Survival and Growth of Three Conifer Species Following Three Types of Site Preparation and Three Levels of Subsequent Shrub Control 21 Years After Planting

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Disturbance, such as fire or logging, often lead to a forest site being occupied by commercially undesirable vegetation. On the west side of the Sierra Nevada mountains, weedy trees such as black oak (*Quercus kelloggii*), and shrubs, such as manzanita's (*Arctostaphylos sp.*) and *Ceanothus sp.*, are common invaders after disturbance, particularly on harsh (hot, dry) sites. Efforts to re-establish conifers on harsh sites have often led to failure. In order to determine the best type of site preparation for conifer planting on harsh sites, an experiment was established in the fall of 1978. The objectives of the experiment were to compare the survival and growth of transplanted white fir, sugar pine, and ponderosa pine following site preparation by the use of fire, a rotary masticator (Hydroax), and a brush rake. We also examined three levels of subsequent weed control, a single herbicide treatment at one year after planting, two yearly herbicide treatments at one and two years after planting, and no subsequent treatment after planting.

A seven-acre area on Humbug ridge road in Tahoe National Forest (Foresthill Ranger District) was used for the study. The area chosen for the study had been occupied by shrubs and weedy trees for at least 18 years since the Volcano fire, and possibly much longer. A split plot design was used with three replications. Main plots were site preparation method (150 ft. X 200 ft.), and sub-plots were number of herbicide release treatments (150 ft. X 66 ft.). Site preparation was done in September, 1978. A Hydroax cut shrubs off close to ground level, with no disturbance to the soil. A brush rake pushed all the shrubs and trees into a pile in the center of each plot, also removing large roots in the process and causing disturbance in the top 12- to 18- inches of soil. Brush piles were later burned, but no effort was made to redistribute the ashes prior to planting. The brush rake also drove over the fire plots (no blade) to crush the shrubs to aid in shrub drying and allow a hotter fire. Several weeks later, the fire plots were burned, with only a few random, charred branches still standing after the burn. Soil disturbance on the fire plot was limited to heating of the top layer and the addition of ash to the surface.

In early May 1979, 1-0 ponderosa pine, sugar pine, and white fir seedlings were transplanted into every plot. A forest service crew used a power auger to prepare each planting hole. Trees were planted in a 6 ft. X 6 ft. grid, with 11 trees per row and 24 rows in each subplot. Each 11-tree row consisted of a single species, with 8 rows of each species being randomly arranged in each sub-plot. The untreated subplot did not receive any further management.

The single release plots received a directed herbicide treatment in the spring of 1980, and the two-release plot received a directed herbicide treatment in the spring of 1980 and 1981. In September 2000, 21 years after conifer planting, conifer survival, diameter at breast height, and height were measured on each surviving tree.

Ponderosa pine survival was affected by an interaction of site preparation and the level of subsequent weed control (Figure 1). Each release treatment increased ponderosa pine survival approximately 10%. However, each site preparation method differed. Following brush raking, a single release treatment resulted in less survival than the untreated, but two-release treatments improved ponderosa pine survival about 10 % over the untreated. Ponderosa pine survival on the fire plots benefited greatly (over 25%) by a single release treatment, but no further gain occurred with two treatments. On Hydroax plots, survival increased by 15% following a single release, and by 22% when two release treatments were made. In general, the greater the level of soil disturbance, the better the ponderosa pine survival, but also the lower the response to subsequent weed controls.

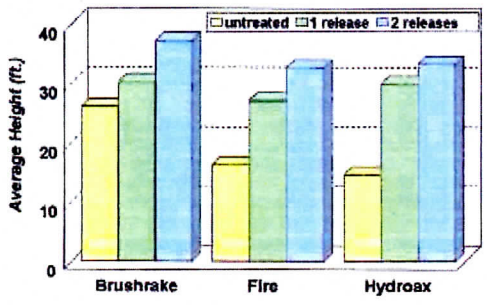

Figure 1. Ponderosa pine survival percentage relative to site preparation and the number of subsequent herbicide applications.

Ponderosa pine height was least when no weed control was used after planting (Figure 2). A large growth increase (over 10 ft. in ht.) in ponderosa pine was observed when a single herbicide treatment was used. Ponderosa pine ht was greatest when two yearly weed control treatments were used, but the increase over a single treatment was only about 5.4 ft. in height. There was no interaction between site preparation method and subsequent weed control on the height of ponderosa pine.

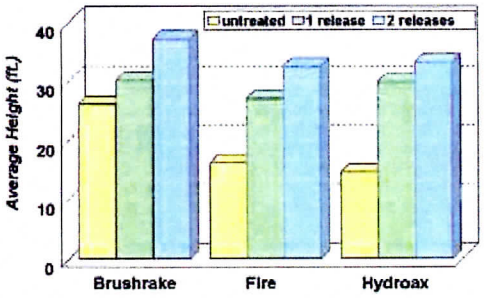

Figure 2. Average height of ponderosa pine relative to site preparation and the number of subsequent herbicide applications.

White fir survival was affected by the level of subsequent weed control following site preparation, but not by the interaction of site preparation and the level of subsequent weed control (Figure 3). The first release treatment appeared to have decreased white fir survival by over 50%, down to only 15%. Two release treatments improved white fir survival about 10% over the single release treatment, but still 9% less survived than the average survival on the untreated plots. At the 10% confidence interval, the white fir survival on the brush rake plots receiving two herbicide

treatments or untreated, was greater than survival on other plots.

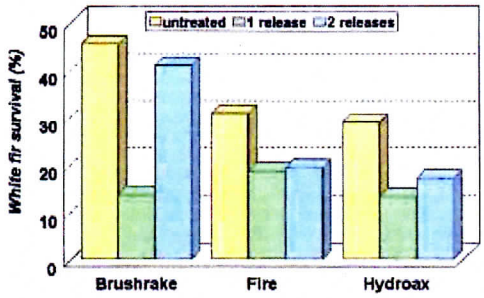

Figure 3. White fir survival percentage relative to site preparation and the number of subsequent herbicide applications.

White fir height was least when no weed control was used after planting (Figure 4). A large growth increase (almost 2 ft in ht) in white fir was observed when a single herbicide treatment was used. White fir heights were greatest when two yearly weed control treatments were used, with an increase of 4.5 ft. in height over the single treatment. There was no interaction between site preparation method and subsequent weed control on white fir.

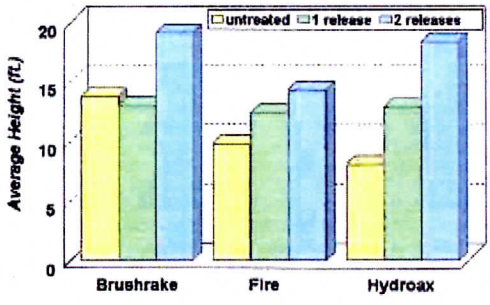

Figure 4. Average height of white fir relative to site preparation and the number of subsequent herbicide applications.

Sugar pine survival was extremely poor in all plots (Figure 5). Disease has killed most of the sugar pine found in these plots. There was better survival with two herbicide release treatments compared to the other treatments. The reduction in weeds on these plots may have reduced alternative host plants for the disease, which killed the sugar pine. There was less survival on the Hydroax plots than on the other two site prep methods. Sugar pine survival on the fire plots with two release treatments and the brush rake plots with one or two release treatments was greater than survival on other plots. Again, these plots had less competing weeds, which could have reduced the alternative host plants for the disease which killed the sugar pine.

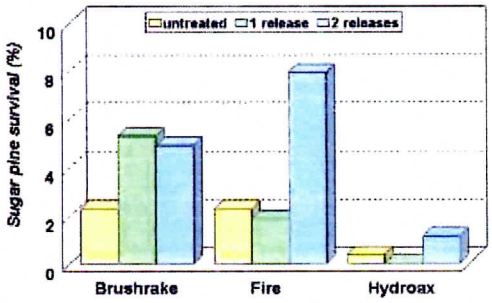

Figure 5. Sugar pine survival percentage relative to site preparation and the number of subsequent herbicide applications.

Sugar pine height data (Figure 6) should be regarded as less reliable than the other two species, due to the small number of surviving trees. Sugar pine height was greatest when two herbicide release treatments were used and also better on brush rake plots. As the trends in the sugar pine data parallel the other two conifer species, it seems that these are an accurate representation of tree growth response.

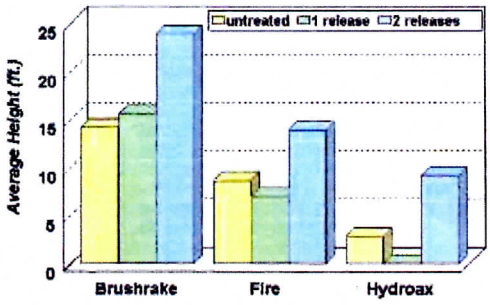

Figure 6. Average height of sugar pine relative to site preparation and the number of subsequent herbicide applications.

At 21 years after transplanting, ponderosa pine survival was about 60%, white fir about 25%, and sugar pine less than 5%, of the original number of planted trees. On many of the plots which received two herbicide treatments, conifers had achieved canopy closure and shrub growth was minimal. However, if tree survival was poor, the shrubs continued to significantly compete with the remaining conifers. It appears that the brush rake treatments reduced shrub re-growth better than fire and Hydroax treatments, which has improved survival and growth. Although there were consistent conifer growth benefits associated with herbicide treatments, there also appeared to be some conifer injury, based on the reduction in white fir survival. Where survival is high, trees are competing more with each other than other vegetation, as they are planted on a 6 ft X 6 ft grid.

These and other details of our 21-year findings can be viewed at http://wric.ucdavis.edu/sierracascade/ under the members only section. Future plans include assessing GPS coordinates, which will allow others to view this research site and know where they are located. Once those data are obtained, they will be forwarded on as an attachment to this report.