Effects of Pasture Size on the Efficacy of Off-stream Water or Restricted stream Access to Alter the Spatial/Temporal Distribution of Grazing Cows

A.S. Leaflet R2692

Justin Bisinger, graduate assistant;
Jim Russell, professor of animal science

Summary and Implications

Cattle congregating near pasture streams decrease forage sward height and root mass and increase fecal cover, thereby, increasing the risk of sediment, nutrient, and pathogen loading of the streams. Restricting stream access to stabilized crossings or offering off-stream water may decrease the time cattle spend near or in pasture streams, in turn reducing the risk of water quality impairment. However, the effectiveness of these management practices may be affected by pasture size. In a two-year study, six 30-acre cool-season grass pastures bisected by a 475-ft stream reach on the Rhodes Research Farm were used to analyze the effects of pasture size on the efficacy of restricted stream access or off-stream water to alter the spatial/ temporal distribution of grazing cows in and near the pasture stream. Three grazing management treatments: unrestricted stream access without off-stream water (CSU), unrestricted stream access with off-stream water (CSUW), and restricted access to 16-ft wide stabilized crossings (CSR) were compared in two pasture sizes (10 and 30 acres) in five 4-week intervals with 2-week periods between May 18 and October 12 in 2010 and May 18 to October 8 in 2011. Five and fifteen fall-calving Angus cows were continuously stocked in each small and large pasture, respectively. At the beginning of each period two to three cows were fitted with GPS collars that recorded cow position every 10 minutes. Cows in small pastures with unrestricted stream access with or without off-stream water spent more ($P<0.05$) time in stream (0 to 16 feet from stream) and streamside (16 to 118 feet from stream) zones in small treatments than large treatments. Restricting stream access to stabilized stream crossings reduced the time cows spent in the stream and streamside zones compared to unrestricted stream access in small and large treatments. Regardless of pasture size, off-stream water had little effect on cow presence in the stream zone.

Introduction

If poorly managed, cows grazing riparian pastures may congregate in streams to meet needs for thermoregulation and thirst. As a result, sedimentation and fecal contamination of pasture streams may occur. However, the extent of this damage is related to the intensity, duration, frequency, and timing of grazing.

The proportion of time that cattle spend in or near pasture streams is reduced by restricting stream access to stabilized crossings. Off-stream water access has also reduced the percentage of time cattle spend in streams in some studies, but not in others. In previous studies, pasture size and shape have been shown to supersede the effects of shade distribution or botanical composition on cattle distribution. Therefore, pasture size may affect the efficacy of practices to manage the temporal/spatial distribution of cattle grazing in or near pasture streams. The purpose of this study was to evaluate the effects of pasture size on the efficacy of restricting stream access to stabilized crossings or providing off-stream water to influence the amount of time cattle spend in and near pasture streams.

Materials and Methods

Six 30-acre cool-season grass pastures each bisected by a 475-ft reach of Willow Creek in central Iowa were used to determine the effects of grazing management and pasture size on cattle distribution. The experiment was arranged as a 3 x 2 switchback design with three grazing management treatments (unrestricted stream access without off-stream water (CSU), unrestricted stream access with off-stream water (CSUW), and restricted access to 16-ft wide stabilized crossings (CSR) and two pasture sizes (10 and 30 acres) over five 4-week intervals. The 10-acre treatments were constructed in the center of the 30-acre treatments with temporary electric fence. Off-stream water sites in pastures with the CSUW treatment were an average of 888 and 424 feet from the stream in large and small treatments, respectively. A phosphorus-free mineral supplement was continually available ad libitum in feeders located near alternative water sites and at equivalent distances in the pastures without off-stream water. In May 18 through October 12 of 2010 and May 18 through October 8 of 2011, large and small pastures were continuously stocked with 15 and 5 fall-calving Angus cows, respectively, in mid-gestation.

Each interval was divided into two 2-week periods in which large and small treatments were switched within the same grazing management treatment. Pastures used for the CSU and CSUW treatments were switched between 2010 and 2011. At the beginning of each interval, two or three cattle in each pasture were fitted with collars with GPS receivers which recorded cow position at 10 minute intervals 24 hours per day for a 2-week period. At the end of each period, collars were removed, data downloaded, new batteries inserted, and the collar reattached to the cow. When the cattle returned to the pastures for the second 2-

week period of each interval, size treatments were rotated between pastures with the same grazing management treatment. Because dry conditions inhibited stream flow in 2011, all treatments were allowed off-stream water and data were not collected during interval 4.

Cattle position was determined on aerial maps using ArcGIS version 10 software. Two zones were used to evaluate cattle position data; the stream zone (0 to16 feet from the stream), and streamside zone (16 to 118 feet from the stream).

Microclimate data were measured with two HOBO weather stations placed near the center, and on the north end of the study pastures. Weather stations recorded ambient and black globe temperatures, wind speed and direction, relative humidity, dew point, and precipitation.

To monitor the effects forage height, mass, and quality may have on cattle distribution, forage sward heights were measured with a falling plate meter (8.8 lb/yd^2) biweekly, and in 2010 forage was hand-clipped from a .25-m^2 square at 6 sites within the fenced off area of each restricted stream access pasture. Biweekly forage samples in 2010 and falling plate meter measurements in 2010 and 2011 were also recorded at 16 sites in two sections in each pasture: 0 to 575 feet (within the center 10 acres of each pasture) and greater than 575 feet (within the outer 20 acres of each pasture) from the stream.

Cattle distribution was calculated as the proportion of total observations that cattle were in the stream or streamside zones. The MIXED procedure of SAS was used with a model that included grazing management treatment, pasture size, and the grazing management by size interaction by interval within year with pasture as the experimental unit. Differences between means with significant treatment effects were determined by the PDIFF procedure of SAS. The logistic procedure of SAS was used to analyze the effects of microclimatic variables on the probability of cattle presence in the stream or streamside zones of pastures with different size and grazing management treatments.

The probability of cattle presence in the stream, streamside, and within 16 feet of tree driplines at each heat index increment was calculated as an odds ratio equal to the proportion of total observations that cattle were in the stream and streamside zones at that heat increment in 2010 from May 18 to October 12. Heat indices were used to develop a model in SAS which included ambient temperature, black globe temperature, black globe temperature humidity index, heat level index, and temperature humidity index. Based on the Akaike's Information Criteria (AIC), ambient temperature provided the model of best fit, and is the basis for the microclimate effect results.

Results and Discussion

In 2010, cows spent less ($P<0.05$) time in the stream (Figure 1) and streamside (Figure 2) zones of large pastures grazed by the CSU and CSUW treatment in every interval when compared to cows in small pastures. The presence of off-stream water had no advantageous effects on the proportion of time that cows were present in the stream zone in large pastures (Figure 1). However in small pastures, cows spent more ($P<0.05$) time in the stream zone in intervals 2, 3, and 4 than in small pastures without access to off-stream water. Similarly, the presence of off-stream water increased ($P<0.05$) the proportion of time cows were present in the streamside zone of small pastures in interval 3 and 4 (Figure 2). However, in interval 5 cows spent less ($P<0.05$) time in the streamside zone with access to off-stream water in small pastures. Within small pastures, restricting stream access to stabilized crossings reduced ($P<0.05$) the proportion of time cattle were in the stream (Figure 1) and streamside (Figure 2) zones. By restricting stream access to stabilized crossings in large pastures. the proportion of time cows were in the stream zone (Figure 1) was reduced ($P<0.05$) in every interval, while the proportion of time cows were in the streamside zone (Figure 2) was reduced ($P<0.05$) only in intervals 1 and 2.

Similar to 2010, cows in small pastures spent more ($P < 0.05$) time in the stream (Figure 3) and streamside (Figure 4) zones than cows in large pastures in 2011. Because of dry conditions in interval 5 of 2011, stream flow was reduced which could have reduced the probability cows spending time in the stream zone of unrestricted stream access treatments (Figure 3). Access to off stream water had little effect on the time cows spent in the stream zone in large or small pastures. Similarly, off-stream water had little effect on the time cows spent in the streamside zone in large pastures (Figure 4). However, cows in small CSUW pastures spent more ($P < 0.05$) time in the streamside zone in interval 1 than small CSU pastures. Cows in CSR pastures spent less ($P < 0.05$) time in the stream zone compared to the CSU or CSUW treatments in small pastures in all intervals and in large pastures in intervals 1 and 2 (Figure 3). Similarly, the CSR treatment reduced ($P < 0.05$) the proportion of time cows spent in the streamside zone in small pastures in all intervals, but only in large pastures in interval 1 (Figure 4).

Across all treatments, the probability of cows presence in the pasture stream zone increased as the temperature increased in 2010 (Figure 5). Between pasture size treatments, the probabilities of cattle presence in the stream zone increased at a greater rate with increasing temperature in small pastures than large pastures ($P < 0.05$). Compared to CSU and CSUW treatments, cows in CSR treatments were less likely to spend time in the stream zone as temperature increased ($P < 0.05$). Access to off-stream water in large pastures with unrestricted stream access did not affect the probability of cattle presence in the stream zone with increasing temperature ($P > 0.10$). However, in small pastures, the probability of cattle presence in the stream zone increased at a lower (P < 0.05) rate as temperature increased in CSU compared to CSUW treatments. The probability of cattle presence within 16 feet of tree driplines increased in all paddocks as temperature increased. However, the probability of cattle presence within 16 feet of tree driplines was less in large CSUW pastures compared to other treatments.

Conclusion

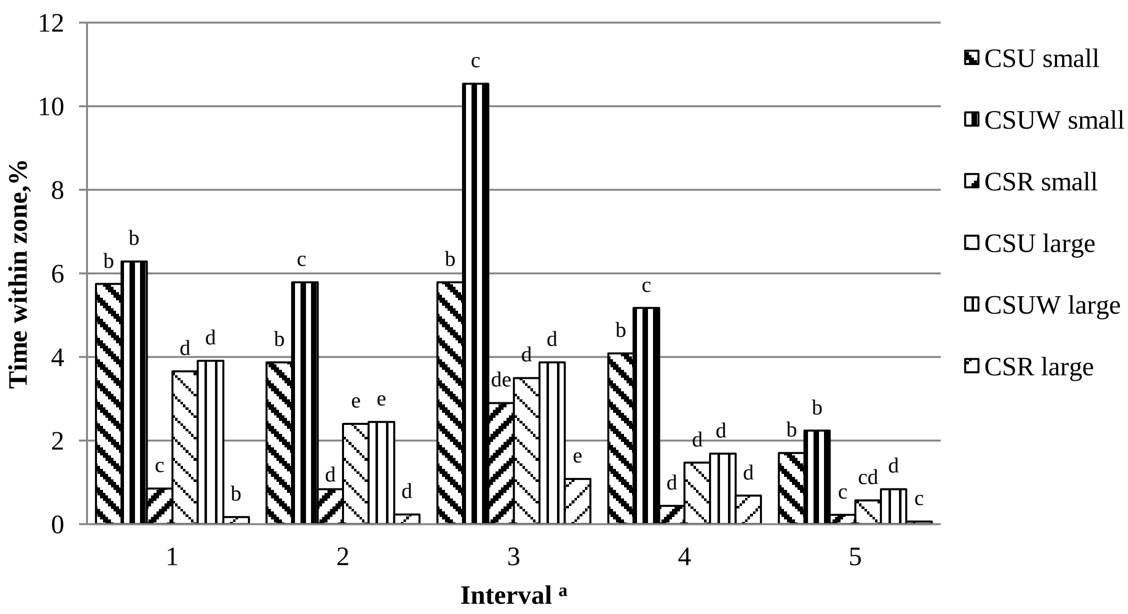
This study indicates pasture size is a major factor in the amount of time cows spend in or near pasture streams. Cows in small pastures spend more time in and near pasture streams, thereby, increasing the risk of non-point source pollution of pasture streams in comparison with large pastures. Off-stream water had little effect on cow distribution in and near streams in pastures with plentiful sources of natural stream water. However, restricting stream access to stabilized crossings is effective in reducing the time that cows spend in and near pasture streams in small pastures.

The inclusion of microclimate effects in the study analysis indicates an increase in temperature will increase the probability cows will spend time in stream and streamside zones. Therefore, increasing pasture size or restricting stream access to reduce congregation of cows in or near pasture streams becomes increasingly important at increased temperatures. However, further analysis of the microclimate effects and their interaction with shade presence is necessary to develop site-specific management practices to reduce the risk of non-point source pollution caused by the congregation of cows near pasture streams.

Acknowledgements

The authors would like to thank the undergraduate and graduate students that have helped with the data collection and analysis. This material is based upon work supported by the Leopold Center..

Figure 1. Mean proportions of time cattle spent in the stream zone of large (30 acre) or small (10 acre) pastures with continuous stocking with unrestricted stream access with access to off-stream water (CSUW), continuous stocking with unrestricted stream access (CSU), or continuous stocking with restricted stream access (CSR) during the 2010 grazing season.



[a] Intervals include: 1=May 18-June, 2=June 15-July 13, 3=July 13-August 10, 4=August 17-September 14, 5=September 14: October 12

[b-d] differences between pasture size and treatment (CSUW, CSU, CSR) means with different superscripts are significant (P<0.05)

Figure 2. Mean proportions of time cattle spent in the streamside zone of large (30 acre) and small (10 acre) pastures with continuous stocking with unrestricted stream access with access to off-stream water (CSUW), continuous stocking with unrestricted stream access (CSU), or continuous stocking with restricted stream access (CSR) during the 2010 grazing season.

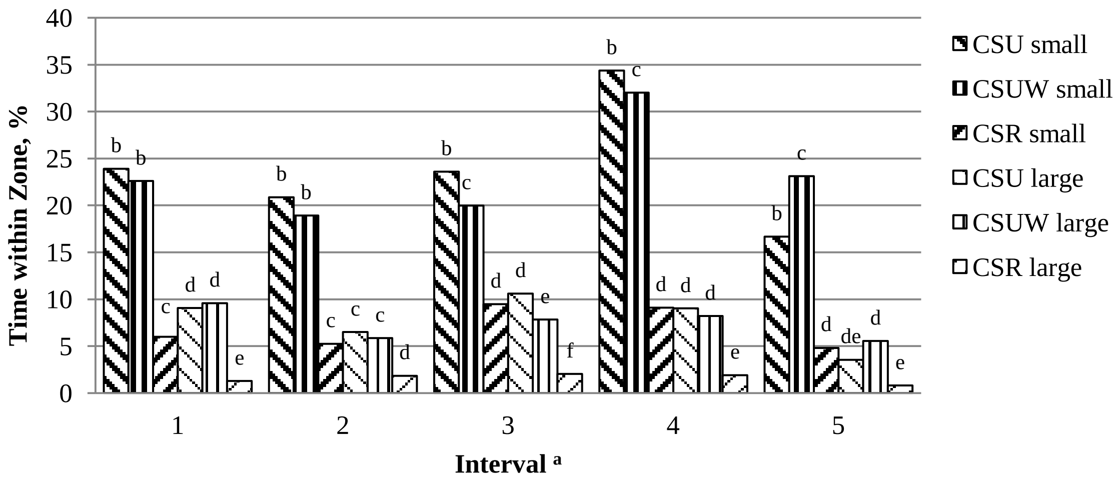


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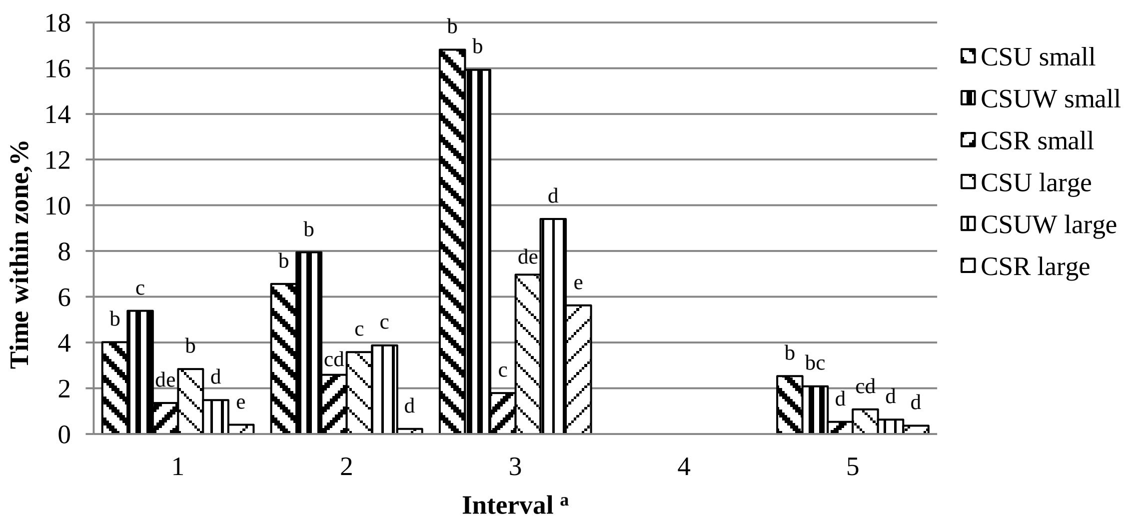
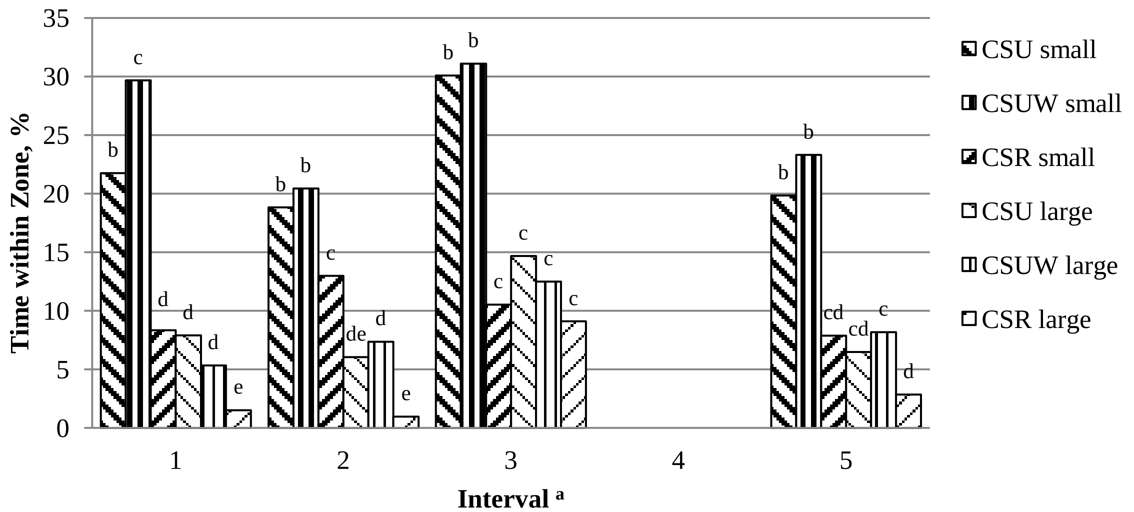
Figure 3. Mean proportions of time cattle spent in the stream zone of large (30 acre) and small (10 acre) pastures with continuous stocking with unrestricted stream access with access to off-stream water (CSUW), continuous stocking with unrestricted stream access (CSU), or continuous stocking with restricted stream access (CSR) during the 2011 grazing season.



[a] Intervals include: 1=May 18-June, 2=June 15-July 13, 3=July 13-August 10, 4=August 17-September 14, 5=September 14: October 12
[b-e] differences between pasture size and treatment (CSUW, CSU, CSR) means with different superscripts are significant (P<0.05)

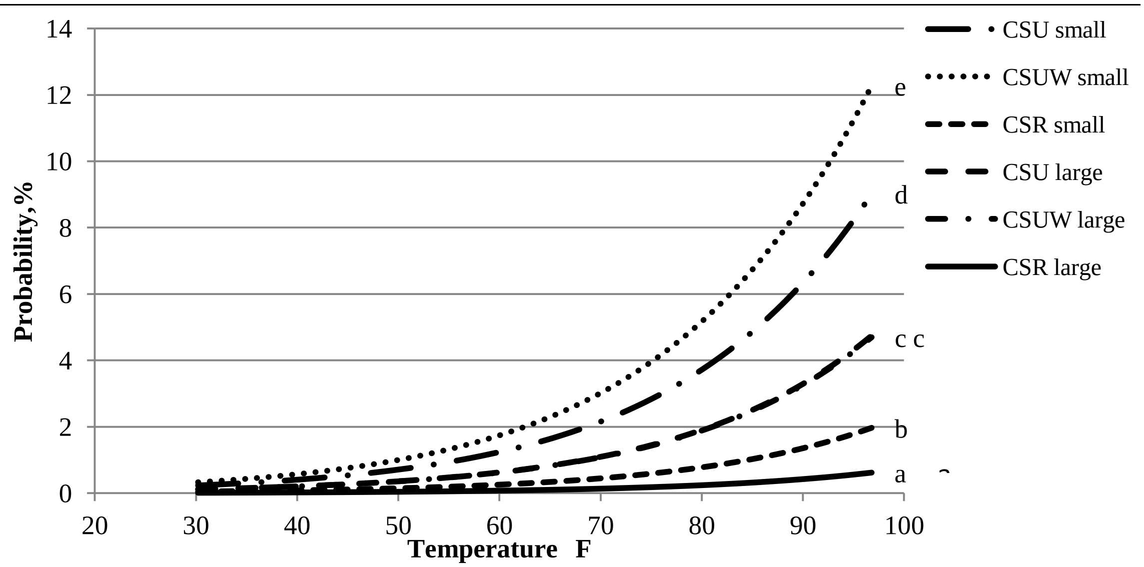
Figure 4. Mean proportions of time cattle spent in the streamside zone of large (30 acre) and small (10 acre) pastures with continuous stocking with unrestricted stream access with access to off-stream water (CSUW), continuous stocking with unrestricted stream access (CSU), or continuous stocking with restricted stream access (CSR) during the 2011 grazing season.



[a] Intervals include: 1=May 18-June, 2=June 15-July 13, 3=July 13-August 10, 4=August 17-September 14, 5=September 14: October 12

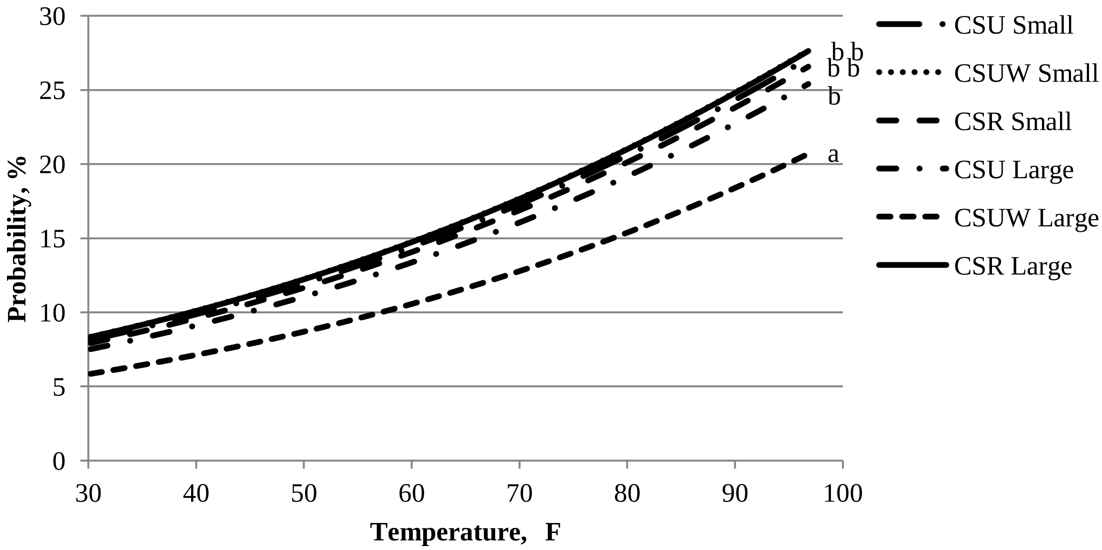
[b-e] differences between pasture size and treatment (CSUW, CSU, CSR) means with different superscripts are significant (P<0.05)

Figure 5. Probability of cows presence in the stream zone over the temperature range in large (30 acre) and small (10 acre) treatments with continuous stocking with unrestricted stream access with access to off-stream water (CSUW), continuous stocking with unrestricted stream access (CSU), or continuous stocking with restricted stream access (CSR) during the 2010 grazing season.



[a-e] Differences between pasture size and treatment (CSUW, CSU, CSR) means with different superscripts are significant (P<0.05)

Figure 6. Probability of cows presence within 16 feet of tree driplines over the temperature range in large (30 acres) and small (10 acres) treatments with continuous stocking with unrestricted stream access with access to off-stream water (CSUW), continuous stocking with unrestricted stream access (CSU), or continuous stocking with restricted stream access (CSR) during the 2010 grazing season.



[a-b] Differences between pasture size and treatment (CSUW, CSU, CSR) means with different superscripts are significant (P<0.05)