Short-term Vegetation Responses to Fire in the Upper Sonoran Desert

GEORGE H. CAVE AND DUNCAN T. PATTEN

Abstract

Annual and perennial plant vegetation was sampled following a controlled burn (1981) and a wildfire (1980) in the Upper Sonoran Desert near Phoenix, Ariz. Perennial plant composition 1 year after controlled burning included 32% shoot survivors, 30% sprouters, and 38% seeders, mostly brittle bush *(Encelia farinosa*[1]*)*. Several invader species, stickweed *(Stephanomeria exigua)* and four o'clock *(Mirabilis bigelovii)* were important seeders, indicating that there may be postfire successional communities in the Upper Sonoran Desert. Most cacti were fire killed or died eventually from fire damage. Total annual plant density decreased (69%) while biomass increased significantly (131%) on burned areas. Red brome *(Bromus rubens)* was essentially eliminated 1 year after fire while schismus *(Schismus arabicus)* and Indian wheat (*Plantago* spp.) increased in both density and biomass. Fire appears to enhance rangeland productivity in the Upper Sonoran Desert.

Deserts of the southwestern United States have been increasingly impacted by man and as a result may be rapidly deteriorating. One such impact is an increase in fire occurrence on desert or semidesert recreation and rangeland areas. Desert fire ecology research, however, is lacking compared to available data from other ecosystems (Wells et al. 1979 and Lotan et al. 1981). This deficiency may be attributed to Shreve's (1925 and 1951) statements characterizing the desert responses to fire disturbance as a direct and relatively rapid recovery back to the climax community. Muller (1940) and Whittaker (1975) have presented similar hypotheses for general disturbances in the desert. In addition, Humphrey (1963 and 1974) stated that fires have never been a factor of much importance and that their occurrence in the Upper Sonoran Desert is rare. All of these statements have undoubtedly discouraged researchers from studying desert fires. Fire can, however, occur relatively frequently in the Upper Sonoran Desert during dry seasons that follow moist winters (USDA 1980).

Fires in southern Arizona desert grassland near Tucson, where fires can occur more frequently than in most desert areas, have been studied by Humphrey (1949), Humphrey and Everson (1951), Reynolds and Bohning (1956), Humphrey (1963), Cable (1967), White (1969), and Martin (1983). These studies reported vegetation responses to fire and investigated the use of fire as a tool for controlling undesirable species on grazing land.

Fire ecology in the Upper Sonoran Desert of central Arizona has only been recently studied (Whysong and Heisler 1978, Rogers and Steele 1980, McLaughlin and Bowers 1982, Patten and Cave 1984). This desert is floristically different from the southern Arizona desert grasslands, and fire recovery data are not comparable. Other recent studies have been conducted in southern Arizona semidesert (Wright 1980), the western Colorado Desert (O'Leary and Minnich 1981), the Chihuahuan Desert (Ahlstrand 1982), and the Great Basin Desert (Rogers 1980). All these efforts reflect contemporary interests in re-evaluating and contributing to knowledge of fire ecology in North American deserts. To the extent that large portions of the Upper Sonoran Desert are used as rangeland, the present study is of particular interest because of the potential stimulatory effect fire has on rangeland productivity.

This study was designed to examine short-term effects of fire on both annual and perennial plant communities in the Upper Sonoran Desert through the use of controlled burning and study of an adjacent wildfire area. Specific objectives were: (1) to characterize 1- and 2-year postfire, herbaceous plant communities (annuals) with respect to changes in density and biomass in both open/shrub (small shrubs plus interspaces) and shaded (small trees) microhabitats; and (2) to examine the density and survival/recovery strategies of 1- and 2-year postfire tree, shrub, and cactus plant communities.

Methods

The study site was located in Bulldog Canyon, a desert canyon near Phoenix, Ariz., in the Tonto National Forest at 33° 15′N and 111°33′W with an elevation of 450 m. Three fire treatment sites were studied: (1) a wildfire area in which 84 ha burned on 26 May 1980; (2) 1 unburned hectare used for the controlled burn site and located adjacent to the wildfire site; and, (3) another adjacent, unburned hectare selected as a no fire control site. The controlled burn site was burned on 12 June 1981 by fire crews from Tonto National Forest.

Vegetation in the canyon was typical of the Upper Sonoran Desert in central Arizona and is characterized by the palo verde-cactus (mostly *Opuntia*[1] and *Carnegiea gigantea*)-shrub (mostly *Ambrosia deltoidea*) association (Shreve 1951). These perennial plants occupy about one-third of total ground cover. Perennial grasses are rare in this portion of the Upland Desert, but herbaceous annual forbs and grasses are abundant after winter and heavy summer rains.

Precipitation data were from Stewart Mountain Weather Station operated by the National Oceanic and Atmospheric Administration and located approximately 5 km (33°34′N and 111°32′W) from the study site.

Herbaceous Plants

Herbaceous plant data were collected during 2–5 April 1981 and 13–17 March 1982, during each year's peak annual plant growth period. Plants were sampled on the no fire, controlled burn, and wildfire sites using randomly located 20 × 20 cm plots within both shaded and open/shrub areas. This segregation was designed to permit separate comparisons for annual plant species that grow primarily in shaded microhabitats (Tiedemann et al. 1971 and Patten 1978), and to distinguish fire recovery effects in shaded areas where annual plant growth can frequently be much greater than in partially shaded or unshaded areas created by low shrubs

Authors are graduate assistant, Department of Botany/Microbiology, and director of The Center for Environmental Studies and professor of botany, Arizona State University, Tempe 85287.

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[1]Nomenclature follows Kearney and Peebles (1960) and Lehr (1978).

and open interspaces. Twenty plots were located in each area except for open/shrub areas on the no fire site which had 14 plots during 1981 sampling. For each species within the plots, density and above-ground biomass were calculated, the latter by harvesting above-ground growth and drying for 48 hrs at 60°C before weighing.

Table 1. Mean herbaceous (annual) plant density (no. plants/m²) and biomass (gm/m²) in 1981 and 1982 for two microhabitats (open/shrub and shade) within three fire treatment areas (no fire, wildfire 1980, and control burn 1981). Means followed by the same letter (a or b for 1981 comparisons among the three treatments and x or y for 1982 comparisons) are not significantly different ($P<0.05$) according to Dunn's multiple comparison test. Where no significance is given, data were absent for comparison or were grouped (e.g., others).

		No fire		Wildfire 1980		Controlled burn 1981	
Species/microhabitat	Variable	1981	1982	1981	1982	1981*	1982
Indian wheat							
Open/shrub	Density	232a	542xy	126a	790y	336a	149x
	Biomass	2.6a	21.4x	16.0a	84.7y	7.1a	19.4x
Shade	Density	38a	36x	61a	258x	25a	60x
	Biomass	1.6a	1.9x	5.4a	31.8y	0.9a	18.0xy
Red brome							
Open/shrub	Density	396a	120x	20b	20y	184ab	11y
	Biomass	12.4a	5.6x	3.8b	2.5y	11.0ab	2.4y
Shade	Density	824a	258x	11b	105xy	1016a	4y
	Biomass	26.3a	29.0x	1.2b	34.7xy	18.1a	1.0y
Six-weeks fescue							
Open/shrub	Density	121a	123x	20a	34x	88a	153x
	Biomass	0.5a	1.5xy	1.2a	0.7x	0.6a	9.7y
Shade	Density	84a	8x	40a	35x	99a	23x
	Biomass	0.3a	0.3x	0.5a	1.0x	0.3a	1.5x
Schismus grass							
Open/shrub	Density	27a	26x	66a	186y	34a	99x
	Biomass	0.3a	0.4x	13.8b	32.8y	0.4a	10.6y
Shade	Density	20a	48x	98b	284y	56a	125x
	Biomass	0.7a	1.9x	11.1b	63.2y	0.2a	31.2y
Filaree							
Open/shrub	Density	29a	49x	10a	26x	41a	33x
	Biomass	0.6a	3.9x	4.1a	1.8x	3.4a	5.5x
Shade	Density	7a	61x	10a	18x	4a	11x
	Biomass	0.3a	4.7x	1.2a	8.8x	0.1a	7.2x
Goldfields							
Open/shrub	Density	11a	266x	19a	85xy	9a	53y
	Biomass	0.1a	5.9x	0.3a	4.3x	0.2a	6.3x
Shade	Density	4a	193x	26a	48x	8a	51x
	Biomass	0.03a	4.4x	0.5a	1.6x	0.04a	5.8x
Filago							
Open/shrub	Density	4a	451x	3a	7y	1a	145xy
	Biomass	0.1a	5.8x	0.1a	5.3x	0.04a	10.1x
Shade	Density	—	151x	9	56xy	—	25y
	Biomass	—	2.6x	0.1	2.9x	—	1.3x
Comb bur							
Open/shrub	Density	20a	208x	4a	11y	40a	39xy
	Biomass	1.3a	10.8x	0.4a	0.9y	0.7a	2.9xy
Shade	Density	9a	55x	4a	1y	8a	11xy
	Biomass	0.2a	2.6x	0.1y	0.1y	0.2a	0.9xy
Red maids							
Open/shrub	Density	—	6	4	3	—	4
	Biomass	—	0.2	2.9	1.0	—	1.8
Shade	Density	18a	46x	33a	33x	4a	76x
	Biomass	0.3a	4.0x	2.7a	6.1xy	0.1a	31.4y
Others							
Open/shrub	Density	39	141	83	199	190	230
	Biomass	2.4	8.7	10.8	2.1	3.2	66.3
Shade	Density	41	252	66	128	36	210
	Biomass	1.6	28.5	9.4	34.0	5.9	57.6
TOTALS							
Open/shrub	Density	879a	1914x	355b	1361xy	923a	916y
	Biomass	20.3a	64.2x	53.4b	136.1y	26.6ab	138.0y
Shade	Density	1045a	1108x	358b	966x	1256a	596y
	Biomass	31.3a	79.9x	32.2a	184.2y	25.8a	155.9y

*Preburn measurements.

Shaded area herbaceous plant plots were located under randomly selected palo verde *(Cercidium microphyllum)* and ironwood *(Olneya tesota)* trees at 4 aspects (N, S, E, and W) from the stem at one-half canopy radius. Open/shrub area plots were located at random points not associated with tree canopies but including both open interspaces or low shrubs. Density and biomass values for the 9 most abundant annual plant species were analyzed among the 3 collection sites at each sampling time using the Kruskal-Wallis procedure (Dixon 1977) followed by Dunn's test (Hollander and Wolfe 1973). Separate comparisons were performed for shaded and open/shrub area plant data. Values for all species were then totaled and analyzed in the same manner.

Woody Perennials and Cacti

Tree, shrub and cactus plant data were collected on permanent 4 × 8-m quadrats (Cox 1974) for both the controlled burn (n = 23) and wildfire (n = 10) sites. Plant densities were censused 3 times on the controlled burn site (27 May 1981 for preburn values, and 16 June 1981 and 17 March 1982 for postfire values), and 2 times on the wildfire site (23 June 1981 for 1 year after fire and 17 March 1982 for 2 years after fire). The 5 most important species (based on importance values) on the controlled burn site were analyzed using Kruskal-Wallis procedure and Dunn's test in order to test for significant differences among sampling times. In addition, for all postfire measurements, the survival and/or recovery strategy of each plant was classified and recorded as a seedling, sprout, or surviving adult.

The use of the word significant in statistical analysis and discussion of data indicates a probability level <0.05, unless otherwise stated.

Results and Discussion

Precipitation at Stewart Mountain for the winter growing season (December through March) was 275 mm in 1979–80, 90 mm in 1980–81, and 154 mm in 1981–82. These represent 216, 71, and 121% of the 1951-1980 30-year annual average of 127 mm for the 4-month period. As a result of above-normal precipitation, prefire standing crop of herbaceous annual plants prior to the 1980 wildfire was lush. The wildfire was probably more intense than the 1981 controlled burn; however, the 2 sites appeared similar enough after burning to justify intersite comparisons. Lower than normal 1981 precipitation did not produce good winter and spring annual plant growth for ground cover, but this biomass was supplemented by remaining litter on unburned areas from the 1979-80 wet winter. Good germination and growth conditions for most desert species did occur in 1982 following above-normal winter rainfall.

Herbaceous Plants

Mean density and biomass values for the 9 abundant annual plant species are presented in Table 1. Species listed as "Others" include plants from the following genera: *Plagiobothrys, Amsinckia, Cryptantha, Astragalus, Poa, Eriophyllum, Calandrinia, Lotus, Lupinus, Dichelostemma, Eschsholzia, Platystemon, Euphorbia, Silene, Pholistoma, Bowlesia, Orthocarpus, Androsace, Daucus, Phacelia, Parietaria, Eucrypta, Chenopodium, Rafinesquia, Linathus,* and *Lepidium.*

Before the controlled burn in 1981, all herbaceous plant means calculated for the no fire and controlled burn (1981* — Table 1) sites were not significantly different. This supports the assumption that comparisons between the 1982 no fire and controlled burn sites will accurately reflect fire-induced changes. Since the 1980 wildfire site was located adjacent to the other 2 sites, its prefire status was presumed to have been sufficiently similar to allow for statistical comparisons among all sites. No comparisons were calculated between 1981 and 1982 data because differing temperature and rainfall patterns between years affects each desert growing season's annual plant productivity and species composition (Patten 1978, Webb et al. 1978).

In 1981, of the 9 species listed in Table 1, only red brome *(Bromus rubens)* and schismus *(Schismus arabicus)* grasses responded significantly to the 1980 wildfire. In open/shrub areas, red brome density on the wildfire site was reduced by 95 and 89% while biomass declined by 69 and 65% when compared to the no fire and controlled burn (preburn conditions) site. Similar trends were recorded for red brome in shaded areas. In contrast to red brome, schismus grass density increased significantly in both open/shrub and shaded areas 1 year after the wildfire.

Red brome continued to show a reduction for the second year after the 1980 wildfire and repeated the first-year reduction patterns on the controlled burn. After 2 years, intermediate values for brome in the shade indicated a gradual recovery. Horton and Kraebel (1955) also found brome grasses in southern California to be greatly reduced in the first postfire year. Studies by Keeley et al. (1981) suggest that reductions may be caused by low seed survival during fire or low soil seed reserves at the time of the fire.

Horton and Kraebel (1955) postulated that peak populations of brome grasses require several postfire years for either seed dispersal into burned areas and/or on site build-up from pioneering postfire plants. Since red brome remained significantly reduced in open/shrub areas 2 years after burning in the present study, it appears that at least 3 to 4 years will be necessary for full red brome recovery in the desert. However, in the more mesic, shaded areas where seeds may have survived better because of light surface burning and low fire temperatures below the thick insulation (Pat

Table 2. Mean tree, shrub, and cactus densities (no. plants/ha) at three sampling times on the 12 June 1981 controlled burn site (n = 23) and at two sampling times on the adjacent 26 May 1980 wildfire site (n = 10). Means for the controlled burn site followed by the same letter (a or b) are not significantly different ($P<0.05$) according to Dunn's multiple comparison test. Only the five most important species were analyzed. There were no significant differences between 1981 and 1982 data on the wildfire site.

	Controlled burn 1981			Wildfire 1980	
Species	27 May 1981*	16 June 1981	17 March 1982	23 June 1981	17 March 1982
Bursage	6275a	1141b	1141b	3590	3844
Cholla cactus	450a	191b	177b	280	157
Foothill palo verde	203a	150a	55a	—	—
Jojoba	143a	142a	68a	31	31
Brittle bush	82a	14a	707a	63a	81
Ironwood	32	27	27	31	31
Desert mallow	27	—	14	31	31
Barrel cactus	14	14	14	—	—
Saguaro	14	—	—	—	—
Four o'clock	—	—	109	—	—
Stickweed	—	—	95	310	313
Others	149	177	69	31	31
TOTALS	7607	1856	2476	4367	4516

ten and Cave 1984), red brome density and biomass attained intermediate values within 2 years after burning.

In 1982, schismus continued to respond to fire with higher densities in open/shrub areas on both the controlled burn and wildfire sites (Table 1). Schismus biomass production also significantly increased manyfold on the 2 burn sites with increases in the shade greater than in the open. Apparently schismus grass seeds survive fire well, and subsequent germination, which appears to be stimulated by fire, allows this species to achieve higher density and biomass in the postfire herbaceous plant community.

Of the remaining 7 genera and species in Table 1, 3—goldfields (Lasthenia californica); filago *(Filago arizonica* and *F. californica;* and comb bur *(Pectocarya recurvata* and *P. playtcarpa)*—were reduced by fire. One—filaree *(Erodium cicutarium)*—showed no significant response; and 3—red maids*(Calandrinia ciliata),* six-weeks fescue *(Vulpia octoflora),*and Indian wheat *(Plantago insularis* and *P. purshii)*—were stimulated by fire. Goldfields was reduced in density primarily in the open/shrub areas. Filago, which normally grows best in intermediate shade locations, was reduced in all conditions; however, it recovered more rapidly in the shade. The absence of filago in the shade in 1981 was probably a result of year-to-year variations in temperature and precipitation because it had a uniform presence in 1982. Comb bur had lower densities and biomass in 1982 on the wildfire site than on the controlled burn site, indicating that the probable higher intensity of the 1980 wildfire reduced these species more than the controlled burn.

Of the herbaceous species that showed a positive response to fire, red maids increased in biomass primarily in the shade, but these increases diminished by the second year. The density of red maids was not significantly affected by fire. Indian wheat, a characteristic annual in open and semishaded areas in the desert, had significantly greater biomass (ca. 300%) on the wildfire site than on the controlled burn or no fire sites in 1982. Its response in shade was high biomass values on the 2-year-old wildfire, intermediate values on the 1-year-old controlled burn, and lowest values on the no fire site, indicating a continued increase for a few years following fire. Six-weeks fescue increased dramatically in biomass (547%) in the open/shrub areas 1 year after fire as measured on the controlled burn and then showed a reduction after 2 years measured on the wildfire site. Densities of this species showed little change. There were no significant changes in density or biomass of six-weeks fescue in the shade, although the pattern of first-year increase with a subsequent decline occurred.

In open/shrub areas during 1981 there were significant reductions in total herbaceous plant density (ca. 60%) and increases (163%) in biomass on the wildfire site when compared to the no fire site (Table 1). In 1982, herbaceous plant density in open/shrub areas was also reduced 1 year after controlled burning, but the 2-year wildfire site had intermediate values that were significantly different from either the no fire or controlled burn sites. In contrast, biomass was significantly greater on both fire treatment sites when compared to the no fire site.

Similar trends in total herbaceous plant density and biomass were recorded in shaded areas (Table 1). In this microhabitat, however, increased biomass (ca. 13%) in 1981 on the wildfire site was not significant, but the reduction in density (ca. 69%) was. In 1982, a 46% reduction in herbaceous plant density on the controlled burn site was observed when compared to the no fire site. The 1980 wildfire site density was intermediate again. Biomass was greater on both fire treatment sites (controlled burn 95% and wildfire 131%) when compared to the no fire site. These data indicate significant reductions in herbaceous plant density 1 year after fire. During the second postfire year herbaceous plant density achieved intermediate status between prefire and 1 year after fire. Aboveground biomass, on the other hand, increased significantly after fire. This increase was attenuated into the second postfire year for both shaded and open/shrub areas. Since biomass increased after fire, while density decreased, the average biomass per plant must have also increased after fire. This demonstrates the ability of desert annuals to respond positively to fire, initiating a solid recovery with increased biomass within 2 years.

The reduction in total herbaceous plant density was primarily a result of low red brome density on burned sites, while increases from schismus, Indian wheat, and red maids contributed to total increases in biomass. These results for herbaceous plant responses parallel findings for southern Arizona desert grasslands (Reynolds and Bohning 1956, and Cable 1967), the Chihuahuan Desert (Ahlstrand 1982), North American annual plant grasslands (Daubenmire 1968) and California chaparral (Christensen and Muller 1975).

Woody Perennials and Cacti

Tree, shrub and cactus responses are presented in Table 2. Density of the most abundant species, bursage, was reduced by 82% after the controlled burn. However, numerous seedlings had established on the adjacent wildfire burn site (ca. 78% of all bursage individuals) producing intermediate density values. McLaughlin and Bowers (1982) also recorded very high mortality rates for bursage after fire in the Sonoran Desert in south-central Arizona.

Cholla cactus (*Opuntia acanthocarpa*, 95%; *O. fulgida*, 3%; and *O. bigelovii*, 2%) densities were reduced by about 58% immediately after controlled burning. In addition to initial reductions in density, these cacti declined further between the 2 postfire sampling times on both sites (Table 2), indicating that some cacti, not killed at the time of or shortly after fire, die eventually from latent heat damage to epidermal and mesophyll tissue. Visual observations of cacti in later sampling dates verified this result. No seedlings or sprouts were recorded for any cactus species; postfire cacti consist entirely of adults that survive fire with little or no injury. Barrel cactus *(Ferocactus acanthodes)* was unaffected by controlled burning while all saguaro cacti *(Carnegiea gigantea)* found within sampling quadrats were killed by fire. However, other larger saguaros, that were not sampled on the site, managed to survive, although scorched epidermis may permit invasion of fungi or other lethal vectors. Observations of burned sites indicate that small saguaros less than about 2–4 m in height do not survive when large fuel quantities are present near the base, while larger individuals with extensive corky bases usually survive with limited damage. On the wildfire site, all cacti except chollas had died within a year after fire. As noted earlier, this site probably burned more intensely thereby consuming more of the perennial plant community than on the controlled burn site. Results for cacti presented in this study differ slightly from McLaughlin and Bowers (1982) as they did not record any cactus mortality subsequent to initial postfire measurements. Rogers and Steele (1980), however, recorded observations in the Upper Sonoran Desert similar to this study as did Bunting et al. (1980) for cacti in Texas mixed prairie.

The 2 tree species, palo verde and ironwood, had different responses to fire. Density of ironwood was virtually unaffected by fire while palo verde underwent an initial 26% reduction followed by an overall 73% reduction 9 months after fire (Table 2 -controlled burn site). These results are supported by high ironwood densities on the wildfire site where palo verde was essentially eliminated after fire. The decline in palo verde density (Table 2) indicates that this species also suffered from heat damage (probably to the cambium) during the fire, taking several months to eventually kill trees or portions of their crowns. In comparison, ironwood with thicker bark is rather resistant to fire and/or heat damage. Twenty-two percent of palo verdes that survived had basal or aerial sprouting within 9 months after fire; ironwood was present only as surviving adults. These results parallel findings by Rogers and Steele (1980), and McLaughlin and Bowers (1982).

Density of the economically important plant, jojoba *(Simmondsia chinensis),* was substantially reduced within 9 months after the controlled burn (Table 2). On the wildfire site, jojoba was less abundant than on the controlled burn site, but its density remained unchanged between sampling times. Jojoba is an active postfire sprouter in the desert in that 60% of postfire jojoba plants on the controlled burn site and 100% on the wildfire site were sprouting.

Brittle bush *(Encelia farinosa)* underwent an initial 83% reduction in density, but within 9 months it had increased to 762% above preburn status on the controlled burn site (Table 2). This was caused by very successful seed germination and subsequent seedling establishment on the controlled burn site. Similarly, desert mallow *(Sphaeralcea ambigua)* appears to be greatly reduced or eliminated by fire and shows recovery or reinvasion within a year.

Two species that were not recorded in the prefire vegetation appeared after fire: four o'clock *(Mirabilis bigelovii)* and stickweed *(Stephanomeria exigua)* (Table 2). Densities of these species were large enough to indicate that they may be initiating an invasion of the site. Both species were present only as seedlings and neither species was recorded by Rogers and Steele (1980), or McLaughlin and Bowers (1982) on other Upper Sonoran Desert burn locations. Rogers and Steele (1980), however, recorded two genera *(Cassia* and *Castilleja)* not normally found in the climax community growing at their study area.

Total tree, shrub and cactus density was reduced by 76% immediately after the controlled burn (Table 2). Nine months after the fire, density for these growth forms had increased slightly because of extensive brittle bush seedling establishment. Averages from recovery and/or survival strategy data indicate that on 16 June 1981, 98% of all perennials were adults surviving the controlled burn while on 17 March 1982, 9 months after burning, the same site was composed of 38% seedlings, 30% sprouts, and 32% adults. At the latter sampling time, the wildfire site consisted of 48% seedlings, 13% sprouts, and 52% adults indicating that seedling establishment is more important than sprouting for postfire desert recovery as noted by Rogers and Steele (1980).

Conclusions

The herbaceous plant community responds rapidly to fire with an overall reduction in plant density and increase in above-ground biomass. Soil fertility increases commonly observed after burning in other ecosystems also occur in the desert (Whysong and Heisler 1978) and at least partially account for the reported increases in above-ground biomass after fire.

Although red brome seeds (with large awns) apparently do not survive fire well in the desert, schismus seeds (without awns) do; subsequently, postfire schismus growth is extensive. If herbaceous plant biomass remains high for several more postfire years, it is reasonable to conclude that burning may stimulate desert rangeland productivity. Where grazing allotments are involved, this suggestion has very important ramifications for desert rangeland management, especially in light of current trends to convert desert land into more profitable uses. Therefore, any efforts to use prescribed burning should remain experimental until a long-term data base exists on which to make more reliable predictions.

Desert perennials also respond quickly to fire with large amounts of seed germination and aerial or basal sprouting. Due to the short-term nature of this study, data presented primarily record immediate fire loss and the initial recovery phase.

The appearance of two nonclimax species (four o'clock and stickweed) suggest that in the Upper Sonoran Desert ecosystem, specific postfire successional plant communities may exist, or at the very least, specific postfire successional species occur. Results from Rogers and Steele (1980) support this hypothesis as they also recorded nonclimax postfire species. They postulated that it may take 20 years for plant density and decades for species composition to return to prefire status. These hypotheses seem tenable in light of the marked vegetation changes recorded here during the first two postfire years, especially the reduction in such long-lived species as saguaro.

If partial postfire successional plant communities do exist in the desert, then it is reasonable to infer that present plant distribution patterns may have been more influenced by fire than originally hypothesized by Shreve (1925 and 1951) and Humphrey (1963 and 1974). Desert fire ecology therefore requires additional study in order to determine the full extent of the effects of fire on the desert ecosystem.

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