EFFECT OF HUMAN RECREATION ON *ESCHERICHIA COLI* LEVELS IN THE CHATTAHOOCHEE RIVER IN HELEN, GA

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Abstract. The economy of Helen, GA relies heavily on tourism and recreation in the Chattahoochee River. Tubing the river is a particularly popular activity, with several thousand people in the water each week from June - September. Sampling during the summer of 2003 by the Georgia Mountains Regional Development Center (GMRDC) reported high levels of the fecal indicator bacterium *Escherichia coli* in the Chattahoochee River near Helen. The present study focused on determining whether sediment disturbance by humans increases bacterial load in the water column, thus amplifying exposure risk for people engaging in recreational activities. Sediment acts as a reservoir for *E. coli* and disturbance of sediment may lead to sudden and significant increases in *E. coli* concentrations. In this study, water samples were collected once or twice per week from June through September, in the morning (before the tubing period began) and evening (after tubing ended) of the same day. Samples were collected at control sites upstream of the tubing region and at experimental sites spanning the stretch of river through Helen where the majority of tubing activity occurs. Samples were prepared for total coliform and *E. coli* quantification using the Colilert® Quanti-tray® 2000 system (IDEXX) and incubated for 24 hours at 35.5°C. Mean *E. coli* levels at control sites were 47.5 MPN/100 ml for AM sampling and 38.8 MPN/100 ml for PM sampling. *E. coli* levels at test sites were 230.2 MPN/100 ml for AM sampling and 259.9 MPN/100 ml for PM sampling, with over half of the test site readings being greater than the USEPA proposed standard of 235 MPN/100ml. *E. coli* levels were significantly greater at test sites compared to control sites. However, *E. coli* levels did not differ significantly between morning and evening collections, suggesting that human activity in the water had little impact on the levels of *E. coli* either through addition of bacteria directly to the water column or through the disruption of sediment bacteria stores.

INTRODUCTION

The city of Helen, located in northeast Georgia along the Chattahoochee River, is a popular rural destination for recreational freshwater activities. Tubing on the river has become increasingly popular, attracting several thousand participants throughout the summer months. Due to the high frequency of human contact with the water, recurrent water quality testing is required to ensure the safety of individuals that utilize the river. Currently, the United States Environmental Protection Agency (USEPA) and the state of Georgia base water quality standards on fecal coliform. The reliability of fecal coliform as an indicator of fecal contamination and subsequent risk for gastrointestinal illness has been debated for the last few years. The USEPA suggested in 1986 and 2002 that *Escherichia coli* levels are a better indicator of risk of gastrointestinal illness than fecal coliform levels (USEPA, 2002). Although *E. coli* has not been officially determined as the standard, organizations in Georgia have switched to *E. coli* testing, using the USEPA proposed acceptable limit of 235 CFU/100ml for recreational waters (Gregory and Frick, 2001). In the summer of 2003, a survey of the Upper Chattahoochee River and tributaries around Helen completed by the Upper Chattahoochee Riverkeeper (UCR) and Georgia Mountain Regional Development Center (GMRDC) reported *E. coli* levels above the proposed 235 CFU/100ml standard (GMRDC, unpublished results).

Sediments are known to be a reservoir for fecal bacteria (Stephenson & Rychert, 1982). A study by McDonald, et al. (2006) suggested that conditions resulting in sediment disturbance can potentially lead to increases in bacterial load in the water column with the potential to exceed recommended standards. The primary objective of this study was to determine if sediment disturbances created by recreational tubing in the Chattahoochee River through the city of Helen result in significant increases in *E. coli* concentration in the water column, thus amplifying exposure risk.

MATERIALS AND METHODS

Water quality sampling took place once or twice a week during peak tubing season from June through

September, 2006 when stormy conditions did not exist. Sampling was conducted twice daily, in the morning (before a tubing event) and in the evening (after a tubing event) at four control sites in the Chattahoochee National Forest upstream of Helen and at four test sites spanning the stretch of the Chattahoochee River through Helen, where the majority of tubing activity occurs. Dissolved oxygen content and temperature of the water were measured using a YSI dissolved oxygen probe (YSI, Yellow Springs, OH) and air temperature was measured using a standard pocket thermometer. Grab samples were collected mid - river in 500ml Whirl-pak bags (Nasco, Fort Atkinson, WI), placed directly on ice and processed within 8 hours of collection.

Samples were prepared for total coliform and *E. coli* quantification using the Colilert® Quanti-tray® 2000 system (IDEXX Laboratories, Westbrook, ME). For each sample, 100ml of water were transferred into a sterile IDEXX bottle and Colilert® reagent was added. The bottles were sealed and gently mixed to dissolve the Colilert® reagent. Each sample was poured into a sterile IDEXX 97 – well Quanti-tray then sealed with the IDEXX Quanti-tray sealer, thereby uniformly distributing sample to all wells. All trays were incubated for 24 hours at 35.5°C after which results were read for both total coliform and *E. coli* with a hand-held 365 nm light (Mineralight UVS – 54, Ultraviolet Products, Inc., San Gabriel, CA). Positive results were converted to a most – probable number (MPN/100ml) using the MPN table supplied by IDEXX. A two-way ANOVA was performed on mean control sites data and mean test sites data comparing *E. coli* levels at control sites versus test sites and also comparing *E. coli* levels from morning and evening sampling periods.

RESULTS

As shown in figure 1, a significant difference did not exist between *E. coli* levels in morning versus evening ($F_{1,12}$ = 0.182, p = 0.67). However, figure 1 also shows that there was a very significant difference between *E. coli* levels at the control sites versus the test sites ($F_{1,12}$ = 67.45, p = <0.0001). Bars on graph show standard error.

DISCUSSION

Predictions based on initial assessment of *E. coli* levels in the Chattahoochee River near Helen suggested that recreational tubing would result in an increase in *E. coli* levels due to sediment disturbance. However, final data analysis indicated that although test sites had significantly higher *E. coli* levels than control sites,

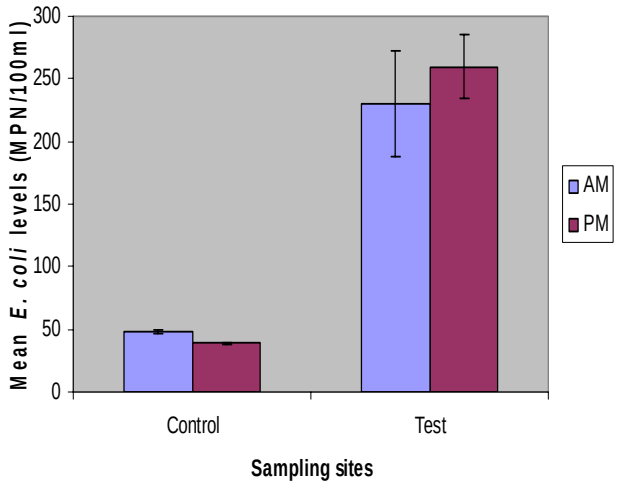

Figure 1. The mean *E. coli* levels for control and test sites during morning and evening samplings.

bacterial load did not significantly increase after a tubing event. These data indicate that tubing does not appear to impact *E. coli* levels to any appreciable extent.

It is unlikely that morning samples were affected by the previous day's tubing activity based on evidence with both natural and simulated disturbances showing a very transient (seconds to hours) elevation in water *E. coli* levels (Stephenson and Rychert, 1982). Previous work has shown a diurnal oscillation in *E. coli* levels in the Chattahoochee River, with highest levels at night and in the early morning, and a purportedly sunlight induced die-off during mid afternoon (Gregory and Frick, 2001). However, the portion of the river tested by Gregory and Frick (2001) is wider and more exposed to sunlight than the sampling sites in Helen. These sites were, for the most part, heavily shaded and showed little variation in water temperature between morning and evening sampling periods (data not shown). Thus, we would expect any observed difference between morning and evening *E. coli* levels to be due primarily to human activity.

During the summer of 2006, Helen experienced a period of drought resulting in decreased flow and, consequently, decreased turbidity. Positive correlations have been recorded between turbidity and fecal coliform levels when using IDEXX based systems (McDonald et al., 2003). Low water levels impacted the tubing industry of Helen as well. Tubing companies shortened tubing runs mid-season in response to unsustainable water levels and reported lower than normal participant numbers (Cool River Tubing Co., pers. comm.). It is possible that the lack of precipitation resulted in decreased turbidity and decreased tubing activity, both of which decreased *E.*

coli levels in the water column and, possibly, in the sediment.

The city of Helen is centered on the Chattahoochee River with most restaurants and homes crowding the riverbanks. The possibility exists that the homes and/or businesses could be leaking or draining waste into the river. The close proximity of these establishments to the river is a possible cause for the significant difference between *E. coli* levels at control sites versus test sites. Control sites are located north of the city of Helen where fewer establishments are located.

Given the results of this study, additional water and sediment sampling along with bacterial source tracking and turbidity measurements are planned for summer 2007 (peak tubing season) to more definitively elucidate whether recreational tubing has a significant impact on *E. coli* concentrations in the water column. This research will be critical to maintain the quality of recreation in the Chattahoochee River near Helen.

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