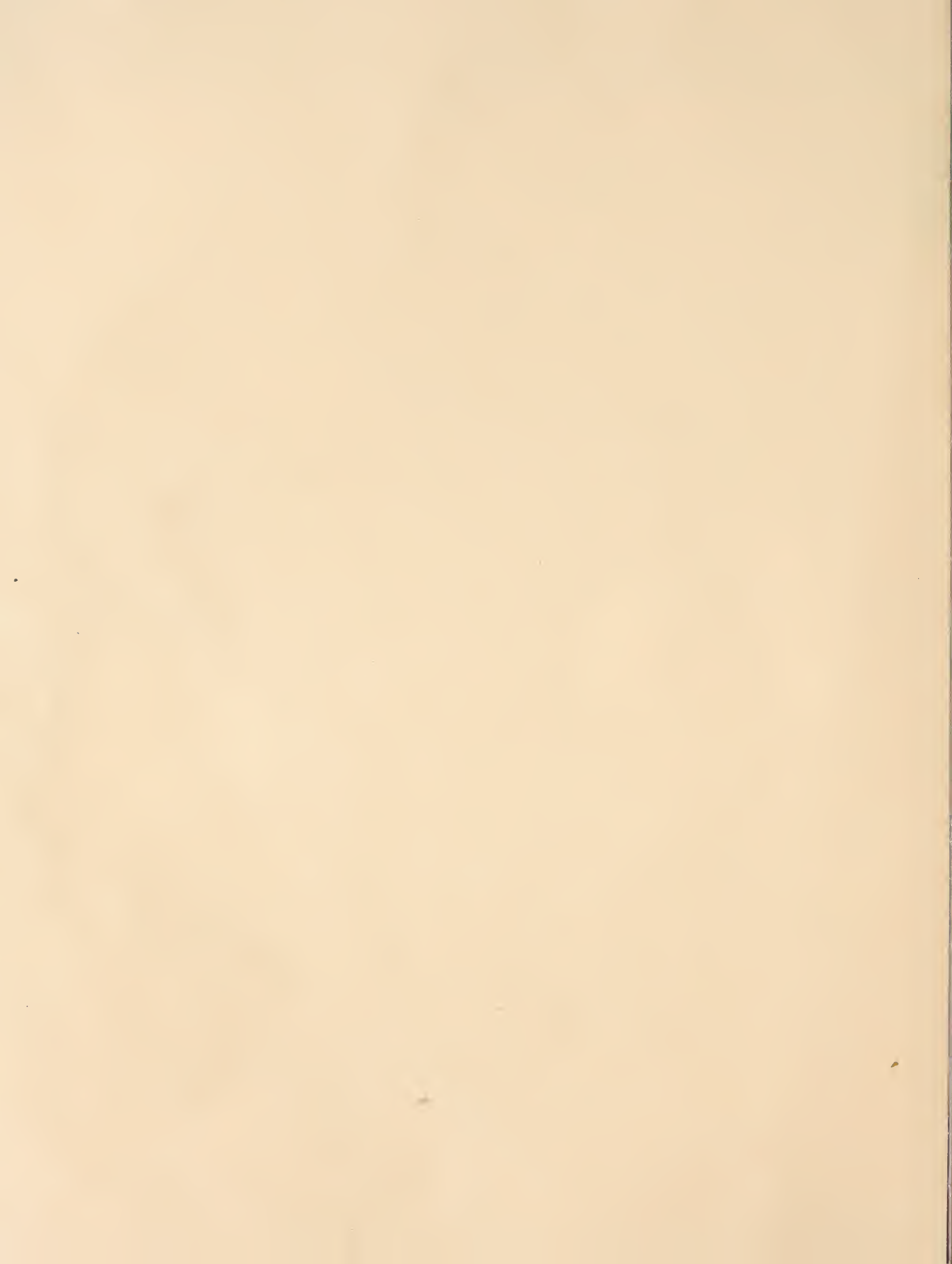


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FOREST SERVICE

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PUBLICATIONS SECTION

Vegetation Changes Following the Mingus Mountain Burn¹

by

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Wildfires are common in Arizona's 5 1/2 million acres of chaparral type. Precipitous topography and remoteness from roads make fire control difficult and uncertain. Moreover, the structure of the mature shrub community, consisting largely of sprouting shrubs or those whose germination is greatly improved by heat treatment, indicates a high level of adaptability to repeated fires.

Secondary vegetation which characteristically becomes established immediately after fire, contains a large variety of herbaceous species that are important sources of forage for both wildlife and domestic livestock. This temporary cover diminishes quickly, however, as the shrub cover rapidly resumes its pre-fire stature.^{3 4}

The vegetation changes following fire in Arizona chaparral are little known at present. The purpose of this paper is to report successional changes in chaparral vegetation after the Mingus Mountain fire.

STUDY AREA

In June 1956, a wildfire burned over approximately 18,000 acres of rough mountain land between Jerome and Dewey in central Arizona. The fire began in a relatively open shrub live oak⁵ and skunkbush sumac area at 5,000 feet elevation, and stopped within the ponderosa pine type at 6,500 feet near the top of Mingus Mountain. The lower area was aerially seeded with weeping lovegrass; the high-

er area, above 6,000 feet, to both weeping lovegrass and crested wheatgrass.

At Jerome, 8 miles north of the burn at an elevation of 5,245 feet, longtime average precipitation is 17.08 inches, 51 percent of which falls from November 1 through May 1. From 1956 to 1961, the years of the study, precipitation averaged 17.77 inches, with a range of 6.11 to 25.87 inches.

Topography of the burned area consists of steep, hilly country at the lower end interspersed with numerous shallow, narrow valleys. Deep canyons, long, steep slopes with occasional benches, and mesas occur at the higher elevations.

¹ Personnel of the Watershed Management Department of the University of Arizona, the Arizona Game and Fish Department, and the Prescott National Forest assisted in the vegetation measurements.

² Research Forester and Range Conservationist, respectively, located at the Station's project headquarters at Tempe, in cooperation with Arizona State University; central headquarters maintained at Fort Collins, in cooperation with Colorado State University.

³ Horton, J. S., and Kraebel, C. J. Development of vegetation after fire in the chamise chaparral of southern California. *Ecology* 36: 244-262. 1955.

⁴ Pond, Floyd W., and Cable, Dwight R. Recovery of vegetation following wildfire on a chaparral area in Arizona. U. S. Forest Service, Rocky Mountain Forest and Range Expt. Sta. Res. Note 72, 4 pp., illus. 1962.

⁵ Common and botanical names of plants are listed on p. 8.

On the lower area, the coarse soils are poorly developed, shallow, and are derived from granitic parent material. The finer textured, better developed soils, at higher elevations, are derived from shales, sandstones, and limestones, and contain considerably more organic matter.

METHODS

Vegetation was measured on 30 permanent sample plots in the lower area and 20 in the upper area, all within the shrub type. No permanent sample plots were located in the pine type.

Each sample plot consisted of two 50-foot line intercept transects. Vegetation was measured each fall by the procedure outlined by Canfield.⁶

Each transect was paralleled by 10 permanently marked 9.6-square-foot circular plots spaced 5 feet apart. Production of herbaceous material and total weight of shrubs on the ground was determined on five selected permanent plots by the weight-estimate method.⁷ Of the five remaining plots, one was selected, estimated, and clipped each year for use in the double-sampling technique to correct weight estimates.⁸

Production in the pine type was determined at one site in 1961 by the same method, based on sixty-six 9.6-square-foot circular plots.

Part of the lower burned and seeded area was treated with 2,4,5-T and silvex in 1957, 1958, and 1959. This application was part of a

general evaluation of chemical shrub control by the Arizona Agricultural Experiment Station. The affected plots were discarded until 1961 when they were again measured to compare grass and shrub production on both treated and untreated areas. Air-dry grass production averaged over 1,000 pounds per acre on the treated area in 1959.⁹

RESULTS AND DISCUSSION

Production And Distribution Of Shrubs

Both crown canopy and accumulated weight of shrubs, reduced to zero in June 1956, were still increasing six growing seasons after the fire (fig. 1). The 41.7 percent canopy cover probably represents three-fourths of the original estimated cover of 50 to 60 percent. Air-dry weight of shrubs on the entire area averaged 4,180 pounds per acre, and was still increasing slowly at the end of study (fig. 2).

Shrub composition was largely shrub live oak, although its relative importance de-

⁶Canfield, R. H. Sampling ranges by the line-interception method. U. S. Forest Serv. Southwest Forest and Range Expt. Sta. Res. Rpt. 4, 28 pp., illus. 1942. (Reprinted 1957)

⁷Pechanec, J. F., and Pickford, G. D. A weight-estimate method for determination of range or pasture production. Amer. Soc. Agron. Jour. 29: 894-904. 1937.

⁸Wilm, H. G., Costello, David F., and Klipple, G. E. Estimating forage yield by the double-sampling method. Amer. Soc. Agron. Jour. 36: 194-203. 1944.

⁹Schmutz, Ervin M., and Whitman, David W. Shrub control studies in the oak-chaparral of Arizona. Jour. Range Manag. 15: 61-67. 1962.



Figure 1.--Typical shrub live oak chaparral on Minus Mountain, elevation 5,000 feet:

A, August 1956, after wildfire;

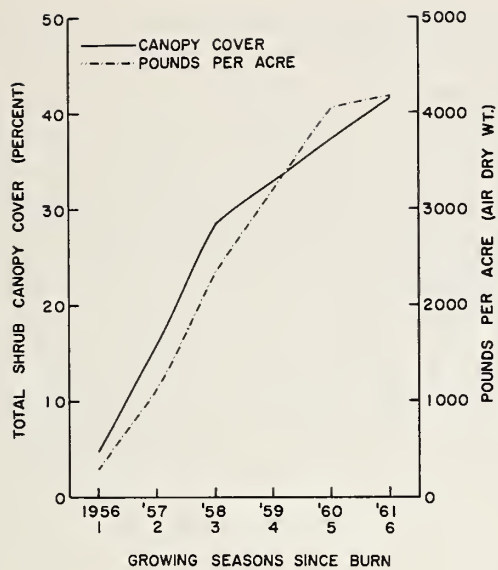


Figure 2.--Crown cover and total weight of all shrubs following June 1956 wildfire.

creased as seedling shrubs and halfshrubs regained prominence in the stand (table 1). At the end of the sixth growing season, composition was shrub live oak 68.0 percent, broom snakeweed 11.8 percent, and skunkbush sumac 9.0 percent. Manzanitas made up 2.4 percent. The more desirable species for game and livestock use--hairy cercocarpus, desert ceanothus, Wright silktassel--made up about 5.0 percent of the cover.

Fire greatly reduced desert ceanothus, and pointleaf and Pringle manzanitas. These shrubs reproduce primarily by seeds, although both manzanitas may extend themselves by ground layering in the absence of fire. Desert ceanothus may rarely sprout from the root crown when the top is destroyed. Seeds of all three species germinated in the spring after

Table 1.--Percent composition of shrubs based on line intercepts (average of upper and lower areas¹)

Species	1956	1957	1958	1960	1961
	- - - - - Percent - - - - -				
Broom snakeweed	0	² T	7.20	11.49	11.80
Catclaw mimosa	5.74	2.74	3.19	2.16	2.37
Desert ceanothus	.04	T	.35	1.45	1.78
Hairy cercocarpus	.40	1.38	2.08	1.64	2.26
Pointleaf manzanita	0	.08	.15	.21	.38
Pringle manzanita	0	0	.39	1.56	2.02
Shrub live oak	81.02	80.36	69.45	70.48	68.00
Skunkbush sumac	11.32	12.88	14.76	9.19	9.04
Others	1.48	2.56	2.43	1.82	2.35
Total	100.00	100.00	100.00	100.00	100.00

¹ Upper area = 6,500 ft. elevation, 8 miles south of Jerome.
Lower area = 5,000 ft. elevation, 8 miles north-east of Dewey.

² T = trace.

the fire, and in lesser amounts for several following springs. By 1961, there were 335 pointleaf manzanita and 4,063 desert ceanothus seedlings per acre on the lower area. On the upper area, pointleaf manzanita was absent, but there were 3,677 Pringle manzanita and 340 desert ceanothus seedlings per acre (table 2).

B, October 1961. Shrub live oak dominates; herbaceous plants are scarce.



Table 2. --Density of shrub seedlings at two elevations following wildfire on Mingus Mountain. Fire burned in June 1956; observations made each autumn

Species	Lower area					Upper area				
	1956	1957	1958	1960	1961	1956	1957	1958	1960	1961
----- Plants per acre -----										
Desert ceanothus	0	2,748	2,581	4,565	4,063	0	0	340	272	340
Pointleaf manzanita	0	486	287	239	335	0	0	0	0	0
Pringle manzanita	0	0	0	0	0	0	2,860	3,541	3,155	3,677

Table 3. --Vegetation recovery on the Mingus Mountain Burn, expressed as percent of 9.6-square-foot plots in which species occurs (shrubs were considered present when any part of the canopy extended into the plot)

Species	Lower area					Upper area				
	1956	1957	1958	1960	1961	1956	1957	1958	1960	1961
----- Percent -----										
<u>Shrubs and halfshrubs:</u>										
Broom snakeweed	0	16.3	21.0	31.6	42.6	0	6.0	12.0	22.0	25.5
Catclaw mimosa	10.5	11.0	8.9	14.7	12.1	0	0	0	0	0
Desert ceanothus	0	23.7	27.3	28.9	31.0	0	0	4.5	7.0	6.5
Hairy cercocarpus	.5	1.0	3.2	5.3	4.7	11.5	21.0	19.5	22.5	19.5
Pointleaf manzanita	0	8.9	2.6	3.7	4.2	0	0	0	0	0
Pringle manzanita	0	0	0	0	0	0	16.5	17.0	17.5	16.5
Shrub live oak	37.9	44.2	40.0	49.4	51.0	48.0	57.5	56.5	62.5	61.5
Skunkbush sumac	7.9	15.2	16.3	18.4	19.5	1.5	4.5	5.5	7.5	6.0
<u>Grasses:</u>										
Bottlebrush squirreltail	0	.5	.5	0	.5	0	2.5	4.0	10.5	21.5
Crested wheatgrass	--	--	--	--	--	0	14.0	20.5	17.5	13.0
Longtongue mutton bluegrass	0	0	0	.5	.5	1.0	2.0	2.5	4.0	3.0
Side-oats grama	9.5	7.9	6.8	10.0	15.2	10.5	15.0	23.0	32.5	33.5
Weeping lovegrass	3.7	5.3	9.5	12.6	12.1	.5	2.0	1.5	4.0	6.0
<u>Forbs:</u>										
Arizona rockcress	0	0	0	1.6	0	0	1.0	3.0	2.0	0
Hoarhound	0	0	0	0	0	0	0	0	3.0	2.5
Eaton penstemon	0	1.0	0	0	0	0	4.5	7.0	6.5	4.0
Few flowered goldenrod	0	0	0	0	0	0	5.0	15.5	23.0	22.5
Wrights verbena	0	28.9	5.8	1.6	2.6	0	9.0	11.5	0	2.5
Palmer penstemon	0	2.1	5.3	2.6	.5	0	25.0	26.5	25.5	2.5
Toadflax penstemon	0	0	1.0	1.0	0	0	0	13.5	13.0	8.5
White dalea	0	.5	1.6	0	0	0	2.0	2.5	0	0

Shrub live oak and broom snakeweed occurred most frequently on the circular 9.6-square-foot plots on both upper and lower areas (table 3). On the lower area, the low occurrence of pointleaf manzanita (4.2) was primarily due to its restriction to the vicinity of older colonies. This was also true, but to a lesser extent, for Pringle manzanita (frequency 16.5) and desert ceanothus (frequency 6.5) in the upper area. Catclaw mimosa was absent from the upper area, and the frequency of desert ceanothus and skunkbush sumac was much reduced (table 3).

Production And Distribution Of Herbaceous Plants

Within the chaparral type, weeping lovegrass was considerably more successful in the lower than in the upper area. Although native grasses recovered about 1 year later at the upper elevation, they contributed greatly to that area's superiority in grass production. Grass production during the best year was just under 200 pounds per acre on the upper area, and just under 100 pounds on the lower area (table 4). Production on all sites

Table 4. --Total herbaceous production at two elevations following wildfire on Mingus Mountain

Species	Lower area					Upper area				
	1956	1957	1958	1960	1961	1956	1957	1958	1960	1961
----- <u>Air-dry pounds per acre</u> -----										
<u>Grasses:</u>										
Bottlebrush squirreltail	0	0	1	0	0	0	1	5	12	13
Crested wheatgrass	--	--	--	--	--	0	0	39	31	21
Longtongue mutton bluegrass	0	0	0	¹ T	1	T	T	8	8	8
Side-oats grama	T	8	9	15	13	4	14	65	111	89
Weeping lovegrass	T	27	29	28	60	0	T	14	8	12
Others	T	5	18	13	23	T	1	10	26	14
Total grasses	T	40	57	56	97	4	16	141	196	157
<u>Forbs:</u>										
Arizona rockcress	0	0	0	0	0	0	T	1	0	0
Hoarhound	0	0	0	0	0	0	0	0	8	6
Eaton penstemon	0	T	0	0	0	0	T	5	8	2
Few flowered goldenrod	0	0	0	0	0	0	1	19	14	5
Wrights verbena	0	10	1	T	T	0	3	14	0	T
Palmer penstemon	0	2	18	21	2	0	12	197	79	1
Toadflax penstemon	0	T	T	0	0	0	0	5	5	2
White dalea	0	T	1	0	0	T	T	4	0	0
Others	0	3	8	10	6	0	6	14	13	6
Total forbs	0	15	28	31	8	T	22	259	127	22
Total herbaceous	T	55	85	87	105	4	38	400	323	179

¹ Trace

averaged 100 pounds per acre by 1958 and was slowly increasing at the end of the study (fig. 3). Basal area reached a peak in 1960 and declined slightly in 1961.

Weeping lovegrass, seeded on both upper and lower areas, occurred on 12.6 percent of the circular plots in 1960 in the lower area, but never exceeded a frequency of 6.0 percent in the higher area. Crested wheatgrass, seeded only in the higher area, reached a peak frequency of 20.5 percent in 1958, and dropped to 13.0 percent by 1961. Side-oats grama was most widespread of all grasses, native or seeded; it occurred on a maximum of 15.2 percent of the lower plots and 33.5 percent of the upper plots. Bottlebrush squirreltail was also much more frequent on the upper area (table 3).

Forbs, unlike grasses, reached a peak in both production and frequency of occurrence during the second and third growing seasons after the fire, and then declined rapidly. In the upper area, however, several forbs, notably hoarhound and few flowered goldenrod, became prominent a year or more after peak production had been reached by Palmer penstemon and Wrights verbena.

Only three forbs produced more than 10 pounds per acre in any year--Palmer penstemon, few flowered goldenrod, and Wrights verbena (table 4). Palmer penstemon, at its peak three growing seasons after the fire, produced about 50 percent of the total herba-

ceous production in the upper area. By 1961, Palmer penstemon contributed less than 1 percent of total herbaceous production in the upper area. During the peak year of forb production, three growing seasons after the fire, forbs in the lower area produced approximately one-half as much as grasses; in the upper area, forb production was approximately twice that of grasses.

The first forb to become prominent in the postfire vegetation in the lower area was Wrights verbena, which reached a peak frequency of 28.9 percent by the second growing season, then declined rapidly to 2.6 in 1961. In the upper area, Palmer penstemon had a frequency of 25.0 percent in the second growing season, remained high for 3 years, then rapidly declined to a frequency of 2.5 percent (table 3).

By 1961, six growing seasons after the fire, few flowered goldenrod was the most common forb in the higher elevations (frequency 22.5 percent), while no single forb was common in the lower area.

Grass Production On Sprayed Plots

Sprayed vegetation plots were used only to compare production on treated and untreated areas in 1961. On the untreated area, native grasses produced 37 pounds per acre, while weeping lovegrass produced 60 pounds. On areas where shrubs had been sprayed (mostly

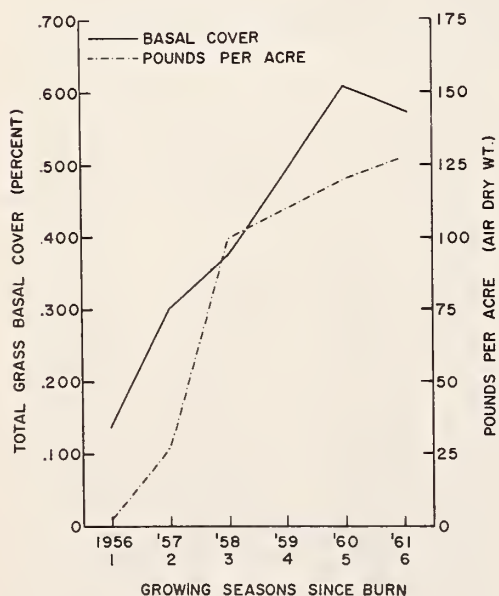
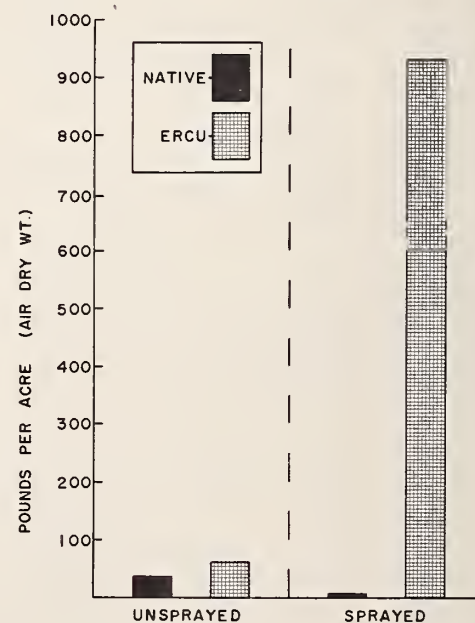


Figure 3.--
Grass production and basal cover on the Mingus Mountain burn.

Figure 4.--
On shrub live oak areas sprayed with 2,4,5-T and silvex, weeping lovegrass (ERCU) greatly outproduced scattered remnant native grasses.



on gentle slopes or swales) native grasses produced only 4 pounds per acre while weeping lovegrass produced 931 pounds (fig. 4).

Utilization

After the fire, the area was closed to livestock grazing for 2 years, then opened to limited grazing in the summer of 1958. The upper area was grazed by cattle mostly in the summer, while the lower area was held for winter use. Deer used both areas yearlong, but the lower area was used most heavily during the winter.

Utilization was estimated for only 2 years --1957-58 and 1958-59. The first year represents deer use only, while the second year represents both deer and cattle use. Percent utilization on permanent plots was computed from use estimates made in April before new growth began, and weighted against production on the same plots determined the previous fall. Estimates were based on annual production of herbaceous plants, and on total weight of shrubs.

	1957-58	1958-59
	(Percent utilization)	
<u>Shrubs and halfshrubs:</u>		
Broom snakeweed	1	1
Catclaw mimosa	0	0
Desert ceanothus	50	8
Hairy cercocarpus	55	20
Hollyleaf buckthorn	25	26
Pointleaf manzanita	17	30
Pringle manzanita	7	6
Shrub live oak	1	1
Skunkbush sumac	1	1
Wright silktassel	51	25
<u>Grasses and grasslike:</u>		
Bottlebrush squirreltail	0	3
Crested wheatgrass	0	22
Dryland sedge	0	8
Side-oats grama	2	2
Weeping lovegrass	2	9
<u>Forbs:</u>		
Eaton penstemon	16	58
Few flowered goldenrod	1	1
Palmer penstemon	1	1
Purple nightshade	-	7
White dalea	0	1
Wrights verbena	2	1

Deer used hairy cercocarpus, Wright silktassel, and desert ceanothus moderately the winter of 1957-58. Little grass was used--only 2 percent use of side-oats grama and of weeping lovegrass. None of the more abundant forbs were taken in quantity. During the winter of 1958-59, with grazing by both deer and cattle, use of grasses increased significantly. Eaton penstemon was the most heavily grazed forb, with purple nightshade second.

Percent use of shrubs was based on total weight rather than annual growth, and would ordinarily be expected to decrease as the sprouts grew older and larger. Annual growth increments on many shrubs, especially hollyleaf buckthorn, were difficult to detect.

Production And Use In The Fringe Pine

Herbaceous production in the pine type in 1961 was considerably higher than that in the upper chaparral. Grass production alone amounted to 426 pounds per acre. Twenty grass species were found in the plots, but only nine of these produced over 5 pounds per acre. The highest producer was weeping lovegrass, with almost three-fourths of the total grass herbage. The other seeded species, crested wheatgrass, produced less than 1 pound per acre.

<u>Species</u>	<u>Production</u> (Lbs/Acre)	<u>Use</u> (Percent)
<u>Grasses:</u>		
Blue grama	14	T
Dryland sedge	7	4
Hairy grama	12	13
Longtongue muhly	36	4
Plains lovegrass	5	26
Red three-awn	6	4
Side-oats grama	22	31
Single three-awn	15	2
Weeping lovegrass	294	16
Other grasses	15	T
	<u>426</u>	
<u>Forbs:</u>		
Flannel mullein	23	T
Other forbs	5	T

Use in the vicinity of the study plots was considered light to moderate. Three grasses

were used in excess of 15 percent, the highest use being on side-oats grama (31 percent). Weeping lovegrass, the major producer, was utilized only 16 percent.

SUMMARY

Chaparral crown canopy and total shrub weights were still increasing six growing seasons after a wildfire on Mingus Mountain. Shrub live oak was the main component of the shrub community (68.0 percent) at this time.

Pointleaf and Pringle manzanitas and desert ceanothus plants were greatly reduced by the fire, but seedlings of these species were numerous within 5 years. Desert ceanothus seedlings outnumbered manzanita seedlings at

the lower elevations (5,000 feet), but the reverse was true at higher elevations (6,500 feet).

Production of herbaceous species tended to be small except in one small area where shrub canopy was kept low by repeated chemical applications. On unsprayed plots, seeded and native grasses reached peak production in 1960, with about 200 pounds per acre at the higher elevations and 60 pounds per acre at lower elevations. On the sprayed area, production of weeping lovegrass alone exceeded 900 pounds per acre in 1961. Production of forbs reached a peak during the second and third growing season after the burn, and then rapidly declined.

Grazing, by deer only in 1957-58 and by cattle and deer in 1958-59, was not excessive.

COMMON AND BOTANICAL NAMES OF PLANTS MENTIONED

GRASSES AND GRASSLIKE:

Agropyron desertorum (Fisch.) Schult.
Crested wheatgrass
Aristida orcuttiana Vasey
Single three-awn
A. longiseta Steud.
Red three-awn
Bouteloua curtipendula (Michx.) Torr.
Side-oats grama
B. gracilis (H. B. K.) Lag.
Blue grama
B. hirsuta Lag.
Hairy grama
Carex geophila Mackenz.
Dryland sedge
Eragrostis curvula (Schrad.) Nees
Weeping lovegrass
E. intermedia Hitchc.
Plains lovegrass
Muhlenbergia longiligula Hitchc.
Longtongue muhly
Poa longiligula Scribn. & Williams
Longtongue mutton bluegrass
Sitanion hystrix (Nutt.) J. G. Smith
Bottlebrush squirreltail

FORBS:

Arabis perennans S. Wats.
Arizona rockcress
Dalea albiflora A. Gray
White dalea
Marrubium vulgare L.
Hoarhound
Penstemon eatoni A. Gray
Eaton penstemon
P. linarioides A. Gray
Toadflax penstemon
P. palmeri A. Gray
Palmer penstemon
Solanum xanthii A. Gray
Purple nightshade
Solidago sparsiflora A. Gray
Few flowered goldenrod
Verbascum thapsus L.
Flannel mullein
Verbena wrightii A. Gray
Wrights verbena

SHRUBS:

Arctostaphylos pringlei Parry
Pringle manzanita
A. pungens H. B. K.
Pointleaf manzanita
Ceanothus greggii A. Gray
Desert ceanothus
Cercocarpus breviflorus A. Gray
Hairy cercocarpus
Garrya wrightii Torr.
Wright siltkassel
Gutierrezia sarothrae (Pursh) Britt. & Rusby
Broom snakeweed
Mimosa biuncifera Benth.
Catclaw mimosa
Pinus ponderosa Lawson
Ponderosa pine
Quercus turbinella Greene
Shrub live oak
Rhamnus crocea Nutt.
Hollyleaf buckthorn
Rhus trilobata Nutt.
Skunkbush sumac