

# An Interdisciplinary Study of Stable Isotopes in the Middle and North Oconee Rivers

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## Introduction

- Rivers are of vital importance to the drinking water supply of Georgia. Monitoring of river systems ensure water quality as well as supply of data on chemical, physical and biological water properties for research purposes.

- River systems are controlled by various natural processes, including geologic (e.g. weathering and erosion), hydrologic (e.g. precipitation and runoff) and biologic (e.g. metabolism) processes.

- Different isotopic systems can be used to investigate these processes:

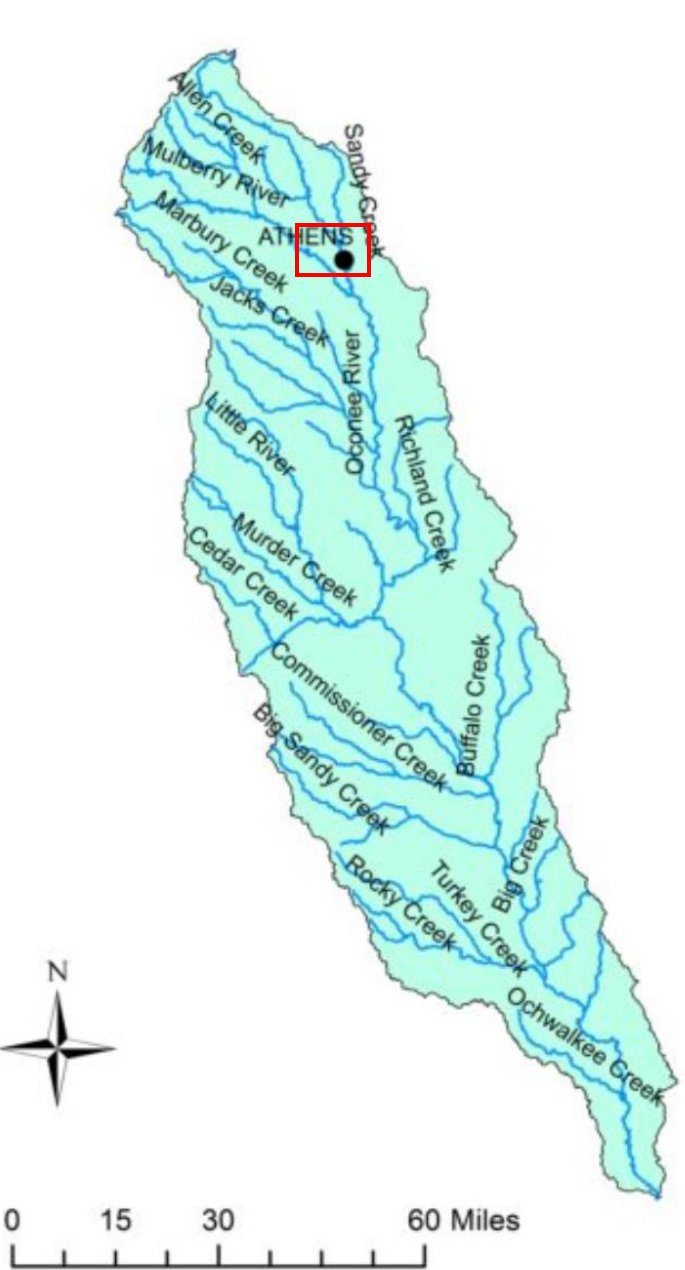
**Strontium** is a biologically conservative trace element with its <sup>87</sup>Sr/<sup>86</sup>Sr ratio being controlled by geologic processes such as selective weathering of minerals contained in the bedrock, types of lithologies eroded by the rivers, etc. <sup>87</sup>Sr/<sup>86</sup>Sr ratios provide the geologic baseline reflecting geochemical and geophysical processes in the catchment area.

**Dissolved Organic Carbon isotopes (δ<sup>13</sup>C DOC)** represent the largely biological component of this river monitoring project. DOC can be affected by both terrestrial organic carbon supplies and subsequent in-stream processes (e.g. primary production and community respiration)

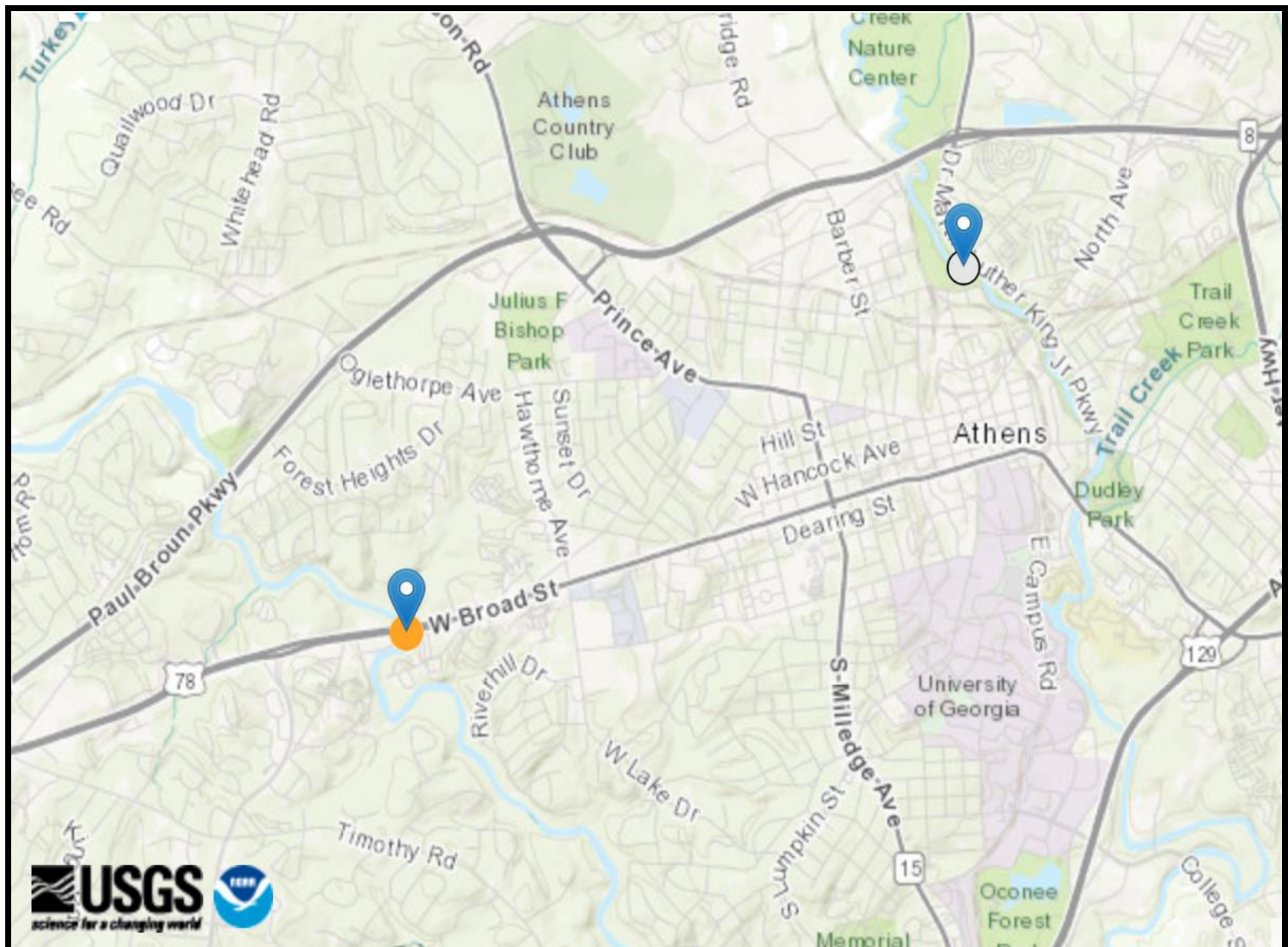
**Oxygen Isotopes (δ<sup>18</sup>O)** in water are of interest because <sup>18</sup>O/<sup>16</sup>O ratios are largely driven by hydrological parameters, such as precipitation and temperature variations. Oxygen isotopes may reveal otherwise unnoticed environmental changes and trends against the Sr background.

- The use of many different isotopes to study complex natural systems requires a multi-disciplinary approach with experts from various academic fields.

## Site Description and Sampling Locations



Map of the Oconee River Basin  
Created by Anna Baynes, UGA River Basin Center



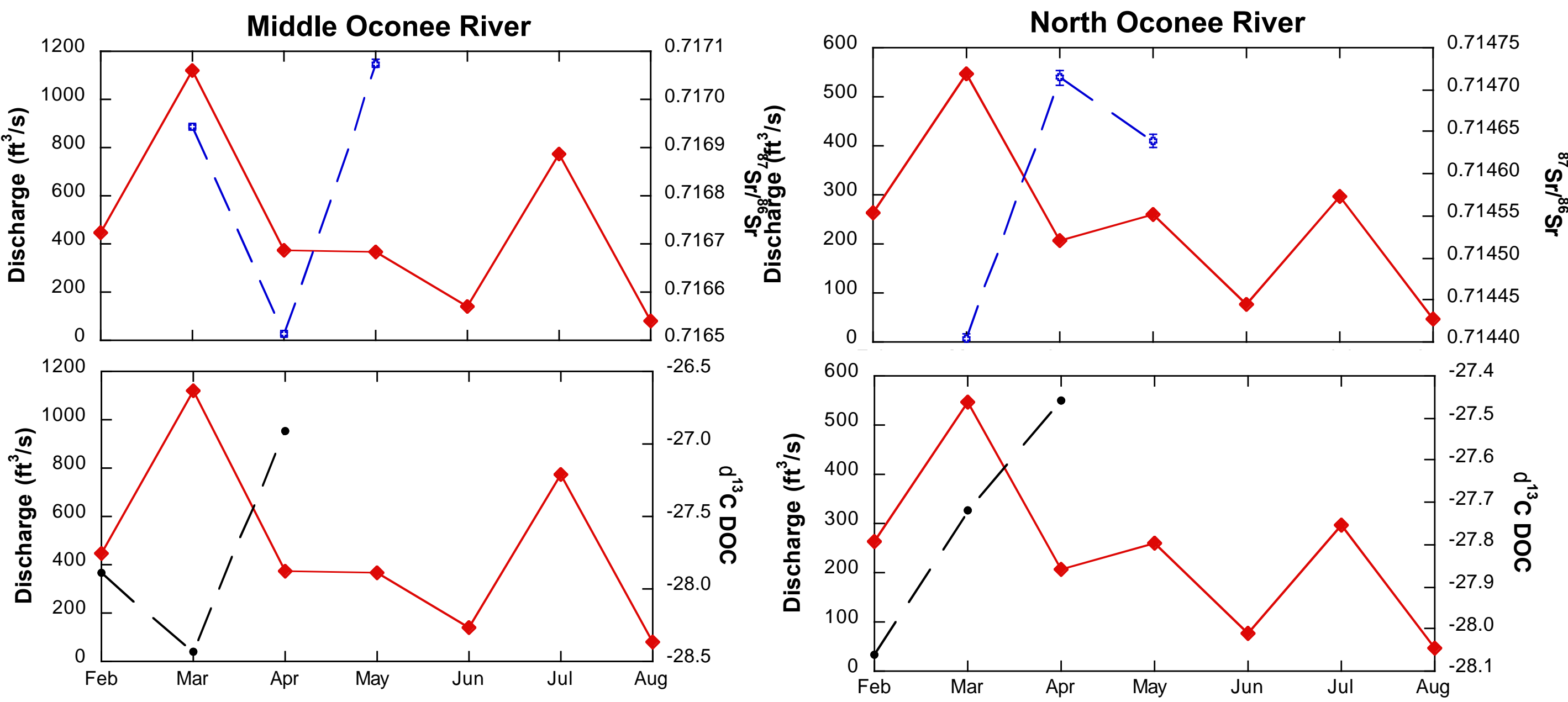
Map of Athens showing the USGS river monitoring sites, where river water samples were taken.

- The Oconee River catchment area is located in the foothills of the Appalachian mountain range, spanning rocks of the Blue Ridge and Piedmont province. These geologic provinces are mainly composed of igneous and metamorphic rocks: gneiss, schist, phyllite and granitic plutons

- Middle Oconee River (MOR):** USGS site Identification no 2217500  
Coordinates (DD): 33.94667, -83.42278; Drainage area: 1031 km2

- North Oconee River (NOR):** USGS site identification no 2217770  
Coordinates (DD): 33.96972, -83.37758; Drainage area: 712 km2

## Preliminary Results Mass Spectrometry



Preliminary Results of Sr isotope and C isotope analysis plotted against river discharge rates as an example

- Average δ<sup>13</sup>C DOC from February through April 2024 in NOR and MOR were both -27.74 per-mil, but with slightly higher variability in MOR (± 0.77 SD) than NOR (± 0.31 SD).

- <sup>87</sup>Sr/<sup>86</sup>Sr ratios observed for the Middle Oconee River are lower than previously reported: Rose, S., & Fullagar, P. D. (2005) analyzed 11 MOR water samples with <sup>87</sup>Sr/<sup>86</sup>Sr ratios ranging from 0.716981–0.717572 with an average of 0.717217 (reported relative to a value of 0.710250 for NBS987)

- All <sup>87</sup>Sr/<sup>86</sup>Sr ratios from CAIS are reported relative to 0.710340 for NBS987

## Project Summary

### Oconee River Isotope Project (ORIP)

- This project investigates the monthly changes in isotopic composition of Strontium, water oxygen and Dissolved Organic Carbon (δ<sup>13</sup>C DOC) over one year in two major rivers in Northeast Georgia.

- The two rivers sampled for this study, the Middle and North Oconee river, both flow through the city of Athens, where samples are taken monthly since March 2024. Sampling locations were chosen adjacent to USGS hydrological gauging stations to assess the effect of river parameters such as discharge and water height on isotope systems. A multimeter probe is used to determine water temperature, pressure, Dissolved Oxygen (DO), %DO, Specific Conductivity (SPC), conductivity (C), and pH at the time of sample extraction.

- In addition, samples are taken of local rain waters and headwaters of the catchment area to assess potential water mixing endmembers

- The goal of this project is to evaluate the combined use of different isotopic systems to investigate processes and their changes in river catchment areas.

## Multiprobe Results

Middle Oconee River (MOR)								North Oconee River (NOR)							
Sampling Date	2/27/24	3/27/24	4/25/24	5/29/24	6/27/24	7/25/24	8/26/24	2/27/24	3/27/24	4/25/24	5/29/24	6/27/24	7/25/24	8/26/24	
Temp (C)	12.1	14.5	18	23.8	27.9	25.3	25.6	11.9	14.5	17.7	22.9	25.8	25.5	23.5	
pressure (mm Hg)	743.8	743.2	749.5	747.8	742.7	750.7	751.5	742.6	743.8	748	746.6	741.2	749.4	750.2	
%DO	105.5	97.5	104.6	92.6	99	85.2	102.6	96	102.4	92.16	82.6	74.3	80	84.1	
[DO] (mg/L)	11.12	9.71	9.62	7.71	7.64	6.96	8.3	10.35	10.37	8.59	6.89	5.98	6.35	6.77	
SPC (µs/cm)	95.4	75.7	100.5	85	127.3	71.2	39.1	80.2	85.3	84.2	88.5	100.5	85.2	106.5	
C (µs/cm)	70.4	60.5	87.1	83	134.4	71.6	40.6	60.2	68.6	72.5	85.1	102.1	86.1	103.3	
pH	6.46	7.55	7.48	7.39	8.25	7.19	7.63	6.9	7.32	7.42	7.2	7.33	6.92	7.51	
USGS Gauge Height (ft)	1.72	2.83	1.62	1.6	1.08	2.33	0.94	5.14	5.98	4.9	5.19	3.83	5.19	3.42	
Discharge (ft3/s)	446	1120	376	369	141	772	79	262	547	208	260	76.8	298	47.1	

Water temperature, pressure, %DO, DO, SPC (Specific Conductivity), conductivity, and pH are measured using a multiprobe. Gauge Height and discharge are recorded by the nearby USGS hydrological gauging stations.

### Multimeter Data

- The pH at Middle Oconee River (MOR) is on average slightly higher than North Oconee River (NOR).
- NOR has a higher Specific Conductivity and Conductivity compared to MOR, indicative of higher collective ion concentration in NOR vs MOR.
- MOR had a consistently higher discharge and dissolved oxygen (DO) concentration than NOR throughout the summer.
- On average, DO continued to decrease across both sites, with a slight increase in the last month of sampling (8/26/2024). The temperature at MOR was slightly higher than NOR.

## Research Outlook

- Completion of monthly river water sampling and additional sampling of potential mixing endmembers (rain and spring waters in catchment area)

- Refinement of analytical methods and re-analysis of samples with preliminary results

- Potential extension of isotopic systems to nitrogen and deuterium isotopes

## References and Acknowledgements

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