Brushfires in California Wildlands: Ecology and Resource Management
Edited by J.E. Keeley and T. Scott. 1995. International Association of Wildland Fire, Fairfield, WA.

Comparison of Seedling Emergence in Hydroseeded and Non-hydroseeded Burn Sites During Early Stages of Post-Fire Recovery

Stephanie H. Asche and Kristin P. Barton

Natural Science Division, Pepperdine University, Malibu, CA 90263
Tel. (310) 456-4321; E-mail: davis@pepperdine.edu

Abstract. Post-fire species diversity and cover were compared in hydroseeded and non-hydroseeded sites. Diversity and prevalence of native chaparral species are negatively affected by hydroseeding, and percentage cover of vegetation is not significantly enhanced during the first two and one-half months following hydroseeding. This study suggests that hydroseeding may not be effective in preventing post-fire erosion and may deter the reestablishment of native seedlings after fire.

Keywords: Chaparral; erosion; hydroseeding; percentage cover of vegetation; species diversity; wildfire

Introduction

The chaparral vegetation of southern California has evolved over thousands of years in response to periodic wildfire. There are two major ways in which species of chaparral shrubs reestablish after fire. The first is by resprouting, and the second is by germination of refractory seeds. Species that lack sprouting ability and thus depend entirely on seed germination for reestablishment after fire are known as obligate seeders (Keeley 1986). The seeds often remain dormant until after fire, which promotes germination by cracking, chemical influence, or temperature dependent mechanisms (Keeley et al. 1981). The most prominent and quickly established plant types following fire are herbaceous flowering annuals. The annuals germinate, grow and flower in the months following fire, and their seeds are dispersed to lay dormant until after the next fire promotes their germination (Well 1969).

A major concern after fire in southern California is the erosion of hillsides. This occurs when the rainy season arrives before new growth has had sufficient time to establish. In an effort to avoid the detrimental effects of erosion to the landscape and the community, a new technique, known as hydroseeding, has been employed. Hydroseeding involves the spraying of fast-growing grass seeds, imbedded in a matrix of wood mulch and fertilizer, over burned areas, theoretically speeding up plant re-establishment and impeding erosion by anchoring the loose soil with their roots.

A possible problem with hydroseeding is that introduced seedlings may out-compete seedlings of native obligate seeders (including the post-fire annuals), and thereby interfere with the natural cycle of chaparral succession (Keeley and Keeley 1988). Because there was a wildfire that burned areas of the Pepperdine campus on November 3, 1993, hydroseeding was done on December 28, 1993, in an attempt to avoid erosion caused by winter rains (Bill Cunningham, NRCS, personal communication).

In our particular experiment, eight plots (four hydroseeded, and four non-hydroseeded) in a native stand of burned chaparral vegetation were compared for percentage cover and species diversity over a four week period. Precipitaion levels were also recorded in an effort to find what, if any, conclusions could be drawn from the subsequent growth rates between the arid chaparral plants and the non-native grasses.

Methods

The experiment was conducted in the Santa Monica Mountains on the south-east side of Pepperdine University campus at Malibu (Los Angeles Co., elevation 320m). A section of this hillside site had been hydroseeded with a 59.6% *Bromus hordeaceus* and 33.3% *Trifolium hirtum* mixture, with a net weight of 3.3 kg/ha (18 lbs./ac). A mixture of wood fiber mulch and paper was applied at 366 kg/ha (2000 lbs./ac) (85% solids; 15% liquid) (Bill Cunningham, NRCS, personal communication). Plots were selected according to the quadrat sampling technique for vegetation analysis (Cox 1985). Eight, square meter plots were staked, four of which were located in the hydroseeded area and four in the nonhydroseeded area, with about ten meters separating the two areas. Plots were selected to match similar elevations and gradients. At both sites, three plots shared a common edge with a neighboring plot, and the fourth was connected by one of its corners.

Data were taken for four consecutive weekends (19 February - 12 March). To find the percentage of each plot covered with seedling growth, a 1 x 1 meter grid divided into four hundred equal squares was placed over the corner stakes. Percentage cover of vegetation (VC) was determined by the leaf cover over the plot's total area:

VC + (squares covered/400 x 100 (%)

Secondly, random sampling was employed in order to analyze species diversity between the hydroseeded and nonhydroseeded plots. Grid squares were given coordinates of numbers for columns and letters for rows, and random numbers were generated with the aid of a Texas Instruments Graphing Calculator. For each of the eight plots, ten random samples were made weekly, and all seedlings with root bases in the square were counted. Species were given letter designations until scientific names could be determined. Also, representatives from weekly observed species were obtained for identification purposes.

We installed a rain gauge at our study site, and measured precipitation for each week from 8 February to 12 March 1994.

Results

Rainfall during the study period varied between 49 mm on February 8 (= week (1)) to 11 mm on March 12 (= week 4) (Fig. 1). Total rainfall between 8 February 8 and 12 March 1994 was 127 mm.

Percentage cover in hydroseeded plots ranged from 4.5 percent to 24 percent, while the nonhydroseeded plots ranged from 4.5 percent to 18 percent (Fig. 1). Through week 3, the percentage cover was nearly identical for both sites, and although week 4 showed a higher mean cover for the hydroseeded plot, it was not significantly higher (P<0.88, Student t-test).

Figure 2 shows the results for the total number of species in the hydroseeded plot (five), compared to the total number of species in the nonhydroseeded plot (nine). The five plants in the hydroseeded plot were *Calystegia* sp., *Trifolium* sp., *Lotus* sp., *Erodium* sp., and one unidentified but prevalent plant (plant a), which was most likely a *Bromus* sp. These five were also seen in the nonhydroseeded plots, along with four additional species (*Dichelostemma* sp., *Phacelia* sp., *Salvia* sp., and another unidentified species (plant f)).

Percentage Cover Over Four Week Period

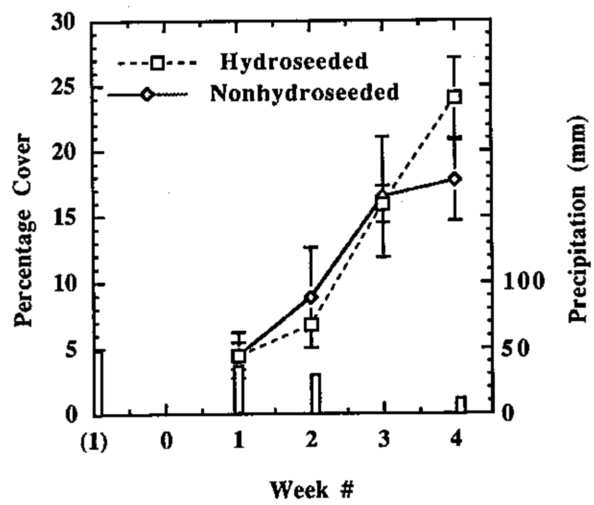

Figure 1. A comparison of percentage cover of post-fire seedlings in hydroseeded versus nonhydroseeded study sites on the Malibu campus of Pepperdine University over a four week period. The fire occurred on 3 November 1993 and hydroseeding was done 28 December 1993. Bars represent weekly precipitation recorded over the four week study period, and two weeks prior to the initiation of vegetation sampling.

Figure 3 shows the prevalence of each species in the nonhydroseeded and hydroseeded plots. The error bars indicate standard error of an individual species' occurrence over the four week time period. Those plants that showed a significant difference between plots were plant a, growing more prominently in the hydroseeded site, and *Dichelostemma* sp., *Phacelia* sp., *Salvia* sp., and plant f, growing only in the non-hydroseeded site. (Student t-test values of P = .0137, P = .0001, P = .001, P = .0033, and P = .0001 respectively). It might also be mentioned here that two unidentified species, with negligible observation rates (mean < 1), are not presented in the results.

Discussion

The results of the study indicate that, at least in the short term, hydroseeding does not significantly increase percentage cover of post-fire seedlings. If regrowth is not substantially increased by hydroseeding, its effectiveness as a means of erosion control is questionable.

A more serious implication of the study, is that there may be a decrease in species diversity (and consequently, their prevalence) due to hydroseeding. The absence of four species in our hydroseeded plots and the decreased prevalence of a fifth species, indi-

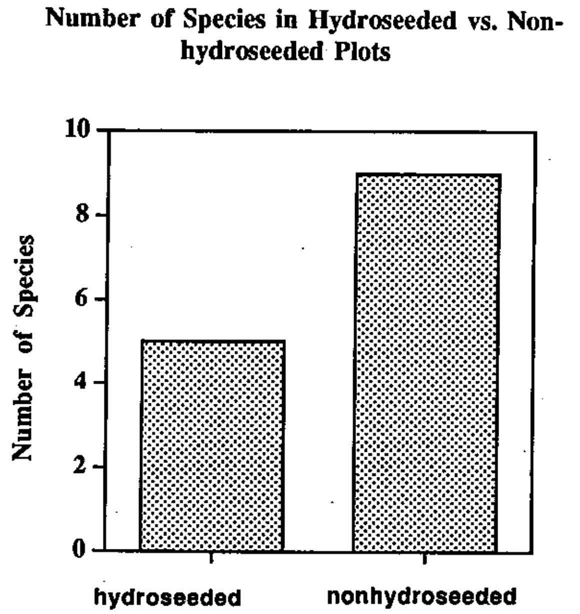

Figure 2. Number of species seen in hydroseeded and nonhydroseeded plots on the Malibu campus of Pepperdine University, 8 February through 12 March 1994. Species numbers are reported for plants with a mean total from all four weeks of the sampling period.

cates that the introduction of nonnative seeds may bring about competition for native species.

In order to investigate why the nonnative seeds introduced by hydroseeding are able to out compete some of the native plants, it is necessary to do studies of other factors such as litter mass, temperatures, soil pH, and soil enrichment (Westman 1981). One interesting piece of information is that *Bromus erectus*, in the same genus as the grass found in hydroseed, grows significantly faster when its nitrogen source is NO_3 -nitrogen. This could be an advantage for *Bromus* seedlings in the post-fire environment for the first several months after fire, since the products of the combustion of nitric oxide and nitrous oxide have been shown to be fixed by microbes in the soil and given off at high levels (Monastersky 1988).

In consideration of these variables, we were surprised to see the lack of increased cover due to hydroseeding during the first five months following fire. It is interesting to note that initially there was no difference between the seedling cover in the hydroseeded and nonhydroseeded sites (Fig. 1). By week three, a slight difference in mean values were evident, but the results were still not significantly different. Perhaps a lengthened observation period would show a divergence between hydroseeded and non hydroseeded treat-

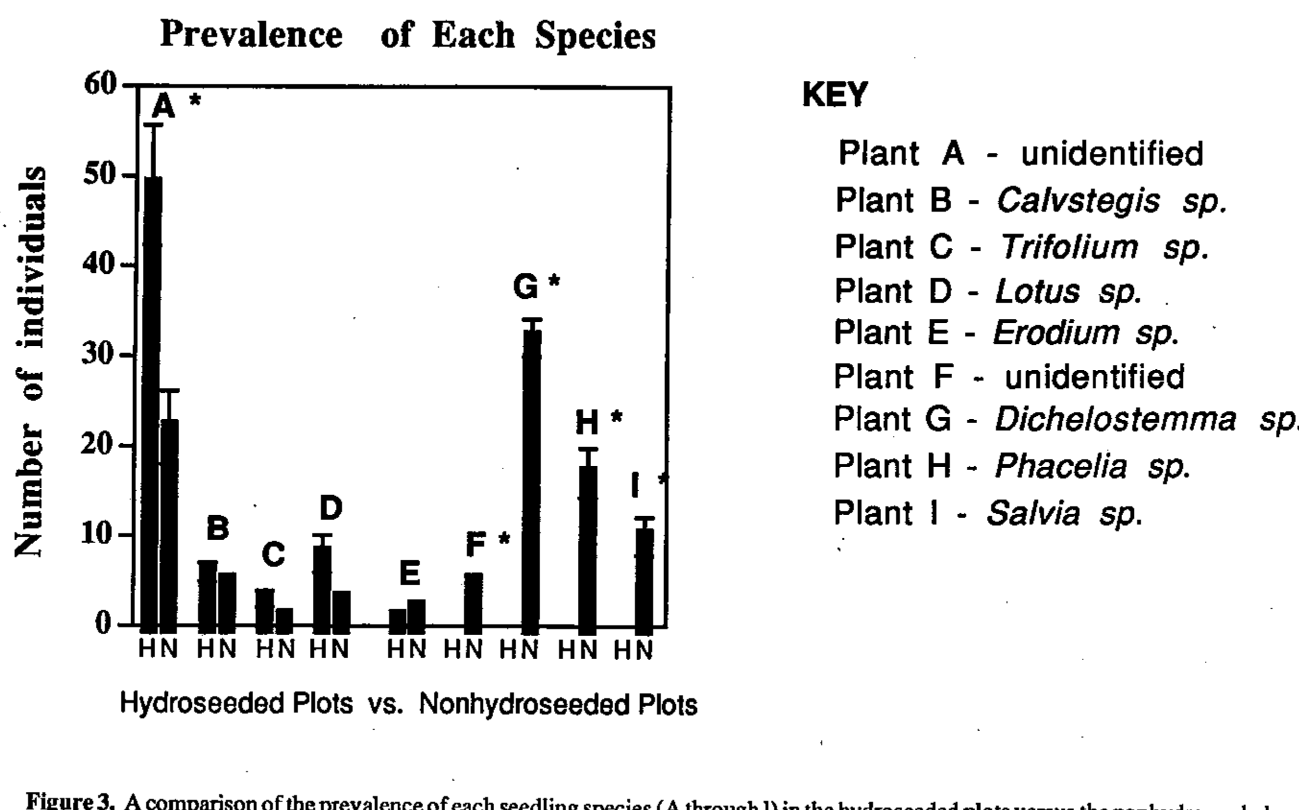

Figure 3. A comparison of the prevalence of each seedling species (A through I) in the hydroseeded plots versus the nonhydroseeded plots on the Malibu campus of Pepperdine University, 8 February through 12 March 1994. The number of individuals is the mean total (to the nearest integer) from all four weeks. An asterisk(*) indicates significant differences (by Student t-test, $p < 0.05$).

ments. However, such a trend would be too late for effective erosion control during the rainy season of a Mediterranean-type climate region like that of southern California. The germination of the fast-growing grasses undoubtedly relies on adequate rainfall. Because they are not native to the chaparral climate, the growth rates should parallel rain levels. This was seen between weeks three and four, as a substantial amount of rainfall was recorded for the first three weeks.

In conclusion, this study indicates that hydroseeding may not provide enough of a short-term benefit as an erosion deterrent to outweigh its costs to the proliferation of native species, including post-fire annuals and non-sprouting perennials (obligate seeders). If a nonnative plant, like *Bromus*, flourishes under warm temperatures and high nitrous oxide levels, it could have detrimental consequences for the success of native species by disturbing the natural cycle of fire succession.

Acknowledgments. We thank the Natural Science Division and Stephen Davis for assistance with this project.

Literature Cited

Cox, G. 1985. Laboratory manual of general ecology (Fifth edition). Wmc. Brown Co., DeMoine, Iowa.

Keeley, J.E. 1986. Resilience of Mediterranean shrub communities to fire, pp. 95-112. In B. Dell (ed), Resilience of Mediterranean ecosystems. Dr. W. Junk. New York.

Keeley, J.E., and S.C. 1988. Chaparral, pp. 165-207. In M.G. Barbour and W.D. Billings (eds), North American terrestrial vegetation. Cambridge University Press, Cambridge, U.K.

Keeley, S.C., J.E. Keeley, S.M. Hutchinson, and A.W. Johnson. 1981. Postfire succession of the herbaceous flora in southern California. Ecology 62:1608-1921.

Montastersky, R. 1988. Legacy of fire: the soil strikes back. Science News 133:231.

Wells, P.V. 1969. The relation between mode of reproduction and extent of speciation in woody genera of the California chaparral. Evolution 23:264-267.

Westman, W.E. 1981. Diversity relations and succession in California coastal sage scrub. Ecology 62:170-184.