Evaluation of Pollution Sources to Lake Glenville

Quarterly Report – June 2019

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Summary

Chemical and microbial analysis of water samples collected at Lake Glenville area sites helps to characterize water quality in relation to potential sources of water pollution. Overall water quality, as evidenced by data collected on June 19, 2019, is acceptable but there is evidence to suggest the influence of recent runoff events on nutrient concentrations, total suspended solids, and turbidity. These concentrations were elevated compared to those observed in March 2019, most likely due to the ~0.5 inches of precipitation that fell during the afternoon of June 18. The next quarterly monitoring event will take place in September 2019. Results from that monitoring event will be evaluated individually and in relation to the results presented in this report to evaluate temporal changes in water quality and evaluate sources of pollution.

Methodology

Lake Glenville area samples were collected on Wednesday, June 19, 2019. At each sampling location, the following data were collected: creek name, time of sample collection, pH, dissolved oxygen, conductivity, air temperature, and water temperature. Weather conditions during the time of sample collection were also recorded. Samples were collected in triplicate at each site in labeled 2L Nalgene™ bottles and transported to Western Carolina University's Environmental Health Lab on ice. Upon arrival to the Environmental Health Lab, samples were analyzed for the following parameters within 6 hours: alkalinity, ammonia (NH_3), nitrates (NO_3), orthophosphates (as PO_4), total suspended solids (TSS), turbidity, and *E. coli*. Detailed explanations of laboratory analyses are available upon request.

Results

Acidity and Alkalinity: pH is used to measure acidity. The ambient water quality standard for pH is between 6.0 and 9.0, although natural pH in area streams generally ranges from 6.5-7.2. Values below 6.5 may indicate the effects of acid precipitation or other acidic inputs, and values above 7.5 may indicate industrial discharge. All pH observations are within the North Carolina water quality standard for freshwater aquatic life (Figure 1). Pine, Norton, and Hurricane Creeks exhibited pH readings above 7.5 while the pH readings of the remaining creeks were comparable to area streams. Glenville, Pine, and Mills Creeks exhibited lower pH measurements while Norton, Hurricane, and Cedar Creeks exhibited higher pH measurements compared to those observed in March 2019.

Alkalinity is the measure of the pH buffering capacity of a water or soil. High alkalinity waters are generally better protected against acid inputs from sources such as acid rain, organic matter, and industrial effluent. Waters with an alkalinity below 30mg/L are considered to have low alkalinity. The observed mean alkalinity concentrations demonstrate low alkalinity in all monitored creeks (Figure 2). Historically low alkalinity concentrations in these creeks may account for the observed fluctuations in pH as the waters have little buffering capacity and are therefore more susceptible to changes in pH. All creeks displayed an increase in average alkalinity concentrations compared to March 2019.

Figure 1. pH levels at each monitoring site, June 2019

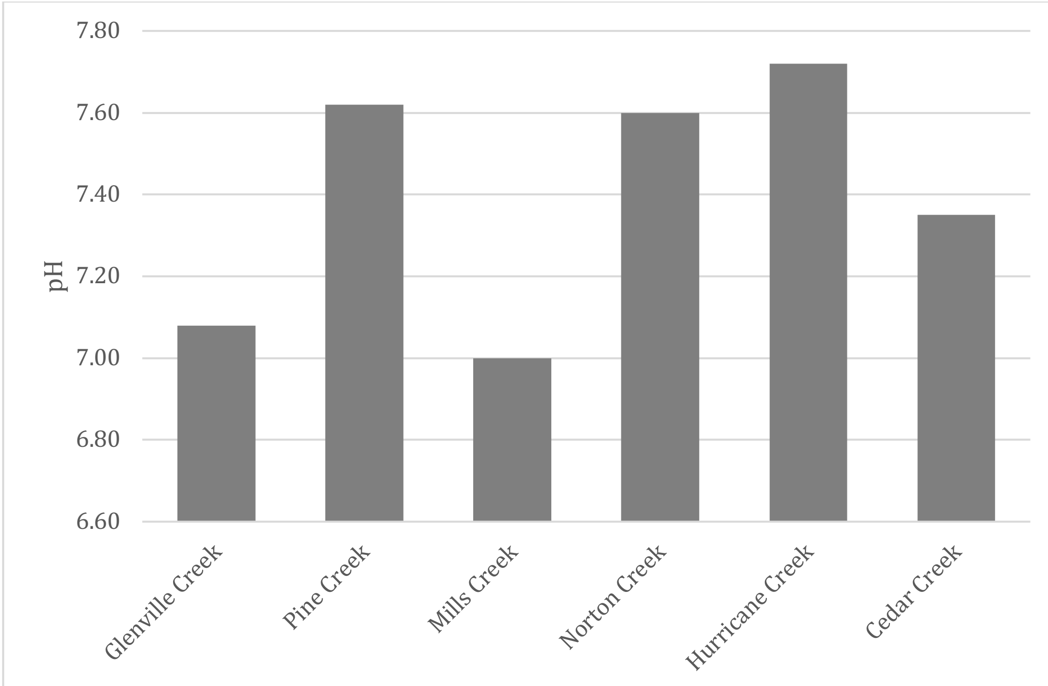
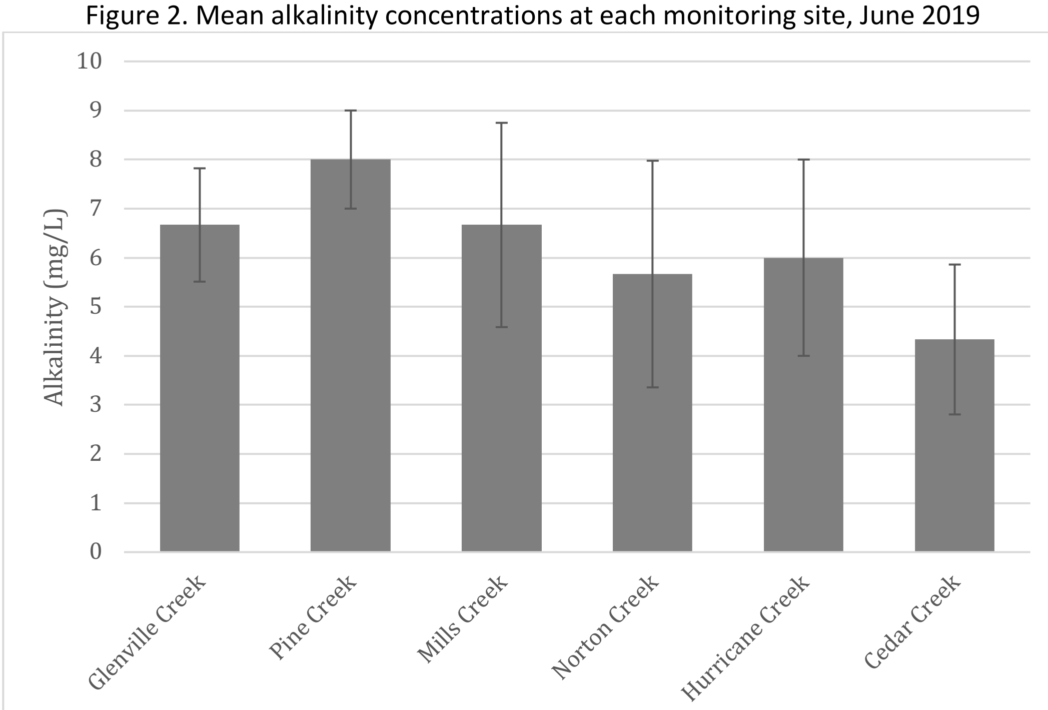


Figure 2. Mean alkalinity concentrations at each monitoring site, June 2019



Turbidity and Total Suspended Solids (TSS): Turbidity is a measure of visual water clarity and of the presence of suspended solids and dissolved organic matter. The standard for trout-designated waters is 10 NTU and the standard to protect other aquatic life is 50 NTU. Turbidity measurements in all creeks are below the 10 NTU trout-designated water standard (Figure 3). TSS quantifies solids by weight and is heavily influenced by a combination of stream flow and land disturbances. Although there is no legal standard for TSS, concentrations below 30mg/L are generally considered low. All monitoring sites exhibited low TSS concentrations (Figure 4). Turbidity and TSS concentrations observed in June 2019 were elevated compared to those observed in March 2019. These observations are likely due to the ~0.5 inches of precipitation that occurred on the day prior to sample collection and subsequent runoff. While moderately heavy precipitation events and land disturbance can increase turbidity and TSS concentrations, the undisturbed forested areas and presence of riparian zones in the Lake Glenville area likely help prevent significant increases in turbidity and TSS particulates during precipitation and runoff events.

Figure 3. Mean turbidity levels at each monitoring site, June 2019

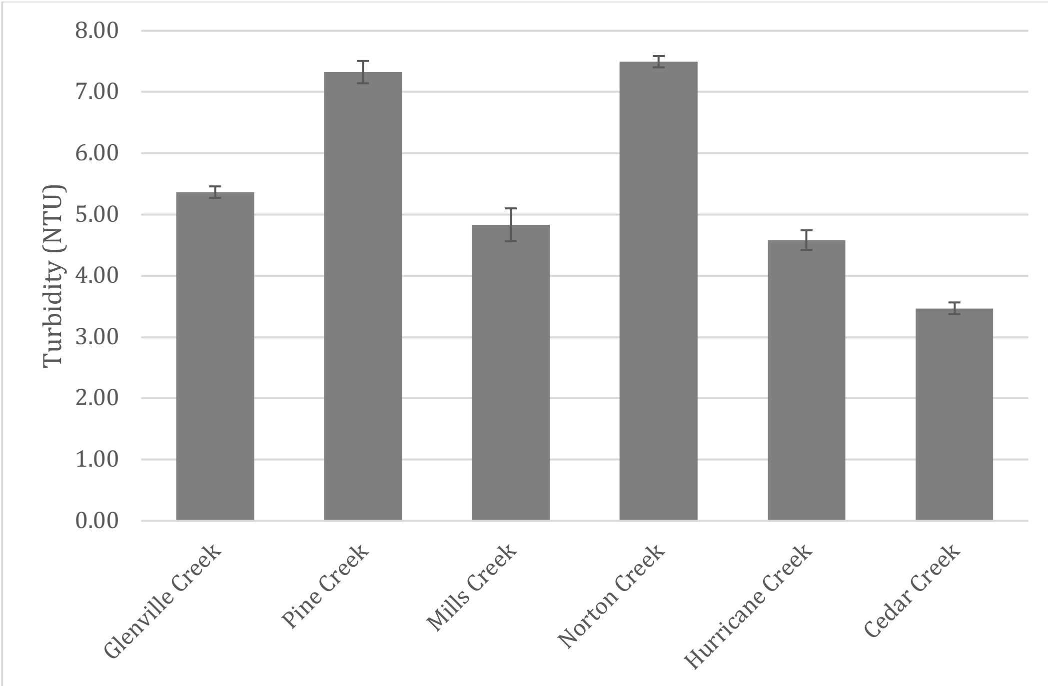
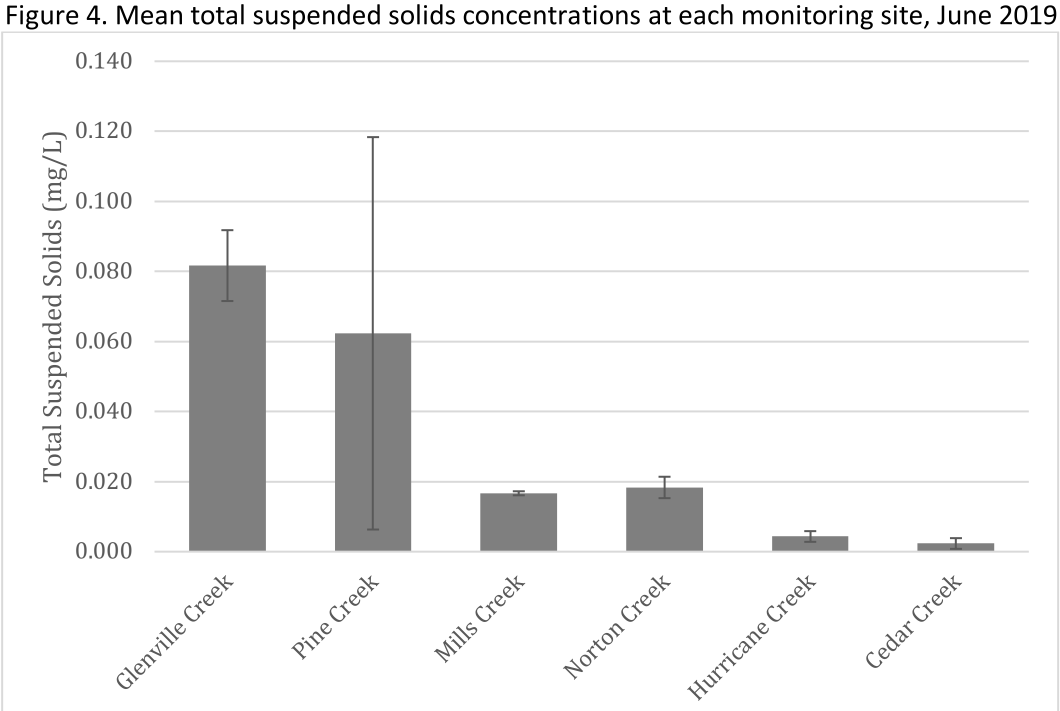
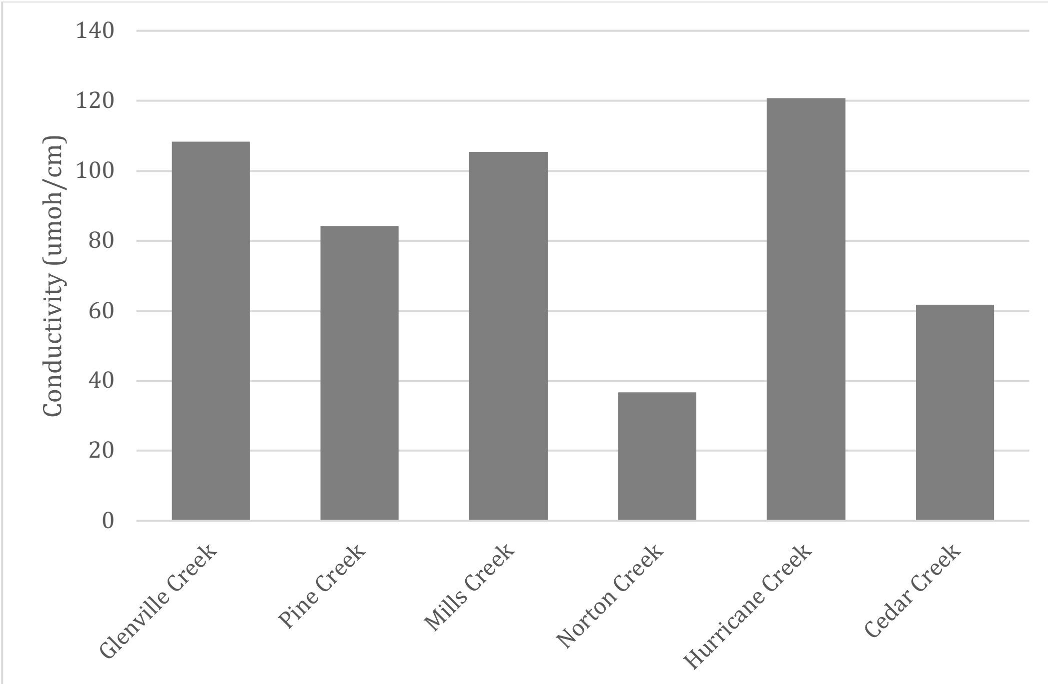


Figure 4. Mean total suspended solids concentrations at each monitoring site, June 2019



Conductivity: Conductivity is used to measure the ability of water to conduct an electrical current. Samples containing dissolved solids and salts will form ions that will conduct an electrical current and the concentration of dissolved ions in a sample determines conductivity. Inorganic dissolved solids such as chloride, nitrate, phosphate, calcium, sulfate, iron, sodium, and aluminum will affect conductivity levels and local geologic conditions will influence the types and extent of dissolved ions. Elevated levels of conductivity are most often seen in streams receiving wastewater discharge, urban runoff, or eroded soils. The observed conductivity levels in all creeks remain low (Figure 5) but were elevated compared to the conductivity measurements observed in March 2019. These elevated conductivity levels are likely influenced by precipitation and runoff events which introduce nutrients and dissolved solids.

Figure 5. Conductivity levels at each monitoring site, June 2019



Nutrients (Orthophosphate [PO_4^{3-}], Ammonia [NH_3], and Nitrate [NO_3^-]): Phosphorus is an essential nutrient for aquatic plants and algae, and is typically the limiting nutrient in most aquatic systems thereby restricting plant growth in an ecosystem. Phosphorus is introduced into water systems from soil, wastewater treatment systems, failing septic systems, and runoff from fertilized land. Excessive phosphorus stimulates excessive plant growth and results in eutrophication, a condition that can result in dissolved oxygen depletion in an aquatic ecosystem. Orthophosphate is the amount of phosphorus that is immediately available to plants or algae for biological assimilation. Generally, orthophosphate levels below 0.05 mg/L are sufficient to prevent eutrophication.

There is no legal water quality standard for orthophosphate, but the Environmental Protection Agency (EPA) nutrient criteria for total phosphorus in rivers and streams in this ecoregion is 0.01 mg/L. Although orthophosphate is only one component of total phosphorous, observed concentrations at all monitored sites exceed the EPA nutrient criteria for total phosphorous (Figure 6). Pine Creek exhibited a decrease in orthophosphate concentrations while all other creeks exhibited an increase in orthophosphate concentrations compared to those observed in March 2019. Orthophosphate concentrations are slightly correlated with conductivity and turbidity suggesting the influence of soil erosion and runoff on orthophosphate concentrations.

Ammonia is contained in decaying plant and animal remains and microbial decomposition of these organic wastes can release ammonia. The most likely sources of ammonia are agricultural runoff, livestock farming, septic drainage, and sewage treatment plants. The ambient concentration of ammonia in water is approximately 0.10 mg/L but concentrations are heavily influenced by water temperature and pH, with higher temperatures and pH leading to more nitrogen being present in the form of ammonia. All creeks with the exception of Norton Creek exceeded the ambient concentration “norm” (Figure 7). Recent precipitation events, higher water temperatures, and higher pH likely contributed to the increased ammonia concentrations in all creeks compared to those observed in March 2019.

Like phosphorus, nitrate serves as an algal nutrient and can contribute to excessive plant growth and eutrophication. Common sources of nitrate include septic drainage and fertilizer runoff from agricultural land and domestic lawns. The ability of nitrate to more readily dissolve in water contributes to its increased likelihood of traveling in surface waters. As a result, nitrate is a good indicator of sewage or animal waste input. There is no legal water quality standard for nitrate, but the EPA nutrient criteria for total nitrogen in rivers and streams in this ecoregion is 0.31 mg/L. Although nitrate is only one component of total nitrogen, observed concentrations in all creeks exceeded the EPA nutrient criteria for total nitrogen (Figure 8). Observed nitrate concentrations were higher in Pine and Hurricane Creeks and lower in Mills and Norton Creeks compared to those observed in March 2019. Observed nitrate concentrations are correlated with turbidity (Figure 9), suggesting that soil erosion and runoff may be contributing nitrate to these creeks.

Figure 6. Mean orthophosphate concentrations at each monitored site, June 2019

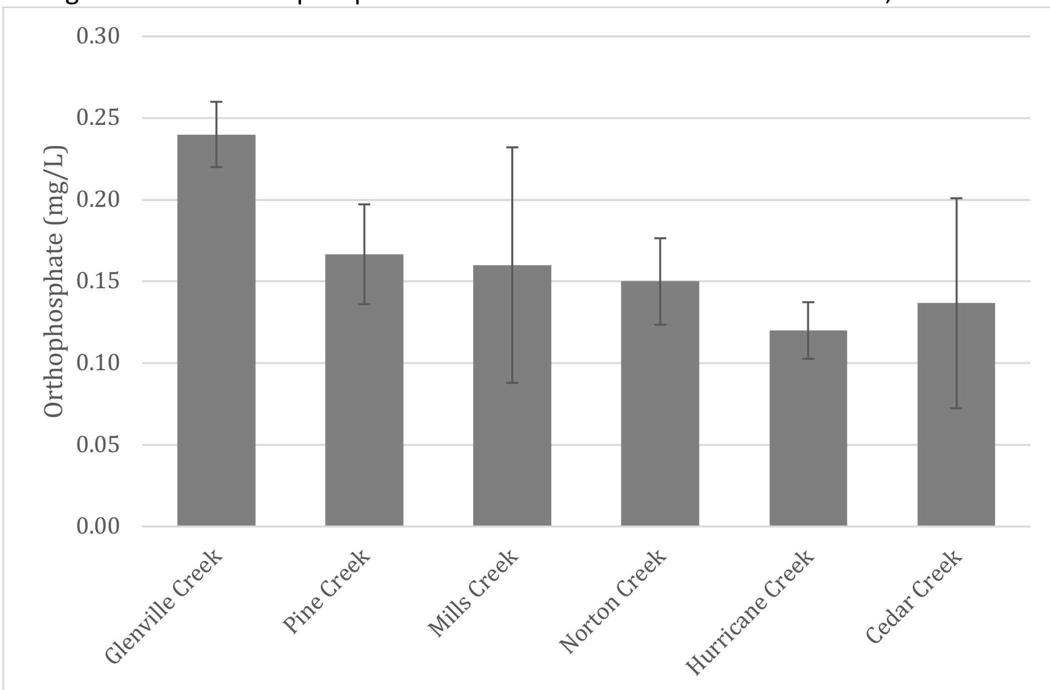


Figure 7. Mean ammonia concentrations at each monitored site, June 2019

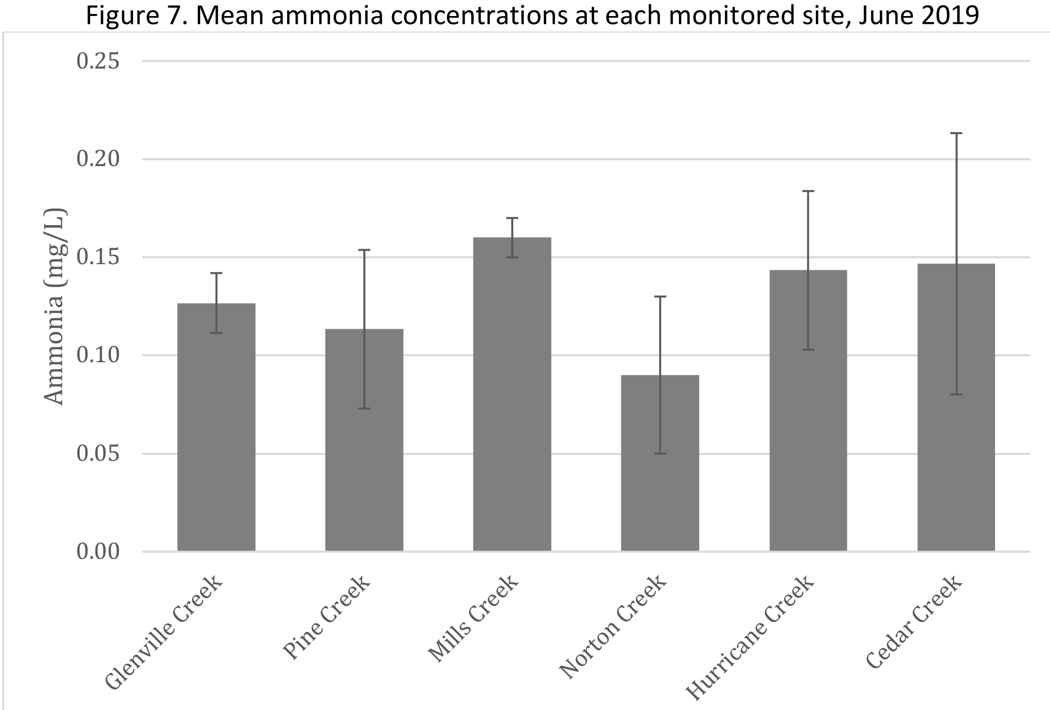


Figure 8. Mean nitrate concentrations at each monitored site, June 2019

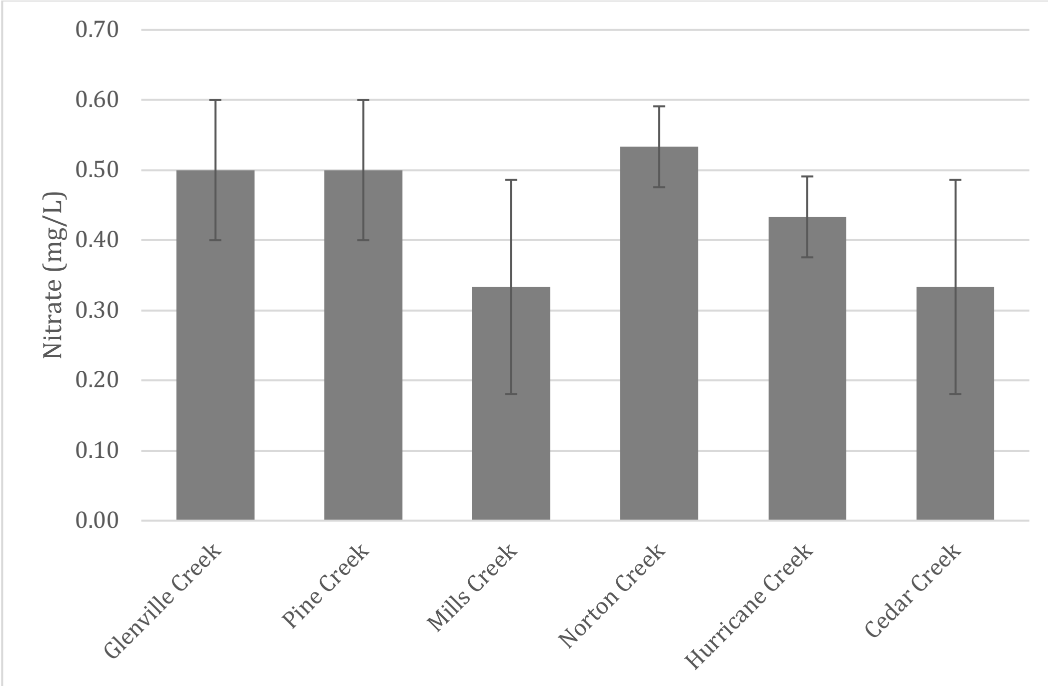
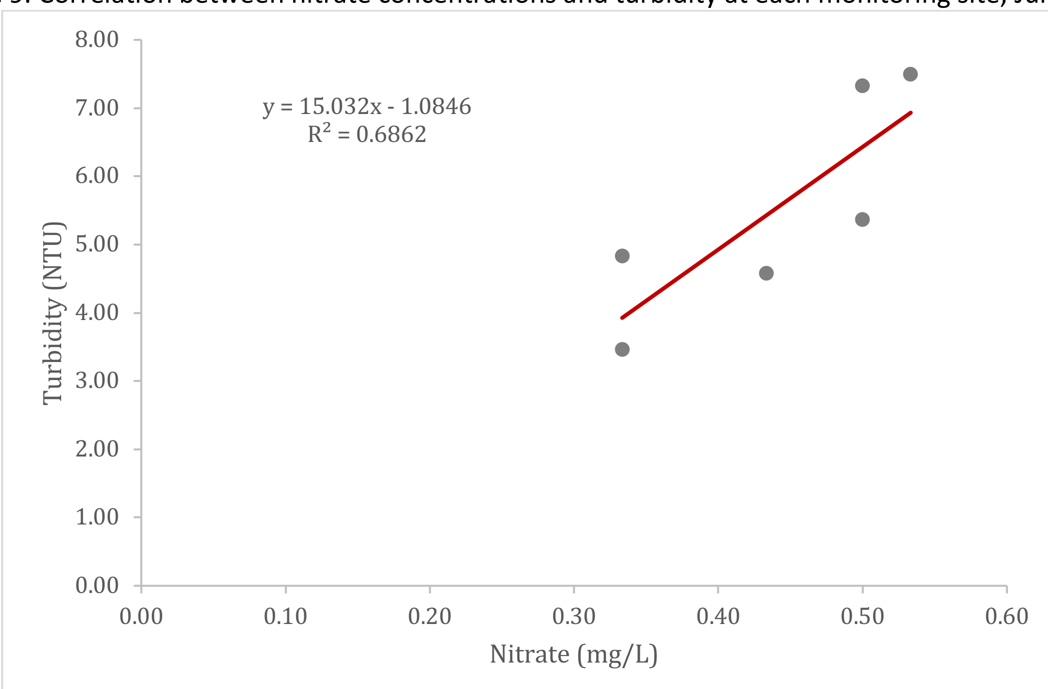


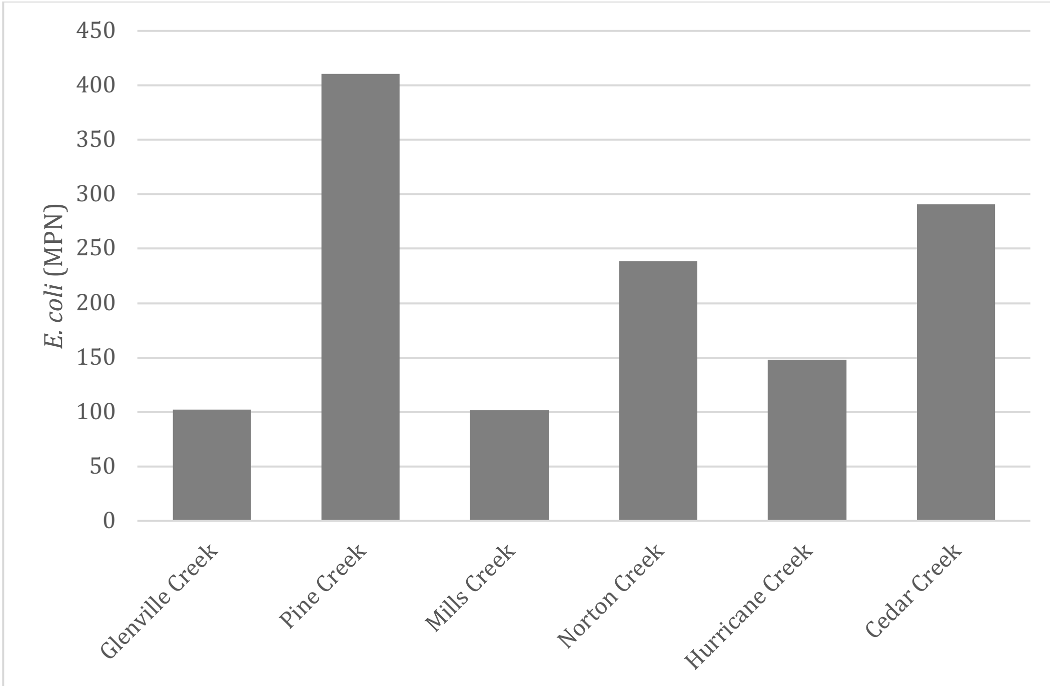
Figure 9. Correlation between nitrate concentrations and turbidity at each monitoring site, June 2019



***E. coli*:**

The potential presence of fecal pathogens in surface water is determined based on a surrogate measurement of fecal indicator organisms, including *E. coli*. The recreational standard for *E. coli* in the State of North Carolina is 200 CFU/100ml. Pine, Norton, and Hurricane Creeks exhibited *E. coli* concentrations above this regulatory standard (Figure 10). These results are likely influenced by precipitation and runoff events, and may not be representative of true watershed dynamics. *E. coli* concentrations in surface waters have been shown to be influenced in part by seasonality and precipitation, and future sampling events will continue to monitor *E. coli* to identify possible influences of seasonality and agricultural activity on fecal pollution in the creeks discharging into Lake Glenville.

Figure 10. *E. coli* concentrations at each monitored site, June 2019



<u>Conclusions</u>

Chemical and microbial analysis of water samples collected at Lake Glenville area sites helps to characterize water quality in relation to potential sources of water pollution. Overall water quality, as evidenced by data collected on June 19, 2019, is acceptable but there is evidence to suggest the influence of precipitation, soil erosion, and runoff events on nutrient concentrations, total suspended solids, and turbidity. The next quarterly monitoring event will take place in September 2019. Results from that monitoring event will be evaluated individually and in relation to the results presented in this report to evaluate temporal changes in water quality and evaluate sources of pollution.