Effect of Grazing Management on Cattle Distribution Patterns in Relation to Pasture Streams

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Summary and Implications

Poorly managed grazing of beef cattle in riparian areas may contribute to sediment and nutrient loading of Midwest surface waters. In order to develop grazing systems that minimize impacts of grazing cattle on sediment and nutrient loading of pasture streams, knowledge of the effects of grazing management systems on the distribution patterns of cattle is needed. Six 30-acre cool-season grass pastures, containing predominantly smooth bromegrass and bisected by a 642-foot stream segment, were grouped into 2 blocks and assigned one of three treatments: continuous stocking - unrestricted stream access (CSU), continuous stocking - restricted stream access (CSR), and rotational stocking (RS). Cattle managed by continuous stocking with unrestricted stream access spent a greater proportion of their time in a pasture stream and within 110 feet of the stream than did cattle managed by either rotational stocking or continuous stocking with restricted stream access based on both GPS collar data and visual observations. Visual observations overestimated the proportion of time cattle spent within the stream or within 110 feet of the stream compared to data from GPS collars. The presence of an off-stream water source did not alter the proportion of time cattle spent within the pasture stream or within 110 feet of the stream. Cattle distribution patterns can be altered by grazing management, possible resulting in positive water quality impacts.

Introduction

Considerable research has been conducted to evaluate the impacts of cattle grazing management on stream bank erosion and water quality in riparian areas in arid regions of the Western United States. Research has been driven by concerns that cattle tend to congregate in riparian areas which are highly susceptible to environmental damage, resulting in impaired water quality from stream bank erosion and manure deposition. Fewer studies have evaluated the effects of grazing management and water quality in the Midwest. Differences in climate, topography, forage species, and management practices between different regions of the country can potentially result in differences in animal behavior, as it relates to use of riparian areas and the subsequent impacts of grazing on stream bank erosion and water quality.

Cattle grazing in riparian areas can result in two types of erosion within the stream channel. As cattle enter and leave a stream, mechanical breakdown of banks is caused by hoof action on the soil surface. Cattle grazing also removes vegetation from the soil surface leading to bank scour on vertical sides of the stream. Cattle may also reduce water quality by direct deposition of manure in streams.

Many concerns regarding livestock grazing on rangelands are a result of uneven livestock distribution rather than inappropriate stocking rates. A variety of management practices have been proposed to alter cattle distribution patterns and reduce the associated damage to streams and riparian areas. Proposed practices have included exclusion of livestock grazing, alternative grazing schemes such as rotational stocking, management of riparian areas as special use paddocks, stabilized access sites, and off-stream salt and mineral supplementation and/or water sites.

The objective of the current study was to evaluate the effects of grazing management strategies and off-stream water sources on the temporal/spatial distribution of cattle in pastures with streams.

Materials and Methods

Six 30-acre cool-season grass pastures, each bisected by a 642 foot stream segment, were grouped into 2 blocks and assigned one of three grazing management treatments. Treatments included: continuous stocking with unrestricted stream access (CSU), continuous stocking with stream access restricted to a 16-foot wide crushed rock crossing (CSR), and 5-paddock rotational stocking with one paddock in the riparian zone (RS). Riparian paddocks in the RS treatment were stocked until forage sward height decreased to a minimum of 4 inches or for a maximum of 4 days. Grazing was not allowed in approximately 2.25 acres that were fenced as riparian buffers on either side of the crossing in the CSR treatment. Each pasture was stocked with 15 fall-calving Angus cows from mid-May through mid-October in 2005, 2006, and 2007 (initial mean BW = 1428, 1271, and 1369 lbs., respectively).

Cattle distribution patterns were monitored by visual observation and with GPS collars. During visual observations, cattle distribution patterns were monitored from 0600 to 1800 hours on two consecutive days during seven observation periods in 2005 and five observation periods in 2006 and 2007. Observations were conducted in May, June, July, August, and September with no alternative watering sites provided for cattle in the continuously stocked pastures in both years. A second observation period occurred in May and July of 2005 after cows were allowed 1 week to adjust to the presence of off-stream water sites in continuously stocked pastures. Off-stream water sources were located at a minimum distance of 730 feet from the stream in the upland portion of the pastures on both sides of the stream. Cow herd location, number of cattle in the herd, and observed defecations and urinations were recorded at 10 minute intervals during observations.

To record cattle distribution with GPS collars, a GPS collar (AgTraX[tm] - BlueSky Telemetry, Aberfeldy, Scotland) was placed on one cow per pasture for approximately 2 weeks in each month from May through September. Collars were programmed to record cattle position data at 10 minute intervals for 24 hours per day during the 2 week period. In 2005, GPS collar data sets were not complete due to technical difficulties, and, therefore, only 2006 and 2007 GPS collar data are presented. Cattle location was determined using position data from GPS collars and ArcGIS 9.1 software. For time periods in which GPS collars were unable to record cattle position, the position was assumed to be the same as the previous reading. In 2006 and 2007, the effects of off-stream water on cattle distribution was evaluated by providing access of off-stream water to cows during the second week in which GPS collars were attached to the cows in May, July, and September.

Using GPS data, cattle location was defined as within stream (stream), 0 to 110 ft (110) from the stream, 110 to 220 ft (220) from the stream, and greater than 220 ft (upland) from the stream. The 110 zone was approximately the same width as the riparian paddock in the RS pastures and the grazing exclusion area in the CSR pastures. The 220 zone included the remainder of the riparian area. The stream, 110, 220, and upland zones were 1.1, 6.1, 6.1, and 86.8% of the total pasture area, respectively.

Data were analyzed using the GLM procedure of SAS. Values reported are LSmeans. Means are considered different at $P<0.05$ with a tendency for a difference at $P<0.10$.

Results and Discussion

Cattle Distribution – Visual Observation

In June, July, and August, cattle managed by continuous stocking with unrestricted stream access spent a greater ($P<0.05$) amount of time within the stream than did cattle managed by rotational stocking or continuous stocking with restricted stream access (Table 1). In every month except September, cattle managed by continuous stocking with unrestricted stream access spent a greater proportion of time within 110 feet of the stream. Time spent in or within the stream did not differ between cows provided restricted access to the stream or those grazing by rotational stocking.

Cattle Distribution – GPS Collars

In May, June, and August, cattle managed by continuous stocking with unrestricted stream access spent a greater ($P<0.05$) proportion of their time within the stream than did cattle managed by either rotational stocking or continuous stocking with restricted stream access (Table 2). In May, June, and July, cattle managed by continuous stocking with unrestricted stream access also spent a greater ($P<0.05$) proportion of their time within 110 feet of the stream than did cattle managed by either of the other grazing management treatments. Although cattle managed by continuous stocking with unrestricted stream access spent more time in or near the stream than cows in other treatments, in no month did cows with unrestricted stream access spend more than 2.4% of their time in the stream or more than 13.5% of their time within 110 feet of the stream. The proportion of time cows grazing by continuous stocking with restricted stream access or rotational grazing spent in or within 110 feet of a stream did not differ.

The proportion of time which cattle managed by continuous stocking with unrestricted stream access spent within the stream or within 110 feet of the stream were greater than the proportion of time cattle managed by other practices are when determined by either visual observation or GPS collar data. However, visual observation data tended to overestimate the proportion of time cattle spend within these zones compared to GPS collar data. This difference is likely due to observations being conducted during daylight hours only, while GPS collar data is collected 24 hours per day. With warmer temperatures during the daylight hours, cattle are more likely to congregate near the stream in an attempt to regulate body temperature.

Alternative Water

Pooled data from 2006 and 2007 failed to show that the presence of off-stream water would decrease the proportion of time cattle spent with or near a pasture stream (Table 3). This result contrasts 2006 data which found the presence of an alternative water source would significantly decrease the proportion of time cattle spent within the stream when managed by continuous stocking with unrestricted stream access. The difference in response may have resulted from the presence of small ponds and gullies in the pastures that may have acted as natural sources of off-stream water in 2007.

Defecation Patterns

Distribution of observed defecations by cattle within pasture zones was highly associated ($R^2 = 0.99$, slope = 1.0) with cattle distribution patterns during the 2005 grazing season (Fig. 1). This result indicates that if GPS collars are used to monitor cattle distribution, instead of visual observation, it can be assumed that cattle will defecate in pasture areas in proportion to the amount of time which they spend in each area.

Microclimate

At higher ambient temperatures, cattle distribution patterns within pastures were altered in an attempt to regulate body temperatures. As black globe temperature increased, the proportion of time cattle spent in the shade increased in pastures grazed by continuous stocking with unrestricted stream access (R^2=0.92, Fig. 2). At ambient temperatures above 80°F, the proportion of time cattle spent within 110 feet of the stream increased (R^2=0.85, Fig. 3) when cattle were managed by continuous stocking with unrestricted stream access. This response was not observed if cattle grazing by continuous stocking with restricted stream access (R^2=0.16, Fig. 4).

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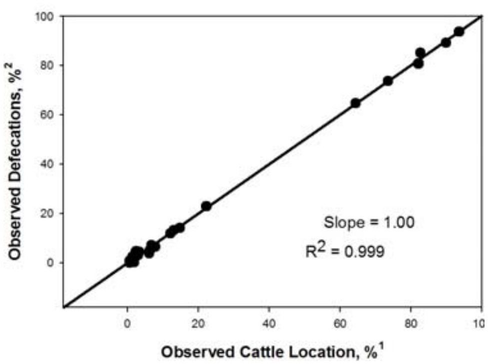

Figure 1. Relationship between cattle distribution and the distribution of observed defecations.

[1]Proportion of time cattle were observed within 4 pasture zones (stream, 110, 220, and upland) in pastures managed by continuous or rotational stocking during the 2005 grazing season.

[2]Proportion of observed defecations by cattle within 4 pasture zones (stream, 110, 220, and upland) in pastures managed by continuous or rotational stocking during the 2005 grazing season.

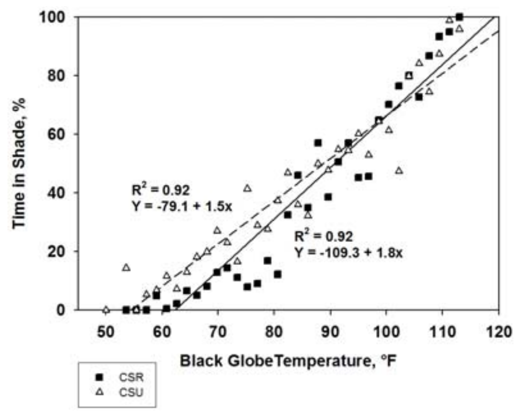

Figure 2. Effect of black globe temperature on the proportion of time cattle spend in the shade.

[1]CSR = Continuous stocking with restricted stream access, CSU = Continuous stocking with unrestricted stream access.

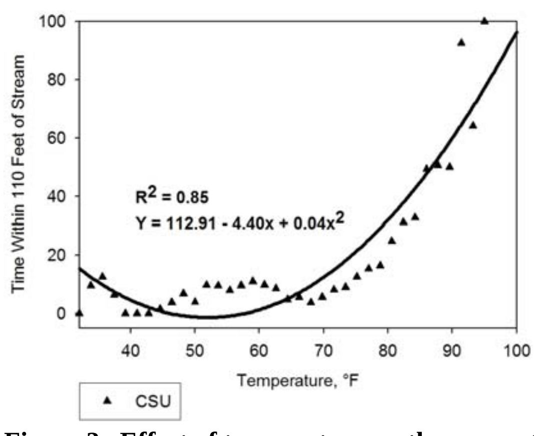

Figure 3. Effect of temperature on the proportion of time cattle spend within 110 feet of a pasture stream when access to the stream is unrestricted (CSU).

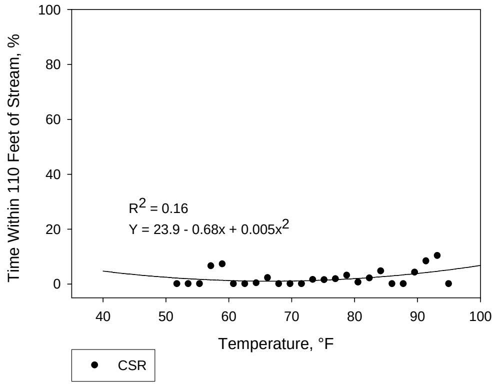

Figure 4. Effect of temperature on the proportion of time cattle spend within 110 feet of a pasture stream when access to the stream is restricted (CSR).

Table 1. Proportion of time cattle spent within different pasture zones from May through September (Visual observation pooled across 2005, 2006, and 2007 data.)

	May				June				July			
	Stream[1]	110	220	Upland	Stream	110	220	Upland	Stream	110	220	Upland
CSU[2]	1.6[a]	18.4[a]	4.8[b]	75.3	9.5[a]	14.1[a]	5.5	70.7[b]	10.5[a]	12.8[a]	4.0	72.7
RS	0.0[b]	1.0[b]	17.3[a]	81.8	0.0[b]	0.2[b]	8.6	91.2[a]	0.0[b]	0.0[b]	12.1	87.9
CSR	0.9[ab]	1.3[b]	7.3[ab]	90.5	1.1[b]	0.7[b]	7.9	90.5[a]	1.5[b]	0.3[b]	11.2	87.1
Trt	.05	.05	.05	.06	.05	.05	NS	.05	.05	.05	NS	NS

	August				September			
	Stream	110	220	Upland	Stream	110	220	Upland
CSU	6.5[a]	11.9[a]	6.0	75.6[b]	2.6	21.3	6.7	69.4
RS	0.0[b]	0.0[b]	3.1	96.9[a]	1.5	16.4	11.4	70.8
CSR	1.2[b]	0.8[b]	7.6	90.4[a]	1.5	0.8	10.9	86.8
Trt	.05	.05	NS	.05	NS	NS	NS	NS

[ab]Values with different superscripts within a column differ ($P<0.05$).
[1]Stream = Within the stream, 110 = from the edge of the stream to 110 feet from the stream, 220 = from 110 feet to 220 feet away from the stream, Upland = greater than 220 feet from the stream.
[2]CSU = continuous stocking with unrestricted stream access, RS = rotational stocking, CSR = continuous stocking with restricted stream access.

Table 2. Proportion of time cattle spent within different pasture zones from May through September (GPS Collar pooled across 2006 and 2007 data).

	May				June				July			
	Stream[1]	110	220	Upland	Stream	110	220	Upland	Stream	110	220	Upland
CSU[2]	0.5[a]	13.5[a]	4.4	81.7[a]	2.1[a]	10.7[a]	4.5	82.7	2.4	11.0[a]	3.7	83.0
RS	0.0[b]	0.6[b]	6.9	87.7[ab]	0.0[b]	0.5[b]	7.5	92.0	0.0	0.5[b]	9.8	89.8
CSR	0.1[b]	1.2[b]	11.8	91.9[b]	0.1[b]	1.7[b]	6.5	91.8	0.6	2.1[b]	5.2	92.1
Trt	.05	.05	.08	.05	.05	.05	NS	.06	NS	.05	NS	NS

	August				September			
	Stream	110	220	Upland	Stream	110	220	Upland
CSU	0.6[a]	7.5	5.2	86.7	0.2	10.1	10.0	79.7
RS	0.0[b]	0.1	0.5	99.4	0.2	6.1	13.7	80.1
CSR	0.0[b]	1.1	6.7	92.3	0.1	1.8	8.0	90.1
Trt	.05	NS	.09	.09	NS	NS	NS	NS

[ab]Values with different superscripts within a column differ (P<0.05).
[1]Stream = Within the stream, 110 = from the edge of the stream to 110 feet from the stream, 220 = from 110 feet to 220 feet away from the stream, Upland = greater than 220 feet from the stream.
[2]CSU = continuous stocking with unrestricted stream access, RS = rotational stocking, CSR = continuous stocking with restricted stream access.

Table 3. Effect of an alternative water source on the proportion of time cattle spend in different pasture zones (GPS Collar Data pooled across 2006 and 2007)

	May				July				September			
	Stream[1]	110	220	Upland	Stream	110	220	Upland	Stream	110	220	Upland
	Continuous Stocking Unrestricted Stream Access											
No Alternative Water	0.6	12.1	4.5	82.8	3.2	12.8	3.8	80.2	0.2	9.7	8.8	81.4
Alternative Water	1.8	8.2	1.5	88.4	0.6	7.7	6.4	85.3	0.1	7.9	13.2	78.9
	Continuous Stocking Restricted Stream Access											
No Alternative Water	0.1	1.0	5.1	93.8	0.4	2.2	5.6	91.8	0.0	2.3	7.5	90.2
Alternative Water	0.0	0.9	4.0	95.0	0.0	0.9	4.7	94.4	0.0	1.7	15.0	83.3
Water	NS	NS	.05	.05	NS	NS	NS	NS	NS	NS	NS	NS
Trt x Water	.07	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[1]Stream = Within the stream, 110 = from the edge of the stream to 110 feet from the stream, 220 = from 110 feet to 220 feet away from the stream, Upland = greater than 220 feet from the stream.