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The Effects of a Storm's First Flush On Nutrient Cycling and the Microbial Assemblage in Parkerson Mill Creek, Auburn, AL

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A 'first flush' is the initial surface runoff from a rainstorm, lasting about 24 hours after precipitation begins. First flushes are characterized by the disproportionate loading of contaminants or pollutants into the surface waterbody during the rising limb of the hydrograph when compared to lower loading during the peak or falling limb (Griffin et al., 1980). Recently, Peter et al. (2020) recognized that peak contaminant loading for stream systems occur prior to or coincidently with that stream's hydrograph peak. However, the microbial response to the first flush, and consequent nutrient and pollutant biogeochemical cycling are less understood. Thus, the purpose of this research was to observe how a microbial community responds to a first flush and concurrent changes in water chemistry. We hypothesized that the microbial community would either grow due to an influx of potential nutrient sources in the water brought in from the first flush, or the community would be diluted by the stormwater.

For this research project, water was sampled from Parkerson Mill Creek (PMC) in Auburn, AL, south of Auburn University. PMC is a first order stream that is part of the larger Tallapoosa River watershed. Its headwaters are on the Auburn University campus near the Beard-Eaves Memorial Coliseum, and it flows into Chewacla Creek south of Chewacla State Park. Single, time-representative grab samples from PMC were collected every 6 hours during rainstorms beginning at initial precipitation and lasting for 36 hours.

However, samples were not collected after 10:00 pm or before sunrise, nor were they taken during severe weather. When the grab samples were collected, a YSI EXO^2 sonde was deployed to record temperature, pH, dissolved oxygen (DO), turbidity, fluorescent dissolved organic matter (fDOM), and specific conductivity (SPC). A total of two storm events were sampled for this study on February 2, 2022, and March 15, 2022.

The microbial community was cultivated from the samples using Biolog Ecoplates™ (Garland, 1997). Biolog Ecoplates™ are well plates that contain 31 different carbon substrates in triplicate, and the microbial community is quantified based on the ability of the community to utilize the array of substrates. Metabolism of the carbon substrate produced a purple color, and the optical density of each plate was recorded every 24 hours to determine the degree of activation in each well. An optical density of 0.25 or higher indicated the carbon substrate had been activated. Once the optical density data were recorded, the average metabolic response (AMR) was calculated for each well plate. The AMR is the average activation level of the carbon source wells against the control (water) and is recorded as a single value, allowing for comparison between Ecoplates (Sigler, 2004). Next, the AMR for each storm event was graphed against PMC's streamflow during respective sample collection time. Figures 1 and 2 show the AMR versus the stream hydrograph for storms 1 and 2 respectively, with the yellow box indicating the first flush 24-hour period.

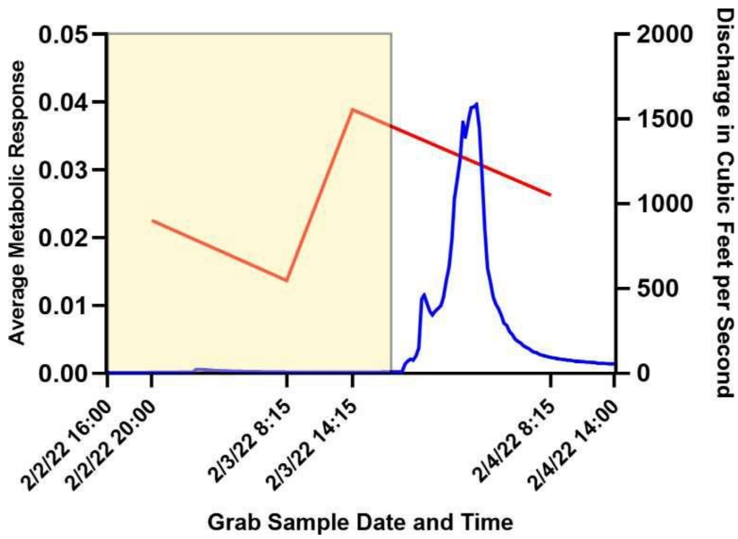

Fig. 1. Storm 1: AMR (red line) is plotted against streamflow (blue line). The yellow box indicates the first flush 24-hour period

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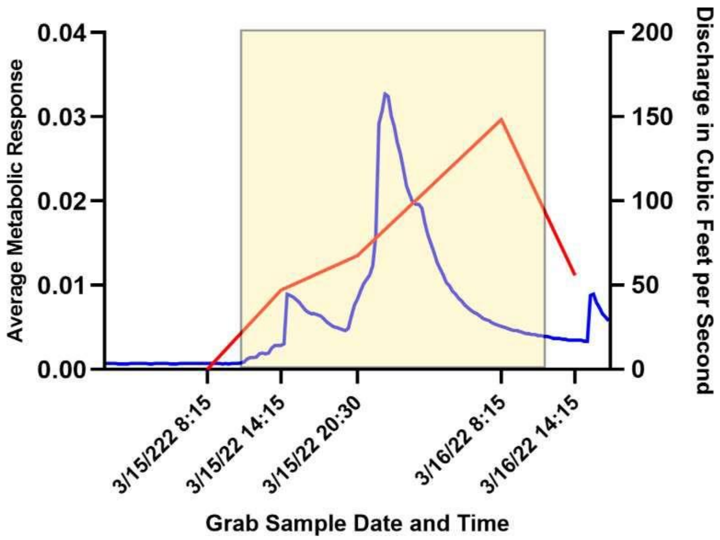

Fig. 2. Storm 2: AMR (red line) is plotted against streamflow (blue line). The yellow box indicates the first flush 24-hour period.

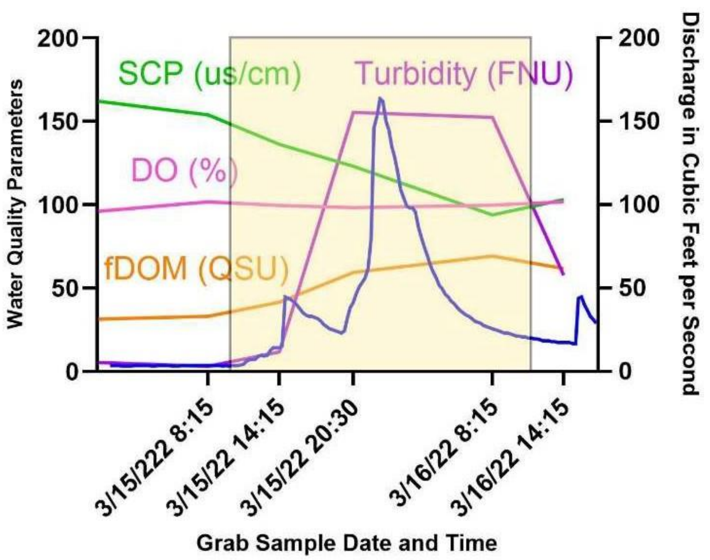

Fig. 3. Storm 2: Water quality parameters are plotted against streamflow (blue line). The yellow box indicates the first flush 24-hour period.

Both storms 1 and 2 show that the AMR increases during the first flush period after the initial precipitation. The AMR did not decrease again until after the streamflow peak and the first flush window have passed. This data suggests that there is an increase in the concentration of microbial communities during the first flush. We also found that the community metabolic diversity increased during the storm events, but not in a predictable pattern. More frequent sampling to better match the high -resolution data from the hydrograph could help to better understand a more precise relationship between a first flush and the stream's microbial community. In storm 2, we found that turbidity, fDOM, and DO all increased in concentration and SCP was diluted with respect to the first flush. According to Hathaway et al. (2012), these relationships are not the same for every stream, but could be unique to PMC. Increased turbidity and fDOM are an indicator that nutrient availability (dissolved organic carbon, particulate carbon, and particulate nitrogen) could be also increasing (Snyder et al., 2018). Storm water samples could be further analyzed to identify the phylogenetic diversity of the microbial community present and how contaminants or pollutants change in response to the dynamics of the microbial community.

Statement of Research Advisor

Parkerson Mill Creek is an impaired waterbody, meaning it doesn't meet water quality standards set by the Alabama Department of Environmental Management. Emma's work helps us understand how microbial communities respond to storm events. Ultimately, her research will better inform nutrient cycling and contaminant fate and transport in this stream.

- *Ann Ojeda, COSAM, Department of Geoscience*

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Authors Biography

Emma Henderson is a graduate of Auburn University's class of May 2022 with a B.S. degree in Geology.

Ann Ojeda studies geology, environmental science, and health science to understand how the geosphere controls health outcomes. Her research advances human health and community resilience through (1) the geo-environmental controls on drinking water contaminants and aquifer vulnerability, (2) controls on freshwater resources, and (3) community dynamics and health outcomes from exposure to untreated or undertreated drinking water supplies