SHRUB CONTROL BY BURNING BEFORE TIMBER HARVEST

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ABSTRACT

Many shrubs do not compete well in well-stocked timber stands. Prescribed burning has the potential to kill many shrubs that would normally sprout when released and grow vigorously in the open. In addition, fires prescribed to consume a great deal of the duff can also kill many dormant but viable shrub seeds stored in the duff and upper soil.

An exploratory study was devised to burn two times before harvest. The first fire reduced fuel loads under moderate conditions, top-killed most shrubs, and caused many shrub seeds to germinate. The second fire, conducted when more duff was consumed 3 and 3 1/2 years later, killed all the new shrub seedlings and drastically reduced sprouting of shrubs. On two plots, 70.9 and 100 percent of the old snowbrush ceanothus (Ceanothus velutinus), 50 percent of the golden chinkapin (Castanopsis chrysophylla), 93.8 percent of the antelope bitterbrush (Purshia tridentata), and 100 percent of the greenleaf manzanita (Arctostaphylos patula) died.

Although the practice appears promising, it will be 10 years before its success or failure is demonstrated. The end result after harvest has not yet been measured, but the summer after logging, no new shrubs were recorded. The question of how many shrub seedlings will develop in the next several years still remains. In the meantime, forest managers might want to explore the practice on their own species and sites.

INTRODUCTION

A major problem in regenerating timber stands is competition from shrubs. This paper addresses the potential use of fire before harvest to reduce shrub competition following the regeneration cut.

Shrubs and other competing vegetation such as grasses and forbs are usually natural components of timber stands. These stands have been regerating over thousands of years, and fire often was the agent destroying the older stands, groups of trees, or individuals. Fire might also have been important in reducing competing vegetation sufficiently to enhance tree regeneration and growth. Some areas have regenerated naturally following complete or partial mortality of tree stands, whereas others have resulted in shrub fields. The question can be asked whether or not prescribed burning before timber harvest might reduce shrub competition during regeneration.

The central Oregon results presented here are preliminary, and I can't say with much assurance to what extent burning before harvest will reduce the shrub competition problem. The study described is exploratory, and a more definitive study is now underway. It will be at least 10 years, however, before we have reasonably sound answers, but then only for these conditions and sites. My reason for presenting these preliminary results is to have land managers consider the logic behind the study and perhaps conduct their own studies under conditions where they work.

PREVIOUS WORK

The effects of shrubs on tree growth has been documented in many studies. Barrett (1970, 1973) has shown that volume growth of thinned ponderosa pine (Pinus ponderosa) saplings at wide spacings in central Oregon was twice as great without shrubs than with. Trees on sites with shrubs grew less in height and diameter than trees competing with shrubs. Bentley et al. (1971) on a site of low productivity in California found brush competition reduced height growth of ponderosa pine for 5 years after planting. On a productive site in northern California, Oliver (1979) found that shrub competition reduced ponderosa pine diameter growth nearly 3 years during the 12 years of the study.

Extensive site preparation is often conducted on harvested areas or established brushfields by machine, chemicals, and fire to allow for regeneration. Purposes of site preparation are many and include control of competing vegetation. Methods of reducing shrubs to regenerate stands are given in Baumgartner and Boyd (1978) and Cleary et al. (1978). Costs for such treatments are high and can cause excessive disturbance to sensitive sites.

Burning to control shrubs has been conducted by several investigators. Biswell et al. (1955) discuss use of fire to kill shrubs and break dormancy of stored seeds and to reburn the shrub seedlings. Effects of fire on shrubs in the northwest has been discussed by Hall (1976), Martin and Johnson (1979), Olson et al. (1981), Adams (1980), and others. Generally, they found that most fires kill the aboveground portion of almost all shrubs. The amount of fuel consumed, soil temperature, moisture, and other factors affect the degree of sprouting for many shrubs. Factors governing the degree of sprouting of antelope bitterbrush (Purshia tridentata) are discussed by Martin and Driver (1982).

RATIONALE

The studies cited above recognized the effect of fire on shrubs, but none was designed to exploit the stresses to which shrubs are exposed while growing in the fully occupied stand. The stresses may come from water, light, temperature, or nutrient deficiencies or may be caused or increased by animals or diseases. In effect, the stresses would be translated into probabilities of mortality for the shrubs. Fire would be used to increase the stresses and thus the mortality of shrubs.

The rationale behind this approach to shrub control is illustrated diagramatically in figure 1. Although we do not have data for rates of shrub mortality in the open and in timber stands, I assumed that shrubs competing with trees would be subject to a higher probability of mortality. The probabilities of mortality might be quite low even in timber stands. I recognize the lines in figure 1 would have seasonal variations caused by heavier mortality from drought, winter kill, or other factors; but I've drawn them straight for simplicity. The mortality depicted would represent a fairly tolerant shrub, capable of competing reasonably well, although stressed, under a timber stand. Basically, it would be as we see snowbrush ceanothus competing under ponderosa pine east of the Cascade Range. If a shrub field devoid of trees were burned, we would expect a very high percentage of sprouting from the ceanothus. In addition, it would produce a large number of seedlings because its "hard" seed is capable of remaining dormant but viable in the duff and soil for 200 to 300 years (Gratkowski 1962), germinating after thermal or mechanical scarification.

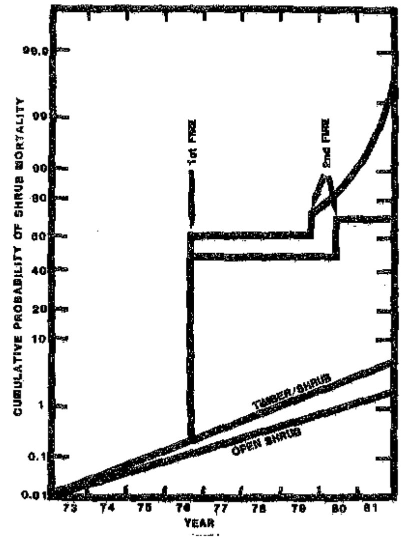

Figure 1.--Probability of mortality of sprouting shrubs following stress added by two prescribed burns under a timber stand. Data represent the effects recorded on snowbrush ceanothus in two plots under a ponderosa pine canopy in central Oregon.

Although snowbrush ceanothus survives in well-stocked timber stands, it becomes straggly and its growth slows. This would suggest a stressed condition. Perhaps additional stress from some agent could increase shrub mortality. Insects, other animals, or diseases might provide the necessary stress as well as fire; although we have chosen the latter because of its ease of application and low expense.

The broad curve in figure 1 of higher mortality going upward from the timbered shrub curve represents roughly the cumulative mortality we measured following two burns in each of two plots. In addition to increasing mortality amongst the old plants, as presented here, the second and any succeeding fires would also kill shrub seedlings, which often do not sprout.

Fire also acts to reduce potential shruh production from seeds. First, the aboveground portions of most shrubs are readily killed by even light fires. Top-killing removes seed production for at least 2 or 3 years. Second, seeds located in the duff and soil surface would he killed by heat. Third, shrub seedlings produced from scarified seeds are killed by subsequent fires. Perhaps one fire before harvest, combined with hroadcast slash burning after harvest will reduce shrub competition sufficiently. A major question is whether even two or three fires can kill enough seeds to significantly reduce the number of shrub seedlings. I want to emphasize that we are not interested in eliminating the shrubs from the site, but merely to reduce their negative effects on tree regeneration and growth during the early part of the rotation.

METHODS

The study was conducted on the east slope of Lookout Mountain, part of the Pringle Falls Experimental Forest about 48 km (30 miles) south-southwest of Bend in central Oregon. Elevations are 1 390 m (4,550 ft) and 1 525 m (5,000 ft) for the lower and upper units. The lower unit lies in the ponderosa pine/bitterbrush-snowbrush/needle-grass habitat (Volland (1976) community type CP-SE-11) and the upper unit in the mixed conifer-ceanothus-sedge community (Volland (1976) community type CW-S1-15). Ponderosa pine was the only overstory tree on the plots, with about 23 to 32 m^2 per ha (100 to 140 ft^2 of basal area per acre), but the upper plot did contain some seedling and sapling white fir (Abies concolor). The area receives about 76 cm (30 in) of precipitation each year, mostly as snow.

The plots were first burned in autumn, 1976, in connection with a nutrient cycling study. The upper plot was reburned on October 2, 1979, and the lower plot on June 9, 1980.

Fuel moisture content and quantity were measured for live and dead fuel categories and for standard National Fire Danger Rating System fuel size classes. Fuel moisture samples were collected in 10-cm (4-in) soil cans, sealed, and weighed upon returning to the Laboratory. They were then ovendried at 70° C (158° F) and reweighed. Fuel quantity was measured by planar intersect (Brown 1974). As the major reason for the first burns was other research, data on some fuels were not collected.

Weather records were kept preceding and during the burns. Prior to burning, precipitation was measured as a guide to meeting prescription conditions. During the burns, temperature, relative humidity, and wind were measured on no greater than a half-hour interval, as well as at the beginning and end of the burn.

Measurement of the effect of fire on shrubs differed between the first and second burns. No shrub seedlings were counted before the first burn; and the effects of the first fire on old shrubs was measured by counting the number of shrub carcasses, noting whether or not they had been burned, and whether or not they had sprouted. For the second burn, shrub seedlings were marked with wire pins bent differently to indicate the various species. Checking the pins after burning was used to tally mortality. Old shrubs were counted again after the second hurn, noting whether or not they had sprouted.

RESULTS AND DISCUSSION

Weather before burning helped meet different prescription conditions for the first and second burns. Both plots received 3.8 cm (1.5 in) of precipitation within a week before the first burn. This provided sufficient moisture in the duff (table 1) to meet moderate fuel moisture conditions as large amounts of fuel were present (table 2). Fuel consumption was low on the first burns.

The second burns were conducted with less moisture in the duff and larger fuels. The second burn in the upper plot was conducted during a dry fall. Duff and large fuels were quite dry. Consequently, 70 percent of the litter and duff, and 57 percent of the 1000-hr-timelag (TL) fuels were consumed (table 2). The lower plot was reburned in early summer when duff and large fuels had not yet dried out, even though no precipitation immediately preceded the burn.

Sprouting of Ceanothus velutinus was controlled best by the drier burning conditions of the second burn on the upper plot compared to the lower plot (table 3). All of the old ceanothus plants on the upper plot died following the second burn, although some sprouted before succumbing. On the lower plot only 71 percent of the old ceanothus plants died. Normally, we would expect the active plant which has just expended food reserves on growth to be more susceptible than the dormant plant. I attribute the difference to application of more heat to or near the root collar or roots of the shrub. This is done by burning when duff is lower in moisture content and more will be consumed in the fire. These conditions would normally be met before extensive precipitation in the autumn or a sufficiently long time after snowmelt in the spring.

Table 1.--Fuel and weather conditions during prescribed burns.

	Upper plot 1st burn	Lower plot 1st burn	Upper plot 2nd burn	Lower plot 2nd burn
Burn date	9/27/76	10/1/76	10/2/79	6/9/80
Weather				
Temperature °F	56-71	70-74	56-67	50-52
°C	13-22	21-23	13-19	10-11
Relative humidity percent	37-61	30-38	38-54	42-43
Wind mph	0-8	0-5	0-5	2-7
km/hr	0-13	0-8	0-8	3-11
Fuel moisture content-percent				
New litter	12-15	10-11	7-20	5-8
Old litter	10-36	11-15	11-21	6-14
Duff	26-65	26-75	14-21	52-54
1 hr TL[1] 1 dead			11-13	9-16
10 hr TL 10 dead			11-13	14-16
100 hr TL 100 dead			12	28-37
1000 hr TL 1000 dead			13-23	14-32
0-1/4" diameter live			75-114	69-109
1/4-1" diameter live			75	82-90
Shrub foliage			95-129	93-128

[1]Timelag fuel classes are used to indicate the time for a fuel theoretically to lose 63.2 percent of its original moisture. Diameter size class ranges for each timelag class areas follow:

Diameter (cm)	(in)	Timelag class (hrs)
0-0.76	0-.25	1
0.76-2.53	.25-1.0	10
2.53-7.63	1.00-3.0	100
7.63-20.32	3.00-8.0	1000

Table 2.--Fuel consumption from the prescribed burns.

Plot and time	Litter and duff	Timelag class[1] 1	10	100	1000
	tonnes per hectare[1]				
Upper plot					
Before 1st burn	30.0	3.7	--	--	--
Before 2nd burn	32.6	1.0	--	6.2	16.6
After 2nd burn	9.8	1.3	--	6.8	7.2
Lower plot					
Before 1st burn	23.0	.5	--	7.4	6.5
Before 2nd burn	32.0	3.0	--	4.9	5.2
After 2nd burn	18.2	2.2	--	--	--

[1]To convert tonnes per hectare to tons per acre, divide by 2.24.

Table 3.—Effects of prescribed burns on old shrubs and shrub seedlings in the fully occupied ponderosa pine stands.

Effects of:	Upper plot			Lower plot		
	Ceve[1]	Arpa	Cach	Ceve	Arpa	Putr
	percent					
1st fire						
Unburned	15.4	0	0	3.3	0	17.6
Burned, sprouted[2]	38.6	0	100	51.7	3.7	1.0
Dead	61.4	100	0	48.3	96.3	8.1
2nd fire						
Unburned	10.3	10.4	0	0	0	15.0
Sprouted, living[3]	0	2.9	0	29.1	0	5.2
Dead[4]	100.0	97.1	50	70.9	0	93.8
Shrub seedling dead[5]	100.0	100.0	0	100.0	100.0	100.0

[1]Ceve—*Ceanothus velutinus*
Arpa—*Arctostaphylos patula*
Cach—*Castanopsis chrysophylla*
Putr—*Purshia tridentata*

[2]Calculated as a percent of those burned.

[3]Calculated as percent of old plants burned, and whether sprouts lived or died later.

[4]Percent of all old plants burned.

[5]Seedlings coming in after first burn and living or killed by the second burn were the only ones counted.

Prescribed burning under these conditions should not be difficult. Remember, it's not necessary to meet the low duff moisture condition in the first burn. It can be conducted under moderate conditions to reduce flash fuel loading and create a vertical separation of fuels. Essentially all aerial portions of the shrubs reached by the fire should be killed. The second burn, conducted with low duff moisture should not only kill the tops but also damage the root crown of sprouting shrubs. The second fire should also consume or kill all seeds in the duff and many in the upper 1/4 to 1/2 inch of soil.

Greenleaf manzanita and antelope bitterbrush both sprouted poorly, as I expected for these species under fully occupied timber stands in this area. Neither are strong sprouters in this area, and sprouting would also be reduced by their stressed condition. Many seedlings of each appeared after the first fire.

Only four large golden chinkapin plants were present on the upper plot. Half these were killed by the second burn. Most impressive was that the two sprouting golden chinkapin were reduced from plants dominating a circle of 5- to 8-m (16- to 26-ft) diameter to two or three sprouts per plant each occupying a circle of 1/4-m (10-in) diameter.

Shrub seedlings did not appear on either plot following the second burn, although we expected some. The upper plot was logged in the winter of 1980-81, but even that disturbance did not produce new shrubs during the first summer after logging. I expect we will see some shrub seedlings becoming established along with natural pine regeneration. We are watching to see if the number of shrub seedlings has been reduced sufficiently to aid survival and growth of the pine seedlings.

SUMMARY

Two prescribed fires were conducted in fully occupied ponderosa pine stands for the purpose of reducing shrub competition with pine seedlings after the regeneration cut. Almost all old shrubs were killed by the two fires. Sprouting species did so poorly, which is attributed to the stressed condition of the shrubs under the timber stand and to the heat generated around the base of the shrub by consumption of the duff layer. Shrub seedlings, which appeared after the first fire from seed in the duff and upper soil,

were killed by the second fire. Prescribing the second fire to consume as much duff as possible appeared desirable for killing both the old shrubs and seeds in the duff and upper soil. The practice may be useful in other timber-shrub types as well, even though success in the regeneration phase has not yet been demonstrated.

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