Prescribed Burning during Winter for Maintenance of Buffelgrass

W.T. HAMILTON AND C.J. SCIFRES

Abstract

Neither a single burn during late winter nor a second burn 2 years later reduced the density of mixed brush dominated by blackbrush acacia, honey mesquite, and twisted acacia which had invaded buffelgrass seedings on the South Texas Plains. Based on canopy cover and height, most woody species had recovered to preburn status after two growing seasons. Buffelgrass responded by a flush of spring growth during the year of burning and cumulative herbage production exceeded that of unburned areas for three growing seasons after the single burn. However, during dry growing conditions, less buffelgrass herbage was produced on burned than on unburned areas. A second burn tended to increase buffelgrass herbage production compared to the single burn. However, when moisture became limiting, less herbage was also produced on the twice-burned areas. Disappearance of buffelgrass, attributed primarily to grazing, closely paralleled herbage production, with the greatest disappearance occurring the first growing season after the burn.

Common buffelgrass (*Cenchrus ciliaris* L.) is a productive, introduced, warm-season perennial used extensively in the south Texas Plains for tame pasture and for seeding rangeland following root plowing. Crude protein content of buffelgrass forage exceeds that of many native species during the 260 to 280-day growing season (Varner and Blankenship 1978). Land-use conversion from native grasses to buffelgrass requires large investments, especially when seeding is preceded by intensive mechanical preparation such as root plowing, raking, and stacking. Such investments are often depreciated rapidly by reinfestation of seeded areas by mixed-brush species such as honey mesquite *(Prosopis glandulosa* var. *glandulosa)*, blackbrush acacia *(Acacia rigidula)*, and twisted acacia *(Acacia tortuosa)* (Box and White 1969).

Buffelgrass pastures are not usually burned but are sometimes shredded to remove rough vegetation and to suppress brush regrowth. Buffelgrass yields usually diminish as brush invades the pastures and, without maintenance practices, often may be seriously reduced within 10 years after planting.

Periodic fires are effective in maintaining grasslands by suppression of woody plants (Sauer 1950; Humphrey 1962; Box et al. 1967; Daubenmire 1968; Scifres 1980). Increasing costs of fuel, labor, and equipment associated with mechanical practices, and the rising costs of herbicides and their application have stimulated interest in fire as an alternative method for maintaining improved rangeland (Scifres 1978). Fine fuel loads produced by buffelgrass the first several years following establishment normally exceed minimum requirements for conducting effective prescribed burns (Scifres 1980).

The primary objective of this study was to evaluate late-winter prescribed burning as a method for suppressing woody plant regrowth in buffelgrass pastures.

Authors are lecturer and professor, Texas Agricultural Experiment Station, Department of Range Science, Texas A&M University, College Station, 77843.
Approved by the Director, Texas Agricultural Experiment Station as TA-16127.

Land and partial support of this research were furnished by the Cerrito Prieto Ranch, Encinal, Texas. Authors greatly appreciate Julia Scifres for typing and preparation of the manuscript, and the support of Ed Harte, Will Harte, Richard Johnson, Dan Sanchez, and Juan Martinez during the conduct of this research. The help of Jim Mutz, Carl Mohr, Herman Mayeux, and Andy Crane in plot installation and evaluation is gratefully acknowledged.

Received for publication June 23, 1980.

Materials and Methods

Study Site Description

The study was conducted on the Cerrito Prieto Ranch, about 24 km south of Encinal in the west-central portion of the South Texas Plains (Gould 1975). The 31-year average annual precipitation at the ranch is approximately 50 cm, with peaks occurring in May and September. The climate of the area is characterized by hot summers and short, mild winters. The experiments were established on a gray sandy loam range site. Soils are primarily of the Copita series, a fine-loamy, mixed, hyperthermic Aridisol of the Ustollic Calciorthid subgroup. The soil is moderately deep, moderately permeable and calcareous, and is underlain by sandstone (Stevens and Arriaga 1977). Topography is gently rolling with generally less than 3% slopes.

The experimental area was broadcast seeded to common buffelgrass in 1967 following root plowing, raking, stacking, and burning of brush piles. Woody plant stands on the area were typical for similarly treated rangeland of the region based on the time lapse since treatment. Primary species on the experimental area were honey mesquite, blackbrush acacia, and twisted acacia with lesser amounts of desert yaupon *(Schaefferia cuneifolia)*, leatherstem *(Jatropha dioica)*, whitebrush *(Aloysia lycioides)*, lotebush *(Zizyphus obtusifolia)*, Berlandier wolfberry *(Lycium berlandieri)*, spiny hackberry *(Celtis pallida)*, guayacan *(Porlieria angustifolia)*, tasajillo *(Opuntia leptocaulis)*, and guajillo *(Acacia berlandieri)*.

Burning Procedures and Vegetation Evaluation

Late-winter burns were selected on the premise that invading woody species would be suppressed with minimal risk of damage to forage species (Scifres 1980; Mayeux and Hamilton 1979). Two 3-ha plots within a 10-ha enclosure were burned on February 7, 1977. One-half of each plot which was burned in 1977 was burned on February 9, 1979. Four permanently marked belt transects, 3.7 m by 61 m, were established in each plot before the initial and second burns and four transects were established on adjacent untreated areas. Experimental design was a randomized complete block with two replications.

Woody plant height, canopy diameter, and number of live plants by species were recorded along each transect before burning and at approximately 4, 6, 10, 17, 23, 25, 27 and 33 months after burning. Immediately before installation of the fires, fine fuel load was harvested from 25, 0.25-m^2 sampling areas, equidistantly spaced across each plot. Fuel samples were oven dried at 60° C for 24 hr and water content calculated on a wet-weight basis.

Weather data obtained immediately prior to initiation of burns included instantaneous wind speed at a height of 2 m, wind direction, air temperature, relative humidity, and soil temperature at a depth of 5 cm. In addition, six soil samples were collected at 0 to 15 and 15 to 30 cm depths from each plot for estimating soil water content gravimetrically. Before burning in 1979, soil-water samples were also recovered from 30 to 45 cm deep.

Burns were conducted as headfires following backfiring on the lee side of the plots to an average distance of 15 m (Scifres 1980). Sets of heat-sensitive pellets mounted on asbestos plates were placed at four locations in each burn for estimating maximum temperatures. The tempil sets were placed at 10 cm, 50 cm, and 1 m above the soil surface during the burn in 1977, and at 10 cm and 50 cm for the burn in 1979.

Ten exclosures, 3.8 m in circumference and constructed of 9-ga, 15-cm mesh wire, were equidistantly spaced diagonally across each plot. The study area was grazed with cows at approximately 1 AU/8 ha from 60 days after burning for about 17 months. The pasture was then deferred for 10 months, and then grazed continuously at the same stocking rate until termination of the study. Buffelgrass standing crop inside each exclosure and at 1 m from the exclosure in a randomly selected cardinal direction was harvested to ground line within a 0.25-m^2 quadrat at 4, 6, 10, 17, 23, 25, 27 and 33 months after the first burn. Exclosures were moved to new locations after each harvesting date. Herbage production was calculated as the average difference between herbaceous standing crop measured the preceding sampling period on the grazed area and that within the exclosure at the current sampling period (NAS-NRC 1962). Disappearance was estimated as the difference between the herbaceous standing crop on the grazed area and that within the exclosure at the current sampling period. Disappearance represented herbage utilization by livestock and losses such as trampling, consumption by rodents and insects, and weathering. Buffelgrass foliar cover was estimated at 24 and 33 months following the initial burn with 50, 10-point frame samples in each plot.

Data were subjected to analysis of variance, and differences among means were determined with Duncan's multiple range test at the 5% level.

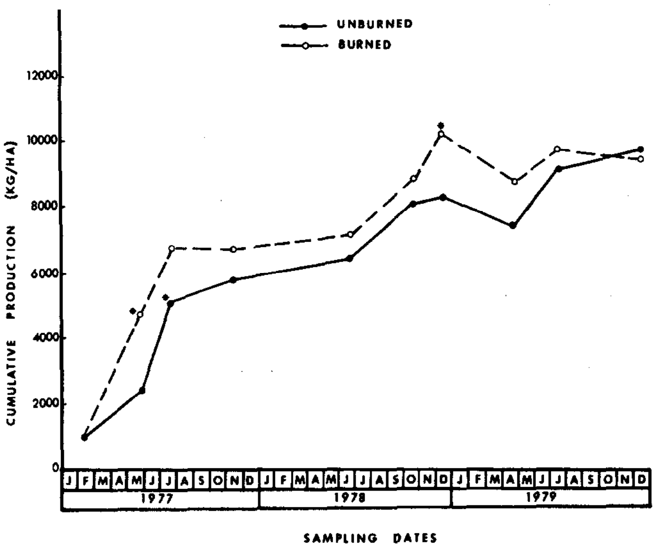

Fig. 1. *Cumulative buffelgrass herbage production (kg/ha) at various dates after burning in February 1977 on the South Texas Plains near Encinal. Asterisks indicate significantly more herbage produced for the interval since last clipping (P≦.05).*

Results and Discussion

Burn Conditions

Woody plant density on the area burned February 7, 1977, was adequate to impair fine fuel production and continuity, especially in the immediate vicinity of the woody plants. In addition to low fine fuel load (1,140 kg/ha) and poor fuel continuity, the wind speed, 13 km/hr at headfire ignition, diminished to 8 km/hr shortly after ignition (Table 1). Relative humidity was 89% at headfire ignition and increased to 100% during the burn. Fine fuel water content was 23% at ignition. The burn blackened an estimated 80% of the surface area.

Table 1. Fuel and weather conditions at the time of ignition of burns for suppression of woody plants invading buffelgrass on the South Texas Plains, Encinal, Texas.

Variable	Burn date (February) 1977	1979
Fine fuel load (kg/ha)		
Standing crop	1120	2448
Mulch	20	882
Fine fuel water content (%)	23	14
Soil-water content (%)		
0–15 cm	16	14
15–30 cm	19	14
30–45 cm	—	13
Maximum burn temperature (C)		
at 15 cm	225	223
Wind speed (km/hr)	8–13	0–8
Wind direction	SE	E/NE
Air temperature (C)	16	14
Soil temperature at 5 cm (C)	14	11
Relative humidity (%)	89	40

Conditions for the second burn (February 9, 1979) were more favorable than for the initial burn. Fine fuel load averaged 3,320 kg/ha, relative humidity was 40%, and fine fuel water content was 14%, all within the limits suggested for successful range burning in South Texas (Scifres 1980). However, wind velocity was only 8 km/hr at ignition, and diminished to calm before burnout. Other variables, such as soil moisture, soil temperature, air temperature, and maximum fire temperatures were similar for the two burns.

Buffelgrass Production

The plots burned in 1977 had produced significantly more buffelgrass herbage (*P*≦.05) by late May, approximately 4 months after the burn, than was produced on unburned areas (Fig. 1). Soil water was adequate at the time of the burn (Table 1) to promote early spring growth on the burned areas. In addition, 30.5 cm of precipitation occurred on the study area between the date of burning and the herbage harvests in May. However, from May 24 to harvests in mid-July, only 4.1 cm of precipitation were received. During that period, the unburned plots produced significantly more buffelgrass that was produced on the burned plots but cumulative herbage production was higher on the burned areas (Fig. 1). Greater herbage production on the unburned plots (1,230 kg/ha) than on burned plots (360 kg/ha) during the next 11 months nullified the difference in cumulative herbage production between treatments. This response was attributed to dry growing conditions, since only 21.2 cm of precipitation were received during this period. However, buffelgrass herbage production on the burned plots was significantly greater for the December 1978 sampling, compared to that of unburned plots. During that period, June to December 1978, 51.5 cm of precipitation was received. Thus, cumulative buffelgrass herbage production was greater on plots burned once compared to that of unburned plots for 29 months following the burn, even though standing crop on burned areas was reduced more than that on unburned areas during dry periods (Fig. 1).

As with the initial burn, soil water content at the time of the second burn in February 1979 (Table 1) was apparently adequate for rapid growth initiation of the buffelgrass. Although 12 cm of precipitation occurred from the time of the second burn to sampling in May 1979, 70% of the rainfall fell within 3 weeks of the sampling. The plots burned twice had produced 838 kg/ha of herbage by May 1979, while those burned once and the unburned plots had produced no additional herbage since the date of the second burn (data not shown).

No significant precipitation occurred on the study area from June to the final sampling in mid-December 1979. Cumulative buffelgrass herbage production following the second burn (2,460 kg/ha) tended to exceed that on the unburned plots (1,440 kg/ha) by December, 1979. There was no additional herbage production during the same period on the plots burned once. The greatest amount of cumulative buffelgrass herbage production during the extremely dry period from May through December 1979 occurred on the unburned plots.

Thus, burning promoted buffelgrass herbage production by mid spring following each fire, but less herbage was produced on burned than on the unburned plots as soil water was depleted during the summer. Apparently, the lush buffelgrass growth promoted by burning depleted available soil water more quickly than water was consumed on the unburned plots. Sharrow and Wright (1977) reported that increased soil temperature stimulated the growth of tobosagrass *(Hilaria mutica)* when moisture was not limiting, which caused subsequent reductions in soil water and nitrates. In our study, this consumptive depletion of soil water usually resulted in less buffelgrass herbage production on burned than on unburned plots during subsequent dry periods. However, significant rainfall following the dry periods resulted in more buffelgrass herbage being produced on burned than on unburned plots for the first two growing seasons following burning.

Foliar cover of buffelgrass 24 and 33 months after the first burn did not differ significantly among the treatments (data not shown). However, there was a trend toward slightly greater buffelgrass foliar cover on the burned plots (62%), compared to unburned plots (56%) after 24 months.

Buffelgrass Disappearance

The plots burned in February, 1977, and the adjacent, unburned plots were stocked with cows in April 1977 (approximately 60 days following the burn) at a stocking rate of 1 AU/8 ha. Cumulative buffelgrass disappearance (Fig. 2) closely paralleled the cumulative

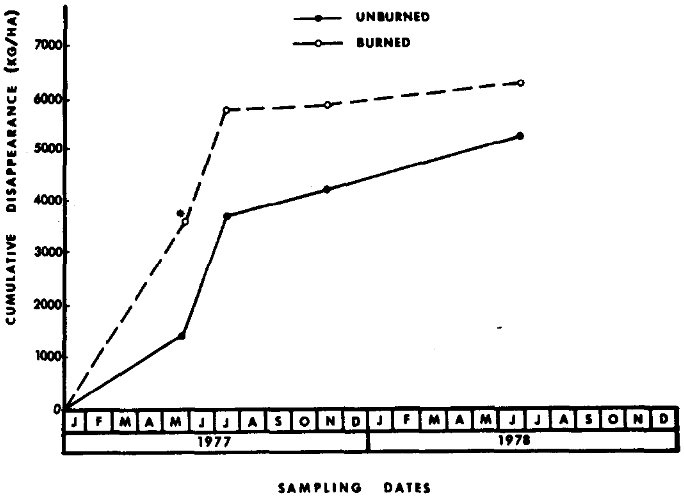

Fig. 2. *Cumulative buffelgrass herbage disappearance (kg/ha) at various dates after burning in February 1977 on the South Texas Plains near Encinal. Asterisk indicates that significantly more herbage disappeared for that sampling period (P≦.05).*

buffelgrass herbage production (Fig. 1). Cumulative disappearance for the 15-month grazing period on the burned plots was 6,270 kg/ha compared to 5,230 kg/ha on the unburned plots, representing 88% and 69% of the cumulative herbage production, respectively. Although the difference in herbage disappearance between burned and unburned plots was significant only at the first harvest date (May 1977), there was a trend toward greater cumulative herbage disappearance from the burned than from the unburned plots for the next 13 months. These data confirm other reports that grazing animals prefer the fresh, new growth following burning over that on unburned areas (Scifres 1980; Oefinger and Scifres 1977; Wright 1974, 1976, 1978).

Woody Plant Responses

Blackbrush acacia, twisted acacia, and honey mesquite accounted for more than 95% of the woody plant canopy on the study area. Preburn canopy cover of woody plants on the area averaged 8%.

The density of live plants was not altered by burning, regardless of species or whether the areas were burned once or twice. Moreover, woody plant height replacement was similar to canopy replacement following both burns, and canopy replacement following the second burn followed the same pattern as replacement after the first burn. Therefore, only the data on canopy replacement following the first burn are presented.

Honey mesquite canopy cover, as reflected by canopy diameters, progressively increased on the unburned plots during the course of the study (Fig. 3). Reductions in December 1978, compared to canopy measurements the previous June, reflect expected seasonal variations. In contrast to unburned plots, honey mesquite canopy diameters on burned plots tended to be less than preburn estimates for 6 months following the initial burn. However, canopy cover of honey mesquite on the burned plots exceeded the preburn values after 10 months. Regardless of time of post burn measurement, canopy cover of honey mesquite on burned areas was less than that on unburned areas.

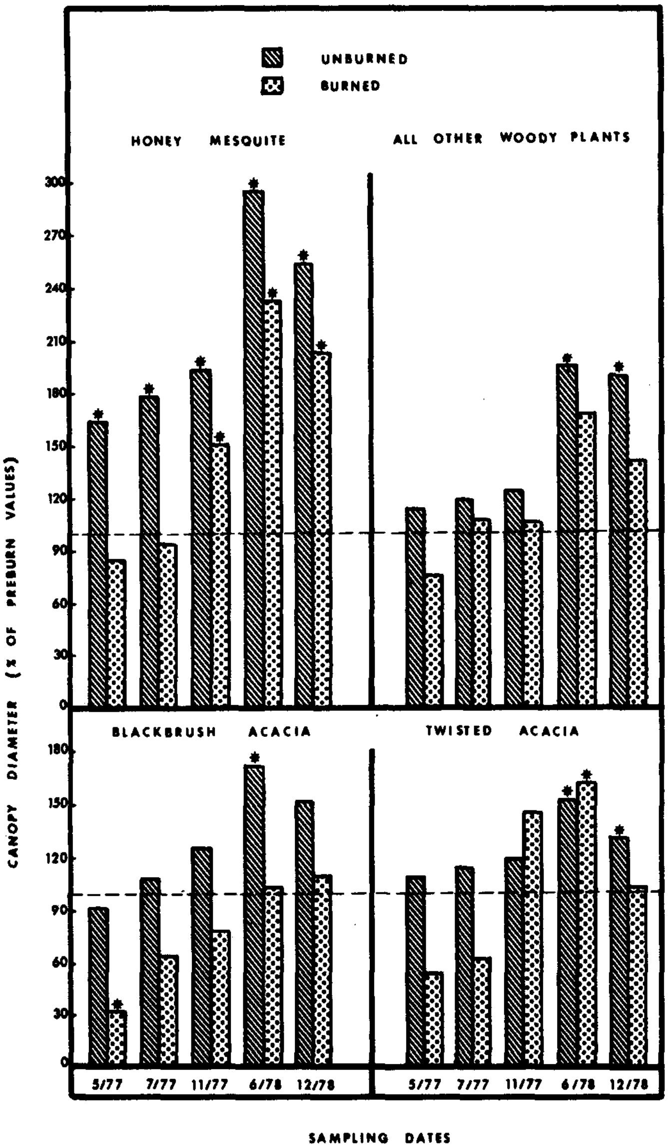

Fig. 3. *Sum of woody species canopy diameters expressed as a percent of preburn canopy estimates at various dates after burning buffelgrass in February 1977 on the South Texas Plains near Encinal. Asterisks indicate significant differences in sums of canopy diameters compared to preburn estimates (p≦.05).*

Canopy cover of blackbrush acacia was significantly reduced ($P \leqq .05$), compared to preburn estimates, at 4 months after the initial burn in February 1977 (Fig. 3). Moreover, canopy cover of blackbrush acacia tended to be less than preburn estimates until June 1978, the second growing season after the burn. In comparison, canopy diameter of blackbrush acacia on unburned areas in June 1978 was significantly greater than preburn.

There was a strong trend toward reduced canopy diameters of twisted acacia on burned areas, compared to preburn measurements, for 6 months following the first burn (Fig. 3). However, the twisted acacia canopies had recovered by November 1977 and were significantly greater than preburn canopy cover estimates by June, 1978.

The category "all other woody plants" included desert yaupon, leatherstem, whitebrush, lotebush, Berlandier wolfberry, spiny hackberry, guayacan, and guajillo, and accounted for less than 5% of the woody plant cover. Although canopy diameters of all other woody plants tended to be reduced, compared to preburn estimates, for 4 months following the initial burns, they equalled or exceeded preburn canopy diameters at all other evaluation dates (Fig. 3).

Conclusions

These data indicate that fire has the potential for maintaining productivity of buffelgrass pastures which are being invaded by mixed brush. Although cool-season burns did not kill the woody plants because of the ability of most species typical of South Texas mixed-brush communities to resprout following damage to topgrowth, there was a reduction in brush canopy cover and heights following burning. This canopy and height reduction apparently contributed to increased herbage production during the spring following the fires when moisture was not limiting. Based on regrowth of woody plants in this study and under a rainfall regime considered normal for the study area (about 50 cm precipitation annually for the last 30 years), it appears that cool-season burns about every third growing season will suppress and maintain mixed brush at acceptable levels. However, care should be exercised in timing burns to coincide with years of normal or above-average preburn rainfall because of the increased water demand imposed by the luxuriant buffelgrass growth following burning.

Also, it appears that maintenance burning program should be initiated before the woody plants reach the height and canopy cover of those in this study, perhaps 4-6 years after clearing and seeding. The blackbrush acacia, honey mesquite, and twisted acacia plants averaged 1.2, 1.0 and 1.6 m tall, respectively, at the time of the first burn. Burning sooner after establishment of buffelgrass would not only subject smaller woody plants to the fire but would also help ensure a heavier, more continuous load of fine fuel.

Literature Cited

Box, T.W., J. Powell, and D.L. Drawe. 1967. Influence of fire on south Texas chaparral communities. Ecology 48:955-961.

Box, T.W., and R.W. White. 1969. Fall and winter burning of south Texas brush ranges. J. Range Manage. 22:373-376.

Daubenmire, R. 1968. Ecology of fire in grasslands. Adv. Ecol. Res. 5:209-266. Academic Press, N.Y.

Gould, F.W. 1975. Texas plants. A checklist and ecological summary. Tex. Agr. Exp. Sta. Misc. Pub. 585 Rev. 121 p.

Humphrey, R.R. 1962. Range Ecology. Ronald Press Co, New York. 234 p.

Mayeux, H.S., Jr., and W.T. Hamilton. 1979. Cool-season burns suppress common goldenweed. Proc. South Weed Sci. Soc. 32:255.

National Academy of Sciences-National Research Council. 1962. Basic Problems and Techniques in Range Research. Pub. 890. Nat. Acad. Sci.-Nat. Res. Council. Washington, D.C. p. 111-112.

Oefinger, R.D., and C.J. Scifres. 1977. Gulf cordgrass production, utilization and nutritional status following burning. Texas Agr. Exp. Sta. Bull. 1176. 19 p.

Sauer, C.O. 1950. Grassland climax, fire, and man. J. Range Manage. 3:16-21.

Scifres, C.J. 1978. Range vegetation management with herbicides and alternative methods: An overview and perspective. Symp. Use of Herbicides in Forestry, U.S. Dep. Agr., U.S. Environ. Prot. Agency (Feb. 21-22), Arlington Va. 151-165.

Scifres, C.J. 1980. Brush Management. Principles and Practices for Texas and the Southwest. Texas A&M Univ. Press, College Station. 360 p.

Sharrow, S.H., and H.A. Wright. 1977. Effects of fire, ash, and litter on soil nitrates, temperature, moisture and tobosagrass production in the Rolling Plains. J. Range Manage. 30:266-270.

Stevens, J.W., and D. Arriaga. 1977. Soil survey of Maverick County, Tex. U.S. Dep. Agr., Soil Conserv. Serv. Unnumbered Pub. 63 p.

Varner, L.W., and L.H. Blankenship. 1978. Seasonal changes in nutritive values of six south Texas grasses. Annu. Mtg. Soc. Range Manage. 31:56.

Wright, H.A. 1974. Range burning. J. Range Manage. 27:5-11.

Wright, H.A. 1976. Fire as a tool to manage tobosa grasslands. Proc. Tall Timbers Fire Ecology Conf. 12:153-167.

Wright, H.A. 1978. Use of fire to manage grassland of the Great Plains: Central and southern Great Plains. Proc. Internat. Rangeland Congr. 1:694-696.

SRM Election Results

The Elections Committee composed of Wally Gallaher (Chairman), Herbert Fisser, Lee Carr, Bob Newlin, and Floyd Kinsinger met in Denver, December 8, to count ballots for new officers. Elected officers are:

First Vice President — Gerald W. Thomas
Second Vice President — Joseph L. Schuster
Directors 1982-1984 — Thomas E. Bedell
— Don D. Dwyer

Present Directors Jack R. Miller and S. Clark Martin will leave the Board in February, 1982.

The following members of the Colorado Section served as ballot counters under the supervision of the Elections Committee: John N. Baker, Jim Stone, Bob Buttery, Allan Strobel, Eric B. Janes, Dave Kathman, Bob Wagner, Lee Carr, Len Hendzel, Bob Newlin, Wally Gallaher, Gordon Bentley, Jeff Burwell, Edward C. Dennis, E.T. Bartlett, William V. McGinnies, C.H. Wasser, Dick Antonio, Allen Schroeder, Larry R. Rittenhouse, Terry Foppe Wendell Hassel

Ballots and tally sheets are retained in the Denver office for one year for review. A total of 1,639 ballots were cast, or approximately 31 percent of the voting membership.