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B.H. Dunn
South Dakota State University

A.J. Smart
South Dakota State University

R.N. Gates
South Dakota State University

P.S. Johnson
South Dakota State University

M.K. Beutler
South Dakota State University

See next page for additional authors

Authors
B.H. Dunn, A.J. Smart, R.N. Gates, P.S. Johnson, M.K. Beutler, M.A. Diersen, and L.L. Janssen

Long-term production and profitability from grazing cattle in the northern mixed grass prairie[1 2]

B. H. Dunn[*3], A. J. Smart[†3], R. N. Gates[†3], P. S. Johnson[†4], M. K. Beutler[‡4], M. A. Diersen[‡3], and L. L. Janssen[‡4]

[*]King Ranch Institute for Ranch Management, Texas A&M University- Kingsville
[†]Department of Animal and Range Sciences, South Dakota State University
[‡]Department of Economics, South Dakota State University

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SUMMARY

Conventional wisdom among rangeland professionals has been that for long-term sustainability of grazing livestock operations, rangeland should be kept in high good to low excellent range condition. Our objective was to analyze production parameters, economic costs, returns, and profit using data generated over a thirty-four year period (1969-2002) from grazing a Clayey range site in the mixed-grass prairie of western South Dakota with variable stocking rates required to maintain pastures in low-fair, good, and excellent range condition classes. Cattle weights were measured at turnout and at the end of the grazing season. Gross income per acre was calculated by multiplying total gain per acre times price using historical National Agricultural Statistics Services feeder cattle prices. Annual variable costs were estimated from a historical yearling cattle budget developed by South Dakota State University (SDSU) agricultural economists. All economic values were adjusted to a constant dollar using the Bureau of Labor Statistics' Consumer Price Index. Stocking rate, average daily gain, total gain, net profit, gross revenue, and annual costs per acre varied among range condition classes. Net income for low-fair range condition ($11.18 per acre) and good range condition ($11.86 per acre) were not different, but both were greater ($P < 0.01$) than excellent range condition ($ 9.31 per acre). Over the life of the study, real profit (adjusted for inflation) steadily increased ($P < 0.01$) for the low-fair and good treatments while it remained level for the excellent treatment. Neither drought nor wet springs impacted profit differently for the three treatments. These results support generally observed rancher behavior regarding range condition: to maintain their rangeland in a lower range condition than would be normally recommend by rangeland professionals. Ecosystem goods and services of increasing interest to society and associated with high range condition, such as floristic diversity, hydrologic function, and wildlife cover, come at an opportunity cost to the rancher.

INTRODUCTION

A powerful mental model persists in the field of range management. It is widely held that grazing livestock on rangeland in lower range condition classes is less productive from both a biological and an

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[3] Associate professor.
[4] Professor.

economic perspective when compared to rangeland in higher range condition classes. This is based on the observation that heavy grazing of rangeland leads to changes in species composition and a decline in range condition class which negatively impacts forage production, animal production, the ability of a ranch to generate wealth, and the market value of the land itself. In the northern mixedgrass prairie, long-term, season-long differential stocking shifts species composition from vegetation dominated by midgrasses, to co-dominate mid- and shortgrasses, and ultimately shortgrass dominant vegetation (Smart et al., 2007). Historically, midgrass dominated plant communities have been preferred over shortgrass plant communities by federal and state conservationists and rangeland professionals because of their forage production for livestock, habitat for wildlife, diversity of fauna and flora, and hydrologic function. The conventional wisdom has become that grazing livestock over long periods of time on lower condition rangeland is not biologically or economically sustainable. In spite of this, generally observed rancher behavior is to maintain rangelands and pasturelands in condition classes lower than recommended.

Plant communities in the Great Plains have a long evolutionary history of grazing such that shortgrass dominated plant communities are stable (Smart et al., 2007). A 55 year economic analysis of light, moderate, and heavy stocking rates on shortgrass prairie near Nunn, CO showed a net return to land, labor, and management of $2.04, $2.98, and $3.92 per acre, respectively (Hart and Ashby, 1998) with predictable changes in range condition occurring as heavy grazing caused an increase in shortgrasses and a decrease in mid-grasses. If livestock grazing on rangeland in lower condition can sustain high net income for greater than 50 years, then grazing of low condition rangeland would be considered biologically and economically sustainable. Therefore, we hypothesize that net profit from grazing livestock on rangeland in lower range condition is just as (or more) profitable and sustainable over a long period of time as grazing livestock on higher range condition rangeland in the northern mixed-grass prairie. The objective of this study was to determine the long-term production and profitability of grazing yearling steers on rangeland in three range condition classes and the actual stocking rate required to maintain those condition classes in the northern mixed-grass prairie.

MATERIALS AND METHODS

The data were collected at the South Dakota State University Range and Livestock Research Station near Cottonwood, SD. Topography is gently sloping with long, rolling hills and relatively flat-topped ridges. Climate is continental and semi-arid with hot summers and cold winters. Soils of the experimental pastures are predominantly Kyle clay and Pierre clay. Predominant ecological site classification is Clayey. Vegetation is typical of mixed-grass prairie. Dominant species include the cool-season mid-grass, western wheatgrass and warm-season shortgrasses, blue grama and buffalograss.

In 1968 six pastures were rested from grazing and fence boundaries were adjusted to uniformly allocate topographic characteristics across three experimental treatments. These treatment units were pastures in low-fair, good, and excellent range condition class with two replicates per treatment. From 1969 to 2002 pastures were variably stocked with yearling steers to maintain their three original range condition classes. Stocking rates were reduced during the droughts of 1980, 1981 (which was a recovery year) 1989, and 2002.

Plant community composition in each replication was monitored annually and recorded in order to adjust stocking rate to maintain the pastures in their original range condition classes. Variable stocking rates were used in each replicate pasture to maintain 50% annual utilization and were recorded. Cattle weights were measured and recorded at turnout and at the end of the grazing season. Average daily gain and gain per acre were calculated.

The economic parameters determined were annual total gross income per acre, annual total expenses per acre, and annual net income per acre. Gross income per acre was calculated for each treatment by multiplying annual gain per acre with the fall seasonal price of yearling cattle per pound as found in Agricultural Price Reports from the National Agriculture Statistics Services for each study year. As the final steer weights, and removal and marketing dates, varied little within years across treatments, a single final price was uniformly applied. Annual total expenses per acre were calculated by summing monthly pasture rental rates, capitalization of initial investment, death loss, veterinary, supplemental feed, supplies, and marketing expenses. Pasture rental rates were determined by the average value of an AUM of grazing for this geographical region as reported by the USDA Economic Research Service for the actual length of the grazing period in each treatment each year of the study. The cost of capitalization of the livestock investment was calculated by multiplying the value of a 550 lb steer in the spring of each year as reported by the USDA Economic Research Service by the historical interest rate as reported by the Federal Reserve for the exact number of grazing days for each year of the study. A 0.5% death loss charge, which is reasonable for this type of enterprise in this region, was calculated by multiplying the initial investment by 0.005. Annual veterinary, supplemental feed, supplies, and marketing expense were calculated from a 1982 SDSU summer grazing stocker budget. In order to standardize the economic inputs and outputs, the impact of inflation or deflation was removed by adjusting all expenses and prices to 2002 dollars using the United States Consumer Price Index for 2002 as reported by the Bureau of Labor Statistics. Annual net income per acre was determined by subtracting total annual expenses per acre from annual gross revenue per acre for each treatment.

For the years between 1974 and 1984, replicate data was missing. Therefore, for all variables, replications within each year were averaged, and year became the replication of treatment. Based on previously demonstrated influence of spring precipitation on vegetation production (Smart et al. 2007) data were analyzed in four separate data sets based on spring precipitation (April+May+June); the entire 34 year data set, the average springs (n = 23), dry springs (n = 5), and wet springs (n = 6). A year was classified as an average spring if the amount of precipitation received was within 1 standard deviation of the 33 year mean, dry spring as having received 1 standard deviation below the mean, and as a wet spring as having received 1 standard deviation above the mean. An analysis of variance and mean comparison were conducted using PROC MIXED for each data set. Residuals of all variables were tested for the assumptions of normality using the NORMAL option in PROC UNIVARIATE by plotting the box-plot and the normal probability plot. All variables were normally distributed. Homogeneity of variances of the variables was compared between treatments using the HOVTEST option in PROC GLM. The computed *P*-value for Levene's test for homogeneity of all the variables was $P > 0.05$, which indicated that variances of each variable among treatments was similar. Linear regression models for profit were developed for each treatment over time using PROC REG.

RESULTS AND DISCUSSION

In order to maintain the pastures in their initial range condition over the 34 years of this study, the stocking rate of the low-fair pastures was higher ($P < 0.01$) than for the good or excellent treatments (Table 1). Average daily gain of steers in the good treatment was greater ($P < 0.05$) than the steers in the low-fair treatment. Total annual steer gains per acre were not different for the low-fair and good treatments, but both were greater ($P < 0.01$) than the excellent treatment. Total gross income$\cdot$ha^{-1} was not different for the low-fair and good treatments, but both were greater ($P < 0.01$) than the excellent treatment. Total annual expense per acre was greatest for the low-fair treatment when compared to those in the good or excellent treatments. Net income per acre was similar for the pastures in the low-fair and good treatments, and both were greater (*P* < 0.01) than the pastures in the excellent treatment.

Table 1. Mean annual productivity and financial performance for pastures in three range conditions grazed to maintain that condition from 1969-2002.

Range condition	Stocking rate	Ave. daily gain	Total gain	Gross income	Total expenses	Net income
	AUM /acre	lb/day	lb/acre	\$/acre	\$/acre	\$/acre
Excellent	0.36^b	1.61^{cd}	23.96^b	16.50^b	7.19^b	9.31^b
Good	0.37^b	1.69^d	27.56^a	19.23^a	7.37^b	11.86^a
Low-Fair	0.40^a	1.56^c	27.93^a	19.57^a	8.39^a	11.18^a
Standard error	0.020	0.016	0.894	1.387	0.545	1.082

^{a,b} Means within a column followed by a different letter are significantly different (*P* < 0.01).
^{c,d} Means within a column followed by a different letter are significantly different (*P* < 0.05).

Over the 34 year period of the study, real profit (adjusted for inflation) steadily increased for the low-fair (R^2 = 0.29; *P* < 0.01) and good (R^2 = 0.39; P < 0.01) treatments while it remained basically level for the excellent treatment (R^2 = 0.02; *P* = 0.49). It is difficult to speculate as to the cause of these differences, but it is important to note that the profitability of the low condition pastures, which had the heaviest stocking rate, did not decline over time, it actually improved. When the data set was separated to consider only average, dry, or wet springs, neither dry nor wet springs impacted profit differently for the three treatments.

Based on these results, if a rangeland professional were making stocking rate recommendations for this range site using commonly recommended formulas based on forage production, standard estimates of livestock intake, and a harvest efficiency of 25% of total forage production, and it was in good or better range condition, a decline in range condition would result. In fact, using forage production data from these pastures as reported by Smart et al. (2007) and standard formulas, the calculated stocking rates for excellent and good range condition treatments would result in stocking rates of 69 and 22% higher, respectively, than what was used to maintain these range conditions in this 34 year study. If a rangeland professional were making stocking rate recommendations for this range site and it was in low-fair range condition, use of the standard formula would underestimate the actual carrying capacity of the rangeland by approximately 13%. In summary, if stocking rate had been determined by the standard formula, it may have proven to be unsustainable for the good and excellent treatments, and economic opportunities would have been lost for the low-fair.

In a capitalistic economy, it is irrational for businesses to operate in ways that are detrimental to their interests. As applied to ranching, it would be logical and rational for ranchers operating in a market driven economy to choose a range condition class for their rangeland that is both profitable for the short-term as well as the long-term and is sustainable. Their livelihood depends on their ability to keep their land in a condition that is appropriate from an ecological as well as financial perspective. It would follow then, over long periods of time, ranchers will manage for the optimum range condition for their rangeland. Results of this study do not support the general belief that ranchers should chose management strategies that lead to an improvement in range condition of their rangeland (Workman 1995; Holechek 2004). These results demonstrate no financial incentive for management to shift range condition to a higher range condition class as the adjustments required to do so carry with them a serious opportunity cost (Pearson and Whitaker 1973; Arthington et al. 2007).

IMPLICATIONS

In our 34 year study, rangeland managed to maintain either low-fair or good range condition was equally profitable. Profit for both steadily increased over time. Excellent condition rangeland was the least profitable to maintain and profit remained stable over time. These results are consistent with generally observed rancher behavior concerning range condition decisions. Plant communities in excellent range condition have significant proportions of midgrasses that if heavily utilized will decrease in abundance and vigor. Lighter stocking rates used to benefit these grasses results in less gross revenue and profit. For the range site evaluated in this research, rangeland in low-fair or good condition is sustainable from both an ecological as well as a financial basis. Results also document that ecosystem goods and services, increasingly demanded by society, come at a cost to the rancher. If services generally associated with high range condition such as wildlife habitat, floristic diversity, and improved hydrologic function are publically valued, then funds cost-shared by federal, state, and private organizations must provide the incentive to direct ranchers' decisions.

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