BEEF CATTLE PRODUCTION IMPACTS ON WATER QUALITY

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Abstract. Water quality monitoring was begun in March of 1999 on the Redbud Farm near Calhoun, Georgia to evaluate the effects of beef cattle production on water quality. The monitoring network includes streamwater entering and leaving the farm, and sites comparing areas where the cattle have no access to the stream and unrestricted access. Overall water quality during baseflow is good. Average nutrient and sediment concentrations increase where cattle have stream access. Average stormflow concentrations of nutrients and sediment are five to 15 times higher than baseflow concentrations. Preliminary data indicate water quality can be maintained by restricting cattle access to the stream.

INTRODUCTION

The Redbud Farm is part of the Northwest Georgia Experiment Station located near Calhoun, Georgia in the Ridge & Valley Physiographic Province. The 264 ha (653 ac) farm has a herd of predominately commercial Black Angus, consisting of 190 cow-calf pairs, 40 heifers, 70 yearling stocker heifers, and 8 bulls. Applied research at the farm focuses on the overall water quality of the farm and the effect of grazing management on water quality. This paper reports the overall water quality on the farm from April 1999 - 2000.

There are two first-order streams crossing the farm (Figure 1). The east tributary has a watershed of 372 hectares (918 ac). It heads up in forested property and enters the farm property at a culvert on Nesbitt Loop Rd. The west tributary heads up just off farm property and has a watershed of 119 hectares (294 ac). Both these streams are "flashy" in that they rise and recede quickly in response to rainfall. These streams flow seasonally. During 1999/2000, the streams dried up in July and did not begin to flow again until mid-January 2000.

METHODS

In April 1999, we established a water quality monitoring network for the farm. This paper will focus on the network located on the east tributary. Grab samples are collected monthly at four locations (Figure 1):

- RB1- from water flowing into the farm,
- RB2 - on the farm where the cattle have no access,
- RB3 - on the farm where cattle have access to the stream, and
- RB4 - leaving the farm near the confluence of the stream and the river.

An additional sample of river water upstream of the farm is taken every month (RB6). Unfiltered samples are analyzed for pH (Orion Model 720A), specific conductance (Fisher Scientific meter) , total suspended solids (gravimetrically, Method 2540,Standard Methods, 1998), and fecal coliforms (membrane filtration, Method 9222, Standard Methods, 1998). Total nitrogen and total phosphorus are analyzed colorimetrically (Perstorp Analytical methodology) after Kjeldahl digestion. Nitrate-nitrogen and ortho-phosphorus are measured colorimetrically (Rapid Flow Analytical methodology and Perstorp Analytical methodology respectively) after samples are filtered through 0.45 μm filters.

In January 2000, rising stage samplers were installed to sample stormwater. These samplers were placed:

- RS1 - on the east tributary entering the farm, and
- RS2 - on the east tributary leaving the farm.

The samplers are set to collect the initial rise of the stream and a sample when the stream is approximately bankfull. Twelve sets of storm samples have been collected since January 2000. Samples are analyzed for the same parameters as the monthly samples listed above except for fecal coliforms.

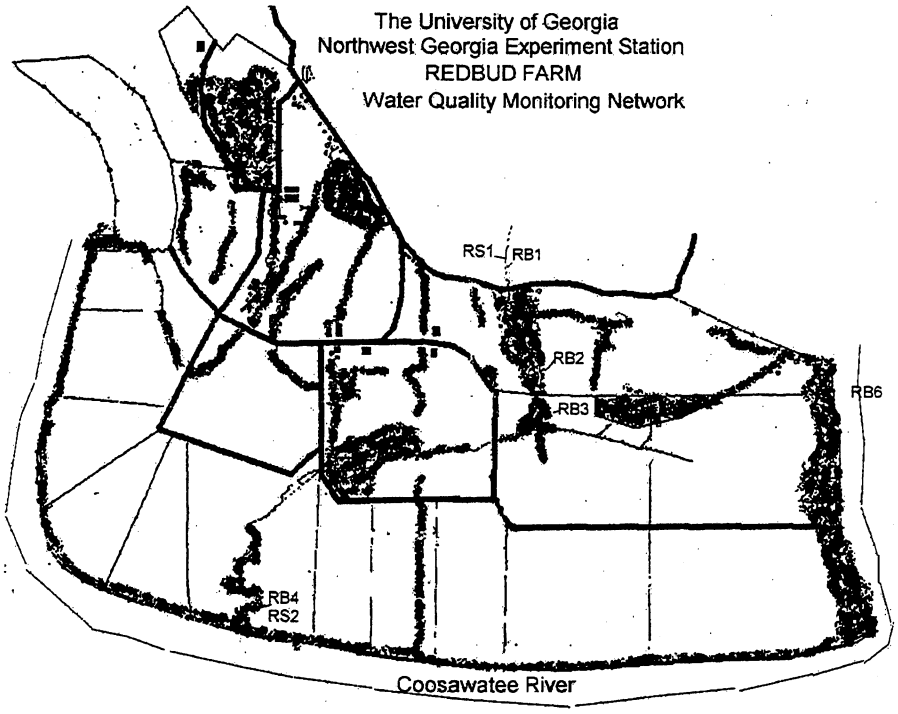

Figure 1. Schematic of the water quality monitoring network at the Redbud Farm.

RESULTS AND DISCUSSION

The major water quality issues with cattle are increased sediment, nutrients and pathogens. Sediment may create the primary impacts because these carry nutrients and pathogens, and can impair habitat for aquatic insects and fish. Average total suspended solids (TSS) concentrations in the range of 25 - 80 mg TSS/L indicate moderate water quality, while average concentrations over 400 mg TSS/L indicate very low water quality (Rasmussen, pers. comm). An average concentration of 25 mg TSS/L has been proposed as an indicator of unimpaired stream water quality (Holmbeck-Pelham and Rasmussen, 1997).

Data collected indicate water quality entering and leaving the farm under baseflow conditions is good (averages < 25 mg TSS/L, Figure 2). The highest average concentration occurs in the area of the farm where cattle have access to the stream (146 mg TSS/L). Concentrations during stormflow are much higher (Figure 2, RS1 and RS2), and average 418 mg TSS/L entering the farm and 331 mg TSS/L leaving the farm. The sampling stations near the river may be influenced by back flow from the river.

Total nitrogen (TN) concentrations under baseflow conditions are generally low (Figure 3). Based on the analysis of over 1000 temperate-zone streams, Dodds *et al.*(1998) proposed TN concentrations less than 1.5 mg/L will prevent nuisance algal blooms. The average baseflow concentrations are below this proposed boundary except for the area where the cattle have access to the stream. Stormwater concentrations of TN are higher than baseflow. Most of the TN in the streams is in the organic/ammonium forms (TKN). Seventy percent of TN is TKN in the water entering the farm. The percentage peaks where the cattle have access to the stream at 95%, and decreases as the stream leaves the farm to 30%.

Phosphorus is typically the limiting nutrient for most of our freshwater streams. Dodds *et al.* (1998) proposed a total phosphorus (TP) concentration of less than 0.075 mg/L to prevent nuisance algal blooms in streams. Other EPA proposals for stream concentrations range from 1 mg TP/L to 0.05 mg TP/L for streams entering reservoirs and 0.1 mg TP/L for other streams.

All the sampling stations at the Redbud Farm had average total phosphorus concentrations above the eutrophic-mesotrophic boundary proposed by Dodds, including water coming into the farm (Figure 4).

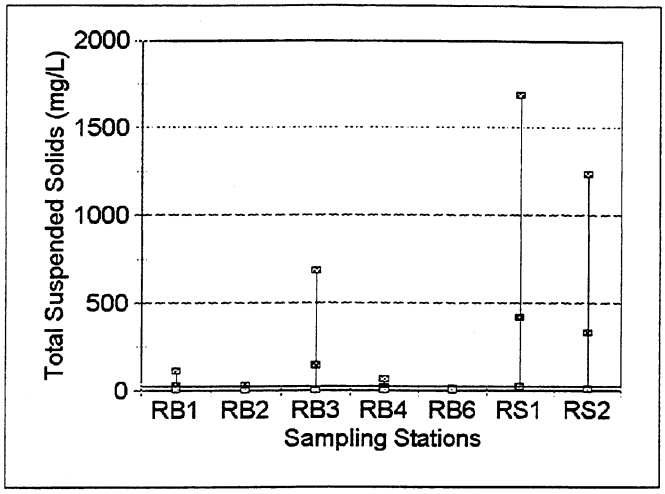

Figure 2. Maximum, average, and minimum total suspended solids from April 1999 through April 2000 at the Redbud Farm. RB1- inflow; RB2 - no cattle access; RB3 - cattle access; RB4 - outflow; RB6 - upstream river; RS1 - inflow stormwater; RS2 - outflow stormwater. The solid horizontal line represents 25 mg TSS/L, a proposed standard for unimpaired water quality.

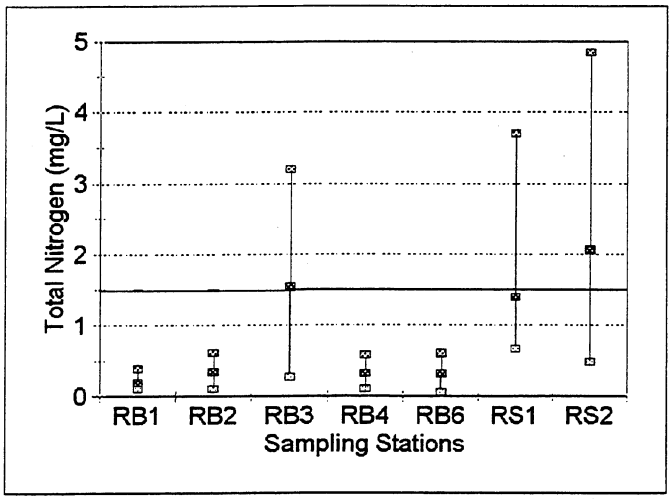

Figure 3. Maximum, average, and minimum total nitrogen from April 1999 through April 2000 at the Redbud Farm. RB1- inflow; RB2 - no cattle access; RB3 - cattle access; RB4 - outflow; RB6 - upstream river; RS1 - inflow stormwater; RS2 - outflow stormwater. The solid horizontal line represents 1.5 mg TN/L, a proposed standard for unimpaired water quality.

The watershed above the farm is largely forested; consequently, these preliminary data suggest the stream may be enriched as it enters the farm, or that the boundary proposed by Dodds is too low for this region.

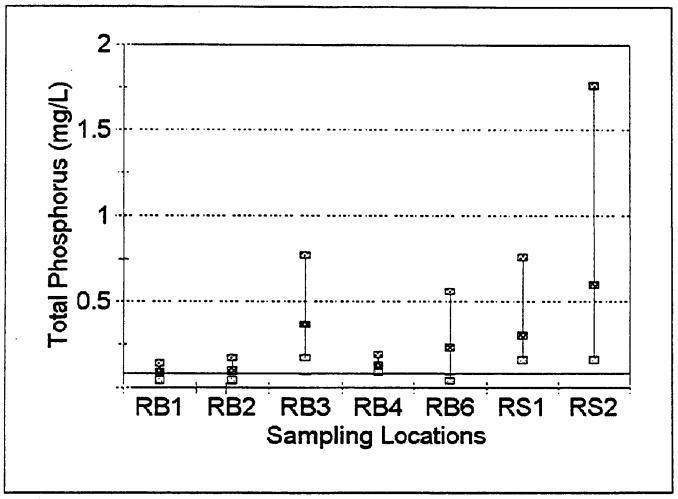

Figure 4. Maximum, average, and minimum total phosphorus from April 1999 through April 2000 at the Redbud Farm. RB1- inflow; RB2 - no cattle access; RB3 - cattle access; RB4 - outflow; RB6 - upstream river; RS1 - inflow stormwater; RS2 - outflow stormwater. The solid horizontal line represents 0.075 mg TP/L, a proposed standard for unimpaired water quality.

Concentrations increase where the cattle have access to the stream. Average concentrations in the upstream river are higher than those leaving the farm (Figure 4). Approximately 30% of TP is in organic forms; ortho-phosphorus concentrations are typically moderate to low (<0.03 - <0.08 mg/L). Stormwater concentrations are triple baseflow concentrations entering the farm, and nearly five times as high as baseflow leaving the farm.

Fecal coliforms are used as an indicator of pathogens in water and are present wherever mammal feces contact the water. The Georgia Environmental Protection Division (EPD) sets standards for fecal coliforms in fishable and swimmable waters. These require a monthly average of less than1,000 cfu/100ml from November through April and 200 cfu/100ml from May through October. The standards set a maximum of 4,000 cfu/100ml. The average of the monthly fecal coliform concentrations at the Redbud Farm are at or below the winter EPD standards under baseflow conditions for all sampling stations except where the cattle have direct access to the stream (Figure 5). The summer standard was exceeded for the stream entering the farm (RB1), and was only met in the farm area where there is no cattle access to the stream (RB2).

The EPD standards are provided as a comparison. The fecal coliform concentrations seen at the farm do not technically exceed EPD standards due to a difference in sampling methodology. EPD sampling call for a monthly geometric average of several samples. Our sampling was

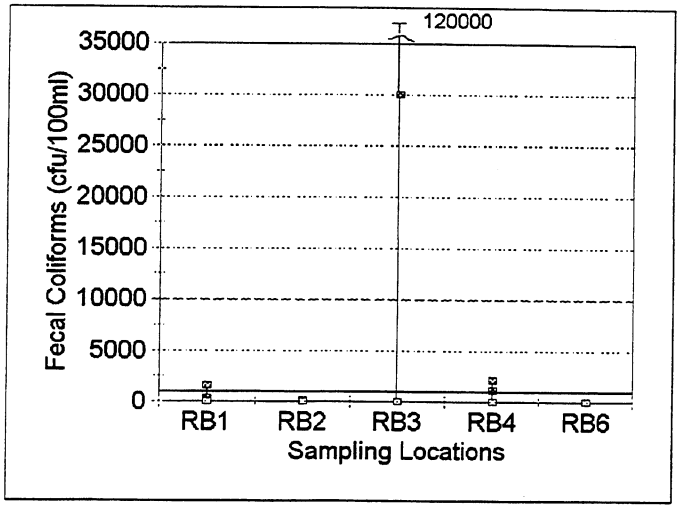

Figure 5. Maximum, average, and minimum fecal coliforms from April 1999 through April 2000 at the Redbud Farm. RB1- inflow; RB2 - no cattle access; RB3 - cattle access; RB4 - outflow; RB6 - upstream river. The solid horizontal line represents 1,000 cfu/100ml standard for unimpaired water quality.

conducted only once a month. We are not able to analyze fecal coliforms on stormwater samples; however, other research has shown fecal coliforms to be highly correlated with TSS and discharge. We expect the fecal coliform concentrations would be much higher during storm events.

CONCLUSIONS

The initial data indicate baseflow water quality entering the farm, where there is no cattle access to the stream, and leaving the farm is good. Average nutrient and sediment concentrations in baseflow increase where cattle have stream access. Average stormflow concentrations of nutrients and sediments are five to 15 times higher than baseflow concentrations. Year-one data indicate that restricting cattle access to the stream can maintain farm water quality. Permanently fencing cattle out of the streams is one management option. Data on other management scenarios such as controlled access for watering, rotational grazing allowing rest periods, or periodic grazing during dry conditions needs to be collected to determine if these practices can also improve water quality. A range of management options is needed for cattlemen to improve water quality with specific site and production needs.

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