Water Quality Assessment in a Restored Section of the Cane Run Watershed, Lexington, KY

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Introduction

Dosskey (2010) stated that more experimental quantification was needed to prove that water quality increased in response to creating riparian buffer zones. This assessment of water quality was conducted concurrently with a riparian buffer restoration project on a channelized tributary of the Cane Run Watershed in Lexington, Kentucky. The tributary receives water from adjacent horse farms up stream and is surrounded by crop land in the area where the buffer treatments have been placed. The riparian buffer restoration project consists of 10 replicates of four treatments (Intense Mow, Moderate Mow, No Mow, and Native Grass) in plots 10 m wide (parallel to the stream) and 15.25 m away from the stream. Plants within the riparian buffer zones were grasses and forbs with forbs being more likely in the No Mow and Native Grass plots.

Our objective was to determine stream distances required to observe changes in water quality parameters. The water quality parameters we monitored consisted of channel depth, pH, EC, nutrient content, biological oxygen demand (BOD), total heterotrophs, and coliforms.

Materials and Methods

Three stream distances were assessed to determine change in water quality parameters: the distance across the stream, and 40 m and 640 m reaches along the stream (Fig. 1). The 640 m reach extended past the boundaries of the riparian buffer zone; the 40 m reach was nested within the riparian buffer zone. Statistical analyses were performed only for data points within the treatment boundary zones using the PROC MIXED procedure in which defined stretches of the tributary were treated as blocks.

Water samples (500 ml) were collected from specific locations on the channelized tributary on seven dates from August 2011 to July 2012. A sampling occurred in August 2011, twice in December 2011, and in April, May, June, and July 2012. The sampling times were not based on rain events. Only 20-25 samples were collected at each of the seven sampling times due to the 24 hour processing time constraint to process the heterotrophs and coliforms.

Channel depth, pH, electrical conductivity (EC), and biological oxygen demand (BOD) were measured. EC was measured by probe. Nitrate nitrogen (NO_3- N) (Crutchfield and Grove, 2011), nitrite nitrogen (NO_2- N) (Crutchfield and Burton, 1989), ammonium nitrogen (NH_4 – N) (Chaney and Marbach, 1962), and phosphorus (P) (Van Veldhoven and Mannaerts, 1987) were measured colorimetrically by microplate method.

Heterotrophs and coliforms were processed using MFC, mEndo, and nutrient agar plates (APHA Part 9222). BOD_5 was determined according to APHA methodology (Part 5210).

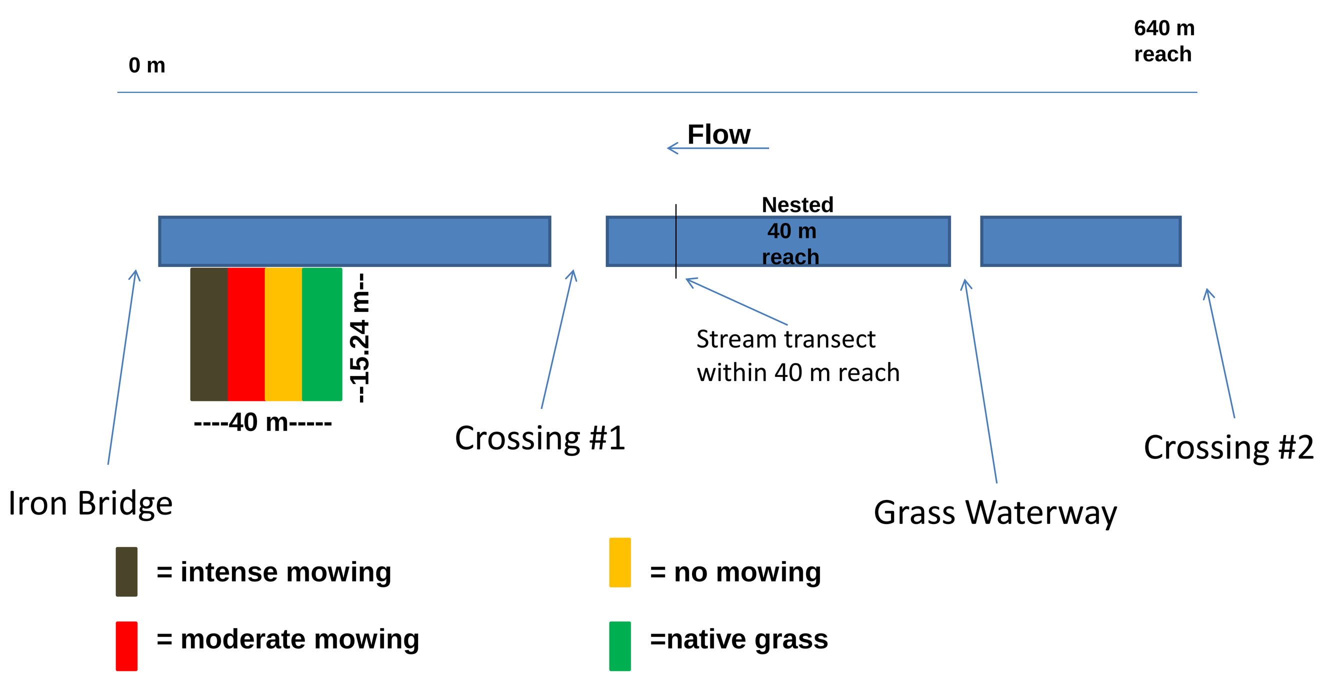


Figure 1. Schematic diagram of stream and riparian treatment buffers. Each set of treatments was replicated 10 times across the length of the reach.

Results

Depending on water quality parameter, there was little (Fig. 2) or extreme (Fig. 3) variability in samples at various locations along the stream.

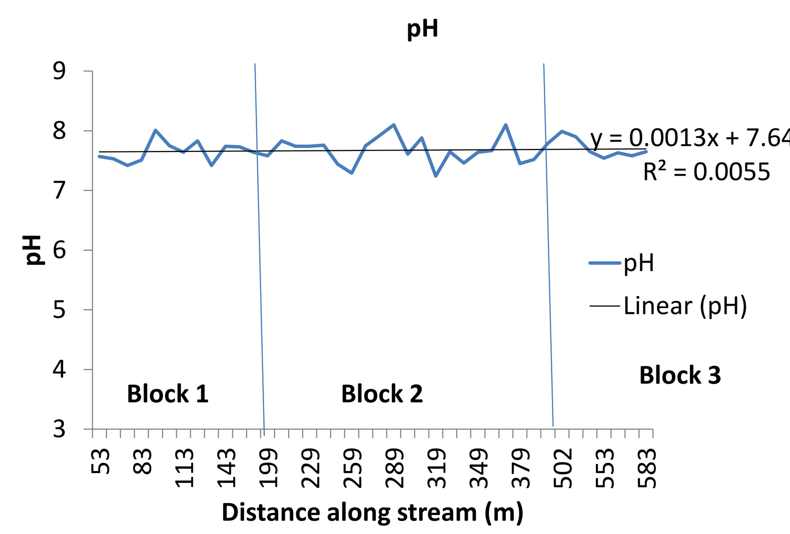


Figure 2. Relationship of pH to stream length in July 2012. Vertical lines represent limits of distance used to partition each block for analysis.

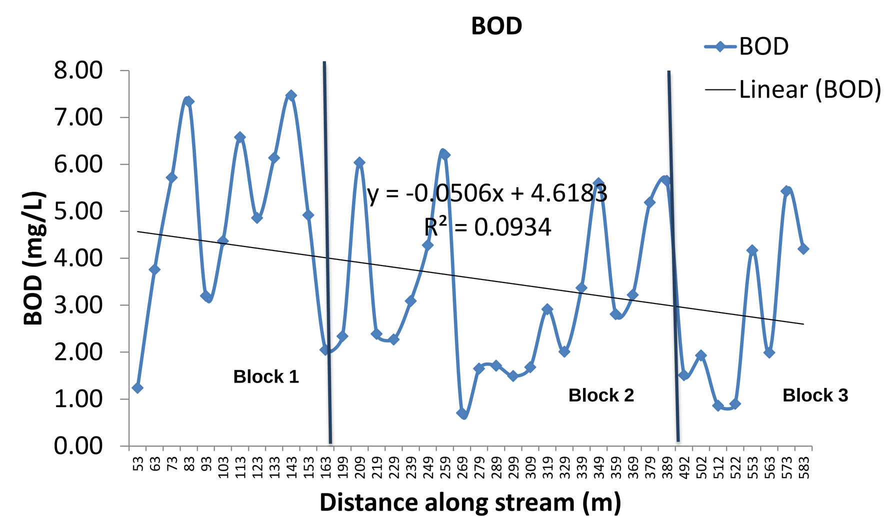
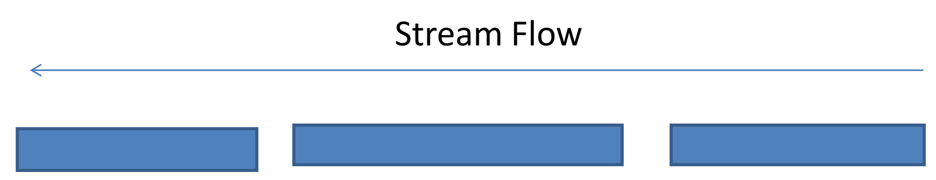


Figure 3. Relationship of average BOD to stream length. Vertical lines represent limits of distance used to partition each block for analysis.

Because of variability, neither the transect across the stream (except for NO_3^-), the 40 m range between a treatment set, nor the approximately 640 m range for the stream distance were significant for any water quality parameter.

When water quality parameters were examined by block, there were statistically significant differences (P < 0.05) for BOD, EC and channel depth (Fig. 4).



Water Quality Parameter	Block 1	Block 2	Block 3
	- - - - - - - -	Average	- - - - - - - -
BOD (mg L^{-1})	4.80	3.23	2.62
Depth (cm)	8.17	9.42	12.22
EC (mS cm^{-1})	0.48	0.44	0.50

Figure 4. Influence of sample block on water quality parameters. Significant (P< 0.05) effects were observed for BOD, channel depth, and EC.

Sample time was a significant effect. Water collected on different sampling dates was significant (p<0.05) for EC, pH, nitrate, fecal coliforms (Fig. 5), and heterotrophs. Channel depth also had a treatment by time interaction (p<0.05).

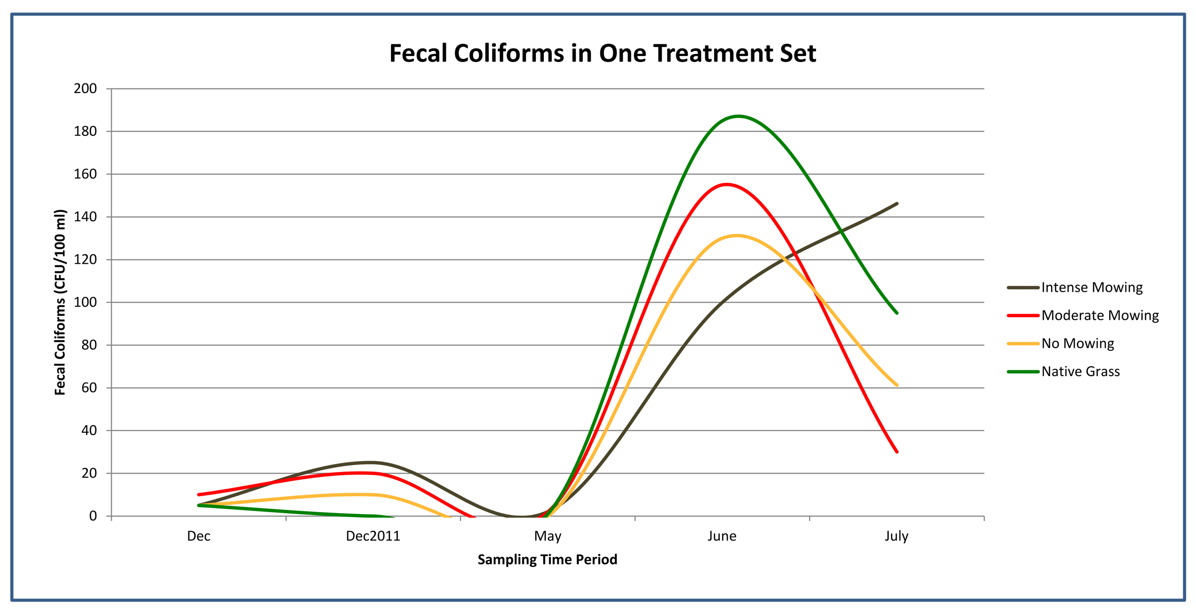


Figure 5. Variability in fecal coliform concentration as a function of sample location and time of sampling. (Figure shows MFC for locations 21-24 in the nested area for 5 sampling dates.)

Conclusions

Previous work in establishing riparian buffer strips has typically used wells within the riparian areas to test groundwater. In this study we attempted to distinguish the water coming from upstream with the water at the edge of the different types of riparian areas to determine if streamside management had significant influence on water quality parameters. To date there has not been enough sampling time to establish true statistically significant trends. There was no difference shown between sampling within a 40 m reach or a 640 m reach of the stream for any parameter. However, significant differences (p<0.05) were seen in the three different areas of the stream for BOD (Fig. 3), channel depth, and EC. Nitrate showed a difference (p<0.05) across the stream. This difference could be due to shading or different amount/type of plant material in the water. Central Kentucky was in drought conditions during the summer in 2012, so the stream noticeably (but not significantly) changed in size, which could have affected the results over the different sampling times.

The variability in the heterotroph and coliform data along the stream prevented significant differences from being observed. Average heterotrophs ranged from 7,250-80,000 CFU/100 ml for the transect, 66,650-79,750 CFU/100 ml for the 40 m reach, and 37,000-88,000 CFU/100 ml for the 640 m reach. The fecal coliform data ranged from about 0-57 CFU/100 ml for both the transect and 40 m reach, while the 640 m reach had a wider range from 3-369 CFU/100 ml.

Future Work

The various parameters influencing water quality in riparian environments include nutrient uptake by vegetation, flow and depth of the stream, temperature, wildlife, nearby agricultural inputs, and temporal variability. This study began to establish sampling protocols and timing to identify variables and factors most related to the streamside management practices being used. There will be a continuation of the work that has already been done to obtain more data. The response of the benthic invertebrate community will be a key factor used to evaluate future water quality.

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Acknowledgements

The senior author would like to thank M.S. Coyne and A. Gumbert for their constant help and advice. Kristen McQuerry for her statistical work. Heather Jordan, Shuang Liu, Qing Li, Joey Van Noy, and Isarapong Norrueang helped collect and process the samples. Financial support was provided by the UK AG and HES Alumni Association, USDA-FAPRU, and the Department of Plant and Soil Sciences, University of Kentucky.