. Error bars indicate one standard deviation of the mean stand heights among treatments. Note that height trends on the Mariposa and Cohasset soil series are not to the same scale.*

On Cohasset, fertilization combined with brush control improved mean stand heights over brush control alone by year 5, but no differences were evident by year 15 (1990).

Conclusions. Height growth was increased by both brush control and fertilization on both soil types, but the greatest effect by far was from brush control. On the poorest site (Mariposa), retreating plots in the second decade after the initial treatments sustained relatively high rates of height growth beyond the normal point of decline. Twenty-five years after the initial treatments, stands with initial brush removal and subsequent retreatment averaged twice the height of control stands, and differences were widening. By 2000, mean differences between controls and the best treatments amounted to about 16 feet on both soils. Tree heights in control stands on Mariposa averaged only 14 feet tall after 33 years. Although trees were twice as tall as the 7-foot mean canopy height of living manzanita, brush appeared vigorous and there was no indication that it would be suppressed soon. On the better Cohasset soil, trees in control stands averaged 45 feet tall and largely had shaded out the 9-foot-tall manzanita understory. However, a dense fuel load of dead brush remained, establishing a fuel ladder between the ground and live crowns of overstory pine (see Fig. 2c in Progress Report 2000).