PASTURE MANAGEMENT EFFECTS ON NONPOINT SOURCE POLLUTION OF MIDWESTERN WATERSHEDS

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JUSTIFICATION

- Previous studies have suggested that sediment, nutrient and pathogen loading of surface water sources were associated with stream bank erosion and manure deposition caused by cattle grazing near pasture streams.
- Improved grazing management practices that control the timing, frequency, duration, and intensity of grazing in riparian areas should provide producers with cost-effective alternatives to total exclusion to enhance water quality of pasture streams.

OBJECTIVES

- To implement a research, education, and outreach program that:
  - Quantifies the effects of pasture management on sediment and phosphorus loading of streams;
  - Evaluates the effects of pasture characteristics, grazing management, and microclimatic factors on the temporal/spatial distribution of grazing cattle in riparian areas; and
  - Demonstrates cost-effective management practices to reduce nonpoint source pollution in two Iowa watersheds.

MATERIALS AND METHODS

- Willow Creek watershed (Figure 1)
  - Pastures
    - Six replicated 12.5-ha pastures bisected by 142 m stream reach
  - Cattle
    - Fifteen fall-calving cows/pasture from mid-May through October of 2005 through 2008
  - Treatments
    - Continuous stocking with unrestricted stream access (CSU)
    - Continuous stocking with stream access restricted to stabilized crossings (CSR)
    - Rotational stocking with grazing of the riparian paddock restricted to a minimum sward height of 10 cm or a maximum of 4 days
  - Measurements
    - Forage sward height and mass by zone
      - Monthly
    - Bare and manure-covered ground by zone
      - Monthly
    - Temporal/Spatial distribution of cattle
      - One cow/pasture fitted with GPS collar for 2 weeks monthly
      - Off-stream water provided at a minimum distance of 215 m from the stream during 2nd week with GPS collar
    - Streambank erosion
      - Erosion pins monthly
      - Ground-based LiDAR in spring and fall
- Rathbun Lake watershed (Figure 2)
  - Pastures
    - Riparian characteristics and streambank erosion
      - Thirteen pastures on 12 farms
    - Temporal/Spatial distribution of cattle
      - Five pastures
  - Measurements
    - Sward height, plant species and bare and manure-covered ground
      - Within 15.4 m of stream bimonthly
    - Streambank erosion
      - Erosion pins every 3 months
    - Temporal/Spatial distribution of cattle
      - Two to three cows/pasture fitted with GPS collars for 2 weeks in spring, summer, and fall

Figure 1. Willow Creek pastures

Figure 2. Rathbun Lake pastures

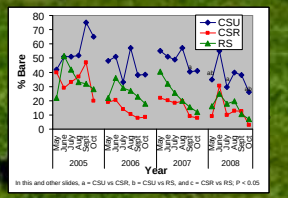

Figure 3. Effects of grazing management on bare ground on stream bank

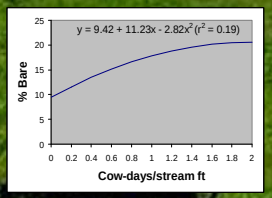

Figure 7. Effects of stocking rate by period on bare ground within 30.5 m of stream

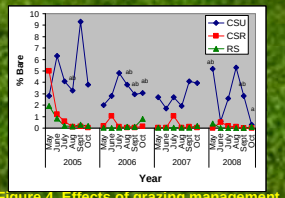

Figure 4. Effects of grazing management on bare ground within 33.5 m of bank

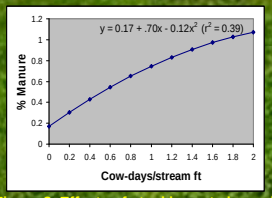

Figure 8. Effects of stocking rate by period on manure cover within 30.5 m of stream

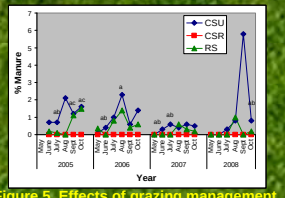

Figure 5. Effects of grazing management on manure cover on stream bank

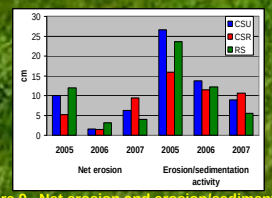

Figure 9. Net erosion and erosion/sedimentation activity on banks of Willow Creek

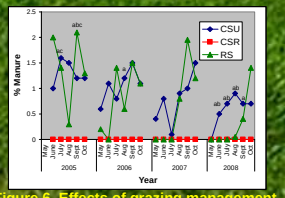

Figure 6. Effects of grazing management on manure cover within 33.5 m of bank

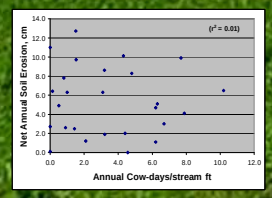

Figure 10. Effects of stocking rate on net annual erosion from banks of streams in the Rathbun Lake watershed

RESULTS

- Streambank characteristics
  - Willow Creek watershed
    - Percentages of bare ground on the streambanks of CSU pastures were greater ($P<0.05$) than CSR pastures in August, 2007 and May, July, and October, 2008 (Fig. 3).
    - Percentages of bare ground within 33.5 m of the streambanks of CSU pastures were greater ($P<0.05$) than CSR pastures in August, 2005, August, September, and October, 2006, and May, September, and October, 2008 (Fig. 4).
    - There were no differences in the percentages of bare ground on (Fig. 3) or within 33.5 m (Fig. 4) of the streambanks of CSR or RS pastures.
    - Percentages of manure cover on streambanks of CSU pastures were greater ($P<0.05$) than CSR pastures in July, September, and October, 2005, June and August, 2006, June and June, 2007 and October, 2008 (Fig. 5).
    - Percentages of manure cover within 33.5 m of streambanks of CSU pastures were greater ($P<0.05$) than CSR pastures in July and September, 2005, August, 2006, and July through September, 2008 (Fig. 6).
    - Percentages of manure cover on the streambanks in RS pastures were greater ($P<0.05$) than CSR pastures in September and October, 2005 (Fig. 5) and were only less ($P<0.05$) than CSU pastures in June through August, 2008 within 33.5 m of the streambanks (Fig. 6).
    - Streambank net erosion and erosion/sedimentation activity did not differ between grazing treatments (Fig. 9), but erosion/sedimentation activity was related to stream stage in CSU (r^2=0.53), CSR (r^2=0.83), and RS (r^2=0.86).
  - Rathbun Lake watershed
    - Percentages of bare ground within 30.5 m of pasture streams were only weakly (r^2=0.19) related to stocking rate per unit stream length (Fig. 7).
    - Percentages of manure cover within 30.5 m of pasture streams were related (r^2=0.39) to stocking rate per unit stream length (Fig. 8).
    - Streambank erosion rates were not related to stocking rate per unit stream length (Fig. 10).
- Temporal/spatial distribution of grazing cattle
  - Willow Creek watershed
    - Proportions of time that cattle were in (Fig. 11) or within 33.5 m (Fig. 12) of pasture streams were lower ($P<0.05$) in CSR and RS pastures than CSU pastures. But, even in pastures with CSU, cattle were in the streams less than 2% of the time.
    - Presence of off-stream water reduced the proportion of time that cattle were in or within 33.5 m of pasture streams in summers when low precipitation minimized natural sources of off-stream water (Data not shown).
  - Rathbun Lake watershed
    - Proportions of time that cattle in five pastures were in the streams or ponds ranged from 0.2 to 2.3% and were within 30.5 m of the stream ranged from 2.5 to 27.3% (Fig. 13).
    - Cattle presence in riparian areas were related to the percentages of the pasture within 30.5 m of the stream as affected by pasture size and shape in spring (r^2=0.76), summer (r^2=0.63), and fall (r^2=0.92).

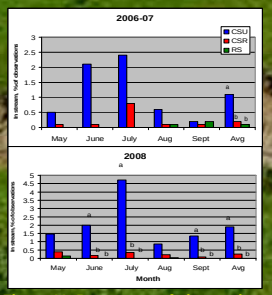

Figure 11. Percentage of observations of cows in Willow Creek

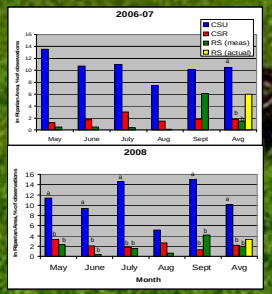

Figure 12. Percentage of observations of cows within 33.5 m of Willow Creek

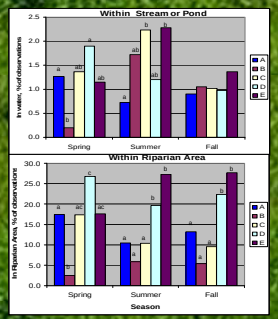

Figure 13. Percentage of observations of cows in or within 30.5 m of a stream or pond in pastures in the Rathbun Lake watershed

IMPACTS

- Restricting pasture stream access of grazing cattle to stabilized crossings or through rotational grazing will reduce the risk of nutrient loading by altering the temporal/spatial distribution of the cattle.
- Because the temporal/spatial distribution of grazing cattle is related to pasture size and shape, Best Management Practices for the protection of pasture streams will be site-specific for individual pastures.
- Streambank erosion of pasture streams seems related to stream hydrology and not related to grazing management or stocking rate.

OUTCOMES

- Results of this project have been the basis for the following:
  - Presentations and workshops
    - Riparian Grazing Workshop for USDA-NRCS, Soil and Water Conservation District, and Cooperative Extension Personnel, August 19-20, 2008, Chariton, IA
    - 'Grazing management of beef cows to limit non-point source pollution of streams in Midwestern pastures' presented at the McNay Research Farm Field Day, August 28, 2007, Chariton, IA; Iowa Forage Conference, November 20, 2007, Des Moines, IA; and Cornbelt Cow-calf Conference, February 23, 2008, Ottumwa, IA.
    - Three presentations at the annual meeting of the American Society of Animal Science, July 7-11, 2008, Indianapolis, IA, two presentations at the annual meeting of the Agronomy Society of America/Crop Science Society of America/Soil Science Society of America, and one presentation at the National Workgroup on Minimizing Agricultural Phosphorus Losses.
  - Extension publications
    - 'A Guide to Managing Pasture Water' series (http://www.iowabeefcenter.org/content/research_projects.html)
    - Four papers in the 2008 Iowa State University Animal Industry Report (http://www.ans.iastate.edu/report/air/?pg=tablecontent08)
  - Web-based course
    - Animal Science/Agronomy 543X 'Environmental Management of Livestock'

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