The Effects of Fire on the Blackbrush [*Coleogyne ramosissima*] Community of Southwestern Utah

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Abstract

Eight general study sites were examined in the blackbrush *(Coleogyne ramosissima)* zone of southwestern Utah in order to assess the impact of burning. All sites had been burned. Age since burning varied from 1 to 37 years. Plots were placed in burned areas with plots in adjacent unburned areas serving as controls. Sites were similar enough that definite trends were distinguishable despite between site variation. Recently burned areas were dominated by forbs, middle aged burns were dominated by grasses, and the oldest burns had reverted back to shrub dominance. Cryptogamic soils crusts were severely affected by burning and showed no signs of recovery after 19.5 years. Blackbrush was also severely affected and showed no signs of recovery after 37 years. Lack of recovery by blackbrush may be due to its paleoendemic nature. Future burning of stands of blackbrush in southwestern Utah is not recommended.

The blackbrush *(Coleogyne ramosissima)* zone of southwestern Utah is an important vegetation type occupying large areas. However, it produces relatively little livestock forage. Controlled burning has been used as a management tool during the last 20 years to remove blackbrush and increase forage production. In the nearby blackbrush zone of southern Nevada, Jensen et al. (1960) concluded that such burning was beneficial and economically feasible. However, Bowns and West (1976) state that burning of blackbrush is not desirable as a management tool since results are unpredictable. The purpose of this study was to examine blackbrush sites in southwestern Utah which have been subjected to fire and to determine what effects the burning has had on the blackbrush community.

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Site Description

The study sites were located in the Dixie Corridor between the Beaver Dam Wash and the Beaver Dam Mountains in southwestern Utah. This area is a transition zone between the hot desert of the Mojave and the cold desert of the Great Basin. Soils are shallow, well drained, and have from 2 to 7% slopes. Parent materials are mixed alluvium from limestone, gneiss, schist, sandstone, and basalt (Bowns 1973). Elevation of the study plots ranged from 1,070 m to 1,400 m (3,510 to 4,590 ft). Average annual precipitation, recorded over a 30-year period at the nearby Gunlock Powerhouse, is 296 mm (11.65 in.). The average annual temperature, from the same location, is 16.1°C (61°F) (Hodges and Reichelderfer 1962). Eubank and Brough (1979) listed extremes of temperature from 46.7°C (116°F) to –23.9°C (–11°F) at St. George which is on the edge of the blackbrush range.

Methods

Eight general study sites were selected. The sites had all been burned, with time since burning, varying from 1 to 37 years. The study sites were considered to be similar enough that trends could be detected despite variation between sites. Two of the burns were 2 years old and data from those sites were combined for analysis. Ten (10 m × 10 m) sampling plots were placed at each site. The sampling plots were paired, with the pairs being arranged so that one member of each was in the burn, the other on a topographically and edaphically similar area in unburned vegetation. All plots were placed on sites of uniform topography with ravines and rock outcroppings being avoided. Pairs of sampling plots were randomly placed along edges of the burn. Unburned plots served as controls. Each plot was subsampled with 15 uniformly distributed 1-m^2 quadrats. Plant cover of each species was estimated (Daub-

Table 1. Environmental factors on both burned and unburned blackbrush sites.

	unburned		1 year		2 years		6 years		12 years		17 years		19.5 years		37 years	
Time elapsed since burning	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.
Elevation (m)	1271.3	94.5	1340	0	1226.7	118.4	1400	0	1280	0	1070	0	1220	0	1250	0
% slope	9.6	9.7	6.0	5.2	9.1	7.4	44	0	2.8	0.5	18.2	1.1	3.6	0.6	4.4	3.1
% litter	7.9	3.8	4.9	4.1	5.9	3.2	3.5	0.9	9.6	4.9	11.6	6.2	5.5	2.0	8.5	3.1
% rock	38.7	10.3	55.9	15.8	19.1	5.1	48.5	4.8	22.0	5.3	15.9	4.2	42.6	11.2	48.5	12.8
soil depth (dm)	1.3	0.7	1.2	0.4	2.2	1.0	1.0	0.3	2.1	2.2	1.3	0.4	1.5	0.6	1.9	0.2
# spp/stand	7.7	2.3	8.4	1.5	10.6	2.2	8.8	2.4	13.4	2.1	13.2	1.3	6.2	0.8	11.0	1.0

enmire 1959) at each quadrat. In addition, cover contributed by rock, litter, and cryptogamic crusts was estimated. Soil depth was measured with a penetrometer (Greenwood and Brotherson 1978) at the corners and center of each plot (the 5 readings were averaged to give a single estimate for each plot). Percent slope and exposure were obtained for each plot using an Abney level and compass respectively. Elevation at each plot was taken from USGS 1:24,000 topographic maps.

Three samples of the surface 20 cm of soil were taken in each plot (from opposite corners and the center) with subsamples pooled for laboratory analyses. Dependence on surface samples alone seemed justified since Ludwig (1969) has shown that the surface decimeter of soil from Utah foothill communities provided over 80% of the information extractable with correlation analyses relating soil mineral content to plant parameters. Holmgren and Brewster (1972) showed that 50% of the fine roots (those most likely to absorb soil minerals) were concentrated in the upper 15 cm of soil profile of Utah cold desert shrub communities. With respect to grasslands, Christie (1979) found that the top layer of soil supplies most of the minerals taken up by plant roots in grassland communities.

Soil samples were analyzed for texture (Bouyoucos 1951), pH mineral composition, and organic matter content. Soil reaction was taken with a glass electrode pH meter on a 1:1 v/v soil-water paste (Russell 1948). Soils were extracted with 1.0 normal neutral ammonium acetate for exchangeable calcium, magnesium, potassium, and sodium (Jackson 1958, Hesse 1971, Jones 1973). Zinc and copper were extracted from the soils by use of DPTA dieehylenetriamine-penta-acetic acid) extracting agent (Lindsay and Norvell 1969). Individual ion concentrations were determined by using a Perkin-Elmer Model 40 atomic absorption spectrophotometer (Isaac and Kerber 1971). Soil phosphorus was extracted using sodium bicarbonate (Olsen et al. 1954). Total nitrogen was determined by macro-Kjeldahl procedures (Jackson 1958). Organic matter was estimated by loss on ignition of 10 grams of soil at 950°C in a LECO medium temperature resistance furnace (Allison 1965).

Prevalent species (those most frequently encountered during sampling) were selected using the procedure of Warner and Harper (1972), but using cover values rather than frequency. Means and standard deviations were computed for all biotic and abiotic variables. One way analysis of variance of site characteristics was used to test for significant differences between study sites (Table 1).

Results and Discussion

Table 1 shows environmental factors measured on the study plots. The unburned control plots were combined in a single column. The burned plots are listed according to the age of the burn. Analysis of variance was used to test for differences among site characteristics. Some significant differences were found, but they were unrelated to any of the changes in vegetation.

Figure 1 shows the changes in vegetation composition over time on burned blackbrush sites in terms of relative cover. Conditions on the 1-year-old burn (column one) were typical for a recently burned area. Most of the shrubs were removed by fire, forbs were greatly increased, and grasses are moderately increased. Over time shrubs increased until they approached preburn levels. Forbs steadily decreased until they approached preburn levels. Grasses increased, reached a peak on the 6-year-old burn, and then declined to preburn levels. The trends depicted in Figure 1 show that shrubs have completely reestablished themselves within 15 to 20 years (some variation between sites). Although the initial impact of fire was profound, the return to shrub dominance was rapid. Table 2 shows the absolute cover values for species found on the burned sites. This rapid return of the study sites to shrub dominance supports the idea that soil factors favor shrubs over grasses and forbs in our study area. Doughty et al. (1976) and Thatcher (1975) state that distribution of blackbrush is largely controlled by edaphic factors.

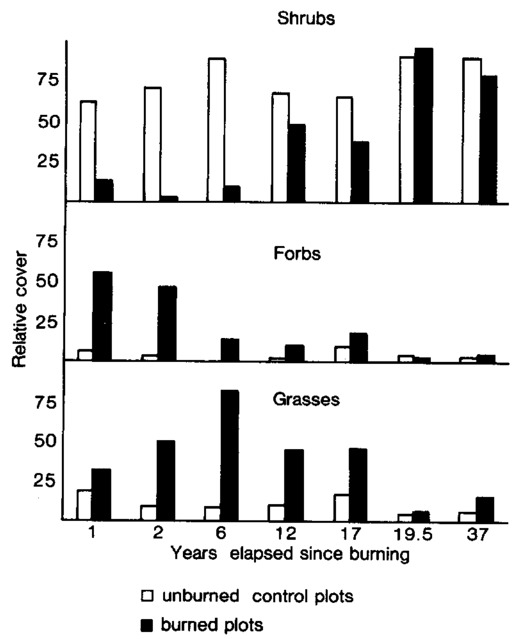

Fig. 1. *Relative composition of shrubs, forbs, and grasses on burns of different ages in the blackbrush community.*

Shrub composition before burning only slightly resembled composition after burning. Before burning, blackbrush comprised 79% of all vegetation and 91% of all shrub cover. After burning, shrub composition varied from site to site, but on all sites blackbrush cover was greatly reduced. Figure 2 shows the relative amounts of blackbrush found on the burned sites. On all sites blackbrush cover was only a small portion of total shrub cover. The contrast between blackbrush cover and total shrub cover was especially obvious on the older burned sites where total shrub cover approached preburn levels. The lack of recovery of blackbrush may be due to its limited

Table 2. Absolute cover values of species present on burned plots.

Time elapsed since burning	unburned mean	unburned S.D.	1 year mean	1 year S.D.	2 years mean	2 years S.D.	6 years mean	6 years S.D.	12 years mean	12 years S.D.	17 years mean	17 years S.D.	19.5 years mean	19.5 years S.D.	37 years mean	37 years S.D.
Shrubs																
Coleogyne ramosissima	38.1	8.4	1.6	1.8	0.0	0.0	0.0	0.0	0.2	0.1	3.8	3.4	0.7	1.1	1.7	2.5
Purshia glandulosa	0.2	0.7	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.5	0.0	0.0	0.0	0.0	3.2	4.0
Ephedra viridis	1.2	1.9	0.5	0.7	1.5	2.2	0.7	0.5	0.1	0.1	3.3	3.0	0.4	0.5	0.0	0.0
Eriodictyon angustifolium	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.5	23.8	9.1	0.0	0.0	0.0	0.0	0.0	0.0
Prunus fasciculata	1.5	1.1	0.0	0.0	0.1	0.3	1.8	1.4	0.2	0.4	1.7	2.0	0.6	1.1	7.7	4.2
Thamnosma montana	0.9	2.3	0.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.7	3.8	15.4	11.4
Xanthocephalum microcephala	0.4	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	10.2	6.4	24.8	5.7	0.0	0.0
Yucca baccata	0.4	0.9	0.1	0.1	0.0	0.0	0.0	0.0	1.6	1.5	0.0	0.0	0.0	0.0	5.5	3.5
Perennial Grasses																
Agropyron cristatum	0.1	0.3	0.0	0.0	11.5	14.0	1.5	2.7	9.2	9.2	0.0	0.0	0.0	0.0	0.0	0.0
Agropyron intermedium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8	5.3	0.0	0.0	0.0	0.0	0.0	0.0
Perennial Forbs																
Melilotus officinalis	0.0	0.0	0.0	0.0	1.3	1.4	0.00.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sanguisorba minor	0.0	0.0	0.0	0.0	0.7	0.9	0.0	0.0	1.9	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Sphaeralcea grossulariaefolia	0.0	0.0	0.0	0.0	0.7	0.7	2.7	2.5	0.0	0.0	0.5	0.7	0.0	0.0	0.0	0.0
Annuals																
Astragalus spp.	0.1	0.2	0.0	0.0	7.2	11.3	0.0	0.0	0.0	0.0	1.5	1.3	0.0	0.0	0.0	0.0
Rromus rubens	3.4	3.1	3.9	2.4	2.4	3.9	10.7	8.2	0.4	0.4	6.9	2.2	1.5	0.6	1.4	0.9
Bromus tectorum	2.8	2.7	2.5	2.7	6.6	8.7	33.5	12.2	11.3	5.3	20.6	4.9	0.0	0.0	4.3	3.3
Erodium cicutarium	0.2	0.7	11.1	4.5	7.1	11.5	1.7	3.1	0.0	0.0	2.5	1.6	0.0	0.0	0.2	0.4
Lepedium spp.	0.0	0.0	0.0	0.0	1.3	2.5	1.7	0.7	0.0	0.0	4.1	1.5	0.0	0.0	0.0	0.0

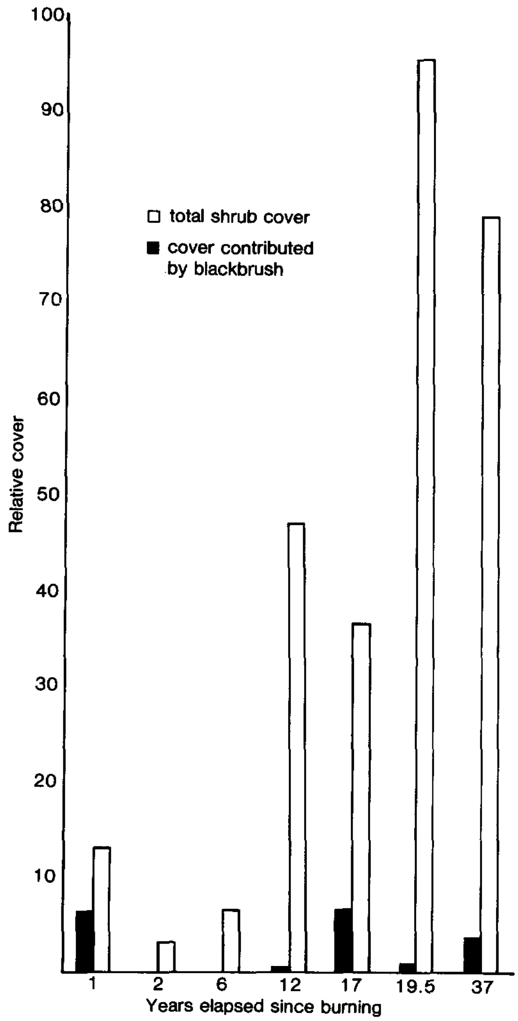

Fig. 2. *Blackbrush recovery compared to overall shrub recovery on burns of different ages in the blackbrush community.*

ability to adapt to new events. Stebbins and Major (1965) classified blackbrush as a paleoendemic, or an ancient species whose range has been reduced to relict areas. They included blackbrush in a group of plants that have little variability, are ecological specialists, are isolated taxonomically, and have a different range from that where they originated. This agrees well with the findings of King and Van Devender (1977) who concluded that blackbrush occupies a much different range presently than in Pleistocene times. The recovery of a paleoendemic species, such as blackbrush, from burning may be much slower than that of other shrub species. Our findings differed significantly from those of Thatcher (1975), who stated that burned blackbrush sites reverted directly back to blackbrush without any intermediate plant association.

Cryptogamic soil crusts are another element of the blackbrush community which are strongly affected by fire. The effects of fire upon cryptogamic crusts are of concern because of the beneficial role they play in stabilizing soil surfaces in desert ecosystems (Anderson et. al. 1982). Before burning, cryptogamic crusts contributed an average of 9% of the total plant cover. After burning, cryptogamic crusts contributed less than 1% of the total plant cover. The 37-year study site showed no evidence of cryptogamic crusts on either the burn or the adjacent control. However, on the other 6 sites where cryptogamic crusts were present, the burned sites showed little tendency for the cryptogamic crust to return to preburn levels (Fig. 3). This lack of recovery by cryptogamic crusts may be unique to the blackbrush community. In a study done in northern Utah, Johansen et al. (1982) found that cryptogamic crusts recovered partially from burning within 3 years. In the present study we found very little evidence of crust formation on the burned sites after 19 years. It is not clear why fire suppresses the cryptogamic crusts. However, it is apparent that if cryptogamic crusts do recover, they do so in a time span longer than that covered by our study.

Beneficial or detrimental impacts of fire on the blackbrush community were found to depend on time elapsed since burning, variation between sites, and site treatment. The 37-year-old site, which was not seeded with grasses following the fire, was dominated by mixed shrubs *(Thamnosma montana, Prunus fasciculata, Purshia glandulosa,* and *Yucca baccata)* and annual grasses *(Bro-*

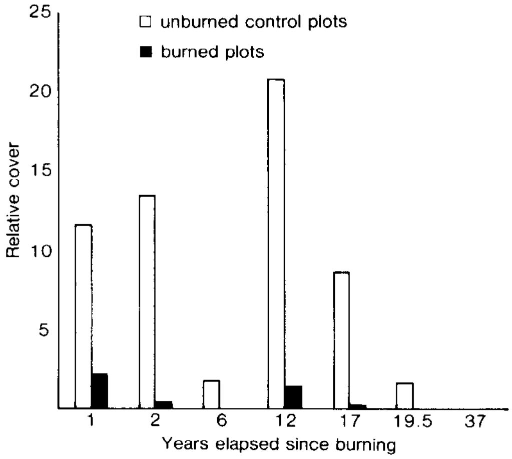

Fig. 3. *Cryptogamic soil crusts on burned sites compared to adjacent unburned control sites in the blackbrush community.*

mus tectorum and *Bromus rubens).* The 19.5-year-old burn (also never seeded) was dominated by snakeweed *(Xanthocephalum microcephala)* and annual grasses. The 17-year-old burn (also never seeded) was dominated by mixed shrubs, annual grasses, and annual forbs *(Astragalus* spp., *Lepidium* spp., and *Erodium cicutarium).* The 12-year-old burn was dominated by Yerba-santa *(Eriodictyon angustifolium),* crested wheat *(Agropyron cristatum),* and annual grasses. The 6-year-old burn was dominated by annual grasses with scattered stalks of crested wheat. On the 6-year-old burn Yerba-santa was beginning to appear. The 2-year-old burns were dominated by crested wheat, annual grasses, and annual forbs. The 1-year-old burn was not seeded with crested wheat and was dominated by annual forbs.

Only 3 burns were seeded with perennial grasses. Because of the small number of seeded burns, no conclusions were drawn about the seed success of perennial grasses. Seeding of crested wheat appeared to be successful on the 2-year-old burns, fairly successful on the 12-year-old burn, and unsuccessful on the 6-year-burn. The low amounts of crested wheat on the 6-year-old burn almost certainly are due to site characteristics rather than any relationship to the age of the burn.

It appears that in the blackbrush community some short-term benefits can be realized from burning and seeding with perennial grasses. However, shrub cover is rapidly reestablished, and the shrubs that replace blackbrush are generally no more desirable as forage than blackbrush. Since fire appears to cause a long term, or permanent, removal of blackbrush and cryptogamic crusts, we do not recommend indiscriminate burning as a method of improving the forage base for livestock in the blackbrush community. However, if cultivars of palatable shrub species that are hardy enough to compete in the blackbrush zone are found, burning of blackbrush may be advisable.

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