Big Sacaton (*Sporobolus wrightii*) Riparian Grassland Management: Annual Winter Burning, Annual Winter Mowing, and Spring–Summer Grazing

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Abstract. We annually burned or mowed big sacaton (*Sporobolus wrightii*) pastures in February and annually grazed these pastures plus an untreated control pasture between May 1 and July 15 for 3 years. Both burning and mowing reduced green biomass available for livestock consumption in the spring–summer grazing period. Pasture stocking rates were based on a target utilization of 60% of the total standing crop of big sacaton and grama grasses. Stocking rates on burned and mowed pastures were only one third as high as on untreated. Mean daily gains in 1981 and 1982 averaged 0.41 and 0.67 kg/day on untreated and treated pastures, respectively, but total gains per pasture were 512 and 235 kg on the untreated and treated pasture, respectively. Burning and mowing can be used to enhance immediate livestock gains. The annual application of burning may, however, destroy these riparian grasslands and ultimately reduce livestock carrying capacity.

Introduction

Big sacaton (Sporobolus wrightii), a robust perennial warm-season bunchgrass, is distributed from southeastern Arizona to central Texas and south into the northern Mexican frontier states; however, stand development is greatest in southeastern Arizona [Wooten and Standley, 1912]. Pure stands of big sacaton once existed along the riparian channels and tributaries associated with the San Pedro and Santa Cruz Rivers in southeastern Arizona [Griffiths, 1901]. These grasslands naturally spread flood waters and trapped sediments [Hubbell and Gardner, 1950], limiting soil erosion [Humphrey, 1958] and providing forage for approximately one million cattle before 1890 [Cox et al., 1983].

Today, big sacaton occupies less than 5% of its original area of distribution [Humphrey, 1960]. The remaining stands are extremely important to livestock producers because they produce large amounts of green forage during the spring–summer dry season when upland grasses are dormant [Thornber, 1910; Cox, 1984].

For most of the year, dead standing big sacaton biomass is the predominant forage component in these riparian grasslands [Cox, 1985]. Land managers generally believe that this biomass component decomposes slowly, and that accumulations of dead biomass reduce livestock utilization and performance. These assumptions have been used to justify the need for either annually burning or annually mowing in winter. Burning and mowing eliminate low quality dead forage, and are thought to stimulate additional live (green) growth and enhance livestock production during the spring–summer dry season. Data to verify these ideas and justify the need for either annual burning or mowing is currently unavailable, although both practices have been recommended and applied for 100 years [Griffiths 1901; Humphrey, 1958].

In order to evaluate the animal-carrying capacity of big sacaton riparian grasslands, ecologic studies are needed to quantify the stand dynamics of these grasslands and then relate these findings to various management strategies. The objective of this study was to evaluate the effect of either annual winter burning or annual winter mowing and spring–summer grazing on plant growth, cattle stocking rates, and animal gains. The results of previously published studies related to the seasonal production

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cycle of big sacaton [Cox 1984, 1985] are reviewed and various management strategies discussed.

Study Sites

A site representative of big sacaton grasslands in the southwestern United States and northern Mexico [Soil Conservation Service, 1979] was selected about 80 km (50 mi) south of Tucson in southeastern Arizona (31° 47′ N Lat., 110° 37′ W Long.). The site was in the Empire Creek drainage and at an elevation of 1370 m (4490 ft). Soils are Pima silty clay loam, with a sandy loam subsoil, thermic Typic Haplustoll [Richardson et al., 1979]. Soils are recent alluvium, weathered from mixed rocks, moderately alkaline, slightly calcareous and greater than 2 m deep.

Annual precipitation in the area (Sonoita, Arizona) has varied from 175–450 mm (6.9–17.7 in) in the past 50 years [Sellers and Hill, 1974]. Sixty percent of the annual precipitation comes in summer (June–September) and 40% in winter (October–May). Daytime temperatures average 30°C (86°F) in summer and nighttime temperatures are often below 0°C in winter.

Methods

In January 1980, a 16-ha (40 ac) pasture was selected for study. The pasture was lightly grazed by horses in fall, winter, and spring between 1976 and 1980, and moderately grazed by cows and calves in winter between 1935 and 1975. The pasture was unfenced between 1885 and 1934 and we suspect that livestock heavily grazed the area within and around the pasture during that time.

Charcoal scars on cottonwood trees (*Populus deltoides*) the mesquite (*Prosopis juliflora*) trees within the pasture indicate the occurrence of fires in the recent past. Previous ranch owners did not intentionally burn this pasture, because it was near the ranch headquarters. Relatives and associates of the owners acknowledge, however, the occurrence of summer wildfires around 1920, 1935, and 1950.

Approximately 80% of the 16-ha pasture was in a big sacaton riparian grassland. The remaining 20% was on an associated upland grama (*Bouteloua spp.*) grassland. The pasture was subdivided into four sections, three were 5 ha and one was 1 ha. Fence lines were constructed so that 80% of each pasture was in the big sacaton riparian grassland and 20% was on the upland grama grassland. Standing crops (kg/ha) of big sacaton and upland grama grasses were similar in each pasture, but total forage (kg/pasture) in the three large pastures was five times greater than the small pasture in February 1980.

One of the following treatments were applied annually to the same 5-ha (12 ac) pasture: (1) annual winter burning on February 27 plus spring–summer grazing (burning), (2) annual winter mowing on February 27 plus spring–summer grazing (mowing), and (3) spring–summer grazing (grazing). The 1-ha pasture (4) was untreated and ungrazed (control). The upland grama (other perennial grasses) grassland portion of each pasture was neither burned nor mowed.

Standing crops of live and dead big sacaton biomass and other perennial grass biomass were sampled in each pasture on February 27, May 1 and 15, June 1, 15, and 30, July 15, and October 20, 1980, 1981, and 1982. Sampling on February 27 was to determine standing crops before burning and mowing. Sampling on May 1 was to set stocking rates, and sampling between May 15 and July 15 was to document forage disappearance and livestock preference during the spring–summer dry season. Sampling on October 20 was to measure plant growth after the summer (July 15–October 1) growing season.

Fifty 0.3 × 2.9 m (1.0 × 9.5 ft) sampling areas were located within each pasture at each sampling date. Forty sampling areas (80%) were randomly located within the big sacaton riparian grassland, ten sampling areas (20%) were randomly located on the associated upland grama grassland. Big sacaton plants in 10 sampling areas were harvested at the soil surface and hand separated into live (green) and dead standing (yellow and gray) biomass components. The standing crops of other perennial grasses (grama grasses) in three sampling areas were harvested at the soil surface and considered a separate biomass component. Each measured component was weighed in the field and a weight-estimate technique [Pechanec and Pickford, 1937] used to estimate both live and dead standing biomass in the remaining 30 big sacaton sampling areas and standing crop in the remaining 7 other perennial grass sampling areas. Harvested samples were dried in a forced draft oven at 40°C for 48 hr. Regression techniques were used to correlate actual dry weights with estimated field weights [Campbell and Cassady, 1949]. These values were used to calculate biomass (kg/ha) for each vegetation component. Values were rounded to the nearest 50 kg/ha (45 lb/ac).

Individually weighed Brahman heifers (1980) and F1 Brahman steers (1981 and 1982) were released into the three large pastures on May 1. Animals were removed and reweighed on July 15. Animals weights on May 1 varied from 170–190 kg (370–418 lb).

Big sacaton growth following early spring burning [Gavin, 1982] and mowing [Haferkamp, 1982] in Texas was greater than 1500 kg/ha in May and June. We expected a similar response in southeastern Arizona, and stocking rates in 1980 were based on the expected growth of big sacaton. Our assumption that rapid growth would occur in May and June was incorrect because this period corresponds with the spring–summer drought in Arizona. Therefore, burned and mowed pastures were overstocked, and animals were removed on June 1, 1980 after 95% of the forage had disappeared.

Fig. 1. Representative site.

In 1981 and 1982, stocking rates were adjusted to obtain a target utilization of 60% of the total standing crop in the three large pastures. Available forage was calculated as 0.60 times the total standing crop measured on May 1.

Treatments in this study were not replicated; therefore, the data are presented as means and standard errors at the same sampling date during the 3 sampled years.

Results and Discussion

Live Big Sacaton Biomass

Air temperatures in big sacaton riparian grasslands vary from 15°–20°C (59°–68°F) in the daytime and from −5° to 5°C (23°–41°F) in the nighttime during February and March [Cox, 1984]. Big sacaton plants produce minor quantities of live biomass under such conditions even when moisture in the soil is available for plant growth [Cox, 1985]. Therefore, equivalent amounts (50± 10 kg/ha) of live biomass were expected in the four pastures on February 1, 1980, 1981, and 1982 (Fig. 2).

Big sacaton plants in burned and mowed pastures began to produce new leaves within 15–20 days, and a lush carpet of green grass was present by May 1. Visually, the removal of dead standing big sacaton appeared to stimulate green growth, but measurements on May 1 in each year, indicated that live biomass was greatest in the grazed and control pastures and least in the burned and mowed pastures (Fig.2).

Live biomass continued to increase after May 1 and peaked on May 15 in the mowed pasture and on June 1 in the burned, grazed, and control pastures (Fig. 2). The annual disappearance of live biomass, calculated as the difference between the peak and July 15, averaged 68% in the burned and mowed pastures, 72% in the grazed pasture, and 26% in the control pasture.

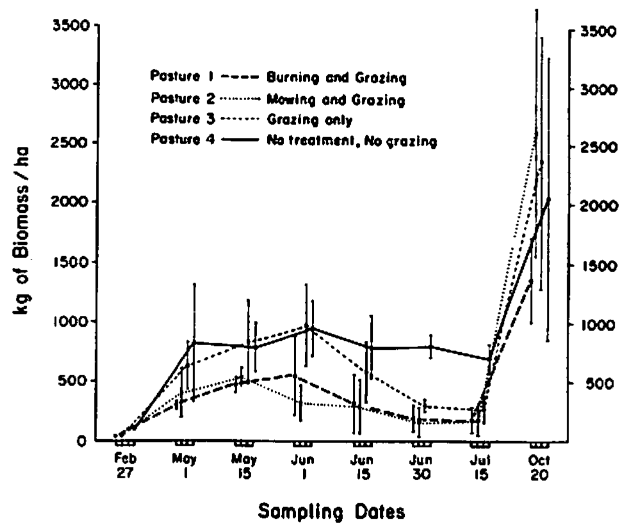

Fig. 2. Three-year means and standard errors (kg/ha) for big sacaton live (green) biomass in four pastures.

Both burning and mowing reduced the amount of live big sacaton biomass available for animal use, but only burning appeared to adversely affect live biomass production during the summer growing season. On October 20, live biomass in mowed, grazed, and control pastures averaged 2350 kg/ha and in the burned pasture averaged 1350 kg/ha, over the 3 years (Fig. 2).

Table 1. Seasonal rainfall (mm) at a big sacaton grassland site in southeastern Arizona between November 1979 and October 1982, and the long-term mean (71 yr) at Sonoita, Arizona[a]

Year	Winter (Nov 1–Apr 30)	Spring–early summer (May 1–July 15)	Late summer–fall (July 16–Oct 31)	Total
1979–1980	20	40	220	280
1980–1981	105	60	230	395
1981–1982	60	65	150	275
Long-term $\bar{X}$	115	35	230	380

[a] Conversion factor: mm × 0.039 = in.
[b] Source: Sellers and Hill, 1974.

Precipitation in spring–summer (May 1–July 15) 1980 was 40 mm (1.6 in) and near the long-term mean (Table 1). Live biomass on October 20 was 1750 kg/ha in the burned, 2200 kg/ha in the mowed, 1600 kg/ha in the grazed, and 1100 kg/ha in the control. Precipitation in 1980–1981 was near the long-term average, but spring–summer precipitation was almost 1.5 times greater than in 1979–1980. Live biomass on October 20, 1980 averaged 1900 kg/ha in the mowed and grazed pastures, 1700 kg/ha in the control pastures, and 1300 kg/ha in the burned pasture. Total precipitation in 1981–1982 was about the same as in 1979–1980, but winter and spring–summer precipitation was twice greater than in 1979–80. Summer precipitation was substantially less in 1982, but runoff from the upland grama grasslands irrigated the four pastures in August 1982. Live biomass on October 20, 1982 averaged 3600 kg/ha in the mowed, grazed, and control pastures, and 1050 kg/ha in the burned pasture.

Under nongrazed conditions, Cox [1984, 1985] measured live biomass production at a big sacaton riparian grassland site in southeastern Arizona during a period of 3 years. Live biomass was produced throughout the year, but peak production over 3 years was in August. Peak live production was 2960 kg/ha in one wet summer and averaged 1330 kg/ha over 2 dry summers. Gavin [1982] measured big sacaton live production in west Texas (30° 05′ N Lat., 103° 75′ W Long.) under climatic, edaphic, and elevational conditions similar to southeastern Arizona. Peak live production occurred in late August at both sites, and was 2660 kg/ha in Texas during a wet summer as compared to the 3-year mean of 1970 kg/ha in Arizona.

Dead Standing Big Sacaton

Burning and mowing removed dead standing big sacaton biomass (Fig. 3), but removal of this low quality forage resource did not stimulate additional live biomass production during the spring–summer dry season (Fig. 2). Removal of low quality big sacaton forage does increase the availability of live biomass [Gavin, 1982; Haferkamp, 1982], but removal resulted in a three-fold decrease in stocking rates as compared to the grazed pasture in 1981 and 1982 (Table 2).

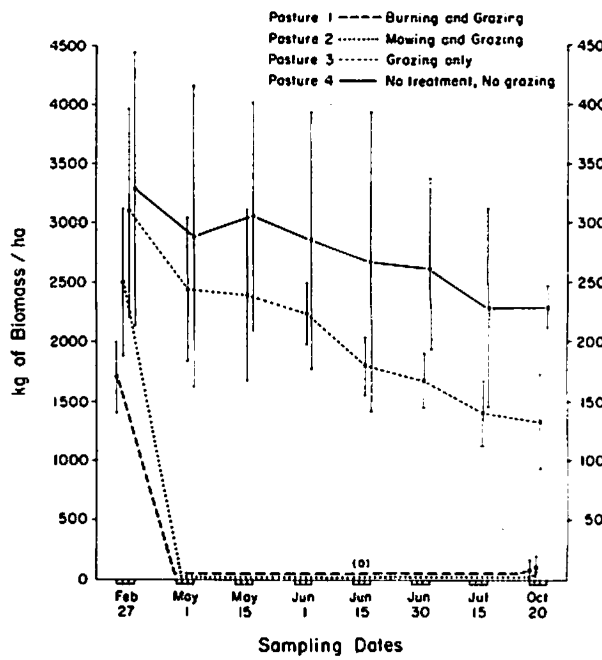

Fig. 3. Three-year means and standard errors (kg/ha) for big sacaton dead standing biomass in four pastures.

Dead standing big sacaton biomass declined after May 1 in the grazed pasture, although it remained relatively stable unit June 1 and gradually declined until July 15 in the control (Fig. 2). Annual disappearance of dead standing biomass averaged 42% in the grazed and 25% in the control pastures. Approximately, 1050 kg/ha of dead standing biomass disappeared in the grazed pasture between May 1 and July 15. Total dead standing biomass disappearance in the 5-ha (12 ac) grazed pasture was 5250 kg (1050 kg/ha × 5 ha). Apparently, 60% (3150 kg; 1430 lb) of the lost forage was due to natural weathering processes and 40% (2100 kg) was due to animal grazing or trampling. Dead standing big sacaton may not be an ideal quality forage source, but the availability of this forage souce can be directly related to the sustained stocking rates in the grazed pasture, whereas the removal of this forage source resulted in approximately three-fold decreases in stocking rates in the burned and mowed pastures (Table 2).

As dead standing biomass disappears following either fall or winter moisture, litter accumulates

Table 2. Stocking rates, daily gains, and total pasture gains of Brahman heifers (1980) and steers (1981 and 1982) grazing big sacaton in southeastern Arizona.[a]

Year	Treatment	Stocking rate (head/pasture)	Daily gain (kg/animal)[b]	Total animal gain (kg/pasture)
1980	Burning and grazing	12	0.23	83
	Mowing and grazing	12	0.23	83
	Grazing	12	0.45	162
1981	Burning and grazing	5	0.75	283
	Mowing and grazing	5	0.67	250
	Grazing	15	0.45	502
1982	Burning and grazing	4	0.74	222
	Mowing and grazing	5	0.50	187
	Grazing	18	0.39	522

[a] Burning and mowing treatments were applied on February 27, 1980, 1981, and 1982 in the same pastures. Grazing began each year on May 1 and ended on June 1 in 1980, and on July 15 in 1981 and 1982.
[b] Conversion factors: kg/animal or kg/pasture × 2.2 = lb/animal or kg/pasture.

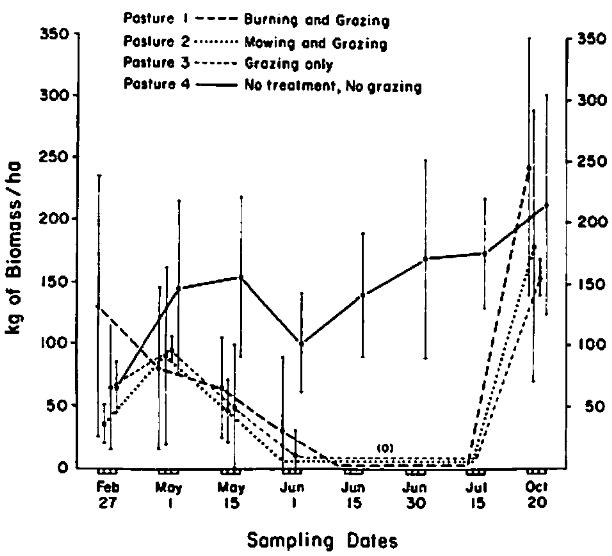

Fig. 4. Three-year means and standard errors (kg/ha) for other perennial grass biomass in four pastures.

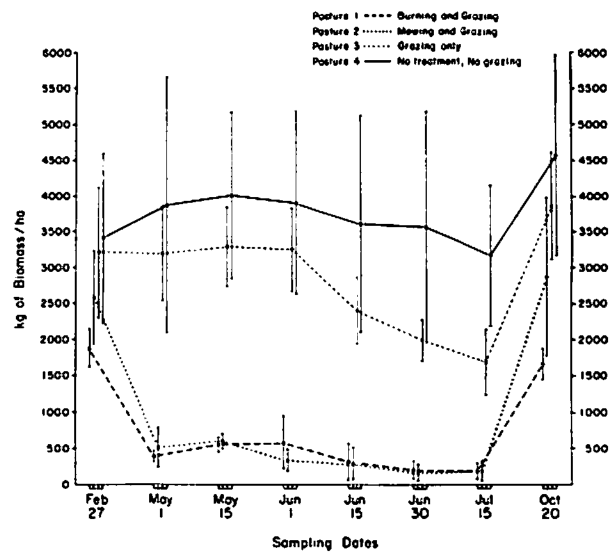

Fig. 5. Three-year means and standard errors (kg/ha) for standing crop in four pastures.

within the remaining dead standing. This litter source may serve as an important N reserve that becomes quickly available for plant growth in summer through the processes of decay, nitrogen mineralization, and nitrification [Sharrow and Wright, 1977]. The entrapment of N within the remaining dead standing biomass probably reduces N losses associated with flooding [Cox, 1985].

Other Perennial Grasses

The grazing animals used in this study preferred other perennial grama grasses and completely removed this forage source before grazing live and dead standing big sacaton (Figs. 2, 3, 4). Other perennial grass biomass present in February and during the May 1–July 15 grazing period were dormant. Only in late July did these grasses begin to produce live biomass.

Standing Crop

Live and dead standing big sacaton and other perennial grass disappearance between May 1 and July 15 averaged 300, 350,1550, and 600 kg/ha in the burned, mowed, grazed, and control pastures, respectively (Fig. 5). Peak standing crop was measured, however, on May 15 in the mowed, grazed, and control pastures and on June 1 in the burned pasture. If animal utilization in the form of grazing and trampling is calculated as the difference between peak standing crop and standing crop on July 15, utilization percentages are 70% in the burned and mowed pastures, and 49% in the grazed pas-

Table 3. Precipitation (mm) between October 2 and February 6, and standing crops (kg/ha) of big sacaton sampled on October 2, 1980–1982 and February 6, 1981–1983[a]

Year	Precipitation (mm)	Standing crop (kg/ha)	
		October 2	February 6
1980–1981	105	3200	1900
1981–1982	60	3950	3450
1982–1983	195	2950	1700

[a] Source: Cox, 1985.
[b] Conversion factors: kg/ha × 0.89 = lb/ac; mm × 0.039 = in.

ture. If we assume that 21% of the standing crop would have disappeared naturally as it did in the control pasture, actual harvest would be 49% in the burned and mowed pastures and 28% in the control pasture. The disappearance of standing crop due to natural causes within big sacaton riparian grasslands can dramatically reduce the amount of forage available to grazing animals [Cox, 1985] and should be considered when determining stocking rates.

Land managers normally set stocking rates based on the standing crop of big sacaton present in October, and these riparian grasslands are grazed in the following spring and early summer. If it snows between November and February, standing crop may decline by 40% before the initiation of grazing, as in 1980–1981 and 1982–1983 (Table 3). Under such conditions, stocking rates might well be twice greater than the forage base would support the following spring. Nevertheless, if cool-season precipitation occurs in October, and November through January are dry, standing crop may decline by only 13%, as in 1981–1982. Under this condition, stocking rates based on October standing crop would be similar to stocking rates based on February standing crop.

Animal Production

Initially we expected big sacaton to grow rapidly following either winter burning or mowing, and stocking rates in 1980 were based on growth rates in Texas where May–June rains stimulate early summer green leaf production [Gavin, 1982; Haferkamp, 1982]. Our assumption that plants would grow rapidly was incorrect and cattle had to be removed on June 1 because the available growth of live big sacaton and other perennial grasses had disappeared in the burned and mowed pastures. Standing crop, however, was 3150 kg/ha in the grazed pasture. Average daily gains (kg/animal) and total animal gains (kg/pasture) on the grazed pasture were about twice that of the burned and mowed pastures in 1980 (Table 2).

Daily weight gains in 1981 were 0.75 and 0.67 kg/animal in the burned and mowed pastures, respectively, whereas gains were 0.45 kg/animal (0.99 lb/animal) in the grazed pasture (Table 2). The increased gains in the treated pastures were attributed to increased forage quality and lower stocking rates. Total animal production/ha in the grazed pasture was, however, about 66% greater than in the burned pasture and 50% greater than in the mowed pasture in 1981.

Again in 1982, daily weight gains in the burned pastures were almost twice that in the grazed pasture and 1.5 times that in the mowed pasture (Table 2). Stocking rates in the grazed pasture, as in 1981, were more than three times greater than in the burned and mowed pastures, and total animal gains in the grazed pasture were more than twice that in the burned and mowed pastures.

For more than 100 years, land managers have either annually burned or mowed in winter to increase livestock utilization of big sacaton in spring and summer [Griffiths, 1901; Humphrey, 1960; Bock and Bock, 1978; Cox et al., 1983]. The data (Figs. 3, 4, 5) and observations made during this 3-year study indicate that Braham heifers and F1 steers prefer dead standing of other perennial grasses to live and dead standing big sacaton. The data also suggest that animal preference is not changed by burning and mowing if big sacaton pastures include upland grama grasslands.

Management Implications

The availability of live biomass and hence the forage quality of big sacaton improves after either annual winter burning or annual winter mowing [Gavin, 1982; Haferkamp, 1982] and this was reflected in the average daily gains of cattle measured in 1981 and 1982 (Table 2). The manager should be aware, however, that both treatments have a negative effect on plant growth early in the spring–summer grazing period (Fig. 2). Reduced plant growth is directly related to reduced pasture stocking rates and total animal gains per hectare (Table 2).

Live biomass produced during the summer growing season (after cattle were removed) in the mowed pasture exceeded that of the burned pasture. Winter burning has a negative effect on big sacaton live biomass production under the stocking and weather conditions reported in this study. We believe that annual winter burning has contributed to the destruction of big sacaton riparian grasslands and suggest that managers discontinue this practice. Managers should substitute mowing for burning, and mowing should be necessary only when unusually dry winters and summers occur in a sequence.

Heifers and steers in this study preferred upland grama grasses and selectively removed the standing crop of these grasses before grazing big sacaton live biomass in the burned, mowed, or control pastures. Managers may wish to use fencing to separate big sacaton riparian grasslands from nearby upland grasslands. If fencing is not used, cattle will overgraze the upland grasses before using big sacaton in the lowlands.

The increase in daily animal gain indicated that big sacaton grasslands, either burned or mowed in late winter, increases forage quality for sping-summer grazing. The increase in carrying capacity on the untreated pasture indicated, however, that these grasslands should not be burned or mowed, but only grazed. Increasing stocking rates is the preferred management option on most ranches with sacaton bottoms although individual animal performance will suffer. Increased gain per area will compensate for reductions in individual gains [Jones and Sandland, 1974].

Winter burning may have been responsible for the decline of big sacaton riparian grasslands, and our results suggest this possibility. Managers who currently burn big sacaton annually, and are concerned with long-term natural resource stability should consider discontinuing the practice until conclusive evidence is available. Proper grazing animal management could enhance the sustained production of these important riparian grasslands.

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