Pasture Management Effects on Nonpoint Source Pollution of Midwestern Watersheds

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ABSTRACT

Without proper management, cattle grazing may cause sediment and phosphorus loading of pasture streams by bank erosion and manure deposition. Practices that alter the timing, frequency, duration, or intensity of cattle grazing may reduce nonpoint source pollution of pasture streams. A project has been initiated to: 1) Quantify the effects of pasture management on sediment and phosphorus loading of streams; and 2) Evaluate the effects of pasture characteristics, grazing management, and microclimatic conditions on the temporal and spatial distribution of grazing cattle in two Iowa watersheds. Sediment and phosphorus loss, bare and manure-covered ground, and vegetation sward height and species are being measured along the banks of streams in thirteen pastures on beef cow-calf farms in the Rathbun Lake watershed in southern Iowa and in six pastures grazed by continuous stocking with full stream access; continuous stocking with stream access at stabilized crossings; or rotational stocking in the Willow Creek watershed near Rhodes, Iowa. These measurements are being compared to the annual and seasonal grazing intensity, pasture shade distribution, presence of off-stream water, stream stage height, and microclimatic data. Temporal and spatial distribution of grazing cattle are being recorded for two weeks with GPS collars on 2 or 3 cows in late spring, mid-summer, and early fall on five beef cow-calf farms in the Rathbun Lake watershed and 1 cow from May through September in the six pastures grazed in the Willow Creek watershed. Cattle distribution is being compared to the pasture species, pasture shade distribution, presence of off-stream water, and microclimatic data. Initial results reveal that restricting stream access to stabilized crossings, rotational stocking or providing off-stream water reduce the time that cattle are in pasture streams and reduce the proportion of bare ground late in the grazing season, but pasture management had little effect on stream bank erosion.

IMPACT STATEMENT

Previous studies have implied that stream bank erosion and manure deposition in pastures contribute to sediment and phosphorus loading of Iowa streams and lakes. These problems likely result from pasture or grazing management practices that promote frequent congregation of cattle near pasture streams. The results of this project will determine the efficacy of management practices that alter cattle distribution near streams on sediment and phosphorus loading. The information obtained will be used as the basis for extension publications addressing management of riparian grazing and a WEB-based course on Livestock and the Environment.

INTRODUCTION

Grazing management practices that allow cattle to congregate near pasture streams may result in the loss of vegetative cover and accumulation of manure near the streams. These conditions may cause loading of the streams with sediment, phosphorus, and pathogens carried in precipitation runoff. Furthermore, the loss of vegetation and increased compaction associated with concentrated cattle traffic may promote stream bank erosion causing further impairment of stream water quality.

ACKNOWLEDGEMENTS

•This material is based upon work supported by the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, under Award No. 2006-51130-03700. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the U.S. Department of Agriculture.

•Iowa Dept. Natural Resources (EPA 319)

•Leopold Center for Sustainable Agriculture

MATERIALS & METHODS

Rhodes Research Farm

Pastures

- Six 30-acre cool-season grass pastures
  - Each bisected by a 642 foot stream segment
  - Three grazing management treatments
    - Continuous stocking with unrestricted stream access (CSU)
    - Continuous stocking with stream access restricted to a 16-foot wide crushed rock crossing (CSR)
    - Five-paddock rotational stocking with one paddock in the riparian zone (RS)
  - 15 fall-calving Angus cows per pasture
  - Grazing mid-May through mid-October in 2005, 2006, and 2007

Data collection

Cattle Distribution

- Visual Observation
  - Monthly May through September
    - Two consecutive days per month, 12 hours per day (0600 to 1800 hours)
  - Cow herd location, number of cows, and observed defecations recorded at 10 minute intervals
- GPS collars (AgTraXtm - BlueSky Telemetry, Aberfeldy, Scotland)
  - One cow per pasture
  - Month May through September
    - Two weeks per month, Cow position recorded at 10 minute intervals 24 hours per day
- Data Analysis
  - Location data analyzed using ArcGIS 9.1
  - Cow location defined as within stream (stream), within 110 ft of the stream, 110 to 220 ft from the stream, and greater than 220 ft from the stream.

Lake Rathbun Watershed

Pastures

- Thirteen pastures on twelve cooperating farms
- Pastures ranged in size from 7 to 265 acres with 948 to 5,511 feet streams reaches per pastures
- Streams drained watersheds of 624 to 13,986 acres

Data collection

Producer Grazing Records

- Number of cows, heifers, and bulls stocked in pastures
- November, 2006 to November, 2007

Forage Measurements

- Bi-monthly
  - May through November, 2007
  - Both sides of the stream at 100-foot intervals along the stream
- Proportions of bare and manure-covered ground
  - Line transect method over 50 ft perpendicular to the stream
- Forage sward height
  - Falling plane meter (8.8 lb/yd^2) at 25 ft from stream
- Vegetation species
  - dominant species at site of sward height measurement

Calculations

- Cow-days per pasture
  - Cow-days = (Number of cows x days stocked) + (Number of heifers x .86 x days stocked) + (Number of bulls x 1.2 x days stocked)
- Stocking rates (interval between each sampling period and the total year)
  - Area bases = Cow days per pasture acres
  - Distance bases = Cow days per stream reach length

Cattle Distribution

- Five cooperating farms
- GPS Collars
  - 2 to 3 cows per farm
  - 3 times per grazing season (Spring, Summer, and Fall) for 14 days
  - Proportion of GPS collar readings in which cattle were in a water body (stream or pond), within 50 ft of water, 50 to 100 ft from water, and 100 to 200 ft from water
    - GPS data analyzed using ArcGIS

RESULTS & DISCUSSION

Rhodes Research Farm

- Cattle in CSU pastures spent a greater ($P<0.05$) proportion of time in and within 110 feet of the stream than did cattle in CSR or RS pastures (Table 1).
- In 2006, the presence of an off-stream water source decreased ($P<0.05$) the proportion of time cattle in CSU pastures were in the stream by approximately half.
- At ambient temperatures above 27°C, the proportion of time cattle in CSU pastures were within 110 feet of the stream increased ($r^2=0.85$).
- Distribution of observed defecations by cattle within pasture zones was highly associated ($r^2 = 0.99$, slope = 1.0) with cattle distribution patterns.

Table 1. Average proportion of time cattle spent within different pasture zones (GPS Collar data pooled across 2006 and 2007).

	Stream	110	220	Upland
			%	
CSU	1.3[a]	8.8[a]	5.6	83.0
CSR	0.4[b]	1.5[b]	7.6	91.6
RS	0.1[b]	3.1[b]	7.7	90.3
P-value	.05	.05	NS	NS

[ab]Values with different superscripts within a column differ ($P<0.05$).

Stream = within stream, 110 = stream edge to 110 ft from stream, from 110 to 220 ft from stream, Upland = greater then 220 ft from stream.

[2]CSU = continuous stocking with unrestricted stream access, RS = rotational stocking, CSR = continuous stocking with restricted stream access.

Lake Rathbun Watershed

Forage

- Annual stocking rates on the 13 sites averaged:
  - 123 (range 0-290) cow-days/acre
  - 3.66 (range 0-10.2) cow-days/foot of stream
- Mean sward height (10.7 cm), bare ground (13.8%) and manure-covered ground (0.61%) differed between the 13 pastures.
- Proportion of bare soil along stream banks was only mildly related to the annual stocking rate per acre ($Y=4.55+0.150X-0.0004X^2$; $r^2=0.20$).
- The proportion of manure-covered ground increased:
  - as the annual stocking rate per acre increased ($Y=-0.038+0.0077X-0.00001X^2$; $r^2=0.47$)
  - as the proportion of tall fescue in pastures increased ($Y= 0.22 + 0.008X$; $r^2 = 0.24$)
- To maintain 4 inches of forage on stream banks, the annual stocking rate should not exceed 88 cow-days/acre in the area adjacent to a stream.

Cattle Distribution

- Across all farms cattle were in or within 50 or 100 ft of the stream 1.3, 6.6, and 6.9% of the time, respectively, during the grazing season.
- At greater black globe temperatures the proportion of time cattle were within 50 feet of the stream increased ($Y = 11.81 + 0.436X + 0.0056X^2$, $r^2 = 0.37$)

PRELIMINARY CONCLUSIONS

Rhodes Research Farm

- Proportion of time cattle spend in or near pasture streams can be reduced with grazing management (rotational stocking, constructed stream access points, off-stream water)

Lake Rathbun Watershed

- Increasing stocking rate will result in significant decreases in sward height and increases in manure cover in riparian zones.

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