Effects of Shrub Removal on the Vegetation Of a Semidesert Grass-Shrub Range

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The increase in shrubby species on semidesert ranges during the last 50 to 60 years is a well-documented fact. Studies conducted on semidesert ranges in southern Arizona have shown that an increase in shrubs is generally accompanied by a decrease in perennial grass production. Efforts to control these shrubs and reduce their competition with grasses have met with varying degrees of success. Chaining, cabling, burning, and chemical herbicides have been the most effective methods used to date.

This paper reports results of a cabling operation carried out on an area dominated by jumping cholla *(Opuntia fulgida)*[2] on the Papago Indian Reservation approximately 20 miles southwest of Tucson, Arizona.

Previous Work

Griffiths (1910) and Thornber (1910) became convinced from observations made between 1903 and 1910 that mesquite *(Prosopis juliflora* var. *velutina)* and other shrubby species were invading grassland areas in southern Arizona. Photographs taken at that time compared with more recent photographs taken from the same points confirm their conclusions. Surveys by Upson, Cribbs, and Stanley (1937) show that over one million acres of rangeland in southeastern Arizona were dominated by cactus in 1937. Brown (1950) and Glendening (1952) give both photographic and experimental evidence of the increase of shrubby plants on the Santa Rita Experimental Range and their effect on grass production. Glendening reported that jumping cholla on certain areas increased from an average of 6 to 155 plants per acre during the 17-year period from 1932 to 1949. During the same period cane cholla *(Opuntia spinosior)* increased from 6 to 325 plants per acre, and mesquite from 59 to 122 plants per acre. In contrast, perennial grass density decreased 97 percent. Glendening also reported that spread of cane cholla by seeds was common although few seedlings of jumping cholla were found. These findings appear to confirm in part the earlier work of Johnson (1918) who found that seed of jumping cholla did not germinate readily under field conditions.

A comprehensive review of the literature dealing with vegetational changes of southwestern grasslands bears out these various conclusions (Humphrey 1958). Although mesquite and other woody plants did occur in some upland areas in southern Arizona, these species were largely restricted to river bottoms and cross drainages.

Although some work has been reported on methods of controlling cholla, no studies appear to have been made that show the direct effect of cholla control on

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[2]*Reference for plant nomenclature: Kearney, T. H. and R. H. Peebles. 1951. Arizona Flora. University of California Press, Berkeley and Los Angeles. 1032 pp.*

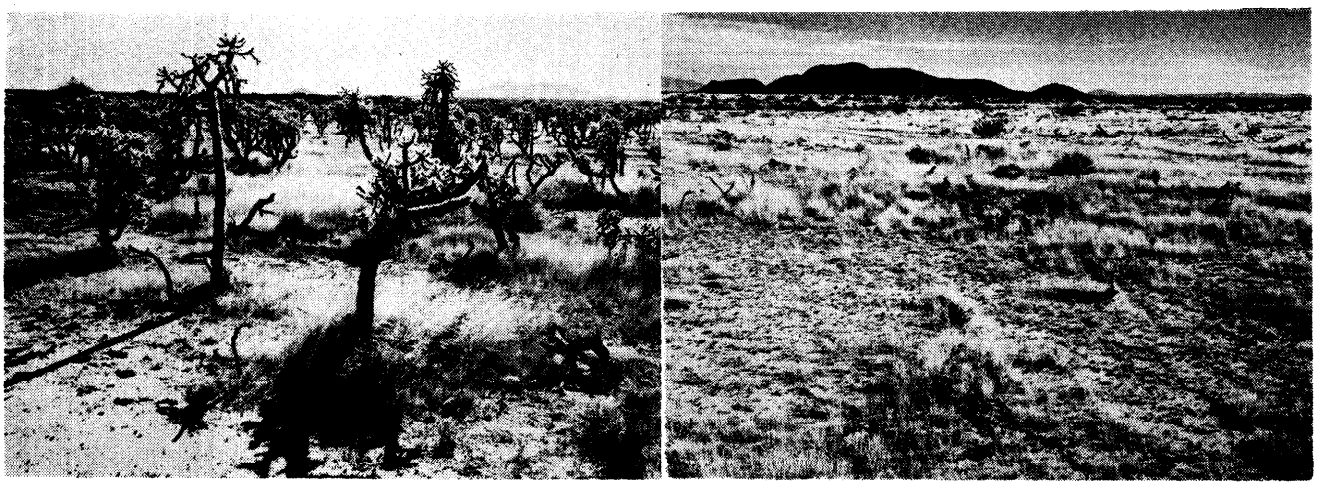

FIGURE 1. General views of the study area showing the unchained area, left, and the chained area, right. Photos were taken in December 1957, 2½ years after chaining. *(Photos by R. R. Humphrey).*

grass density. However, following thinning of mesquite stands, Parker and Martin (1952) recorded three- to four-fold increases in perennial grass production on some areas with lesser increases on others.

In the control of jumping cholla, burning has probably been tried more extensively than any other method. Humphrey (1949) reported that approximately 50 percent of the cholla was killed by a controlled burn in 1933 on a ranch in southern Arizona. By 1948, 15 years later, cholla had reinvaded and was present in about its original density. This same paper reported that a 1935 burn in the Sierrita Mountains of southern Arizona resulted in a 75 percent kill of cholla, with almost no reinvasion 13 years later. Humphrey and Everson (1951) reported a 61 percent kill of cholla on an area burned in 1949 on the Page-Trowbridge Experimental Ranch 35 miles north of Tucson. A part of this loss, however, was apparently due to natural causes, since mortality on an adjacent unburned area was 32 percent. Two growing seasons after an area on the Santa Rita Experimental Range had been burned, Reynolds and Bohning (1956) recorded a 44 percent mortality of jumping cholla and 42 percent of cane cholla.

Chemical herbicides have been tried on cholla to a limited extent. Glendening (1949) found that 2,4-D and 2,4,5-T were ineffective on cactus. More recent studies have shown that complete wetting of the plant with 2,4-D, 2,4,5-T, TCA or DNOSBP will effectively control cholla (Arizona Agricultural Experiment Station, 1950; Young, *et al.*, 1950; Roach and Glendening, 1953).

Study Area

The study area, covering approximately 15 acres, consists of two adjoining parts—one cleared of brush by chaining, the other not chained. The treated area is part of a 1,580-acre tract chained by the Unted States Bureau of Indian Affairs in June 1955. This area lies at approximately 2,700 feet elevation on a uniform, north-facing, 1½ percent slope. Mean annual precipitation is 10 to 12 inches, approximately half of which falls from July to September and half from December through April. The soil is a deep, alluvial sandy loam.

Prior to treatment the area was dominated by shrubs. The overstory was predominantly jumping cholla; burrowed *(Aplopappus tenuisectus)* was the most abundant perennial species in the understory. Other shrubs present in small amounts included: whitethorn *(Acacia constricta)*, creosotebush *(Larrea tridentata)*, pencil cholla *(Opuntia arbuscula)* snakeweed *(Gutierrezia lucida)*, zinnia *(Zinnia pumila)* and *Trixis californica.*

Perennial forbs comprised a very minor part of the total vegetation. The most abundant forbs were white horsenettle *(Solanum elaeagnifolium)* and ironplant goldenweed *(Aplopappus spinulosus).*

Perennial grasses also constituted only a small part of the total vegetation. They grew most commonly along drainages and beneath shrubs. Principal species were Arizona cottontop *(Trichachne californica)*, spidergrass *(Aristida ternipes)* and *Aristida hamulosa.* Occasional plants to bush muhly *(Muhlenbergia porteri)*, fluffgrass *(Tridens pulchellus)*, plains bristlegrass *(Setaria macrostachya)* and other species of *Aristida* were also found.

Treatment and Evaluation Methods

The area was chained early in June before the summer rains began. The chaining technique consisted of pulling an anchor chain looped between two crawler-type tractors, in one direction only. Before chaining the area was seeded by airplane at a rate of 1½ pounds per acre to a mixture of Boer lovegrass *(Eragros-*

Table 1. Relative abundance of forbs and shrubs on chained and unchained areas.

Species	Unchained area		Chained area		
	Plants per acre	Standard error	Plants per acre	Standard error	Difference
	Number	*Number*	*Number*	*Number*	*Percent*
Shrubs:					
Jumping cholla (young)	40	12	956	176	+2390**
Jumping cholla (old)	90	17	24	10	—73**
Burroweed	250	35	334	18	+34*
Whitethorn	28	12	56	17	+100[1]
Creosotebush	22	13	10	4	—55
Pencil cholla	20	7	2	2	—90**
Snakeweed	24	12	88	35	+267
Zinnia	14	8	18	8	+28
Trixis	36	18	24	9	—33
Others	16	....	16	....	0
Total	540	61	1528	198	+183**
Perennial forbs:					
White horsenettle	132	....	50	....	—62
Aplopappus spinulosus	18	....	36	....	+100
Others	4	....	0	....	—100
Total	154	103	86	48	—44

* Difference significant at the 0.05 level.
** Difference significant at the 0.01 level.
[1] Differences not astericked are not significant or not suitable for testing.

tis chloromelas) and Wilman lovegrass *(E. superba)*. The area has been protected from grazing by domestic livestock since chaining.

Evaluation of the effects of reseeding and chaining is based on differences in vegetation between the treated and untreated areas. Basal density of perennial grasses and abundance of forbs and shrubs were used as evaluation criteria. These measurements were made in October 1957, approximately 2½ years after chaining.

Perennial grass densities were obtained by basal-intercept measurements on fifty 100-foot line transects on both treated and untreated areas. These transects were uniformly distributed on adjacent strips 250 feet wide and 1,300 feet long. The two sets of transects were separated by a 100-foot strip covering the border joining the two areas. Method of measurement was similar to that of Canfield (1950).

Abundance of forbs and shrubs was determined by recording the numbers of each species of forb and shrub on 0.01-acre belt transects. These transects consisted of a strip 4.356 feet wide, extending the length of each 100-foot line transect, with the line forming the right side of the belt.

The line and belt transect data were analyzed by species and totals for significance of differences between treated and untreated areas by means of the "t" test.

Results and Discussion

The most noticeable effects of the chaining were a great decrease in the size of shrubs on the chained area, due to knocking down of the old plants (Fig. 1), and a highly significant increase in the total number of shrubs (Table 1). Average number of all species of shrubs per acre on the unchained area was 540, on the chained area 1,528. Most of this increase was due to sprouting of cholla joints that were knocked off the old plants during chaining. Young cholla plants were nearly 24 times more abundant on the chained area than on the unchained, 956 and 40 plants per acre respectively. In contrast with this, chaining reduced the numbers of old cholla plants from 90 to 24 per acre.

Other significant differences in shrub numbers included 34 percent more burroweed plants and 90 percent fewer pencil chollas on the chained area. The increase noted in the number of burroweed plants was apparently due to seed sprouting on the disturbed soil resulting from the chaining operation. The decrease in the number of pencil cholla appeared to be due to poor ability of pencil cholla joints to sprout following chaining.

Perennial forbs averaged 86 plants per acre on the chained area and 154 on the unchained. This difference, though rather large, was not significant, probably because of extreme variability between plots.

Basal density of perennial grasses, as measured by the line intercept method, was very low, 0.056 percent on the unchained

Table 2. Perennial grass basal density on unchained and chained areas.

Species	Basal density	
	Unchained	Chained
	Percent	*Percent*
Spidergrass	0.0254	0.0100
Arizona cottontop	0.0126	0.0228
Aristida hamulosa	0.0116	0
Aristida spp.	0.0006	0.0082
Bush muhly	0.0036	0
Fluffgrass	0.0012	0
Plains bristlegrass	0.0010	0
Wilman lovegrass	0	0.0060
Total	0.0560	0.0470

area and 0.047 percent on the chained area (Table 2). Differences in density between chained and unchained areas for individual species or for total grass density were not significant due to low densities and high variability between plots. Failure of the grasses to increase in density was probably due to extreme drouth during the summers of 1955 and 1956 following chaining, to very limited seed source, and to competition from annuals for the limited moisture available.

Establishment of seeded lovegrasses on the chained area was very poor, apparently because of drouth and competition from annuals. Only one plant of Wilman lovegrass and none of Boer was encountered on the 5,000 feet of transect lines.

Conclusions

In general, the most obvious effect of the chaining operation was to open up the shrub stand by knocking down the woody plants. However, due to the large number of young cholla plants established following the chaining treatment, the opening up of the area appears to be only temporary, and the future stand of mature cholla will probably be much more dense than the original stand.

Native perennial grasses did not benefit noticeably from the chaining treatment, and reseeded lovegrasses failed to become established.

Some shrubby species, such as young jumping cholla and burroweed, increased in abundance, while others, such as old jumping cholla and pencil cholla, decreased in abundance following chaining.

The results of this study indicate that control of jumping cholla by chaining on semidesert ranges in southern Arizona will not be effective until a method is developed for preventing the establishment of new plants from fallen joints.

Summary

In June 1955 an area of 1,580 acres of semidesert grass-shrub vegetation on the Papago Indian Reservation in southern Arizona was chained. Two and a half years after treatment, basal intercept of perennial grasses was measured, and numbers of forbs and shrubs per acre were counted on a portion of the chained area and on an adjacent unchained area to evaluate the effect of chaining. The analysis indicated:

1. A general opening up of the shrub stand.

2. A 73 percent reduction in the numbers of live, old, jumping-cholla plants.

3. A large increase of young jumping-cholla plants on the chained area, presumably from joints which fell off the old plants during chaining.

4. A 34 percent increase in the number of burroweed plants.

5. A 90 percent decrease in the number of pencil cholla plants.

6. No significant change in numbers of forbs or in basal intercept of perennial grasses.

It is concluded that the effect of this chaining treatment will be temporary and the future stand of cholla may be more dense than the original stand.

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