Effect of Heat Treatment on Sprout Production of Some Shrubs of the Chaparral in Central Arizona[1]

FLOYD W. POND AND DWIGHT R. CABLE

Range Conservationists, Rocky Mountain Forest and Range Experiment Station, Tempe, Arizona

Chaparral occupies about 5½ million acres in the central part of Arizona. Most chaparral is used yearlong by cattle and deer. Often the shrubs are too dense for easy access by livestock. Burning is being tried as a means of thinning the shrubs and increasing grass production. The study reported here was undertaken to determine the effect of burning at different intervals on sprout production of several of the important shrub species.

Several shrubby species are found in the chaparral. Among the more important are: shrub live oak (*Quercus turbinella* Greene), Wright's silktassel (*Garrya wrightii* Torr.), desert ceanothus (*Ceanothus greggii* A. Gray), hollyleaf buckthorn (*Rhamnus crocea* Nutt.), pointleaf manzanita (*Arctostaphylos pungens* H.B.K.), Pringle manzanita (*A. pringlei* Parry),

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skunkbush sumac (*Rhus trilobata* Nutt.), sugar sumac (*R. ovata* S. Wats.), hairy mountainmahogany (*Cercocarpus brevifolius* A. Gray), birchleaf mountainmahogany (*C. betuloides* Nutt.), and larchleaf goldenweed (*Aplopappus laricifolius* A. Gray). Grasses and forbs usually are sparse.

The use of fire for modifying chaparral has received more attention in California than Arizona. Their opinions as to fire use are diverse. A sample of viewpoints follows: Sterling (1904) believed that fire was responsible for all chaparral in northern California, for when coniferous forests are denuded by fire they are replaced by chaparral. Clements (1916) thought that chaparral was often a fire subclimax in southern California. Jepson (1925) supported Clements in stating chaparral was, for the most part, a fire type of plant formation and that chaparral showed evidences of long continued burning. Bauer (1936) also believed that fires were frequent in the chaparral. Shantz (1947) concluded that repeated burns developed "soft" brush into broad-leaved chaparral and ultimately even chamise. Sampson (1944) stated that stands of sprouting chaparral are seldom destroyed or materially thinned by periodic burning, and that increases in herbaceous vegetation following a fire virtually disappear by the fifth year because of the suppressive effect of the numerous brush sprouts. More recently, treatment of sprout regrowth with chemical herbicides in conjunction with burning of the original shrub cover has been recommended for control of chamise in California (Buttery, et al., 1959).

Methods

In 1953, an area of chaparral at an elevation of 5,000 feet with annual precipitation of about 18 inches was selected on the Sierra Ancha Experimental Forest. The soils of this area were thin and rocky, and originated from quartzite parent materials.

Seven shrubby species, in sufficient numbers for experimental replication, were selected on the area. These were: shrub live oak, skunkbush sumac, Wright's silktassel, hollyleaf buckthorn, desert ceanothus, pointleaf manzanita, and larchleaf goldenweed. Shrub live oak is usually the dominant shrub not only on the experimental area but throughout the Arizona chaparral type. Pointleaf manzanita and skunkbush sumac may be locally abundant in rather small areas. The other four species are generally present throughout the chaparral but rarely dominate an area. Shrub live oak, skunkbush sumac, hollyleaf buckthorn, and Wright's silktassel sprout from root crowns. The other three species generally invade by seedlings.

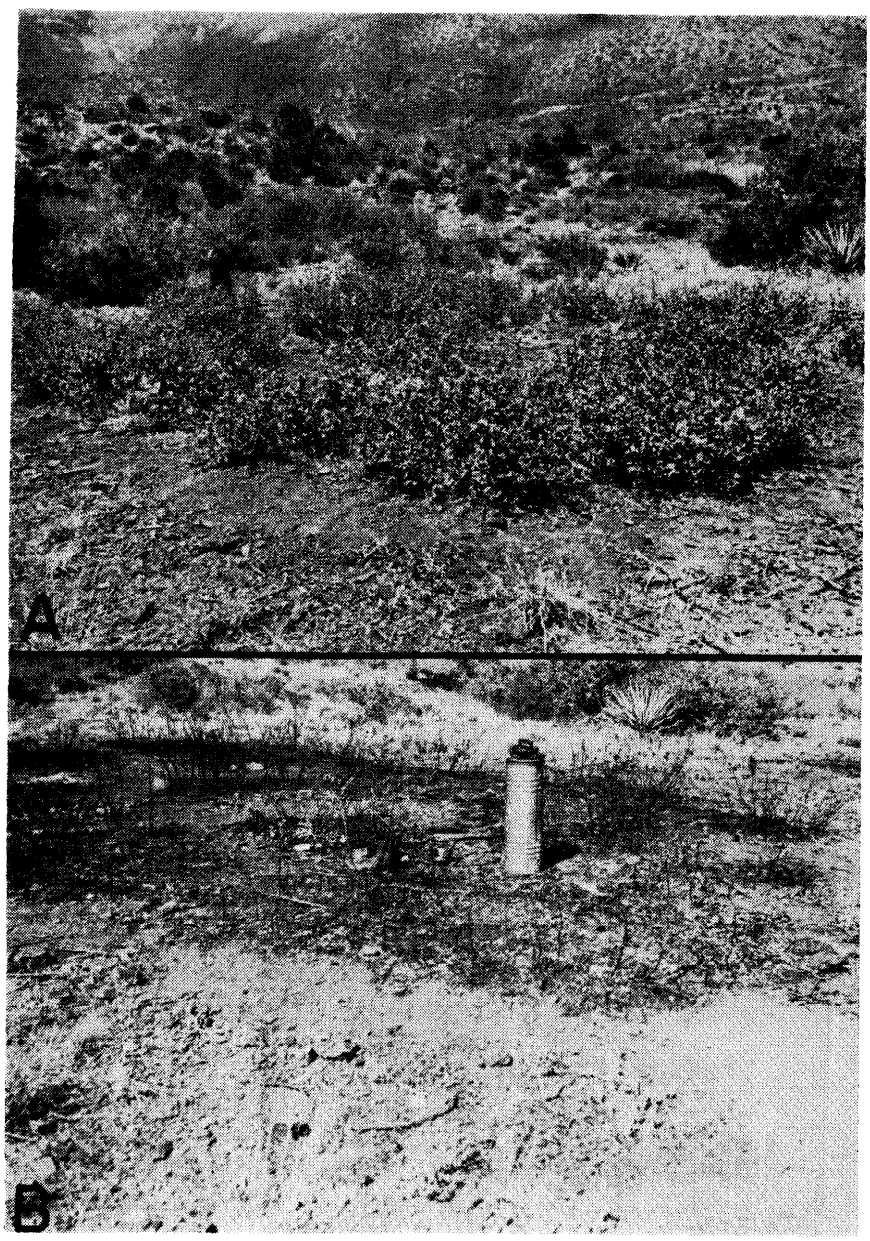

FIGURE 1. Shrub live oak previously burned in 1953 and in 1956. (A) Just before the third burn in 1959 and (B) following the 1959 burn.

Table 1. Composition of seven species of Arizona chaparral at three locations.

Species	Natural drainages	Pinal Mountain	3-Bar Wildlife Area
	Location		
		Percent	
Shrub live oak	75.6	77.7	42.6
Skunkbush sumac	2.1	1.6	1.3
Wright's silktassel	3.2	2.1	0
Hollyleaf buckthorn	2.2	2.5	5.6
Desert ceanothus	9.6	0.4	1.9
Pointleaf manzanita	3.0	0.2	0
Larchleaf goldenweed	1.8	0	0
Other shrubs	2.5	15.5	48.6
Total	100.0	100.0	100.0

The relative importance of the seven species in the composition of woody vegetation on three chaparral sites is given in Table 1. Natural drainages are near the experimental area on the Sierra Ancha Experimental Forest. Pinal Mountain is about 40 miles south near the town of Globe. Other species of woody vegetation are found in this area, the most important being sugar sumac. The 3-Bar Wildlife Area is about 20 miles to the southwest of the experimental forest. Birchleaf mountainmahogany and sugar sumac are important species in this area.

Of the seven species studied, the ones most preferred by livestock and deer are not abundant on most chaparral sites. Hollyleaf buckthorn, desert ceanothus, and Wright's silktassel are all rated fairly good as deer and livestock browse. Shrub live oak and skunkbush sumac are used heavily only when other forage or browse is scarce. Pointleaf manzanita and larchleaf goldenweed are seldom, if ever, used by deer or livestock.

The treatments assigned at random to the plots were: (1) burned each year, (2) burned every second year, (3) burned every third year, (4) burned every fourth year, and (5) burned every fifth year.

Each treatment was replicated two times for each species. Plot size depended on number of stems. Each plot was large enough to contain sufficient stems for experimental counts.

Plots were burned in June with a torch generating 1,500°F (Figure 1). The torch was applied until the plant parts near the ground glowed in order to kill all cambial tissue at the base of the plants. Live stems were counted where they emerged from the ground prior to the first burn and immediately before each succeeding burn.

Results

Shrub Live Oak

This species proved difficult to kill by burning (Table 2). Following the first four annual burns, stem counts were considerably higher than the pretreatment number. Only after the fifth annual burn, were the live stems fewer than before the first burn. Numbers were further reduced by the sixth burn.

Burning at intervals of 2 or more years failed to reduce sprouting (Figure 2). In 1959, the number of live stems present on all plots except those burned each year was several times the original.

Skunkbush Sumac

Results with this species were somewhat erratic. On plots burned each year, the number of live stems was reduced by the first burn and none was found following the second burn. The following year, however, more than the original number of live stems were found on the plots. These were burned and during the fourth year live stems were again not found. A few live stems were found in the fifth year and burned. In 1959, living stems were not found on the plots.

On plots burned at 2-, 3-, and 5-year intervals, live stems were found following each burn. The number of stems varied from several times to only a fraction of the original number.

On plots burned every fourth year, live stems were not found following the first burn.

Wright's silktassel

Four annual burns or two burns spaced 2 years apart were sufficient to completely eliminate the sprouts of this species. Burning less frequently did not completely kill sprouts, although numbers were considerably reduced after three burns at 3-year intervals.

Hollyleaf buckthorn

Two annual burns or two burns spaced 2 years apart completely killed sprouts of this species. The number of live stems more than doubled following the first burn but was reduced to zero by the second burn. Burning less frequently failed to reduce the number of sprouts.

Desert ceanothus

One burn was sufficient to kill most of the old plants of this species. Seedlings were observed coming in on the burned plots over the years. Also, two of the old plants definitely sprouted on the plots treated at 2-year intervals. These were the only sprouts of this species observed. They were eliminated by the second treatment.

Pointleaf manzanita

This species was completely killed by one burn. Though manzanita seed are reported to ger-

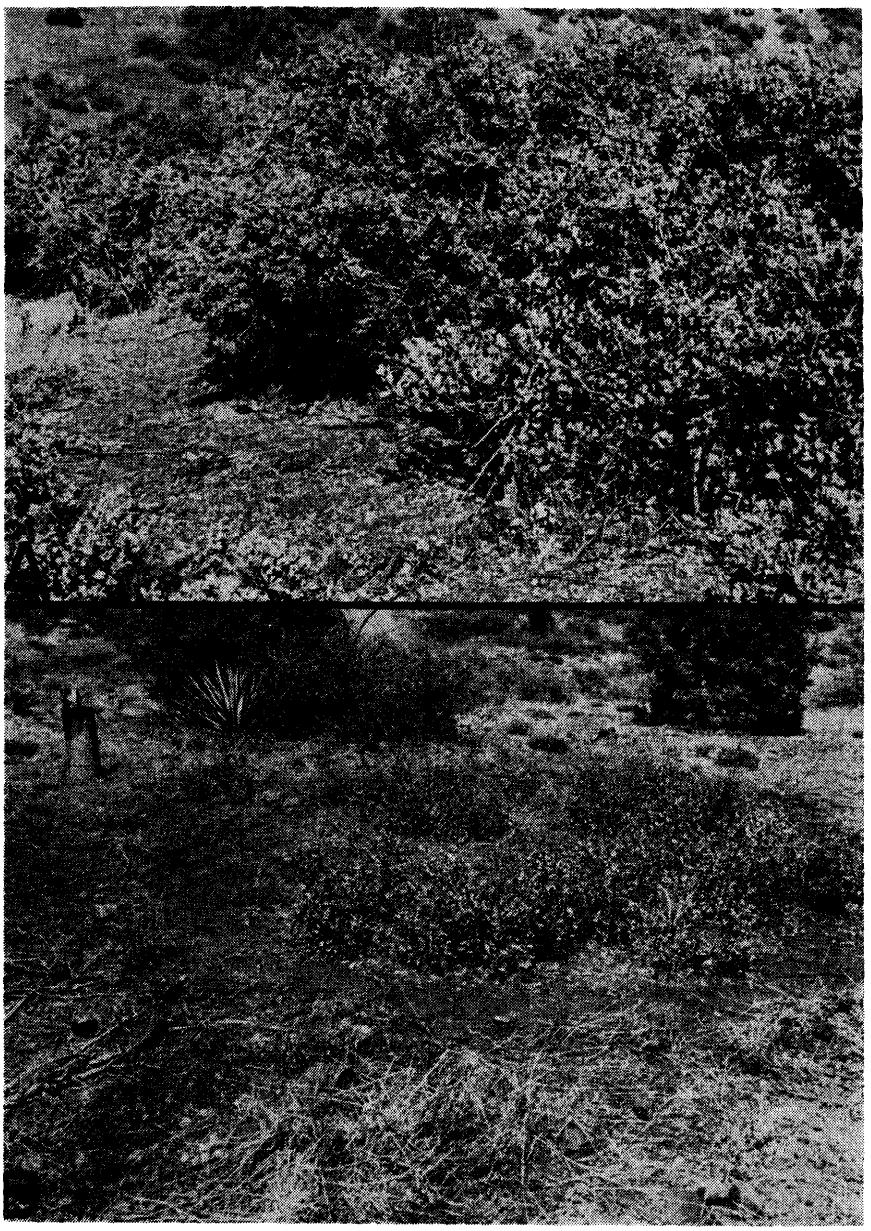

FIGURE 2. Shrub live oak burned at 2-year intervals showing (A) the plot prior to the first burn in 1953 and (B) the same plot prior to the fourth burn in 1959.

minate readily after a fire, no seedlings were observed.

Larchleaf goldenweed

This species was also eliminated by one burn. No sprouts or seedlings were observed on the plots following the first treatment.

Discussion

Shrub live oak sprouts are difficult to control with fire. Burning increased the number of sprouts, and five annual burns were necessary to reduce the number of sprouts below the pretreatment level. Broadcast burning for five successive years is practically impossible in Arizona because of lack of sufficient fuel to carry a fire. How long it would take to reduce the oak sprouts by burning less often is unknown. After three treatments at 2-year intervals, there was still 4.37 times as many live stems as originally. Burning at less frequent intervals showed about the same results.

Sprouting of skunkbush sumac was erratic during the study. This species appears to have the ability of delaying sprouting for a full year. Because of the impractibility of burning each year and delayed sprouting characteristics, it is unlikely that this species could be reduced by broadcast burning alone.

Wright's silktassel is not as difficult to kill with fire as either shrub live oak or skunkbush sumac. It was eliminated by four successive annual burns, and by two burns at 2-year intervals. Deer and livestock graze this species readily so that it is considered a valuable browse species. That it will survive one burn easily is important. Reburning at 1 or 2 years may, however, seriously injure or completely kill this species.

Hollyleaf buckthorn survives one burn with ease. Plants may be eliminated by a second burn if it occurs within an interval of 3 years. This species furnishes important forage for deer and livestock and its elimination would be detrimental to the forage value of a chaparral range.

Old plants of desert ceanothus and pointleaf manzanita are virtually eliminated by burning. Both, however, are usually replaced by seedlings. A few desert ceanothus may sprout from old stems, but sprouts of pointleaf manzanita were not observed. Desert ceanothus is a valuable browse plant, particularly for deer, while pointleaf manzanita is seldom used by deer or livestock except as cover.

Larchleaf goldenweed is easily killed by a single burn. The species is of little or no value as forage.

The possibilities of reducing the abundance of the less desirable shrubs in the chaparral by broadcast burning appear to be remote. This is especially true from the standpoint of range management. Moreover, the species of most value to livestock and deer are more easily killed by fire than some of those with little or no value.

Table 2. Effect of burning at different intervals on sprouting of four species within the Arizona chaparral.

Years between treatments	Stem counts before burning in indicated year						Final count
	1953[1]	1954	1955	1956	1957	1958	1959
				Shrub live oak			
1	121	710	330	371	161	38	17
2	152		1231		1142		662
3	276			1161			1469
4	170				790		773
5	94					436	1107
				Skunkbush sumac			
1	91	26	0	99	0	16	0
2	95		529		233		11
3	41			109			16
4	61				0		0
5	13					24	23
				Wright's silktassel			
1	15	7	26	10	0	0	0
2	25		58		0		0
3	56			41			7
4	59				35		32
5	22					26	26
				Hollyleaf buckthorn			
1	21	62	0	0	0	0	0
2	25		58		0		0
3	9			64			13
4	23				102		93
5	13					24	23
				Desert ceanothus			
1	173	0	0	0	0	0	0
2	223		8		0		0
3	147			0			0
4	131				0		0
5	175					0	0
				Pointleaf manzanita			
1	58	0	0	0	0	0	0
2	51		0		0		0
3	74			0			0
4	77				0		0
5	15					0	0
				Larchleaf goldenweed			
1	29	0	0	0	0	0	0
2	27		0		0		0
3	15			0			0
4	22				0		0
5	22					0	0

[1] Original stem counts prior to first burn.

Summary

Seven chaparral species were burned and reburned with a hand torch at intervals varying from 1 to 5 years. Number of stems of shrub live oak was reduced only after five annual burns. Burning less frequently produced more live stems than were present prior to the first burn. Skunkbush sumac was also hard to kill by burning, although results were more erratic than with shrub live oak. Wright's silktassel and hollyleaf buckthorn are easier to kill than shrub live oak or skunkbush sumac but must be burned at least twice within 3 years to be eliminated. Old plants of desert ceanothus, pointleaf manzanita and larchleaf goldenweed are killed by one burn.

Reduction of the less desirable species of chaparral by repeat burning appears impractical. However, repeated fires at short intervals may reduce or eliminate many species preferred by deer and livestock.

LITERATURE CITED

BAUER, HARRY L. 1936. Moisture relations in the chaparral of the Santa Monica Mountains, California. Ecol. Monog. 6: 409-454.

BUTTERY, R. F., BENTLEY, J. R., AND PLUMB, T. R., JR. 1959. Season of burning affects follow-up chemical control of sprouting chamise. Pacific Southwest Forest and Range Expt. Sta. Res. Note 154. 11 pp., illus. (Processed.)

CLEMENTS, F. E. 1916. Plant succession. Carnegie Inst. Wash. Pub. 242: 1-512.

JEPSON, W. L. 1925. Manual of the Flowering Plants of California. Assoc. Students Store. Univ. of Calif. Berkeley, Calif. 1238 pp.

SAMPSON, ARTHUR W. 1944. Plant succession on burned chaparral lands in northern California. Calif. Agr. Expt. Sta. Bul. 685. 144 pp.

SHANTZ, H. L. 1947. Fire as a tool in management of brush ranges. Calif. Div. of Forestry Bul. 156 pp.

STERLING, E. 1904. Chaparral in northern California. Forestry Quart. 2: 209-214.

EDUCATION COUNCIL TO MEET

There will be a meeting of the Education Council, A.S.R.M., at 1 p.m., January 30, 1961 in the convention headquarters hotel, Salt Lake City, Utah.