INVESTIGATING COLIFORM BACTERIA RATIOS RELATIVE TO RAINFALL AND STREAM STAGE IN THE UPPER CHATTAHOOCHEE RIVER

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Abstract. Coliforms and other potentially pathogenic bacteria can be transported to streams during storm runoff events or through baseflow exposed to historic septic fields as well as leaking sewage lines. Coliforms are typically associated with turbidity spikes after rainfall events. Accordingly, relationships between turbidity and both total coliforms and *Escherichia coli*, a pathogenic bacterium found in mammalian fecal matter, are used to monitor these components of biological water quality. The ratio of *E. coli* to total coliforms can provide insight to the magnitude of human and domestic animal coliform sources relative to antecedent coliforms. Our objectives are to 1) quantify patterns in ratios of *E. coli* to total coliforms based on stage and prior precipitation; and 2) model coliform ratio changes associated with discharge and precipitation. Stream stage data and coliform monitoring data was downloaded from the USGS Water Watch program and the Bacterialert program for the Chattahoochee river gauging stations located in north Georgia near Norcross (02335000), Powers Ferry Road (02335880), and at Paces Ferry Road (02336000). Coliform ratios were calculated for all sites and dates prior to correlating with stage. Sampling events were also compared based on prior rainfall (-/+). Our data failed to indicate the ratio of *E. coli* to total coliforms increased after rain events compared ($p<0.001$). These results do not indicate that anthropogenic influences on streams proportionally increase post rainfall events. Future analyses will continue to investigate the relationship between stream stage and coliform ratios.

INTRODUCTION

Coliforms and other potentially pathogenic bacteria can be transported to streams during storm runoff events as well as through baseflow contaminated by leaking sewage lines and legacy septic fields. The particular bacterium of interest in this study, *Escherichia coli*, is a common inhabitant of a mammal's natural gut microbiome. The digestive process tends to transport varying quantities of *E. coli* out of any given mammal and into the surrounding environment. This seemingly natural process can actually cause harm to other creatures that come into contact with the excreted *E. coli* due to the fact it also possesses pathogenic characteristics.

Upon ingestion of foreign *E. coli*, the bacterium immediately colonizes the mucosal membranes and efficiently evades the host's immune system. Once it has amounted substantial numbers, which doesn't take long seeing as one bacterium can produce a copy of itself every twenty minutes, it will then begin to secrete toxins which cause varying severities of gastrointestinal illness. This illness has a larger impact on the young and immunocompromised, however healthy adults can be completely debilitated by it as well; the severity of illness depends on the strain of *E. coli* contracted and the concentration to which it grew during its incubation period (Nataro & Kaper 1998).

Turbidity is a common monitoring parameter for coliform pathogen indicators because it is typically strongly correlated with total coliforms and *E. coli*. The ratio of *E. coli* to total coliforms can provide insight to the relative magnitudes of human and domestic animal coliform sources to antecedent (environmental) coliforms. We quantified patterns in ratios of *E. coli* to total coliforms based on stream stage and prior precipitation.

OBJECTIVES

Our objectives are to 1) quantify patterns in ratios of *E. coli* to total coliforms based on stage and prior precipitation; and 2) model coliform ratio changes associated with discharge and precipitation.

METHODS

The USGS collected data used by this study from the Chattahoochee River at the following sampling locations, Norcross (02335000), Powers Ferry Road (02335880), and at Paces Ferry Road (02336000), summarized in Table 1. The U.S Geological Survey's Bacterialert program collected weekly samples from the three locations listed above and produced *E. coli* and total coliform counts using the IDEXX Colilert method.

Table 1: Location of monitoring sites along the Chattahoochee River (site descriptions retrieved from the USGS Baterialert Program).

Station ID	Station Name	Latitude	Longitude
A (2336000)	Paces Ferry at Atlanta	33.8592	-84.4544
B (2335000)	Medlock Bridge near Norcross	33.9972	-84.2019

C (2335880)	Powers Ferry at Atlanta	33.9023	-84.4416

In this process, samples taken from an area of interest are added to a solution containing two nutrient indicators. ONPG is the nutrient indicator for coliforms, and MUG is the nutrient indicator for *E. coli*. Upon metabolism of these nutrient indicators, the presence of coliforms will cause the solution to turn yellow, while the presence of *E. coli* will cause the solution to fluoresce. These samples are then run through a Quanti-Tray to get actual concentrations.

Ratios of *E. coli* to total coliforms were calculated in excel to have a better understanding of the presences of *E. coli* within those total coliforms. Analysis steps were completed in the statistical software package R. ANOVA and TUKEY HSD post hoc tests were used to determine longitudinal differences in coliform ratios among sites. Logistic regression was used to determine if coliform ratios were indicators of prior precipitation events.

RESULTS

A weak positive relationship was observed between *E. coli* and total coliforms (Figure 1). Rain events were not shown to be associated with increases in coliform ratio (Figure 2). Additionally, all three sites exhibited similar coliform ratios (Figure 3).

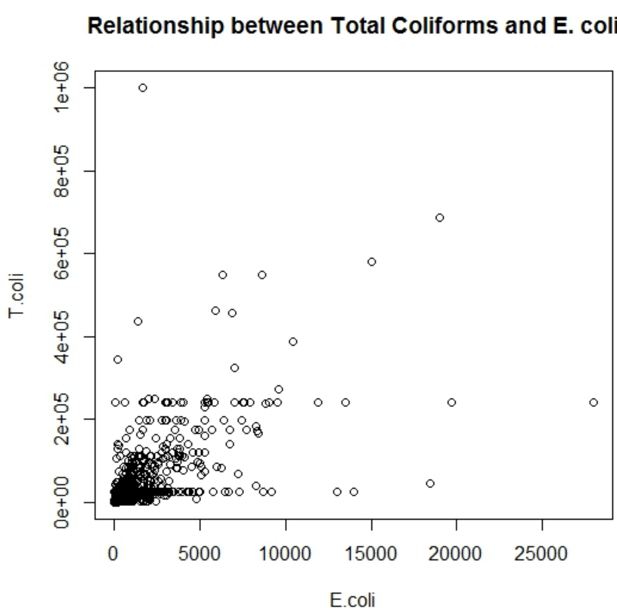

Figure 1. Relationship between *E. coli* and total coliforms.

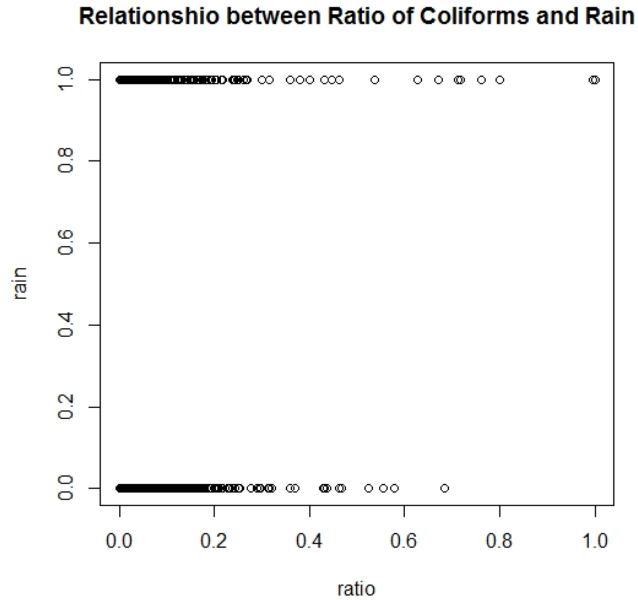

Figure 2. Logistic regression showed no relationship between coliform ratios and of rain events.

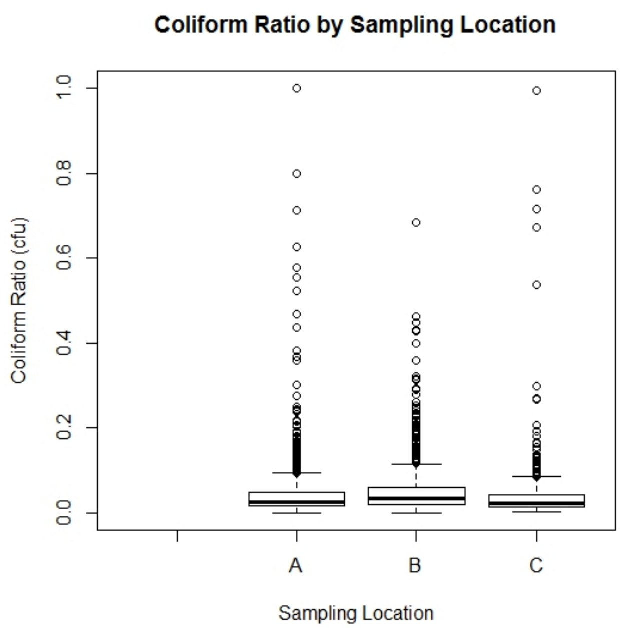

Figure 3. Coliform ratios at each sampling location.

DISCUSSION

The ratio of *E. coli* to total coliforms did not increase in the presence of rain events as opposed to non-rain events. Site B was significantly different from both Site A (p=0.0002) and Site C (p=0.0051). The difference in distance from site B from sites A and C explained the result. Sites A and C did not differ (p=0.8545). Ratio changes are likely due to waste water sources discharging to the river before sites A and C. This could also be the reason that storm runoff events were not associated with coliform ratios despite rain typically being associated with higher coliform ratios (Lawrence 2012).

Fishing, rafting, and swimming are very popular in the Chattahoochee River region which means that it is important to determine parameters and metrics that can be used for assessing pathogen risks. In future studies, we aim to analyze stream stage in this river to determine if water level may be used as a monitoring parameter for potential pathogen exposure where turbidity data is lacking.

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