

Evaluation of Water Quality in Eno River and Ellerbe Creek Between 2019 and 2020

https://github.com/ar157/EDA_Final_Project_DurhamWQ

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1 Rationale and Research Questions

Water quality of urban streams and rivers has been studied across the United States for the past several decades. These evaluations typically provide important insights about stressors on aquatic systems in urban environments, particularly natural pollutants such as nutrients, sediment, and heavy metals, as well as anthropogenic contaminants such as pesticides and other man-made chemicals. Many cities have programs dedicated to monitoring the health of local rivers and streams for the protection of humans and wildlife.

Certain water quality parameters are commonly collected and used to assess health of urban streams. These include measurements of chemical, physical, and biological parameters that can be used independently or together to determine stream health. These parameters are often evaluated over time to highlight general trends in water quality in urban environments. In general, health of urban streams in the United States has been improving since the Clean Water Act was introduced in the 1970s.

The main objective of our project was to understand current water quality trends in local urban streams between 2019 and 2020. Eno River and Ellerbe Creek in Durham, North Carolina were selected for evaluation in our study. These streams were chosen to provide a local context for evaluating recent changes in stream health. Additionally, the City of Durham collects monthly monitoring data for both Eno River and Ellerbe Creek for several metrics that they provide publicly, making this easily accessible data. This project includes an evaluation of the most common surface water quality parameters for which the City of Durham had data, including temperature, pH, dissolved oxygen, metals (zinc and copper), total phosphorus, fecal coliform, turbidity, and total suspended solids. All sites for each water body evaluated by the City of Durham were included.

Research Question:

1. What are the water quality trends between 2019 and 2020 for Ellerbe Creek and Eno River?
 - a. Has water quality changed between 2019 and 2020 for Ellerbe Creek and/or Eno River based on the various water quality parameters?
 - b. Are there differences between sites for each stream?
 - c. Have certain water quality parameters changed while others have not?
 - d. Discussion point: Certain studies have shown that surface water quality improved in 2020 due to the pandemic. Do we observe the same trend?

2 Dataset Information

The data was collected from the City of Durham’s water quality data web portal. The portal includes data collected by the City’s Stormwater Services as part of the Water Quality Monitoring and Assessment Program. The program performs ambient stream monitoring to assess compliance with regulatory benchmarks, assess surface water impairment, identify sources for illicit discharge, and support watershed planning. The monitoring data includes information regarding the monitoring location, conditions, weather, and measurements. Nine parameters were chosen for analysis because of their monthly measurement frequency for 2019 and 2020 at the two streams of interest. The parameters of interest include Copper, Dissolved Oxygen, Fecal Coliform, pH, Total Phosphorus, Total Suspended Solids, Temperature, Turbidity, and Zinc. To extract relevant data from the portal the stream, water quality parameters, and dates of interest were selected for the user interface and downloaded to CSV files.

Once datasets for each of the parameters were downloaded, they were read into R and compiled into a single dataframe. First, a subset of the dataframe was created to keep only relevant columns for analysis. Next, the date column to read as a date to enable plotting and time series analysis. To address duplicate measurements, measurements for the same parameter, with the same date and monitoring location were averaged. Then, the parameters measurements were pivoted to include a column for each of the nine parameters. To map the locations of each of the monitoring stations, the water quality dataframe was joined with station coordinates.

Water Quality Parameters	Unit	Range	Data Source
Copper	ug/L	1.1-4.135	Durham Water Quality Web Portal
Dissolved Oxygen	mg/L	4.7-12.1	Durham Water Quality Web Portal
Fecal Coliform	cfu/100mL	17.5-36000	Durham Water Quality Web Portal
pH	Standard Units	6.1-7.5	Durham Water Quality Web Portal
Total Phosphorus	mg/L	0.003 - 0.38	Durham Water Quality Web Portal
Total Suspended Solids	mg/L	2.5-134	Durham Water Quality Web Portal
Temperature	C	5.7-29.6	Durham Water Quality Web Portal
Turbidity	NTU	2.3-150	Durham Water Quality Web Portal
Zinc	ug/L	0.975-19.2	Durham Water Quality Web Portal
Rain in the last 24 Hours	NA	Yes/No	Durham Water Quality Web Portal

Water Quality Parameters	Unit	Range	Data Source
Sky Condition	NA	Sunny, Partly Cloudy, Overcast	Durham Water Quality Web Portal

3 Exploratory Analysis

As part of the exploratory analysis, water quality data was compiled for the nine parameters for both the Eno River and Ellerbe Creek. The following sections describe the exploratory analysis completed for each waterway.

4 ## Eno River

Both Ellerbe Creek and Eno River have three monitoring stations in Durham. Sites EN13.3ER, EN8.9ER, and EN4.9ER for Eno River all had data for 2019, but only (*insert sites*) had data for 2020. For Ellerbe Creek, sites EL1.9EC, EL5.6EC, and EL7.1EC had data for 2019, but only EL1.9EC and EL7.1EC had data for 2020.

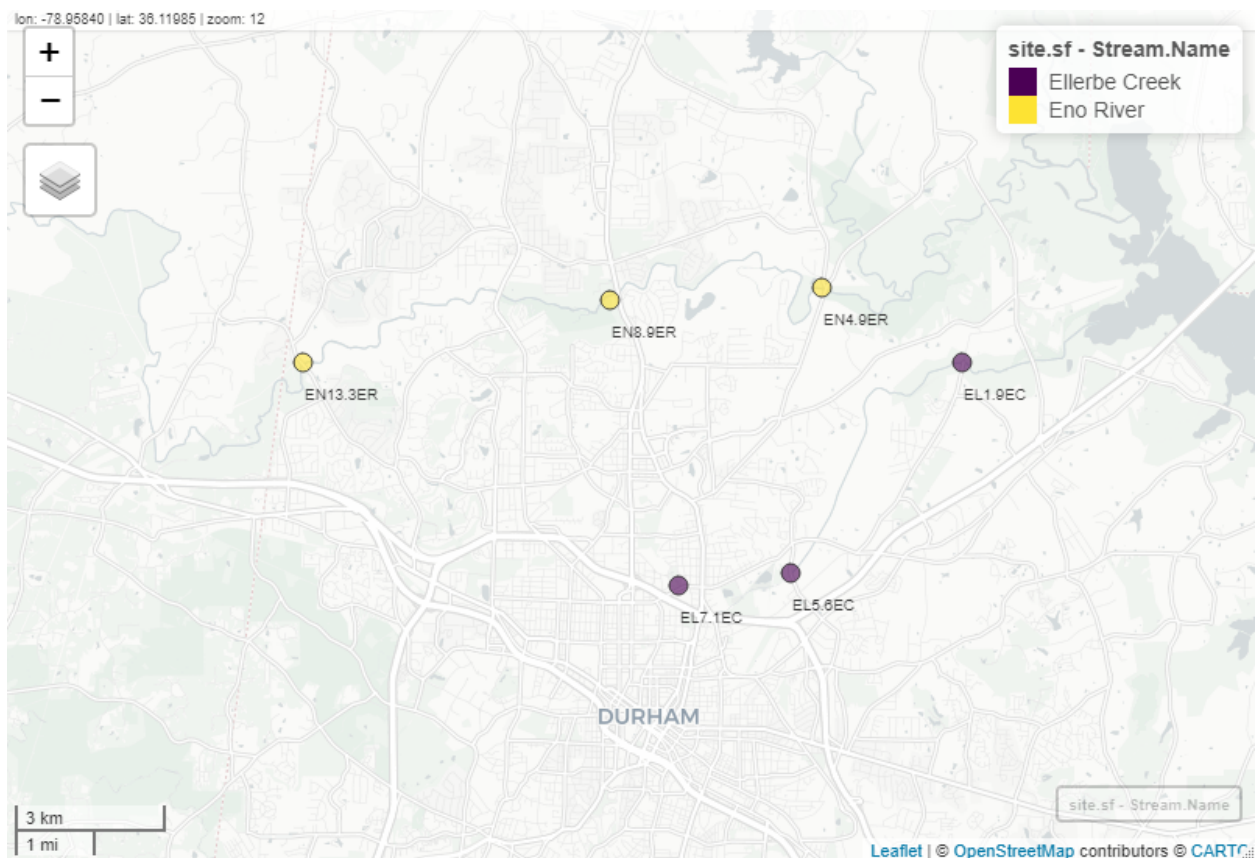
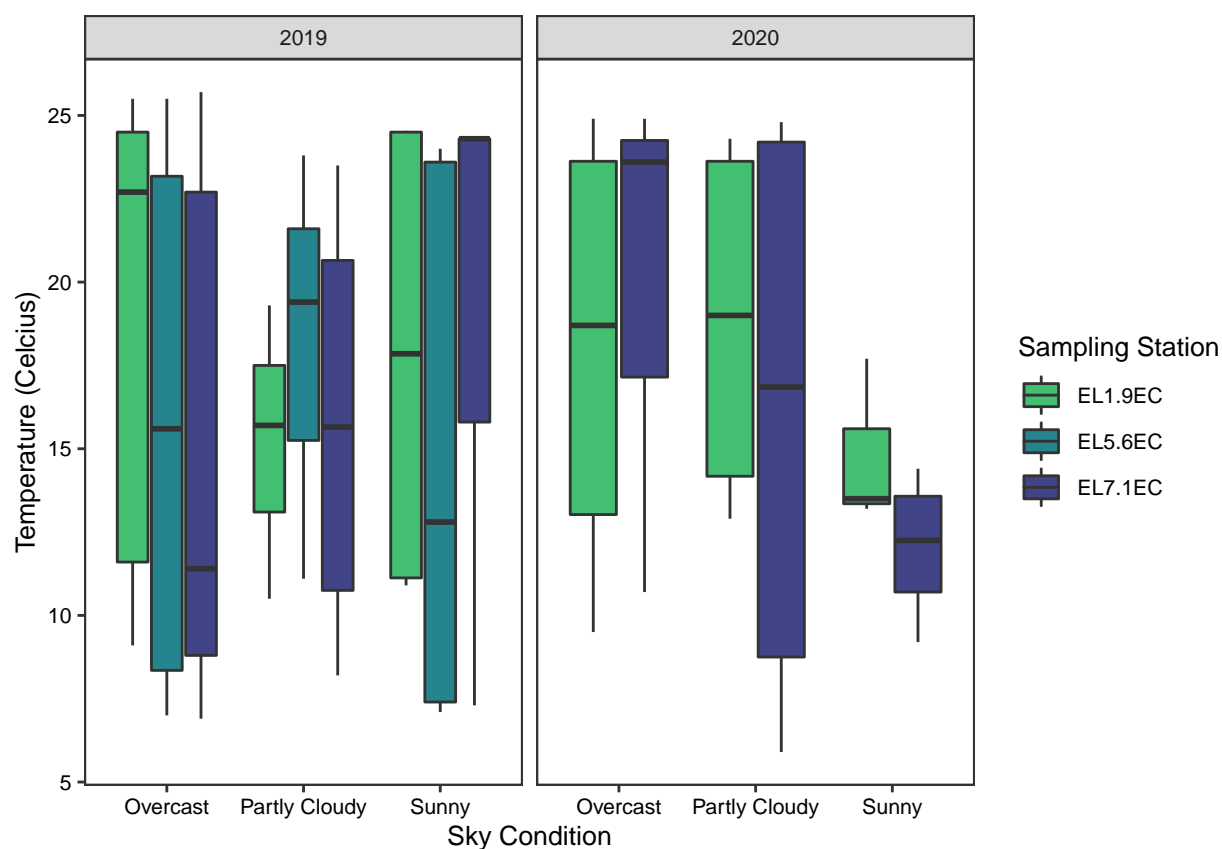


Figure 1: Site Map of Ellerbe Creek and Eno River Monitoring Stations

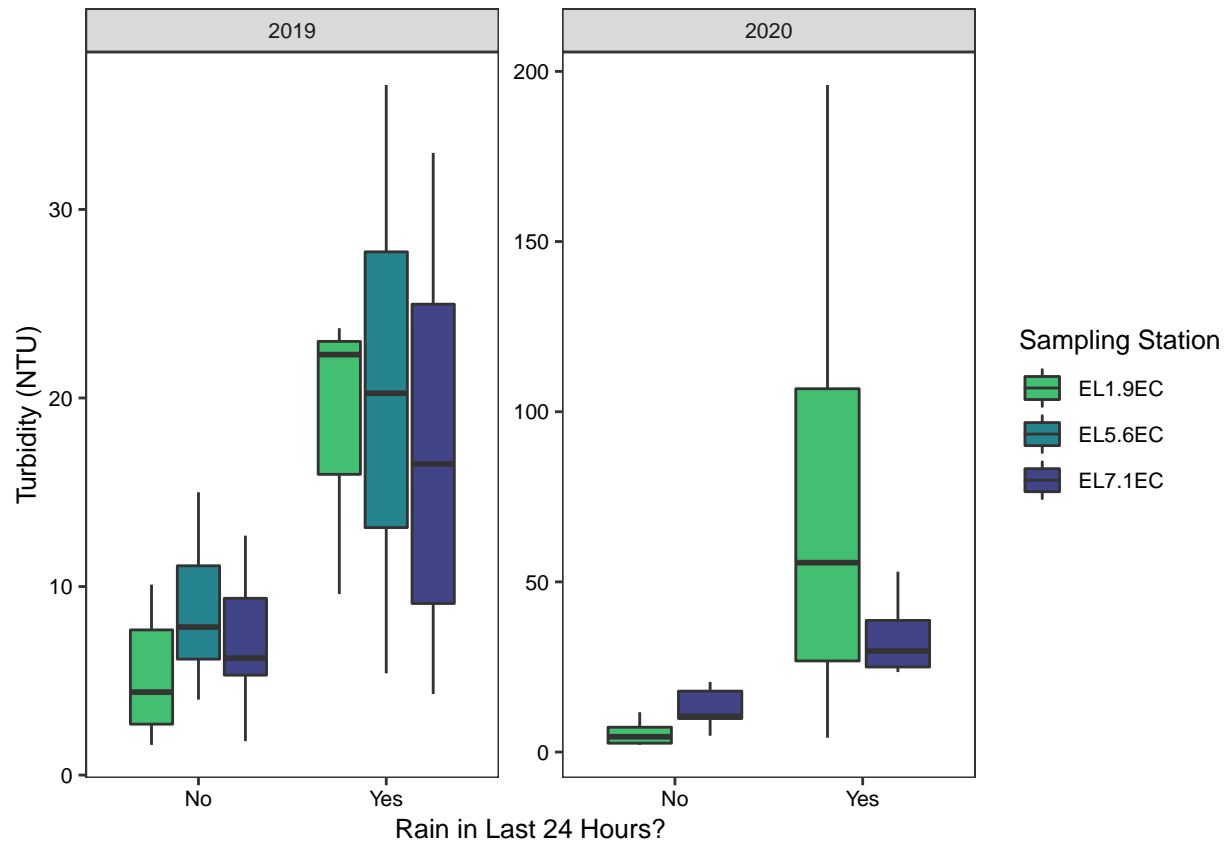
4.1 Ellerbe Creek

Visual explorations of the nine water quality parameters for Ellerbe Creek were conducted to determine how these parameters changed between 2019 and 2020. First, because we are not able to visit the sites, we wanted to determine what the main site characteristics may be. One main exploration was the relationship between temperature and cloud cover, hypothesizing

that if temperature is fluctuating with changes in cloud cover (e.g., temperatures increase on sunny days), this could indicate minimal riparian vegetation. Minimal riparian vegetation has impacts on water quality such as increased sedimentation, temperature, and runoff contamination. At Ellerbe Creek, for all stations, it was observed that temperature does not appear to change directly in response to cloud cover (Figure 1). To make any definitive determinations about this relationship, we would need more finite data than just one sample day per month.



We were also interested in the relationship between turbidity and rain, as an indicator of erosion and to what degree the Ellerbe Creek sites may be influenced by storm events. Visual comparisons show that there appears to be an increase in turbidity after rain events, especially in 2020 (Figure 2). Figure 2 also reveals that there may be an increase in turbidity between 2019 and 2020.



After completing site explorations, we wanted to look specifically at water quality parameters between 2019 and 2020.

ADD individual figures

4.2 Eno River

4.3 Ellerbe Creek

5 Analysis

5.1 Zinc & Copper

5.2 pH

5.3 Turbidity and Recent Rainfall

5.4 TSS and Turbidity

Correlated parameters.

5.5 Temperature and Dissolved Oxygen

Discuss impact of Temperature on DO. Similar Temp from 2019-2020.

5.6 Temperature and Fecal Coliform

5.7 Question 1: <insert specific question here and add additional subsections for additional questions below, if needed>

5.8 Question 2:

6 Summary and Conclusions

7 References

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