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 two blocks and assigned one of three treatments: continuous stocking - unrestricted stream access (CSU), continuous stocking - restricted stream access (CSR), and rotational stocking (RS). In May and July of 2005 and 2006, and September 2006, constructed off-stream water sites, located in the upland portion of the pastures, were made available to cattle in the CSU and CSR pastures for one week. When no constructed off-stream water was available in the CSU pastures, cattle spent 6.2 and 9.0% of their time in the stream in 2005 and 2006, respectively, and 15.0 and 19.1% within 110 feet of the stream in 2005 and 2006, respectively. In both years, cattle spent a smaller proportion of time in the stream and within 110 feet of the stream in the RS and CSR pastures than in the CSU pastures. In 2005, constructed off-stream water did not alter cattle distribution. In 2006, constructed off-stream water decreased the proportion of time cattle in CSU pastures spent in the stream in July. Patterns of defecation and urination distribution followed that of cattle distribution. Compared to CSU, RS and CSR are potential management strategies for decreasing the proportion of time cattle spend in or near streams. The presence of an off-stream water source may be effective in reducing the time cattle spend in or near streams.

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 the 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.

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, 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 two 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 four inches or for a maximum of four 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 (BW = 1428 and 1271 lb in 2005 and 2006, respectively) from mid-May through mid-October in 2005 and 2006.

Cattle distribution patterns were monitored by visual observation and with Global Positioning System (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. 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 and May, July, and September of 2006 after cows were allowed one 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. 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.

A GPS collar (AgTraX^{tm} - BlueSky Telemetry, Aberfeldy, Scotland) was placed on one cow per pasture for approximately two 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 two week period. In 2005, GPS collar data sets were not complete due to technical difficulties, and therefore, only 2006 GPS collar data are presented. Cattle location was defined as was described for visual observation data. Cattle location was determined using position data from GPS collars and ArcView 3.3 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.

Data were analyzed using the general linear model (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

During the 2005 and 2006 grazing season, the mean proportion of observed time that cattle were in the stream or the 110 zone was greater (P<0.05) in CSU pastures than in CSR or RS pastures (Table 1). As a result of the differences, the amounts of time cattle spent in the upland areas of pastures with RS or CSR were greater than CSU pastures. Mean percentages of time spent in the stream, determined by visual observation, were unaffected by either month or treatment by month interactions in 2005. However, in 2006, cattle spent a greater (P<0.05) amount of observed time in the stream in July (7.7% of observations) than in May (0.5% of observations) with the other months being intermediate. No effect of month on cattle distribution was observed in the other pasture zones. Mean distribution patterns of observed defecations and urinations (Table 2) resembled the pattern of cattle distribution in 2005. The proportions of observed defecations and urinations in or within 110 feet of the stream were greater in pastures with CSU than in CSR or RS pastures.

In 2005, significant treatment by month differences existed for the percentage of time cattle spent in the 110 foot zone. Cattle in the CSU pastures spent greater than 20% of their time in the 110 foot zone during May and September, and less than 8% of their time in this zone during July and August. The percentages of time cattle spent in this zone were between 10 and 20% for the rest of the months. In the CSR management system, cattle spent approximately 1% of their time in the 110 foot zone for all months. Cattle managed by the RS treatment spent 46% of their time in the stream during September, while during the other months the cattle spent little time in the stream in the RS treatment. However, these differences were related to the location of the cattle in the rotation when observations were taken. Based on the number of days that the riparian paddocks were actually stocked, cattle were present in the riparian paddocks for 0.0, 13.3, 0.0, 9.6, 8.3, and 0.0% of days in May, June, July, August, September, and October.

In 2006, significant treatment by month differences existed for the amount of time cattle spent in the stream, but not in other pasture locations. Cattle in the CSU pastures spent 21% of their time in the stream in July which was greater (P<0.05) than the amount of time cattle spent in the stream in any other month or grazing management treatment. In this same month, cattle in the CSU pastures spent an additional 24% of their time with 110 feet of the stream. Cattle in the RS pasture were observed to have not spent any time in the stream in any month as a result of cattle not being in the riparian paddock during the observation periods. The riparian paddock of the RS pastures were stocked for 9 days during the 2006 grazing season, allowing cattle to spend a maximum of 5.8% within the stream or 110 zone over the entire grazing season.

As in the 110 zone, significant treatment by month interactions existed for the percentage of time cattle spent in the 220 zone in 2005. In RS treatment, cattle spent about 20% of their time in the 220 foot zone during May, June, and September and no time in this zone during the remaining months of 2005. In the CSU and CSR treatments, cattle spent from 3 to 16% of their time in the 220 foot zone depending on month. No treatment by month interaction occurred for the percentage of time cattle spent in the 220 foot zone in 2006.

In 2005, cattle in the CSU pastures spent less time (74%) in the upland zone than in either the RS (82%) or CSR (88%) pastures. In 2006, cattle spent less time in the uplands of the CSU pastures (65.7%) than either the RS (82.9%) or CSR (86.5%) pastures. No effect in treatment by month existed for the amount of time spent in the upland zone in either year.

Cattle Distribution – GPS Collars

GPS collar data showed no treatment effect on the percentage of time that cattle spent in the stream over the grazing season in 2006. However, there was a slight tendency (P=0.07) for cattle in the CSU pastures to spend more time (1.5%) in the stream than for the CSR (0.4%) and RS (0.0%) pastures (Table 3). Cattle in the CSU pastures spent more (P<0.05) time in the 110 foot zone (11.1%) than cattle in the remaining treatments (0.5 and 2.4% for the RS and CSR treatments respectively). Cattle in the RS pastures spent more (10.6%; P<0.05) time in the 220 foot zone than cattle in the CSU (5.7%) and CSR (8.0%) pastures.

There was no effect month, or month by treatment interactions on the amount of time cattle spent in either the stream or within 110 feet of the stream.

Differences between visual observation data and GPS collar data could be related to the GPS collars recording data over the entire day, while visual observations were only conducted during daylight hours of 0600 to 1800 hours. As the temperature cooled during the night, cattle were less likely to lounge in the stream to cool themselves. Because GPS collar data were also collected over a week period each month while observations were conducted for only two days, day-to-day variability in cattle distribution could also account for some of the difference between observation and GPS collar data.

Alternative Water

The availability of constructed sources of alternative water did not alter cattle distribution patterns in either May or July of 2005. In 2006, the presence of constructed alternative water sources decreased (P<0.05) the time cattle in the CSU treatment spent in the stream, but did not alter the amount of time cattle in the CSR pastures spent in the stream (Table 4). In both the CSU and CSR pastures, cattle spent less (P<0.05) time in the 110 zone when alternative water sources were available in the uplands. Neither the presence of alternative water nor water availability by grazing treatment interactions altered cattle distribution patterns in either the 220 or upland zones. Cattle spent the greatest (P<0.05) amount of time in the stream and 110 foot zone in July when an alternative water source was not available (Table 5). The differences in the effectiveness of off-stream water sources to alter cattle distribution sites in the 2005 and 2006 grazing seasons can largely be attributed to differences in precipitation patterns in the two years. In 2005, precipitation was sufficient to maintain small natural alternative water sources in the uplands of the pastures. In 2006, precipitation was below normal from May through July, resulting in dry natural water sources in the pasture uplands.

Results indicate that the use of rotational stocking and continuous stocking with limited cattle access to the stream will reduce the amount of time cattle spend in and near streams, thus reducing the potential for cattle to cause damage to the stream and reduce water quality. Similarly, the presence of either natural or constructed off-stream water sources seem effective in reducing the amount of time cattle spend in and near streams. Even when cattle had unlimited stream access, they did not average greater than 10% of their time in the stream in smooth bromegrass pastures in either year.

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Table 1. Mean percentages of visual observations that cattle were in different pasture zones during the 2005 and 2006 grazing seasons when no alternative water source was provided.

	RS[a]	CSU	CSR	
	% of observed time			
2005				
Stream[b]	0.9[c]	6.2[d]	2.1[c]	<0.05
110	7.9[c]	15.0[d]	1.0[c]	<0.05
220	9.5	5.1	8.9	NS
Upland	81.7[d]	73.6[c]	87.8[d]	<0.05
2006				
Stream	0.0[c]	9.0[d]	1.1[c]	<0.05
110	1.4[c]	19.1[d]	0.8[c]	<0.05
220	15.7	6.2	11.5	NS
Upland	82.9[d]	65.7[c]	86.5[d]	<0.05

[a]RS = Rotational stocking, CSU = Continuous stocking with unrestricted stream access, CSR = Continuous stocking with restricted stream access.
[b]Stream = in the stream, 110 = 0 to 110 feet from stream, 220 = 110 to 220 feet from stream, Upland = greater than 220 feet from stream.
[cd]Values within a row with different superscripts differ (P<0.05). Values reported are LSmeans.

Table 2. Mean percentages of observed defecations and urinations in different pasture zones during the 2005 grazing season when no alternative water source was provided.

	RS[a]	CSU	CSR	
	% of observed defecations			
Stream[b]	0.5[c]	4.6[d]	2.4[c]	<0.05
110	8.3[c]	14.9[d]	1.6[c]	<0.05
220	9.6	5.8	8.6	NS
Upland	81.6[d]	74.9[c]	87.4[d]	<0.05
	% of observed urinations			
Stream	2.1[c]	8.1[d]	0.1[c]	<0.05
110	6.3[c]	12.6[d]	2.3[c]	<0.05
220	10.1	5.9	9.4	NS
Upland	81.7[d]	73.5[c]	88.4[d]	<0.05

[a]RS = Rotational stocking, CSU = Continuous stocking with unrestricted stream access, CSR = Continuous stocking with restricted stream access.
[b]Stream = in the stream, 110 = 0 to 110 feet from stream, 220 = 110 to 220 feet from stream, Upland = greater than 220 feet from stream.
[cd]Values within a row with different superscripts differ (P<0.05). Values reported are LSmeans.

Table 3. Effect of grazing management on cattle distribution patterns during the entire grazing season as determined by GPS collars (2006).

	RS[a]	CSU	CSR	
	% GPS readings			
Stream[b]	0.0	1.5	0.4	0.07
110	0.5[d]	11.1[c]	2.4[d]	<0.05
220	10.6[c]	5.7[d]	8.0[cd]	<0.05
Upland	88.8	81.7	89.2	0.07

[a]RS = Rotational stocking, CSR = Continuous stocking with restricted stream access, CSU = Continuous stocking with unrestricted stream access
[b]Stream = within the stream channel, 110 = 0 to 110 feet from stream, 220 = 110 to 220 feet from stream, Upland = greater than 220 feet away from stream.
[cd]Values with different superscripts within a column differ (P<0.05). Values reported are LSmeans.

Table 4. Effect of grazing management and the availability of alternative water on cattle distribution patterns managed by CSU and CSR treatments during the 2006 grazing season.

	Stream	110	220	Upland
		CSR		
No Alternative Water, % of GPS readings	0.4[d]	3.6[cd]	7.9	88.2
Alternative Water, % of GPS readings	0.1[d]	1.1[d]	10.2	88.6
		CSU		
No Alternative Water, % of GPS readings	3.2[b]	16.5[b]	6.3	74.0
Alternative Water, % of GPS readings	1.6[c]	10.3[bc]	5.8	82.4
water[a]	< 0.05	< 0.05	NS	NS
water × trt	< 0.05	NS	NS	NS

[a]water = presence or absence of an alternative water source, water × trt = alternative water by grazing management treatment interaction, NS = no significant differences, P<0.05.
[bcd]Values with different superscripts within a column differ (P<0.05). Values reported are LSmeans.

Table 5. Effect of grazing management and the availability of alternative water on cattle distribution patterns managed by CSU and CSR treatments during the 2006 grazing season.

	Stream	110	220	Upland
		May		
No Alternative Water, % of GPS readings	0.4[d]	6.8[c]	5.9	86.8
Alternative Water, % of GPS readings	1.7[c]	7.0[c]	2.8	88.5
		July		
No Alternative Water, % of GPS readings	4.9[b]	17.5[b]	6.9	70.8
Alternative Water, % of GPS readings	0.7[cd]	3.6[d]	4.1	91.5
		September		
No Alternative Water, % of GPS readings	0.1[e]	5.9[c]	8.4	85.6
Alternative Water, % of GPS readings	0.1[e]	6.4[c]	17.1	76.5
water × mth[a]	< 0.05	< 0.05	NS	NS

[a]water × mth = alternative water by month effect, NS = no significant differences, P<0.05.
[bcde]Values with different superscripts within a column differ (P<0.05). Values reported are LSmeans.