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CONSERVATIVE AND MODERATE GRAZING EFFECTS ON CHIHUAHUAN DESERT WILDLIFE SIGHTINGS

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ABSTRACT.—Seasonal wildlife observations were made along transects on 2 pastures conservatively grazed (36% use of perennial grasses) and 2 pastures moderately grazed (47% use of perennial grasses) in south central New Mexico in non-drought (1997) and drought years (1998). Experimental pastures were similar in soils, terrain, spacing of watering points, and brush cover. Average ecological condition score for the conservatively grazed pastures was 60% compared with 64% for moderately grazed pastures. Throughout the study total standing vegetation understory herbage levels were higher ($P < 0.05$) on conservatively grazed than moderately grazed pastures. Total wildlife, total gamebird, and total songbird sightings did not differ ($P > 0.05$) between conservatively and moderately grazed pastures. Black-tailed jackrabbit (*Lepus californicus*) sightings were higher ($P < 0.05$) on moderately grazed than conservatively grazed pastures. Sightings of pronghorn (*Antilocapra americana*), scaled quail (*Callipepla squamata*), mourning doves (*Zenaida macroura*), and desert cottontails (*Sylvilagus auduboni*) showed no differences ($P > 0.05$) between conservatively and moderately grazed pastures. Dry conditions in 1998 depressed total wildlife sightings by >50% compared to 1997. Both songbird and gamebird (particularly mourning dove) sightings were severely reduced in the dry compared to wet year ($P < 0.05$). Our results are consistent with Nelson et al. (1997) that livestock grazing at intermediate levels had no effect on most Chihuahuan Desert upland wildlife species, and that drought years severely depress wildlife sightings.

Key words: grazing, cattle, quail, doves, jackrabbits, birds, mammals.

Conservative grazing, involving about 31–40% use of primary forage species, is a proven management practice for maintaining and improving ecological condition and forage production in the Chihuahuan Desert (Paulsen and Ares 1962, Holechek et al. 1994). It also has other benefits to ranchers that include higher livestock productivity, lower variable costs, lower risk, and similar or higher net returns per hectare compared to moderate (41–50% use of primary forage species) grazing levels (Holechek 1992, Winder et al. 2000). However, the effects of conservative compared with moderate grazing on wildlife populations have not been fully evaluated. Nelson et al. (1997) found higher total wildlife sightings on moderately grazed pastures in mid-seral condition compared to conservatively grazed pastures in late-seral condition. Their study was conducted on the Chihuahuan Desert Rangeland Research Center in south central New Mexico on pastures that had high perennial grass cover and biomass levels due to several years of favorable precipitation. Our objective was to compare wildlife numbers under conservative and moderate grazing on the Chihuahuan Desert Rangeland Research Center after extended drought using the same pastures as Nelson et al. (1997). These 4 adjacent pastures have similar size, topography, soils, and watering point distribution.

STUDY AREA

The 4 pastures are located on the New Mexico State University Chihuahuan Desert Rangeland Research Center (CDRRC). The ranch is 37 km north of Las Cruces, New Mexico, in Doña Ana County. The ranch is in the southern portion of the Jornada del Muerto Plains between the San Andres Mountains to the east and the Rio Grande Valley to the west. Elevation varies from 1188 m to 1371 m with level or gently rolling hills.

Soils of the CDRRC are mainly light sandy loams underlain by calcium carbonate hardpan (caliche) at depths varying from a few centimeters to 1 m or more (Valentine 1970). Soils are classified as fine loamy, mixed, thermic, typic haplargids and are in the Simona-Cruces

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associations (SCS 1980). In areas where groundcover is sparse, sand dunes form around the invading mesquite plants (Wood 1969). Over most of the study area, the soil profile is relatively well preserved and stable.

Climate on the CDRRC is typical of the Chihuahuan Desert. The ranch is arid and has an average of 200 frost-free days. The only permanent water sources are wells and pipelines provided for livestock. Each pasture contains a single permanent water source located near its center. Temperatures are high in summer, with a mean maximum of 36°C during June and a mean maximum of 13°C during January (Pieper and Herbel 1982). Temperature differences are substantial between day and night. Solar radiation is generally greatest in June and lowest in December. Winds are strongest in the spring and cause severe erosion problems and water stress on the plants.

Annual precipitation is bimodal. Summer precipitation, generated from the Gulf of Mexico, is characterized by localized convectional storms of high intensity but low frequency. Because winter precipitation (December–February) comes from the Pacific Ocean, storms are relatively gentle and evenly distributed. Mean annual precipitation is 230 mm, with 52% of the annual rainfall occurring during the summer growing season (July–September).

Rain gauges are located throughout the CDRRC. Total annual precipitation for the CDRRC in 1997 was 329 cm (143% of mean). In 1998 the total was 191 cm (83% of mean). Growing season precipitation was 84% above average in 1997 but 16% below average in 1998.

Primary grass species on our study areas include black grama (*Bouteloua eriopoda*), dropseeds, (*Sporobolus* sp.), threeawns (*Aristida* sp.), bush muhly (*Muhlenbergia*), fluffgrass (*Erioneuron pulchellum*), and tobosa (*Hilaria mutica*). The most commonly encountered shrub species is honey mesquite (*Prosopis glandulosa*). It dominates the overstory and has been increasing over the past 100 years (Pieper and Herbel 1982). Other shrubs commonly found are snakeweed (*Gutierrezia sarothrae*), soaptree yucca (*Yucca elata*), and creosote (*Larrea tridentata*). Leatherweed croton (*Croton pottsii*), the primary forb occurring on the CDRRC, is an important food for livestock and pronghorn.

Mammals observed in our study include pronghorn (*Antilocapra americana*), black-tailed jackrabbits (*Lepus californicus*), and desert cottontails (*Sylvilagus auduboni;* Table 1). Gamebirds observed include scaled quail (*Callipepla squamata*), Gambel's quail (*Lophortyx gambelii*), and mourning doves (*Zenaida macroura*). Songbird species observed include lark buntings (*Calamospiza melanocorys*), western meadowlarks (*Sturnella neglecta*), western kingbirds (*Tyrannus verticalis*), loggerhead shrikes (*Lanius ludovicianus*), mockingbirds (*Mimus polyglottos*), crissal thrashers (*Toxostama crissale*), red-winged blackbirds (*Agelaius phoeniceus*), Cassin's sparrows (*Aimophila cassinii*), cactus wrens (*Campylorhynchus brunneicapillus*), and various species of sparrows. The most commonly observed sparrows were black-throated sparrows (*Amphispiza bellineata*), sage sparrows (*Amphispiza belli*), and Brewer's sparrows (*Spizella breweri*). Raptors observed include northern harriers (*Circus cyaneus*), red-tailed hawks (*Buteo jamaicensis*), and Swainson's hawks (*Buteo swainson).* Other important birds observed include greater roadrunners (*Geococcyx californianus*), brown-headed cowbirds (*Molothrus ater*), common nighthawks (*Chordeiles minor*), and Chihuahuan ravens (*Corvus cryptoleucus*).

METHODS AND MATERIALS

During 1991 four pastures with similar soils (sandy loams), topography (flat), and size were delineated and fenced (Winder et al. 2000). These include pasture 1 (1267 ha), pasture 2 (932 ha), pasture 3 (1219 ha), and pasture 4 (974 ha). The 4 pastures were adjacent to each other and surrounded by rangeland in mid-seral condition. Basically, the spatial ordering of the pastures from west to east was 1, 2, 3, and 4, with pastures 1 and 2 in the west block and pastures 3 and 4 in the east block. All 4 pastures have flat terrain and similar spacing of watering points. During 1992, 1993, and 1994, these 4 pastures were used to study the effects of range condition and grazing intensity on cattle production (Winder et al. 2000) and wildlife populations (Nelson et al. 1997).

After a period of complete destocking due to drought (August 1994 to April 1997), the 4 pastures were partially restocked in April 1997 and fully stocked in November 1997 for implementation of our study. The procedures of Holechek (1988) were used to set stocking rates in 1997, 1998, and 1999. Pastures 1 and 3

TABLE 1. Summary of wildlife sightings per square kilometer by species, category, year, treatment, and season on the Chihuahuan Desert Rangeland Research Center in south central New Mexico.

	Year		Grazing intensity		Season			
Wildlife species	1997	1998	Conservative	Moderate	Fall	Winter	Spring	Summer
Pronghorn	1.1	1.1	1.1	1.1	0.2[a]	1.9[b]	0.3[a]	2.0[b]
Black-tailed jackrabbit	27.6	21.7	18.0[a]	31.2[b]	18.5	26.1	23.9	30.0
Desert cottontail	4.3	5.4	3.5	6.1	4.7[a,b]	2.8[b]	7.0[a]	4.8[a,b]
TOTAL MAMMALS	33.0	28.2	22.6	38.4	23.4	30.8	31.2	36.8
Mourning dove	23.5[a]	4.7[b]	9.9	18.3	0.3[a]	0.5[a]	1.9[a]	53.8[b]
Scaled quail	9.0[a]	2.7[b]	7.9	3.8	10.1	0.3	4.8	8.2
Gambel's quail[c]	0.7	0.6	0.2	0.6	0.0	0.0	0.0	1.6
TOTAL GAMEBIRDS	33.2[a]	8.0[b]	18.0	22.7	10.4[a]	0.8[a]	6.7[a]	63.6[b]
Lark bunting	82.8[a]	16.9[b]	36.7	63.0	0.9[a]	3.4[a]	2.3[a]	192.6[b]
Loggerhead shrike	3.5	4.0	3.7	3.8	2.5[a]	3.0[a]	3.0[a]	6.5[b]
Western meadowlark	0.9	0.8	1.1	0.5	0.9	1.7	0.6	0.0
Western kingbird	1.6	2.2	2.0	1.8	0.0[a]	0.0[a]	6.2[b]	1.2[a]
Crissal thrasher	1.8	2.2	2.2	1.8	1.7	1.9	2.3	2.0
Red-winged blackbird[c]	1.0	6.3	4.4	2.9	0.0	0.0	0.0	14.6
Cassin's sparrow[c]	1.5	0.0	1.2	0.2	2.5	0.0	0.0	0.5
Cactus wren	3.8	4.2	2.8	5.2	1.4[a]	1.9[a]	3.1[a]	9.6[b]
Sparrows	47.0[a]	15.6[b]	21.2	41.4	7.5[a]	9.6[a]	3.4[a]	104.7[b]
Mockingbird	0.3	0.5	0.4	0.5	0.0	0.0	1.1	0.6
TOTAL SONGBIRDS	144.2[a]	52.7[b]	75.7	121.1	17.5[a]	21.5[a]	22.0[a]	332.3[b]
Red-tailed hawk	0.2	0.7	0.3	0.6	0.9[a]	0.5[a,b]	0.5[a,b]	0.0[b]
Swainson's hawk	0.7	1.1	0.6	1.2	0.3[a]	0.0[a]	0.9[a]	2.3[b]
Northern harrier	0.2	0.1	0.2	0.1	0.2	0.2	0.0	0.2
TOTAL RAPTORS	1.1	1.9	1.1	1.9	1.4[a]	0.7[a]	1.4[a]	2.5[b]
Roadrunner	0.2	0.2	0.2	0.1	0.2	0.2	0.0	0.3
Common nighthawk	0.2	0.0	0.0	0.2	0.0	0.0	0.3	0.0
Chihuahuan raven	1.6	5.5	4.2	3.0	4.0[a]	5.4[a]	4.6[a]	0.2[b]
Brown-headed cowbird	0.3	2.4	0.5	2.3	1.6	0.8	2.8	0.3
TOTAL OTHER BIRDS	2.3	8.1	4.9	5.6	5.8[a]	6.4[a]	7.8[a]	0.8[b]
TOTAL WILDLIFE	213.8[a]	98.9[b]	122.3	189.7	58.4[a]	60.2[a]	69.0[a]	436.0[b]

[a,b]Means with different superscripts within years, grazing intensities, and seasons differ at $P < 0.05$.
[c]Not evaluated statistically due to low numbers of observations.

were stocked to obtain a 35% use of forage (conservative grazing), and pastures 2 and 4 were stocked to obtain 45% use of forage (moderate grazing).

During our study, pastures 1, 2, and 4 were in late-seral ecological condition, and pasture 3 was in high mid-seral ecological condition (Molinar 1999), based on the quantitative climax approach of Dyksterhuis (1949). Ecological condition scores averaged 60% for conservatively grazed pastures and 64% for moderately grazed pastures. Ecological condition involves the amount of climax or original vegetation that remains on the site.

In July 1996 we systematically placed 5 transects 1.6 km in length in each pasture. Transects were placed at least 1 km from boundary fences to minimize any ecotone effects where pastures adjoined. All transects (5 per pasture) were at least 0.8 km apart.

We collected basal cover and herbaceous standing crop data for fall 1997 and fall 1998 at 10 evenly spaced key areas in each pasture (Molinar 1999). Autumn forage standing crop was determined by clipping twenty 0.5-m^2 quadrats on each key area (Molinar 1999). A modification of the line-intercept (Holechek and Stephenson 1983) procedure of Canfield (1941) was used to determine percent cover for individual species. A meter stick was used instead of an extended line. Measurements were made approximately every 6.1 m along two 61-m transects at each key area. The meter stick was placed perpendicular to the transect

and the intercept of the plants measured according to Bonham (1989). The intercept for grasses, forbs, and shrubs was measured at the crown intercept. Measurements were recorded in millimeters. Detailed information on cover for individual species is reported in Molinar (1999).

In late May through early June 1998 and 1999, we evaluated grazing intensity on the 4 pastures using procedures of Anderson and Currier (1973) as modified by Holechek and Galt (2000). Percent forage use, residual vegetation, and stubble height of key forage species were evaluated on 4 key areas within each pasture. Percent use and residual vegetation were determined by clipping twenty 0.5-m^2 quadrats at each key area. Fifty plants were measured for stubble height along each of the two 100-m transects at each key area. These data were reported by Galt et al. (1999).

Wildlife sightings were recorded along the 5 transects in each of the 4 pastures. Two observers well trained in wildlife identification recorded wildlife observations while walking each transect. These inventories were taken in summer and autumn 1997; winter, spring, summer, and autumn 1998; winter and spring 1999. All inventories were conducted between the hours of 0700 and 1100. Each transect was surveyed once per season. Binoculars were used to aid in the identification of species. To avoid recording the same line twice, only wildlife species observed within 50 m on either side of the observer were recorded. Data were converted to wildlife sightings per km^2 for statistical evaluation.

Statistical Analysis

A randomized, repeated-measures analysis of variance was used to compare vegetation, foliar cover, and wildlife sightings among pastures, years, and seasons (Milliken and Johnson 1992). Pastures 1 and 3 were used as replicates for conservatively grazed rangeland and pastures 2 and 4 for moderately grazed rangeland. We consider the study pastures to be pseudo-replicates because they are adjacent and not spatially separated.

RESULTS

Total wildlife sightings did not differ ($P > 0.05$) between conservatively and moderately grazed pastures (Table 1). Interactions among season, year, and stocking level were nonsignificant ($P > 0.05$). Total wildlife sightings were over 50% higher ($P < 0.05$) in 1997 when precipitation was above average than in 1998 when precipitation was below average (Table 1). Total Chihuahuan Desert wildlife sightings were higher ($P < 0.05$) in summer than other seasons (Table 1). This was consistent across various wildlife categories evaluated with the exception of total mammals.

Total mammal sightings did not differ ($P > 0.05$) on moderately and conservatively grazed pastures (Table 1). This applied to pronghorn antelope and desert cottontails. However, throughout the study more ($P < 0.05$) jackrabbits were observed on the moderately than conservatively grazed pastures. Jackrabbit sightings did not differ ($P > 0.05$) between years or seasons. Interactions among season, year, and grazing level were nonsignificant ($P > 0.05$) for total mammal sightings and categories of mammals.

Total gamebird, mourning dove, and scaled quail sightings did not differ ($P > 0.05$) between conservatively and moderately grazed pastures (Table 1). However, more mourning doves and scaled quail were observed ($P < 0.05$) in 1997 than 1998. Interactions among season, year, and stocking intensity level were nonsignificant ($P > 0.05$).

Total songbird numbers did not differ ($P > 0.05$) between conservatively and moderately grazed pastures (Table 1). This was generally true for individual songbird species. More songbirds were observed ($P < 0.05$) in 1997 than 1998. Interactions among season, grazing level, and year were generally nonsignificant ($P > 0.05$) for various songbird categories.

Other birds and raptors showed no definite responses ($P > 0.05$) to grazing level or years but did show differences ($P < 0.05$) among seasons (Table 1). Interactions among year, season, and grazing level were nonsignificant ($P > 0.05$). Fewer other birds and raptors were sighted ($P < 0.05$) in summer than other seasons. In contrast, raptor sightings were highest ($P < 0.05$) in summer.

Autumn total standing herbage, autumn perennial grass herbage, and spring perennial grass herbage averaged higher ($P < 0.05$) on conservatively grazed than moderately grazed pastures (Table 2). Autumn total standing herbage, autumn perennial grass herbage, and spring perennial grass standing herbage were higher ($P < 0.05$) in 1997 than 1998. This was

TABLE 2. Summary of vegetation characteristics associated with conservatively and moderately grazed pastures on the Chihuahuan Desert Rangeland Research Center in south central New Mexico.

	Year		Grazing intensity	
Vegetation characteristic	1997	1998	Conservative	Moderate
Ecological condition score	64	60	60	64
Bouteloua eriopoda cover, %	1.2[a]	0.6[b]	0.7[a]	1.1[b]
Perennial grass cover, %	2.5[a]	1.2[b]	1.5[a]	2.2[b]
Forb cover, %	0.6	0.4	0.6	0.4
Shrub cover, %	4.2	3.7	4.6	3.3
Total vegetation cover, %	7.3[a]	5.2[b]	6.6	6.0
Autumn standing herbage, kg ha^{-1}	453[a]	255[b]	385[a]	322[b]
Autumn perennial grass standing crop, kg ha^{-1}	251[a]	200[b]	242[a]	208[b]
Spring perennial grass standing crop, kg ha^{-1}	153[a]	114[b]	155[a]	110[b]
Spring *Bouteloua eriopoda* height, cm	11.4[a]	9.4[b]	11.9[a]	8.9[b]
Spring forage utilization, %[c]	39	43	36[a]	47[b]

[a,b]Means with different superscripts within years and grazing intensities differ at $P < 0.05$.
[c]Data for spring 1998 and 1999.

attributed to lower precipitation in 1998 than 1997. Interactions between grazing level and year were nonsignificant ($P > 0.05$).

Total vegetation cover and perennial grass cover were lower ($P < 0.05$) in 1998 than 1997 (Table 2). Total vegetation, forb, and shrub cover did not differ ($P > 0.05$) on conservatively and moderately grazed pastures (Table 2). However, black grama cover was higher ($P < 0.05$) on moderately grazed than conservatively grazed pastures in both years of study.

Forage use was higher ($P < 0.05$) on moderately than conservatively grazed pastures in both years of study (Table 2). In June 1998 forage use averaged 33% on primary forage grasses and 45% on conservatively and moderately grazed pastures, respectively (Galt et al. 1999). In June 1999 forage use averaged 38% and 48% on conservatively and moderately grazed pastures, respectively. Stubble height of black grama also showed heavier grazing ($P < 0.05$) in moderately grazed (9.9 cm in 1998, 7.9 cm in 1999) than conservatively grazed (13.0 cm in 1998, 10.9 cm in 1999) pastures (Table 2).

DISCUSSION

Our 2-year study of wildlife populations on conservatively and moderately grazed Chihuahuan Desert rangelands showed few differences for individual wildlife species or categories with the exception of black-tailed jackrabbits. Based on our results and those of Nelson et al. (1997), jackrabbits apparently prefer moderately grazed areas over conservatively grazed areas. Primary jackrabbit foods such as leatherleaf croton (Daniel et al. 1993) showed no definite differences in cover and biomass between conservatively and moderately grazed pastures during our study. Improved jackrabbit visibility and mobility due to less dense, shorter vegetation may explain why more jackrabbits were sighted on the moderately grazed pastures.

Flinders and Hansen (1975) found that spring black-tailed jackrabbit densities on shortgrass prairie were similar under moderate and light cattle grazing but were depressed by heavy grazing. Their findings were in conflict with earlier studies. Taylor and Lay (1944) indicated black-tailed jackrabbits in eastern Texas increased in response to overgrazing of grasses by livestock. In the sandhills of Colorado, Sanderson (1959) found higher densities of black-tailed jackrabbits on heavily grazed pastures than on those receiving moderate or light grazing. Pastures dominated by tall vegetation supported the fewest jackrabbits. Black-tailed jackrabbits declined in Kansas on areas that revegetated to dense stands of grasses and forbs (Tiemeier 1965). Flinders and Hansen (1975) believed black-tailed jackrabbits have

maximum and minimum levels of tolerance to height, density, and species composition of vegetation in their habitat.

Other studies have indicated that scaled quail populations are similar under conservative and moderate grazing in the Chihuahuan Desert (Nelson et al. 1997, Saiwana et al. 1998). However, heavily grazed early-seral rangelands and lightly or ungrazed climax Chihuahuan Desert rangelands support fewer scaled quail than those conservatively to moderately grazed in mid- or late-seral condition (Smith et al. 1996, Nelson et al. 1997, 1999).

Mourning dove sightings did not differ ($P > 0.05$) between grazing treatments. Other studies by Smith et al. (1996) and Saiwana et al. (2001) in the Chihuahuan Desert have indicated that intermediate grazing levels and seral stages may provide more favorable habitat for mourning doves than lightly or ungrazed areas near climax or heavily grazed areas in an early stage. In eastern Texas, Baker and Guthery (1990) found mourning doves were favored by heavy compared to moderate grazing. In southeastern Arizona, Bock et al. (1984) reported mourning dove sightings were higher on moderately grazed than ungrazed areas.

Total songbird sightings in our study did not differ ($P > 0.05$) between grazing treatments. Nelson et al. (1997) found higher total songbird numbers on moderately grazed pastures in mid-seral condition than conservatively grazed pastures in late-seral condition. Smith et al. (1996) found no difference in songbird densities between lightly grazed climax grasslands and moderately grazed mixed-grass shrublands in the Chihuahuan Desert. On a semidesert grassland site in southeastern Arizona, Bock et al. (1984) found that moderate grazing, compared with grazing exclusion, appeared to favor songbirds. However, different species of birds differed substantially in their response to grazing. Lack of an ungrazed control in our study prevents drawing any inferences about grazing versus non-grazing impacts on songbirds and other wildlife.

In our study total raptor numbers were not influenced ($P > 0.05$) by grazing level. This agrees with Nelson et al. (1997).

Our study is consistent with Nelson et al. (1997) in showing that drought depresses gamebird and songbird populations in the Chihuahuan Desert. This may be explained by lower availability of forbs and insects, which are important foods for many birds. In addition, water is less available in vegetation, puddles, and stock tanks.

Both our study and that of Nelson et al. (1997) showed total wildlife sightings in the Chihuahuan Desert to be higher in summer than in other seasons. This was particularly true for songbirds and mourning doves ($P < 0.05$). Most songbirds and mourning doves are migratory in the Chihuahuan Desert. They begin vacating the area in October when temperatures decrease and move back into the area in March and April when temperatures increase.

Just as wildlife diversity appears to be maximized by maintaining a mosaic of pastures in different seral conditions (Nelson et al. 1997, 1999), variation in grazing intensities within and across pastures should be advantageous to wildlife by increasing habitat structural diversity. Therefore, a mix of ungrazed, conservatively grazed, and moderately grazed pastures should theoretically support higher and more diverse wildlife populations than a single grazing intensity uniformly applied. Most conservatively or moderately grazed pastures will contain areas with a mix of grazing intensities ranging from ungrazed to heavily grazed. Conservative grazing has important benefits in terms of soil stability, forage productivity, livestock production, and lower rancher risk. However, our study and Nelson et al.'s (1997) indicate conservative grazing did not benefit most upland wildlife species in the Chihuahuan Desert. Our study should not be applied to pastures with riparian habitat because that habitat characteristic was not included in our experimental areas. Concurring with Nelson et al. (1997), our study indicates livestock grazing at conservative to moderate intensities was not harmful to most upland Chihuahuan Desert wildlife species, but drought depressed gamebird and songbird populations.

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