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Long-Term Forage and Cow-Calf Performance and Economic Considerations of Two Stocking Levels on Chihuahuan Desert Rangeland ☆

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A R T I C L E I N F O

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A B S T R A C T

Forage and cow-calf productivity on two lightly and two conservatively grazed pastures were evaluated over a 15-year period (1997–2011) in the Chihuahuan Desert of south-central New Mexico. Spring-calving Brangus cows were randomly assigned to pastures in January of each year. Pastures were similar in area (1 098 ± 69 ha, mean ± SE) with similar terrain and distance to water. Utilization of primary forage species averaged 27.1 ± 3.0% in lightly stocked pastures and 39.4 ± 4.0% on conservatively stocked pastures. No differences in perennial grass standing crop (163.5 ± 52.2 kg·ha^{-1}) and calf weaning weights (286.1 ± 2.6 kg) were detected ($P > 0.10$) between light and conservative treatments. Lightly grazed pastures yielded greater ($P < 0.05$) kg of calf weaned·ha^{-1} and calf crop percent than conservatively grazed pastures in 1998 due to complete destocking of conservatively grazed pastures during that slight drought (i.e., rainfall was 75% of normal in 1998). After the initial 5 years of study (1997–2001), all pastures were destocked for 4 years (2002–2005) due to drought as rainfall was only 50% or less of normal. Pastures were then restocked for another 6 years (2006–2011). Postdrought, the percentage change in perennial grass standing forage crop (kg·ha^{-1}) was -4.0 and -14.4 ± 2.5 % ($P < 0.09$) in the light and conservative grazed pastures across the 6 years, respectively. While conservative stocking rates may provide higher net financial returns than light stocking rates during nondrought years as there were more AU per pasture, potential losses from cattle liquidation during short-term (i.e., 1-year) droughts could nullify this advantage. Results suggest that light grazing use of forage is a practical approach for Chihuahuan Desert cow-calf operations to minimize risk of herd liquidation during short-term drought.

Introduction

A major managerial challenge confronting ranchers on desert rangelands is that periodic droughts necessitate destocking to avoid harmful impacts on soils, vegetation, and livestock (Holechek et al., 2011). Global warming has the potential to exacerbate frequency and severity of drought, especially on desert rangelands (Brown and Thorpe, 2008; Polley et al., 2013). In the Chihuahuan Desert of New Mexico, 5 multiyear droughts have occurred in the 44-year period from 1969–2013 (Petrie et al., 2014). During these types of droughts, many ranchers were most likely forced to relocate or liquidate their livestock, creating challenges to finance herd rebuilding when the drought ends (Doye et al., 2013). These challenges are exacerbated on large-rangeland ranches because naïve cattle are not as adapted to desert environments and may select lower-quality diets and have less desirable grazing distribution patterns than cattle born, raised, and kept on the ranch (Bailey et al., 2010).

Conservative stocking targeting 31% to 40% use of primary forage species has become a well-accepted management practice in the Chihuahuan Desert because it reduces the need for stocking rate reductions in years of below-average precipitation, gives similar or higher net financial returns, improves livestock performance, lowers variable costs, and enhances forage productivity compared with moderate grazing (41% to 50% use of primary forage species; Paulsen and Ares, 1962; Winder et al., 2000; Holechek et al., 2003). Light grazing (20–30% use of primary forage species) can reduce the need for stocking rate adjustments in dry years and may better facilitate range recovery following drought compared with conservative grazing (Valentine, 1970; Khumalo et al., 2007).

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A preliminary 5-year report of this study conducted at the Chihuahuan Desert Rangeland Research Center in south-central New Mexico showed little difference in forage or livestock productivity between light and conservative stocking (Thomas et al., 2007). However, light grazing did reduce the need to destock during short-term (1-year) drought. Our objectives herein are to describe 15 years of results from the study. This report includes the initial 5 years of data collection followed by 4 years of extended drought that required complete destocking of pastures, then a 6-year postdrought grazing period when pastures were restocked. These data permitted predrought and postdrought comparisons of forage and livestock productivity under light and conservative stocking. Comparative financial effectiveness of the two stocking treatments was also assessed, taking into consideration risk of drought-induced herd liquidation and subsequent herd rebuilding.

Materials and Methods

Study Site

Our study was located on the Chihuahuan Desert Rangeland Research Center (CDRRC) 37 km north of Las Cruces in south-central New Mexico. It is in the southern portion of the Jornada del Muerto Plains (lat 32°32′N; long 106°48′W) with level to gently rolling hills varying from 1 188 to 1 371 m in elevation. Soils of the CDRRC are mainly light sandy loams underlain by calcium carbonate hardpans at depths varying from a few centimeters to greater than 1 m (Valentine, 1970; Joseph et al., 2003). Soils are classified as fine loamy, mixed thermic, typic haplargids and are in Simona-Cruces associations (SCS, 1980).

Typical Chihuahuan Desert climatic conditions occurred across our CDRRC study site, which averages 200 frost-free days per year (Joseph et al., 2003). Wells and pipelines are the only permanent sources of water available for livestock on this research facility. In summer, temperatures are high with a mean maximum of 36°C during the month of June and a mean maximum of 13°C during January (Pieper and Herbel, 1982). Winds are often strong in the spring of the year (Joseph et al., 2003). Rain gauges are well distributed throughout the CDRRC. Historic mean annual precipitation (1930–2012) was 234 ± 20 mm, with 52% of the precipitation coming in the growing season of July to September. Average annual precipitation from 1997 through 2011 was 241 ± 20 mm.

Primary grasses on the CDRRC are black grama (*Bouteloua eriopoda* [Torr.] Torr.), dropseeds (*Sporobolus* spp.), and threeawns (*Aristida* spp.). Honey mesquite (*Prosopis glandulosa* Torr.) and broom snakeweed (*Gutierrezia sarothrae* [Pursh] Britton & Rusby) are the most commonly found shrubs.

Pasture and Forage Use Description

Four adjacent pastures with similar soils (sandy loams) and topography (flat) were delineated and fenced in 1991. Pasture 1 was 1 267 ha, pasture 2 was 932 ha, pasture 3 was 1 219 ha, and pasture 4 was 974 ha. Calculation of the grazable area of each pasture was based on distance from water and the procedures of Holechek (1988). Therefore, distance to water was not a concern for grazing distribution as stocking rates were based on the area defined as suitable for grazing.

Two treatments were randomly assigned to the four pastures in November of 1997. Pastures 1 and 3 were stocked to obtain 25% to 30% forage use (light), and pastures 2 and 4 were stocked to obtain 35% to 40% forage use (conservative). Stocking rates assigned to achieve these levels were based on the procedures of Holechek (1988). Perennial grass standing crop was estimated in November after the growing season, and stocking rates were determined using desired forage use levels and standing crop estimates. Pastures were stocked in January, which was the next time the cows were penned. Forage use was revaluated in June, and if critical stubble height levels were observed in a particular pasture, it was destocked. The following paragraph describes the stubble height measurement protocol. Pastures 1, 2, and 4 were in late-seral ecological condition, and pasture 3 was in midseral ecological condition at the start of the study based on the quantitative climax approach of Dyksterhuis (1949). Ecological condition scores for pastures 1, 2, 3, and 4 at the beginning of the study in 1997 were 65%, 60%, 46%, and 63%, respectively (Molinar, 1999). In 2010 ecological condition scores were 67%, 68%, 59%, and 58% for pastures 1 through 4, respectively (Mohamed, 2011).

Perennial grass standing crop was measured in autumn of 1993 through 2011 at 10 permanent sites (evenly spaced key areas) in each pasture (Joseph et al., 2003). Perennial grass standing crop and current year growth were determined by clipping twenty 0.5 m^2 quadrats at each site. Current year growth was separated from standing dead material. The reader is referred to Joseph et al. (2003), Khumalo (2006) and Mohamed (2011) for information on total herbaceous standing crop, herbaceous standing crop relative composition, and percent cover of plant species in the study pastures. Grazing intensity on the four pastures was evaluated in 1997 through 2011 using procedures of Holechek and Galt (2000). Grazing intensity (forage use) was measured in late June of each year because it is the end of the forage cycle before new growth of perennial grasses, which usually occurs in July. Percent use of the perennial grass standing crop was evaluated on 4 of the 10 previously described permanent sites (key areas) within each pasture that we considered a good representation of overall grazing intensity. Residual perennial grass biomass was determined by clipping twenty 0.5 m^2 quadrats at each of these key areas in late June. New systematically selected quadrat locations were clipped each year. Forage use was calculated by dividing the late June perennial grass standing crop by the perennial grass standing crop in the previous autumn. This number was then subtracted from 1 and multiplied by 100 to obtain forage use expressed as a percentage. Stubble heights of black grama, dropseeds, and threeawns were also evaluated in each key area. In drought years, black grama stubble heights were periodically checked during summer and autumn in all four pastures. If average stubble height fell below 7.6 cm, all cattle were removed from the pasture. A minimum stubble height of 7.6 cm has been recommended to avoid damage to black grama from excessive grazing (Paulsen and Ares, 1962; Valentine, 1970). When black grama stubble heights fall below 7.6 cm, damage to plant crowns and impaired soil health due to inadequate residual cover becomes probable. Both low-forage production and black grama stubble heights near or below 7.6 cm justified the decision to destock the conservatively grazed pastures in November of 1998 and all pastures in November of 2001 (i.e., no grazing was allowed 2002–2005).

Experimental Animals

Mature, pregnant, multiparous Brangus cows were randomly assigned by age and body condition score (BCS; scale 1 = emaciated to 9 = obese) to each pasture in January of each year. Cow age ranged from 5 to 10 years, which is the descriptor of a mature cow within the guideline of the Beef Improvement Federation (BIF, 1996). Cow age averaged 7.1 ± 1.5 years for 213 cows used in the 4 pastures across the 15 years of the study. These cattle were part of the Brangus breeding program for desert adaptability that was initiated in 1966 (Luna-Nevarez et al., 2010). Each pasture was assigned a single-sire mated herd. Cow weight and BCS were recorded each January, May, and October. Reproductive performance based on the number of cows exposed to breeding (i.e., pregnancy and calf crop percentages) and calf weaning weights were determined each October. To obtain these data, cows were gathered using horses and herded to a working facility central to the four pastures and this section of the CDRRC. Because of the extensive pasture system used in this study, weights were collected within 2 hours of penning the cattle and then animals were herded back to their assigned pasture (Luna-Nevarez et al., 2010). Body

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