Fire Effects on Blue Grama-Pinyon-Juniper Rangeland in New Mexico[1]

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Highlight

Study of an April 1964 fire in the blue grama-pinyon-juniper vegetation type of New Mexico showed that forage production was reduced significantly the first year on the burned area but recovered by the end of the second. Species composition of herbaceous vegetation was not significantly affected. Loss of live grass crowns was fully recovered by the second year. Litter was significantly less on the burned area all three years of the study. About 24% of the juniper and 13.5% of the pinyon pine were killed by the fire. Cholla less than one ft tall were damaged more by the fire than those 2 to 3 ft tall.

Pinyon pine (*Pinus edulis* Engelm.) and oneseed juniper (*Juniperus monosperma* (Engelm.) Sarg.) are dominant species on 60 million acres in the western United States, and about one-fifth of this acreage is in New Mexico (Choate, 1966). This area provides important grazing capacity for the state. Frequent wildfires, mostly accidental, occur on this type, but little is known about the effects of fire on the vegetation.

The use of fire to control pinyon-juniper stands has been tried by ranchers and by state and federal agencies (Arnold et al., 1964). Effects of fire on other species have also been studied (Cable, 1965; Choate, 1966; Gay and Dwyer, 1965; Pechanec et al., 1954). On April 10, 1964, a fire occurred on the Fort Stanton Experimental Range in south central New Mexico which furnished an opportunity to evaluate effects of fire on the blue grama-pinyon-juniper vegetation.

Study Area and Procedures

Characteristics of the Vegetation.—The area that burned was primarily blue grama (*Bouteloua gracilis* (H.B.K.) Lag.) grassland with juniper and pinyon pine on the rocky ridges. It was ungrazed and had been for several years so there was an accumulation of grass which provided ideal fuel. Scattered plants of winterfat (*Eurotia lanata* (Pursh) Moq.), apacheplume (*Fallugia paradoxa* (D. Don) Endl.) fourwing saltbush (*Atriplex canescens* (Pursh) Nutt.), algerita (*Mahonia trifoliolata* Moric.) and skunkbush sumac (*Rhus trilobata* Nutt.) occurred throughout. Walkingstick cholla (*Opuntia imbricata* (Haw.) DC.) was a common but sparsely distributed plant.

Samples clipped the week following the fire along the unburned boundary lines (Fig. 1) showed that 738 lb/acre of ovendry grass were burned. Although no samples were taken, the stand of grass under the juniper and pine on ridges was much thinner and less grass fuel was available for burning.

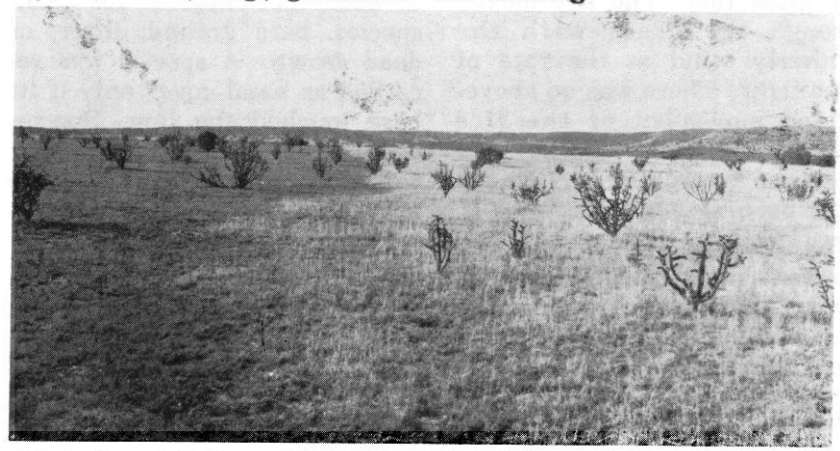

FIG. 1. Burned (left) and unburned boundary. Cholla occurs in a scattered stand in the open blue grama areas.

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FIG. 2. Pinyon pine in the background showing 50% defoliation and juniper in the right foreground 100% defoliated. There were very few pinyon less than six ft tall.

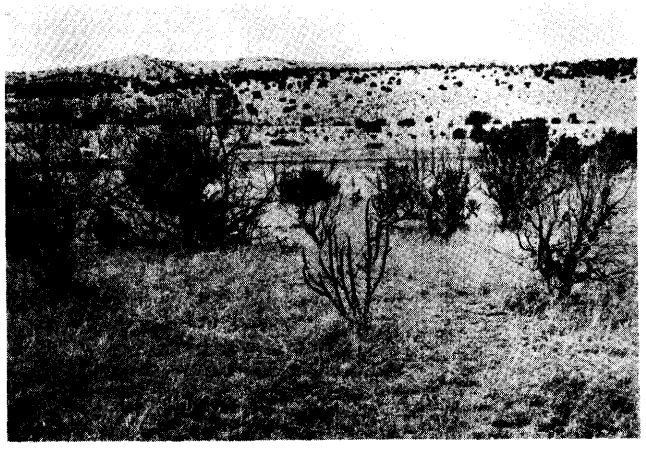

FIG. 3. Junipers less than six feet tall were very susceptible to fire damage. The pinyon-juniper occurred in a rather scattered stand on the rocky ridges. Grass recovery following the fire is illustrated in the foreground.

The topography is rolling with slopes of 0 to 9%. The elevation varies from 6,000 to 6,500 ft. Average yearly precipitation is about 15.5 inches with 69.8% coming June through October. Most of the soils on the burned area are very fine sandy loams developed on recent alluvium derived from the San Andres Formation and mixed material of Guadalupe age.

Characteristics of the Fire.—Records from the Smokey Bear Ranger District Fire Report showed that the fire was started accidentally at 1:45 PM near a refuse burning area. Conditions were ideal for a wildfire: low relative humidity, warm dry wind, dry soil and litter, and dry grass fuel. The fire moved through the grass with the southerly wind at the rate of 1,250 ft/hr. There was no aboveground movement of the fire through the tree crowns. The fire was controlled at 4:33 PM after burning 935 acres.

Procedures.—Juniper and pinyon pine trees were tagged following the fire so that response of individual trees to defoliation could be studied. Trees of different sizes and degrees of defoliation were selected for observation. The percentage of defoliation was estimated (Fig. 2). The trees were reexamined during June in 1964, 1965, and 1966. Tree counts within belt transects were used to determine the relative percentages of juniper and pine. Cholla plants also were tagged following the fire so that effects on individual plants could be observed. Ten plants less than one ft high and 10 plants from 2 to 3 ft in height were tagged in both burned and unburned areas. These plants were evaluated for new growth and vigor at the same time the junipers and pinyon pine were evaluated.

Ten line-point transects 100 ft long were permanently located in adjacent areas of comparable burned and unburned grassland. These transects were examined at each foot interval for plant species, bare ground, litter, or dead crown. A species was recorded as basal cover only if its base touched the line. Species composition was determined by recording the nearest plant to each one-ft interval. The transects were read in mid-August of each year.

In mid-October of each year, forage production in burned and unburned areas was determined on 30 one-by two-foot plots in each area, hand clipped at ground level. The clipped grasses and forbs were separated, and oven-dry (80 C) weight was converted to pounds of production per acre.

Results and Discussion

Effect of Fire on Juniper and Pinyon Pine.—A total of 47 juniper and 38 pinyon pine trees was tagged in June 1964, following the April burn. Re-examination of these trees in the two succeeding years provided a record of the response of these trees following the fire.

All observed juniper trees less than four ft in height were killed by the fire. Jameson (1962) reported fire killed 70 to 100% of small juniper in Arizona. Juniper was more susceptible to damage by fire than pinyon because the foliage was usually closer to the ground and caught fire more readily (Fig. 3). There were far fewer pinyon trees less than six ft tall in the stand than junipers.

In 1964 seven juniper and seven pinyon trees were tagged as not being defoliated at all, but in 1966 these numbers were two and four, respectively. These trees were unburned but damaged by the high temperatures and did not show damage until the following one or two years. Ten junipers and one pinyon were classed as being completely defoliated in 1964 compared to 9 and 5, respectively, in 1966. Pin-

Table 1. Belt transect count of juniper and pinyon pine trees showing characteristics of the stand in June, 1966, two years following the burn.

Item	Juniper	Pinyon
Total Trees, no.	120	52
Composition %	69.8	30.2
Kill %	24.2	13.5
Unharmed %	13.3	38.5
Partial defol. %	62.5	48.1
Ave. % defol. all trees	44.6	31.7

yon appeared to take longer to show the full effects of the fire. Trees classified 25 to 75% defoliated showed some changes in the degree of defoliation from 1964 to 1966, but these changes were not in a consistent pattern. Pinyon trees showed a greater tendency to die when over 50% defoliated by fire than the juniper. Trees of both species which were partially defoliated in 1964 remained partially defoliated or had died after two years.

The stand of trees was 69.8% juniper and 30.2% pinyon pine (Table 1). About 24% of the juniper trees were killed by the fire while only 13.5% of the pinyon were killed. Table 1 shows pinyon was more resistant to fire damage than juniper, at least in this type of ground fire. Only 13% of the juniper was considered to be unharmed by the fire, while over 38% of the pinyon stand was unharmed.

Effect of Fire on Cholla Cactus. —Cholla less than one ft high were damaged more by fire than the larger plants. The taller plants appeared to be unaffected by the fire; in fact, two of them in the unburned area, rated moderately vigorous in 1964, died of unknown causes by 1966. Fewer plants less than one ft tall showed new growth in the burned than in the unburned areas. Half of the tagged plants less than one ft tall in the burned area died by 1966 and only one in the unburned. The general observations were that most plants six inches tall or less succumbed to the fire.

The algerita, fourwing saltbush, winterfat, and skunkbush all sprouted vigorously following the fire.

Effect of Fire on Herbaceous Species Composition. — Line-point transect data revealed highly significant differences in bare ground, litter, and dead grass crowns between burned and unburned in August 1964, following the burn (Table 2). In 1965 and 1966 there was still significantly more bare ground and less litter in the burned than the unburned areas; however, bare ground and litter are so closely related that the significance of one infers significance of the other. Numbers of dead grass crowns were not significantly different in 1965 and 1966 indicating that the numbers of live grass crowns had been fully recovered by the second year.

No significant differences were found in species composition for the two areas due to the fire, but the data show higher blue grama composition for all years in the burned area (Table 2). Slimstem muhly (*Muhlenbergia filiculmis* Vasey), ring muhly (*M. torreyi* (Kunth) Hitchc.) wolftail (*Lycurus phleoides* H.B.K.), sand dropseed (*Sporobolus cryptandrus* (Torr.) A. Gray), and galleta (*Hilaria jamesii* (Torr.) Benth.) were all decreased as a result of the fire. Forb composition appeared to be unaffected by the fire.

Table 2. Characteristics of grassland in burned and unburned areas as determined by permanent line-point transects. Data in percent.

Item	1964		1965		1966	
	B[1]	U	B	U	B	U
Cover Conditions						
Basal Cover	11.9	14.1	28.7	28.2	15.1	13.4
Bare Ground	33.0	24.3**	39.4	33.5**	40.0	34.5**
Litter	34.3	48.1**	28.5	36.2**	34.9	42.4**
Dead Crown	19.8	12.5**	3.4	2.1	8.9	9.7
Total	100.0	100.0	100.0	100.0	100.0	100.0
Species Composition						
Grasses						
Bouteloua gracilis	92.0	86.9	88.1	81.3	87.5	84.9
Muhlenbergia filiculmis	3.0	4.1	5.7	8.6	4.8	6.3
Muhlenbergia torreyi	2.7	3.4	2.4	2.8	4.8	3.2
Lycurus phleoides	0.1	0.6	0.2	1.4	0.2	1.1
Bouteloua curtipendula	0.4	0.4	0.2	0.0	0.4	0.0
Muhlenbergia richardsonis	0.0	0.2	0.0	0.3	0.0	0.4
Sporobolus cryptandrus	0.4	2.3	0.4	1.3	0.2	0.7
Hilaria jamesii	0.0	0.9	0.0	0.8	0.0	0.6
Other grasses	0.1	0.0	0.2	0.4	0.6	0.4
Total grasses	98.7	98.8	97.2	96.9	98.5	97.6
Forbs						
Sphaeralcea sp.	0.4	0.8	0.7	1.1	0.6	0.6
Zinnia grandiflora	0.4	0.0	0.7	0.0	0.5	0.5
Other forbs	0.5	0.4	1.4	2.0	0.4	1.3
Total forbs	1.3	1.2	2.8	3.1	1.4	2.4

**Significantly different at the 0.01 level as determined by the "T" test.
[1] B=Burned; U=Unburned.

Effect of Fire on Forage Production. — Production of grass was significantly reduced the first year following the fire (Table 3). Reduction in herbage due to the April 1964 fire was nearly 30% when measured in October that same year. The vegetation had made sufficient recovery by October 1965 that differences in production were not significant although trends favored the unburned. Rainfall for 1964 was below average and for 1965 it was above average as well as quite favorably distributed for plant growth. This probably accounts for the higher production in 1965 for all categories. Production trends still favored the unburned area in 1966 but the differences were not significant. No explanation is apparent for the significantly higher production of forbs on the unburned area in 1966 (Table 3).

Protein Content.—The crude protein content of blue grama in early June 1964 was 14.8% on the unburned and 16.1 on the burned area, indicating the burn released some available source of nitrogen for plant use. Only current growth was included in the samples.

Table 3. Production of grasses and forbs (lb/acre) in burned (B) and unburned (U) areas, Fort Stanton, New Mexico.

	Grasses		Forbs		Total	
Year	B	U	B	U	B	U
1964	510.5*	726.2	60.1	63.6	570.1**	789.9
1965	877.2	908.9	157.5	213.5	1034.7	1122.1
1966	727.9	757.7	9.3*	97.9	736.1	855.6
Average	704.9	797.6	75.6	124.9	780.5	922.5

* Differences significant at the .05 level.
** Differences significant at the .01 level.

Conclusions

Although temperature measurements were not possible, it is believed this fire was of relatively low heat intensity. It moved rather quickly with a brisk wind and the fuel available for burning was less than 750 lb/acre in the open grassland. Under the juniper and pinyon stands on the rocky ridges grass fuel was much less.

The main detrimental effects of the fire were loss of forage consumed in the fire and the reduction of herbage production by 30% in the year following the fire. Litter cover was also reduced for 3 years after the fire and this could be important in some cases where erosion is a problem. Possible beneficial effects were the great reduction of small juniper and cholla plants. Probably more juniper and pinyon pine would have been killed if more grass fuel had been available where these trees occurred.

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Errata

In the paper on cane bluestem by Bernardon et al., JRM 20:69-72, Table 1, page 71, number of tillers, herbage weight, and root weight for the 8-tiller stage should read as follows for the first two lines:

11.3	7.19	1.44
14.9	16.19	2.81

Also for the 12-tiller stage, last line, herbage weight should read 17.79 g instead of 17.69.