# Stream Bank Erosion as a Source of Sediment and Phosphorus in Grazed Pastures in Three Physiographic Regions of Iowa


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## Introduction

Row-crop cultivation and pasture grazing are major sources of sediment and phosphorus (P) to aquatic ecosystems (Schultz et al., 2004).

An increase in sediment load to streams decreases water quality and results in the deterioration of aquatic life in stream habitat (USEPA, 1997).

Along with overland flow and stream bed sediment re-suspension, stream bank erosion is one of the most important pathways of non-point source pollutants into surface waters (Sharpley et al., 1993).

**Objective:** Assess the effects of precipitation, grazing stocking density and soil bulk density on stream bank soil losses in three physiographic regions of Iowa.

## Materials and Methods

### 1. Severe and very severe eroding stream bank identification and survey

Pasture sites with stocking densities ranging from 0.23 – 1.15 (cow-calf pairs $ha^{-1}$ * days $yr^{-1}$) $m^{-1}$ length of stream bank were identified in three regions of Iowa (Fig 1).

Severe and very severe stream bank source areas (USDA NRCS, 1998) were identified by visual in-field observations and measured using a tape measure and height pole (Fig 2).

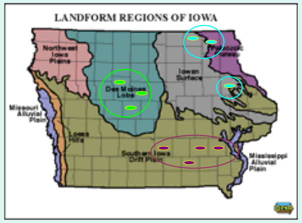


Fig 1. Study sites in Central, Southeast, and Northeast Iowa.

Fig 2. Severely eroded stream bank height and length survey using height pole and tape measure.

Fig 3. Pin plot and pin measurement.

### 2. Stream bank erosion pins and plots

Erosion pin plots were installed on 5 randomly selected severe and very severe eroding stream banks in each treatment reach.

Each plot contained ten 76 cm long and 6.4 mm diameter pins. Pins were arranged in 2 rows of 5 pins each at 1/3 and 2/3 of the stream bank height and in 5 columns, 1 meter apart (Fig 3).

Exposed pin lengths were measured seasonally from the summer of 2004 to late summer of 2006 except winter seasons.

Seasonal erosion rates were equal to the most recent pin measurement subtracted from the previous measurement.

Soil bulk densities were determined by collecting bank samples at 3 pin plots from each site.

### 3. Soil and P loss calculations

Total stream bank soil loss = total eroding area X mean erosion rate X mean bulk density.

Total P loses from stream bank = total soil loss X mean stream bank P concentration.

## Results

Table 1. Treatment pasture characteristics. Stocking density per unit of stream length was calculated as the product of cow days and stocking density divided by stream length to relate stocking density to the length of riparian pasture stream banks. SE is the south east region, C the central region and NE the north east region of Iowa

| Region | Stream length (m) | Cow days (days $yr^{-1}$) | Stocking density (cow calf pairs $ha^{-1}$) | Stocking density per stream length (cow calf pairs $ha^{-1}$*days $yr^{-1}$) $m^{-1}$ |
|---|---|---|---|---|
| SE | 1067 | 178 | 1.4 | 0.23 |
| SE | 315 | 180 | 1.5 | 0.85 |
| SE | 686 | 365 | 2.2 | 1.15 |
| C | 1054 | 180 | 1.6 | 0.27 |
| C | 678 | 195 | 1.5 | 0.44 |
| C | 437 | 210 | 1.2 | 0.55 |
| NE | 783 | 185 | 1.0 | 0.25 |
| NE | 632 | 155 | 1.9 | 0.46 |
| NE | 318 | 160 | 1.8 | 0.93 |

Table 2. Stream bank erosion parameters including region, annual precipitation, erosion rate, bulk density, eroded area, soil and phosphorus loss, and total phosphorus concentrations. The data were presented as average of two years.

| Region | Precipitation | Erosion rate | Bulk density | Eroded area | Soil loss | P concentration | P loss |
|---|---|---|---|---|---|---|---|
| | cm $yr^{-1}$ | cm $yr^{-1}$ | g $cm^{-3}$ | $m^{-2}$ $km^{-1}$ | ton $km^{-1}$ $yr^{-1}$ | mg $kg^{-1}$ | kg $km^{-1}$ $yr^{-1}$ |
| SE | 79 | 7 | 1.29 | 1081 | 93 | 405 | 38 |
| SE | 79 | 5 | 1.35 | 1648 | 122 | 424 | 52 |
| SE | 79 | 10 | 1.32 | 1238 | 157 | 363 | 57 |
| C | 82 | 9 | 1.35 | 618 | 74 | 417 | 31 |
| C | 82 | 20 | 1.39 | 1333 | 378 | 409 | 155 |
| C | 93 | 18 | 1.32 | 1039 | 241 | 289 | 70 |
| NE | 99 | 26 | 1.20 | 1214 | 383 | 490 | 188 |
| NE | 102 | 25 | 1.17 | 1105 | 322 | 560 | 180 |
| NE | 109 | 35 | 1.10 | 484 | 186 | 385 | 72 |

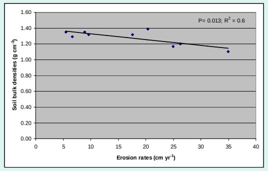

Fig 4. Significant negative correlation between soil bulk density and erosion rate.

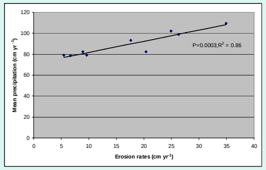

Fig 5. Significant positive correlation between mean annual precipitation and erosion rate.

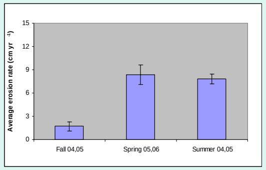

Fig 6. Most of the sediment and P contribution to fluvial environment took place during the spring and summer seasons.

## Discussion

No significant correlation was found between stocking densities and stream bank variables including soil bulk densities, erosion rates, eroded areas, total P concentrations and total soil-P losses.

Livestock trampling on the top of the stream bank had little or no effect on mean soil bulk densities or total soil-P concentrations over the average depths of the banks.

Annual precipitation was highly correlated with stream bank erosion probably through its effect on stream discharge which was not measured. However, the impact of the precipitation on discharge and bank erosion is probably more related to timing, frequency, intensity and duration than to annual amount.

## Conclusions

Annual precipitation and stream bank erosion rates were highly correlated. Increasing precipitation and channel discharge are major agents of stream bank soil loss in grazed pastures.

Stream banks with lower soil bulk densities experienced higher stream bank soil loss than stream banks with higher soil bulk densities.

The effects of stocking densities on stream bank erosion did not differ in this study. However, Zaimes (2004) found that these same densities had significantly higher impacts on bank erosion than riparian buffers or grass filters.

## Literature Cited


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