

Grazing Management Effects on Streambank Characteristics and Surface Run-off into Pasture Streams

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Summary and Implications

Grazing management practices in pastures can affect the sward and physical characteristics of riparian areas near pasture streams. These areas are prone to sediment, phosphorus, and fecal pathogen loading via surface run-off into the streams causing non-point source pollution of water sources. Six cool-season grass pastures were grazed by 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). For data and sample collections, pastures were divided into 2 zones: on the streambank (streambank zone) and 0 to 110 feet from the streambank (110 zone). Forage heights were measured and forage samples were collected from congregation and open areas in each zone to determine forage mass monthly from May to October. The percentages of bare and fecal-covered ground were also measured monthly at each sampling site. Simulated rainfall was applied on bare and vegetated areas on the streambanks of the pastures and the runoff was collected and measured to determine the amounts of total run-off and transport of sediment, phosphorus, and fecal pathogens. Forage height in the streambank and 110 zones was greater in CSR pastures than CSU pastures from July through October and June through October, respectively ($P < 0.10$). Likewise, CSR pastures maintained greater forage mass than CSU pastures in the streambank and 110 zones from September through October and July through October, respectively. Fecal ground cover was greater in the streambank and 110 zones in CSU and RS pastures than CSR pastures in June and October, and September, respectively ($P < 0.10$). Bare ground cover in the streambank zone was greater ($P < 0.10$) in CSU pastures than in CSR and RS pastures in September and October and in the 110 zone from July through September. The percentage of run-off from rainfall simulations and the amounts of total P transported in precipitation runoff were greater from bare ground than vegetated ground along streambanks across grazing treatments ($P < 0.05$).

Introduction

The number of impaired bodies of water in Iowa has increased by nearly 60% from 2006 to 2008 (DNR, 2009). Maintaining quality water sources in Iowa is necessary to provide sources of drinking water, fish habitat, and

recreation. Grazing cattle utilize pasture streams as a source of drinking water, as well as a way to manage heat stress in the summer months. These needs lead to increased grazing pressure caused by the congregation of cattle on the stream banks. This pressure can cause greater amounts of bare and fecal-covered ground and decreased sward heights and forage mass, which may increase the risks of non-point source pollution. The use of different grazing systems can reduce the amount of time that cattle congregate near streams and reduce the negative impacts caused by cattle grazing within these areas.

The objective of this project was to measure the effects of grazing management on forage and physical characteristics of riparian areas and sediment, phosphorus, and pathogen loading of streams in cool-season grass pastures.

Materials and Methods

Six 30-acre pastures containing smooth bromegrass and reed canarygrass and bisected by a stream near Rhodes, Iowa were split into two blocks of three treatments. Treatments included: continuous stocking with unrestricted stream access (CSU), continuous stocking with stream access restricted to a 16-foot wide stabilized stream crossing (CSR), or rotational stocking (RS). Riparian buffers on either side of the crossings in pastures with the CSR treatment were not grazed. The RS pastures were divided into 5 paddocks. Riparian paddocks were grazed to a minimum sward height of 4 inches or for a maximum of 4 days. Cattle in non-riparian paddocks were rotated when half of the available forage was removed or for a maximum of 14 days. Each pasture was stocked with 15 fall-calving Angus cows from mid-May to mid-October during the 2008 and 2009 grazing seasons. All pastures had been grazed by these treatments for the preceding three years.

Sward height, forage mass and the percentages of bare and fecal-covered ground were randomly measured in open and congregation areas on the streambanks (streambank zone) and from 0 to 110 feet from the streambank (110 zone) of each pasture monthly from May to October in both years. Congregation areas were determined as the areas under the drip-line of trees, stream access points, and adjacent to off-stream water and mineral supplementation sites. Sampling occurred at a maximum of 6 randomly selected locations in the congregation and open areas in both the streambank and 110 zones. Forage sward heights were measured using a falling plate meter (4.8 kg/m^2) and the percentages of bare and fecal-covered ground were measured using the line-transect method over 50 feet. Forage samples were collected by hand-clipping all forage within a 0.25-m^2 square to a height of one inch from the

ground. The proportion of congregation area in each zone in each pasture was measured in July of each year. Measurement averages in open and congregation areas were multiplied by the proportion that each area made of that zone, to give an overall average of that zone.

Simulated rainfall was applied to six vegetated and six bare sites in CSU and RS pastures and six vegetated sites in CSR pastures along the streambanks in June, August, and October of 2008. Rainfall was applied using drip-type simulators at a rate of three inches per hour for 1.5 hours on a 5.4 ft² area of streambank. Run-off was collected, recorded and added to a composite sample at 10 minute intervals. At the end of each simulation, the composite sample was sub-sampled and analyzed for sediment, phosphorus, and the presence of *Escherichia Coli* 0157:H7, Bovine Enterovirus, Bovine Coronavirus, and Bovine Rotavirus.

To measure differences between treatments for the rainfall simulations, data was analyzed using the MIXED procedure of SAS using treatment and month as independent variables. Estimate statements compared differences in bare treatments, bare and vegetated within treatments, and vegetated treatments where cattle were and were not allowed. Differences in sward height, forage mass, and bare and fecal ground cover were analyzed separately for each month in each zone using the MIXED procedure of SAS with block, treatment, and year in the model statement.

Results and Discussion

Sward Height and Forage Mass

Pastures with the CSU treatment had lower sward heights ($P < 0.10$) in the streambank zone than CSR pastures and RS pastures from July through October and August through September, respectively. Pastures with the RS treatment had lower sward heights than CSR pastures ($P < 0.10$) from August through September, in the streambank zone (Figure 1). Likewise, sward heights in the 110 zone of CSU pastures were lower than to CSR and RS pastures ($P < 0.10$) from June through October and June through August, respectively. Pastures with the CSR treatment had greater sward heights ($P < 0.10$) than RS pastures from July through September (Figure 2).

In the streambank zone, forage mass in CSR pastures was greater ($P < 0.10$) than CSU and RS pastures from September through October and in October, respectively (Figure 3). In the 110 zone, CSR pastures had greater forage masses ($P < 0.10$) than CSU and RS pastures from July through October and September through October, respectively. Pastures with the RS treatment had greater ($P < 0.10$) forage masses in the 110 zone than CSU pastures from July through September (Figure 4).

Fecal and Bare Ground Cover

Cattle were not allowed to graze in the streambank or 110 zone of CSR pastures, as their only access to these zones was through the 16-foot wide crossing covered in

rock. Therefore, by definition of this experiment, cattle feces was not expected to be found within the streambank or 110 zones in the riparian buffer except on the crossing access ramps. Due to this experimental design, the proportion of fecal-covered ground found in these zones in RS and CSU pastures were tested against the null hypothesis of being equal to zero to compare these treatments to CSR treatments.

Pastures with the CSU treatment had greater proportions of fecal-covered ground in the streambank zone than CSR pastures in June and October, and RS pastures in June ($P < 0.10$; Figure 5). Pastures with the CSU and RS treatments had greater fecal cover ($P < 0.10$) than CSR pastures in September in the 110 zone (Figure 6).

The proportions of ground that had no vegetative cover were greater ($P < 0.10$) in CSU pastures than in CSR and RS pastures in the streambank zone in September and October (Figure 7) and in the 110 zone from July through September (Figure 8).

Rainfall Simulation

The proportion of precipitation and the amounts of P lost in precipitation runoff were greater from bare than vegetated areas ($P < 0.05$) along streambanks across grazing management treatments (Figure 9 and 11). Similarly, bare areas in both CSU and RS pastures had greater ($P < 0.05$) sediment losses in the runoff than vegetated areas of CSR pastures (Figure 10). *Escherichia Coli* 0157:H7, Bovine Coronavirus, and Bovine Rotavirus were not detected in any runoff samples. However, Bovine Enterovirus was detected 8.3% and 16.7% of the runoff samples from bare areas in CSU pastures in June and October, respectively (data not shown).

Conclusion

Results of this study suggest that managing grazing to minimize the amount of bare area near streams can reduce the risks of sediment, phosphorus, and pathogen loading of pasture streams. This study also demonstrated that the risk of these nonpoint source pollutants may be minimized by increasing forage mass and sward height and decreasing bare area and fecal concentration near pasture streams by restricting cattle access to streams through the use of stabilized crossings or rotational grazing.

Acknowledgments

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Figure 1. Forage sward height in the streambank zone of pastures grazed 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 = CSU differs from CSR, b = CSU differs from RS, c = CSR differs from RS, ($P < 0.10$).

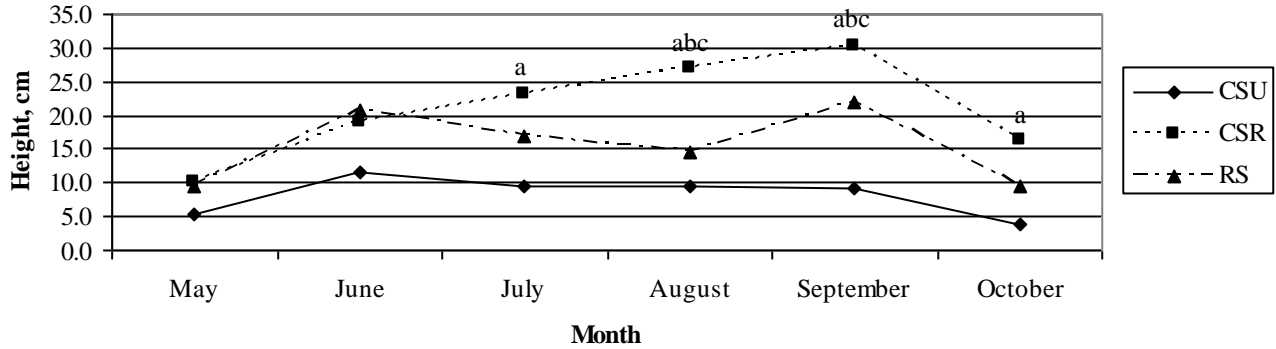


Figure 2. Forage sward height in the 110 zone of pastures grazed continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) during the 2008 and 2009 grazing seasons. a = CSU differs from CSR, b = CSU differs from RS, c = CSR differs from RS, ($P < 0.10$).

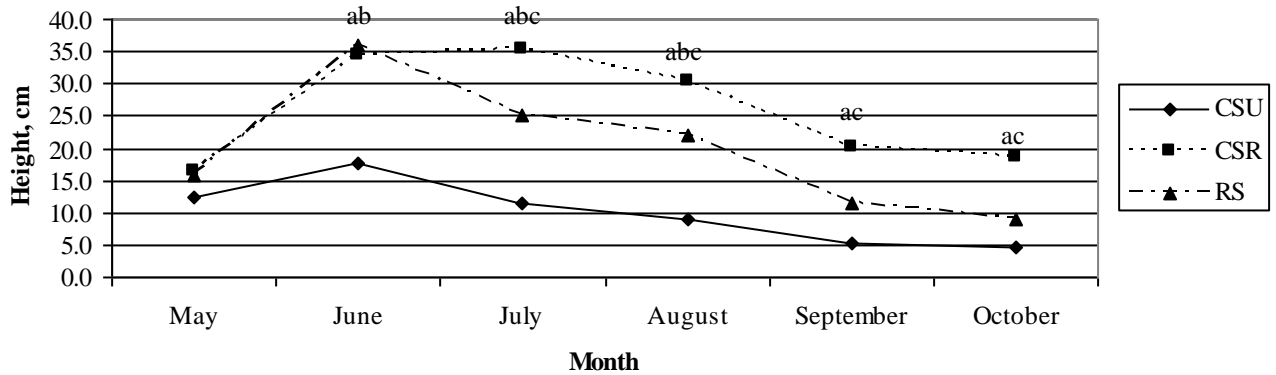


Figure 3. Forage mass in the streambanks zone of pastures grazed continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) during the 2008 and 2009 grazing seasons. a = CSU differs from CSR, b = CSU differs from RS, c = CSR differs from RS, ($P < 0.10$).

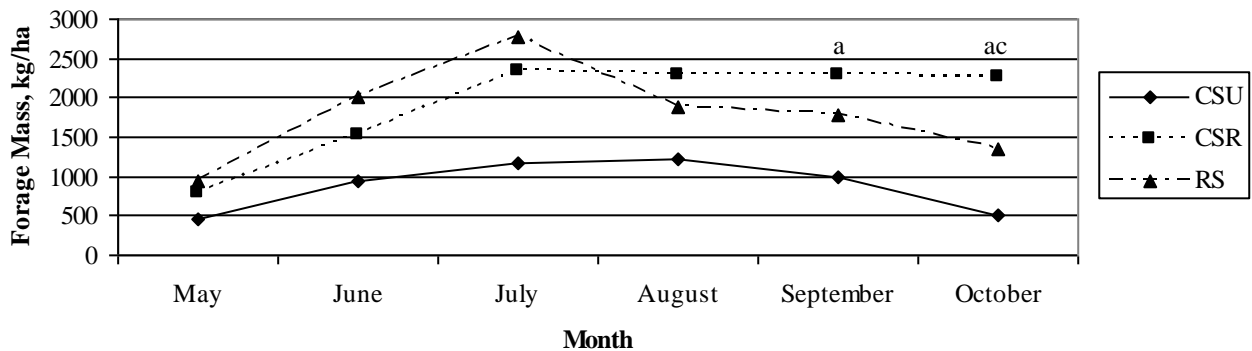


Figure 4. Forage mass in the 110 zone of pastures grazed continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) during the 2008 and 2009 grazing seasons. a = CSU differs from CSR, b = CSU differs from RS, c = CSR differs from RS, ($P < 0.10$).

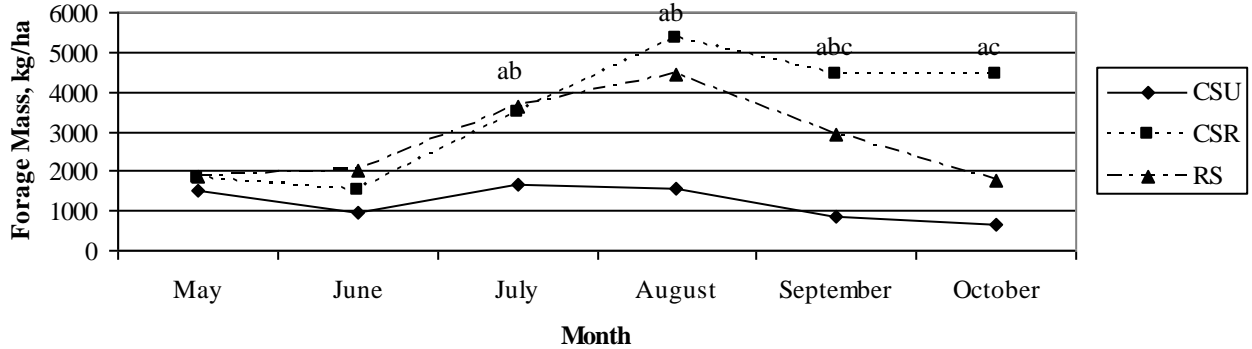


Figure 5. Fecal ground cover in the streambanks zone of pastures grazed continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) in the 2008 and 2009 grazing seasons. a = CSU differs from CSR, b = CSU differs from RS, c = CSR differs from RS, ($P < 0.10$).

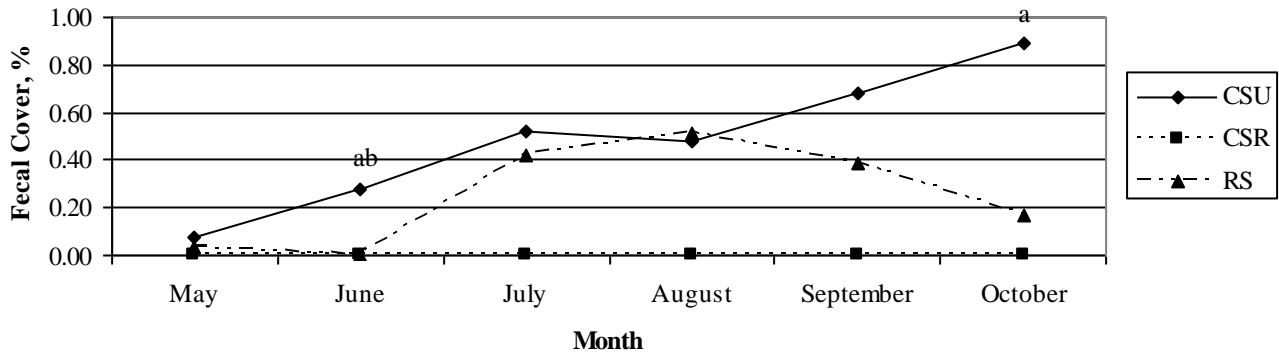


Figure 6. Fecal ground cover in the 110 zone of pastures grazed continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) in the 2008 and 2009 grazing seasons. a = CSU differs from CSR, b = CSU differs from RS, c = CSR differs from RS, ($P < 0.10$).

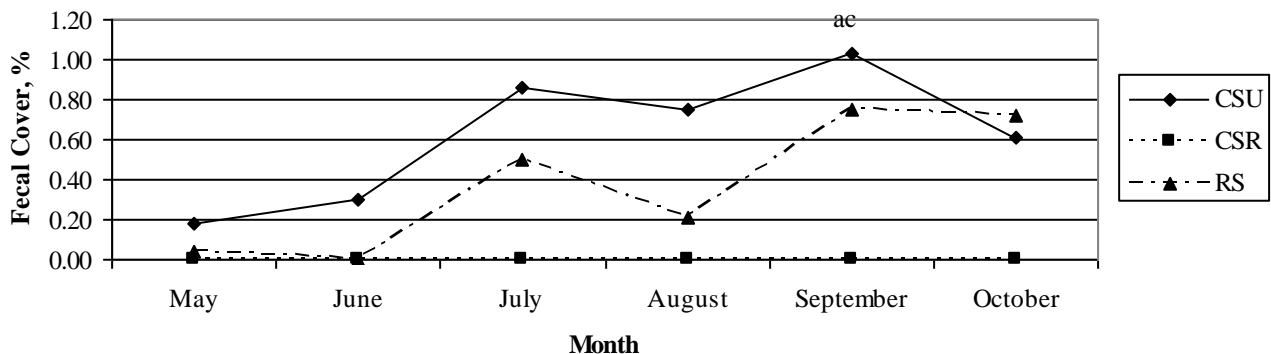


Figure 7. Bare ground in the streambanks zone of pastures grazed continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) in the 2008 and 2009 grazing seasons. a = CSU differs from CSR, b = CSU differs from RS, c = CSR differs from RS, ($P < 0.10$).

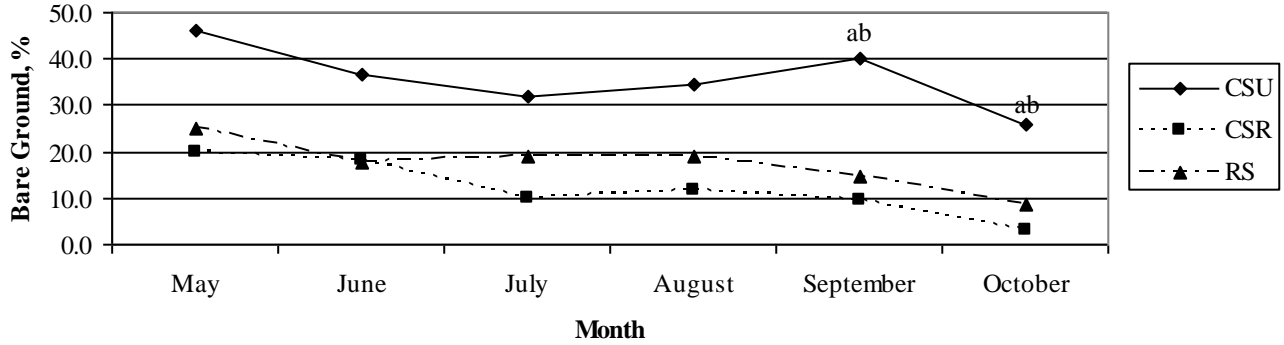


Figure 8. Bare ground in the 110 zone of pastures grazed continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) in the 2008 and 2009 grazing seasons. a = CSU differs from CSR, b = CSU differs from RS, c = CSR differs from RS, ($P < 0.10$).

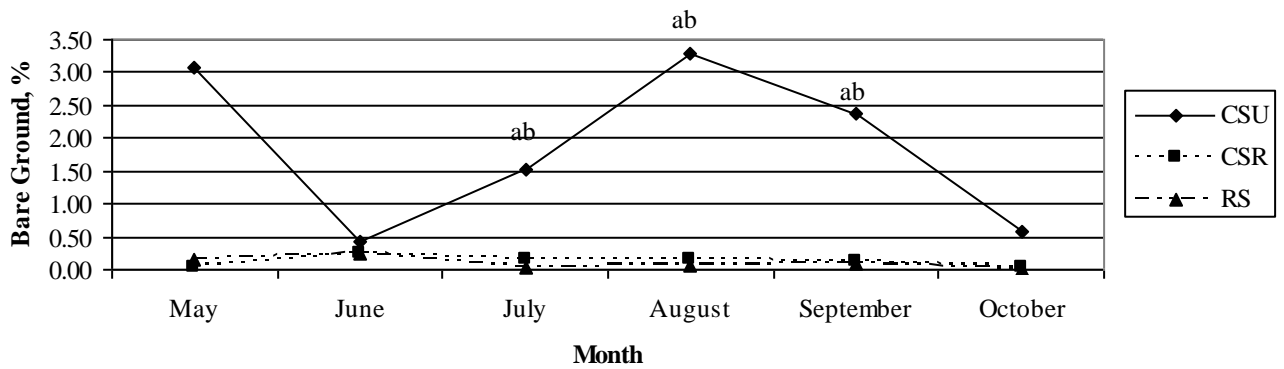


Figure 9. Percent runoff of applied water on areas of bare and vegetated cover in pastures grazed continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) in the 2008 and 2009 grazing seasons.

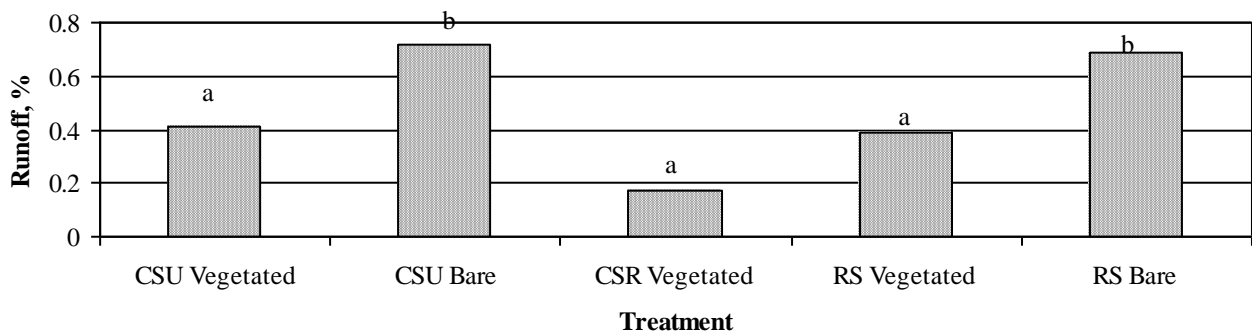


Figure 10. Sediment runoff on areas of bare and vegetated cover in pastures grazed continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) in the 2008 and 2009 grazing seasons.

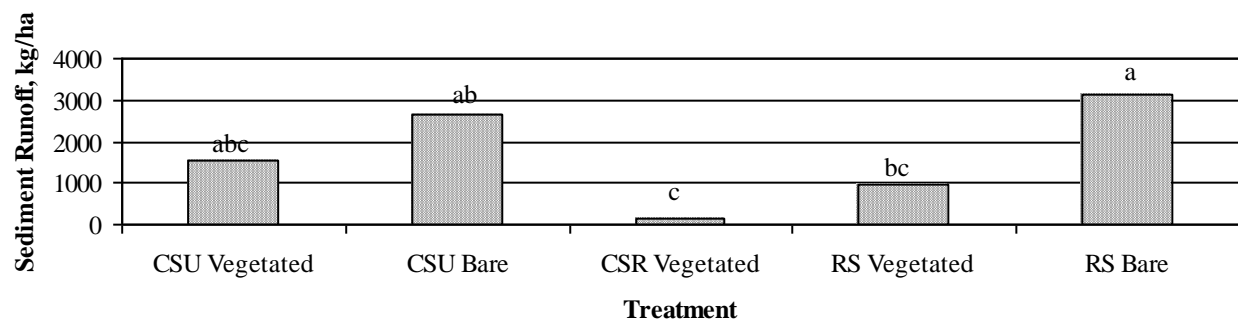


Figure 11. Phosphorus runoff of applied water on areas of bare and vegetated cover in pastures grazed continuous stocking with unrestricted stream access (CSU), continuous stocking with restricted stream access (CSR), or rotational stocking (RS) in the 2008 and 2009 grazing seasons.

