

Microclimate Effects on the Temporal/Spatial Distribution of Beef Cows Grazing Cool-Season Grass Pastures by Different Management Practices

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Summary and Implications

Presence of cattle near pasture streams may increase the probability of bare ground and feces on streambanks and increase the risks of sediment, phosphorus, and fecal pathogen loading of water resources through direct deposition or transport in precipitation runoff. Management techniques such as providing off-stream water sources or managing cattle access to pasture streams through rotational stocking or use of stabilized stream access sites may limit the amount of time that the cattle spend near the stream, decreasing the risks of non-point source pollution. Six 30-acre cool-season grass pastures, bisected by a stream, were split into two blocks with three treatments per block. Treatments were: continuous stocking with unrestricted stream access (CSU), continuous stocking with access to the stream restricted to a 16-foot wide stabilized stream crossing (CSR), and rotational stocking (RS). Each pasture was stocked with 15 fall-calving Angus cows. For two weeks in each month from May through September, at least one cow in each pasture was fitted with a GPS collar programmed to record cow position at 10 minute intervals. Off-stream water was made available to cows in pastures with the CSU and CSR treatments for one week of the two-week position measurement period in each month. Each pasture was divided into four zones to analyze position data; in the stream or on the streambank (stream zone), 0 to 110 feet from the streambank (110 zone), 110 to 220 feet from the streambank (220 zone), and greater than 220 feet from the streambank (upland zone). The combination of the stream and 110 zones were defined as the streamside zone. Cattle in both RS and CSR pastures spent ($P < 0.10$) less time within the stream and 110 zones than CSU pastures in June and May, and July, respectively. Off-stream water availability had no meaningful effect on cattle distribution in the CSU and CSR pastures. With increasing temperatures, the probability that cattle were present in the streamside zone of CSU pastures increased more rapidly than CSR pastures.

Introduction

Allowing cattle to graze near a pasture stream reduces forage mass and height and increases the amounts of bare ground and feces on and near the streambanks, thereby, increasing the risks of sediment, phosphorus, and fecal pathogen loading of water sources. Management of stream access of grazing cattle by rotational stocking or restricting

stream access to stabilized sites may reduce the amount of time that cattle spend in and near the pasture streams. However, the capability of these management practices to deter cattle from congregating in and near pasture streams at varying climactic conditions needs greater study.

The objective of this study was to evaluate the relationships between climatic conditions, grazing management, and off-stream water on the temporal/spatial distribution of cattle within pastures.

Materials and Methods

Six 30-acre cool season pastures, containing primarily smooth brome grass and reed canary grass, were stocked with 15 fall-calving Angus cows from mid-May to mid-October during the 2008 and 2009 grazing seasons. A 463-foot reach of a continual-flowing stream bisected each pasture. Pastures were divided into two blocks with three treatments per block. Treatments included: continuous stocking with unrestricted stream access (CSU), continuous stocking with access to the stream restricted to a 16-foot wide stabilized stream crossing (CSR), or rotational stocking (RS). The approximate 2.25-acre riparian buffers surrounding the stream crossings in CSR pastures were not grazed. Rotationally stocked pastures were divided into five paddocks; four upland and one riparian. The riparian paddock was grazed to a minimum sward height of four inches or for a maximum of four days. Upland paddocks were grazed until half of the live forage was removed or for a maximum of 14 days. Live forage mass was estimated with a falling plate meter (4.8 kg/m^2) at 24 random locations upon the cattle's entry and exit of each paddock.

Each month during the grazing season, a global positioning system (GPS) collar was placed on at least one cow per pasture for a two week period of time. The collars were programmed to record the cow's location at 10 minute intervals with accuracy within 15 feet. Cow position was determined using ArcGIS version 9.2 computer software. Cattle positions were identified as being in one of four zones on either side of the stream including: the stream or on the streambank (stream zone); 0 to 110 feet from the streambank (110 zone); between 110 and 220 feet from the streambank (220 zone); and greater than 220 feet from the streambank (upland zone). The stream and 110 zones were combined to form the streamside zone when estimating the effects of climatic variables on cattle distribution.

Weather data were recorded using data loggers in a HOBO weather station in a central location of the pastures. The weather station measured ambient and black globe temperatures, wind speed and direction, relative humidity, dew point, and precipitation. Precipitation was also measured at two rain gauges on opposite ends of the pastures.

Off-stream water was available to the cattle in the CSU and CSR pastures at a minimum distance of 780 ft from the stream for one week of the two week period that cows were fitted with collars. Off-stream water was not provided to the cattle when the cows were not fitted with GPS collars unless environmental conditions limited cattle access to the stream. Stream access was limited during periods of high flow for 11 days in June and 1 day in July 2008 and periods of low flow for 2 days in September 2009. Phosphorus-free mineral was provided ad-libitum to the cattle in feeders near the off-stream water sites.

Cattle distribution was calculated as the proportion of total observations that cows were measured in each zone. Differences in the proportion of time cattle were in each zone in each month were analyzed by the MIXED procedure of SAS with year, treatment, and block in the model statement. The effects of off-stream water was analyzed using only the CSR and CSU treatments as the distribution of cows in the RS pastures was dependent on management of the grazing system. Repeated measures were used in the MIXED procedure of SAS due to using the same cow each month and the same pastures in each year. The relationship between cattle distribution and microclimatic variables was calculated as the probability of a cow being within the streamside zone using the LOGISTIC procedure of SAS.

Results and Discussion

Grazing Treatments

The periods in time which cattle were stocked in the riparian paddock did not match the time period that GPS collars were on the cattle except for September in 2009. Therefore, distribution statistics of CSR and CSU treatments in the months of May thru August were compared against the null hypothesis of being equal to zero to find statistical differences compared to the RS treatment. In June and August, time spent by cattle in the stream zone of the CSU treatment was greater ($P < 0.10$) than the RS treatment. Cattle presence in the stream zone was also less in the CSR treatment ($P < 0.10$) than the CSU treatment in August (Figure 1).

Cattle spent more time ($P < 0.10$) in the 110 zone in the CSU pastures than the CSR pastures in May, August, and September and the RS pastures in May and August (Figure 2). The proportion of time spent in the 220 zone was unaffected by treatment (Figure 3). Similarly, grazing management had minimal effects on cattle distribution in the upland zone. The only difference observed between treatments was in July, when cattle in the RS pastures spent less time ($P < 0.10$) in the upland zone than the CSR pastures (Figure 4).

Off-stream Water

In June, cattle in the CSU pastures spent more time ($P < 0.10$) in the stream when off-stream water was available than they did when off-stream water was unavailable (Figure 5). Similarly, cattle in pastures with the CSR treatment spent more time in the 110 zone in September

when off-stream water was available than when it wasn't available (Figure 6). However, off-stream water availability decreased the amounts of time cattle spent within in the 110 zone in May and September ($P < 0.10$) in the CSU treatment and in May of the CSR treatment (Figure 6). Also, time spent in the upland zone of both CSR and CSU treatments was less ($P < 0.10$) in June (Figure 8) when off-stream water was made available. The lack of effect or even detrimental effects of off-stream water on cattle congregation near pasture streams was not expected. But these results may have been affected by climatic conditions. In both years of the study, precipitation was in abundance throughout most of the grazing seasons. This precipitation provided natural off-stream water sources for the cattle throughout most of the study via small ditches and wet spots, possibly inhibiting the ability of off-stream water tanks to affect cattle distribution.

Microclimate effects

Climatic data were matched to cattle positions during the 2008 grazing season at each GPS recording. Several previously published heat indices were calculated from the climate data at each GPS measurement. Ambient temperature, black globe temperature, relative humidity, and the heat indices were analyzed statistically using the LOGISTIC procedure of SAS. Of the climatic variables tested, ambient temperature was found to most closely match the statistical model by having the lowest AIC value. Off-stream water did not significantly ($P > 0.10$) affect the mean probability of cattle presence within the streamside zone of the pasture (data not shown). However, differences were observed between grazing treatments ($P < 0.10$; Fig. 9). With each one degree Celsius increase in temperature, the estimated probability that cattle would be found within the streamside zone increased by 11.9 and 8.2% for CSU and CSR treatments, respectively.

Conclusion

This study has illustrated that using rotational stocking and restricting stream access through the use of stabilized stream crossings can reduce the amount of time that cattle spend near or in pasture streams in spite of increasing ambient temperatures. Also, although off-stream water has decreased the amount of time that cattle spend near pasture streams in other studies, it was not seen in this study.

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Figure 1. Mean proportions of time that cattle spent in the stream of pastures with continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) during the 2008 and 2009 grazing seasons. a = differences between CSU and CSR, b = differences between CSU and RS, c = difference between CSR and RS, ($P < 0.10$).

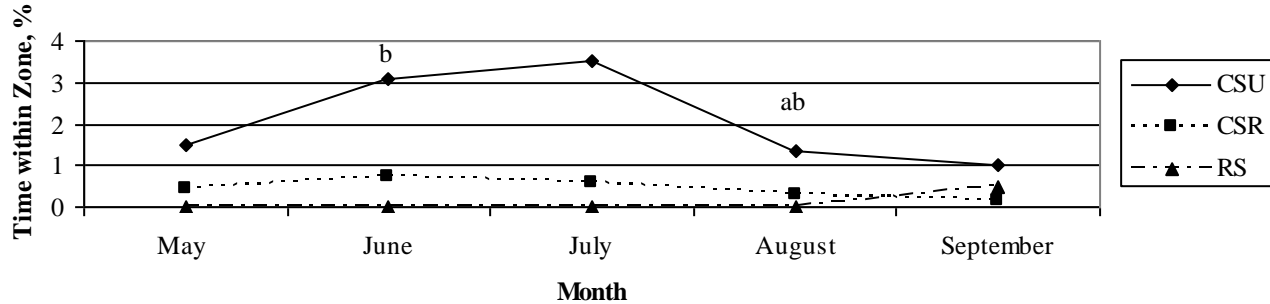


Figure 2. Mean proportions of time that cattle spent within the 110 foot zone of pastures with continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) during the 2008 and 2009 grazing seasons. a = differences between CSU and CSR, b = differences between CSU and RS, c = difference between CSR and RS, ($P < 0.10$).

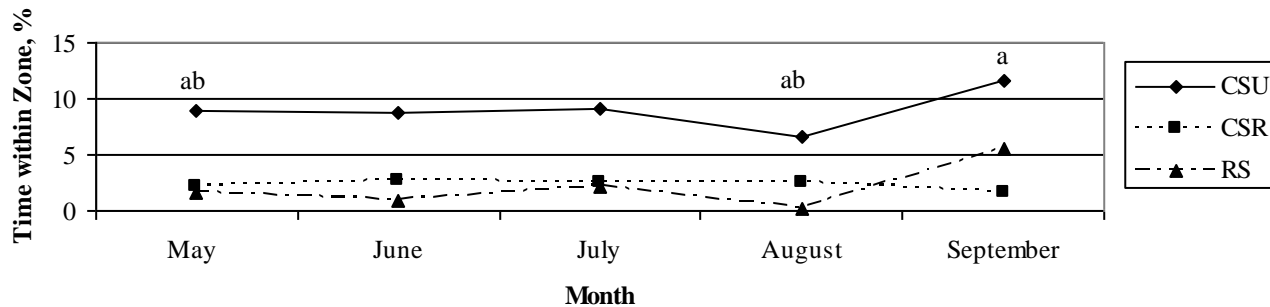
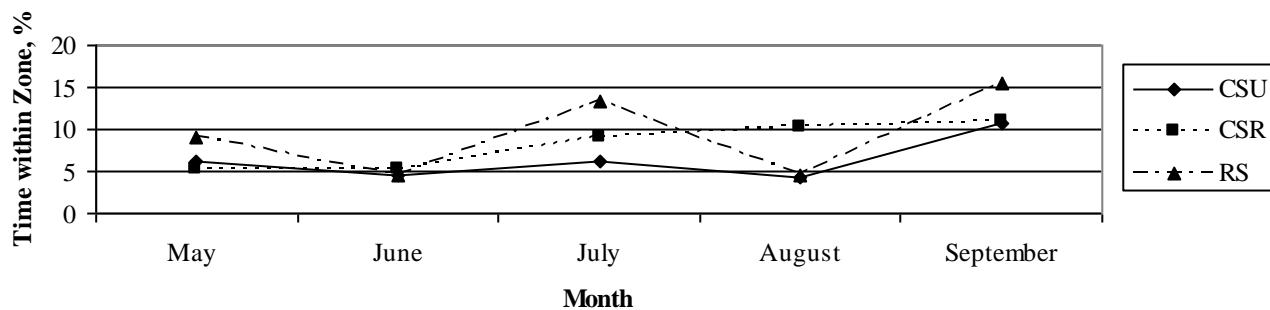


Figure 3. Mean proportions of time that cattle spent with the 220 foot zone of pastures with continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) during the 2008 and 2009 grazing seasons. a = differences between CSU and CSR, b = differences between CSU and RS, c = difference between CSR and RS, ($P < 0.10$).



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Figure 4. Mean proportions of time that cattle spent in the upland zone of pastures with continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) during the 2008 and 2009 grazing seasons. a = differences between CSU and CSR, b = differences between CSU and RS, c = difference between CSR and RS, ($P < 0.10$).

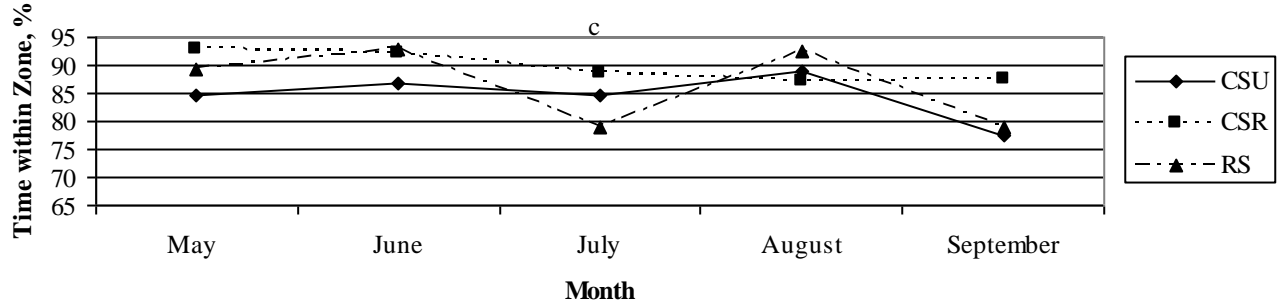


Figure 5. Mean proportions of time that cattle spent in the stream of pastures with or without off-stream water available with continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) during the 2008 and 2009 grazing seasons. a = differences between CSU closed and CSU open, b = differences between CSR closed and CSR open, ($P < 0.10$).

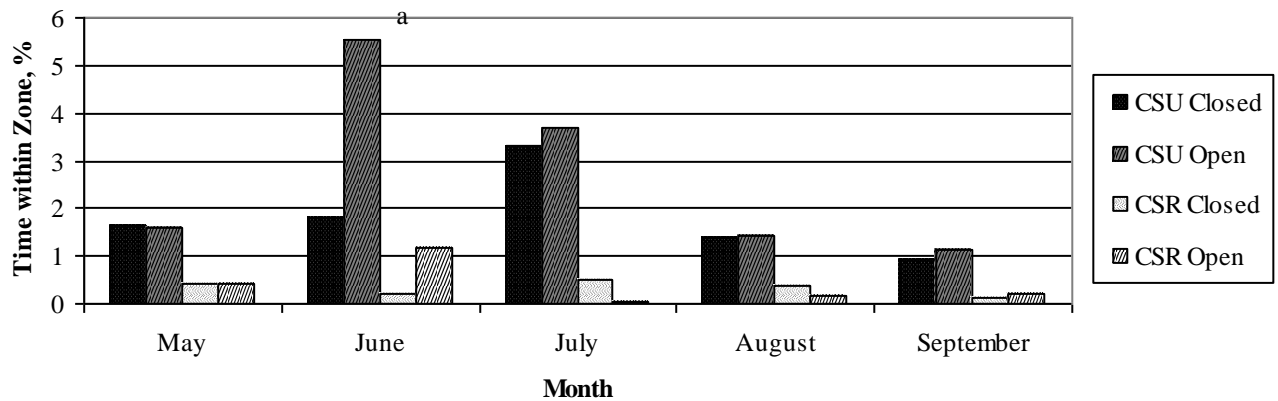


Figure 6. Mean proportions of time that cattle spent within the 110 zone of pastures with or without off-stream water available with continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) during the 2008 and 2009 grazing seasons. a = differences between CSU closed and CSU open, b = differences between CSR closed and CSR open, ($P < 0.10$).

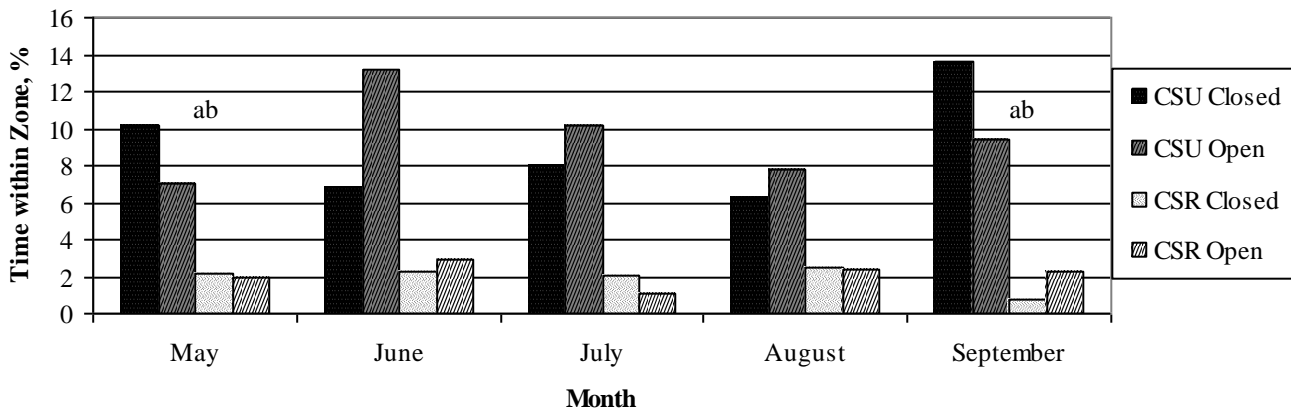


Figure 7. Mean proportions of time that cattle spent with the 220 zone of pastures with or without off-stream water available with continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) during the 2008 and 2009 grazing seasons. a = differences between CSU closed and CSU open, b = differences between CSR closed and CSR open, ($P < 0.10$).

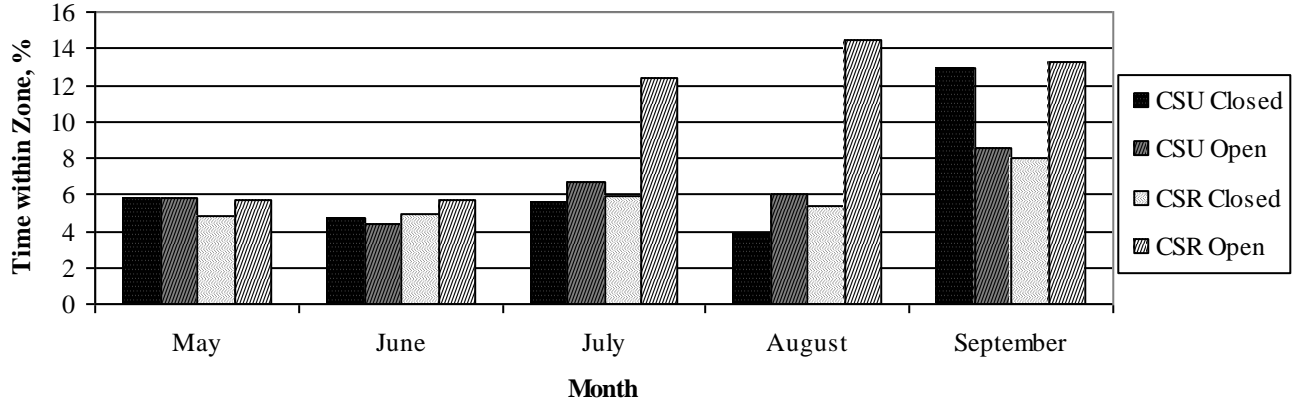


Figure 8. Mean proportions of time that cattle spent in the upland zone of pastures with or without off-stream water available with continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) during the 2008 and 2009 grazing seasons. a = differences between CSU closed and CSU open, b = differences between CSR closed and CSR open, ($P < 0.10$).

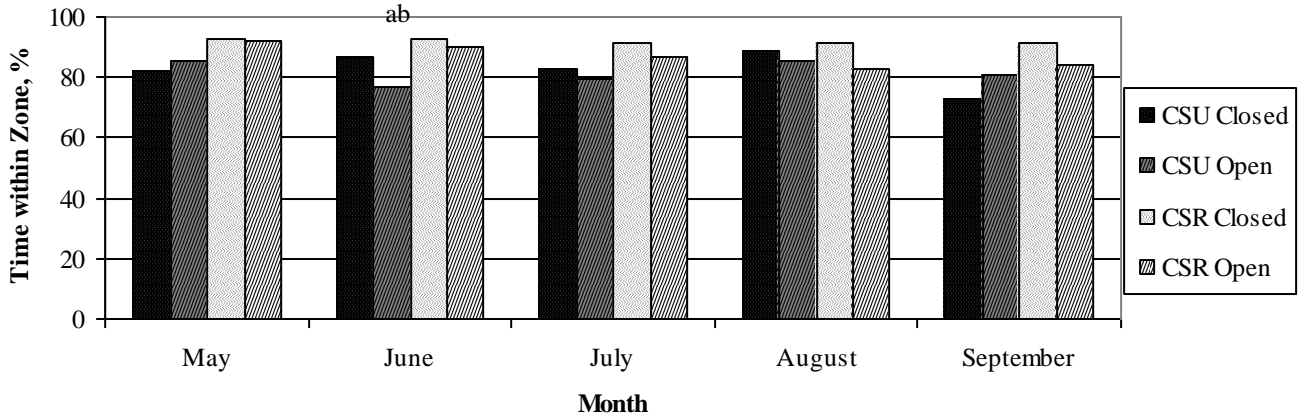


Figure 9. Estimated probability of cattle being within the streamside zone of pastures with continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR). ($P < 0.10$)

