PRELIMINARY DATA FROM A COMPREHENSIVE SAVANNAH RIVER STUDY: THE FIRST 6 MONTHS

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Abstract. Southeastern Natural Sciences Academy has initiated a two year comprehensive study to assess the upstream impacts on water quality in the Savannah River with emphasis on the Augusta urban corridor. One of the driving forces of the study is characterization of the upstream contribution of oxygen demanding substances to the Savannah Harbor. The ongoing study began in January 2006 and encompasses the physical, chemical, and biological domains of limnology. We have employed both Eulerian and Lagrangian approaches through continuous collection of data from static multiparameter probe stations and through flow based chemistry sampling events, respectively, with stations spanning from River Mile 148 (near Plant Vogtle) to River Mile 215 (above Augusta, GA). This presentation represents a portion of the first 6 months of collected Eulerian and Lagrangian data.

Preliminary Eulerian results showed that, on average, temperature and conductivity increased steadily from river mile 215 to river mile 148 with the highest variability for both parameters at the downstream station. The overall trend for pH showed no net change from River Mile 215 to 148 but pH increased by nearly 1 unit at River Mile 202 and was most variable at that location. The overall trend for dissolved oxygen showed a net loss of ~0.5 mg O_2/L from River Mile 215 to 148 but increased by an average of 1.5mg O_2/L at River Mile 202 and remained elevated through River Mile 185.

Lagrangian sampling results for the May sampling event showed that increases in conductivity from River Mile 215 to 148 mostly resulted from downstream increases in sodium, alkalinity (as CO_3), sulfate, chloride, potassium, calcium, and iron. Total organic carbon, almost entirely in the dissolved phase, increased from River Mile 215 to 148. This increase was equivalent to ~700 kg C added to the river over that reach, none of which was characterized as a biologically oxygen demanding substance (BOD_5) but may have been characterized as an oxygen demanding substance under harsher conditions (COD).

INTRODUCTION

EPA has required a reduction of approximately 30% of the total load of oxygen demanding substances currently being discharged into the Savannah Harbor to meet various water column dissolved oxygen concentration targets. Targeted discharges are those that directly discharge into the harbor and/or NPDES-regulated discharges originating within the upstream watershed starting at the Thurmond Dam. This requirement stems from a consent decree obligation resulting from a Sierra Club v. EPA Civil Action lawsuit. In addition, the Savannah River has other issues that require attention: fish consumption advisories pertaining to mercury bioaccumulation, wasteload allocations between Georgia and South Carolina, and water quantity issues as the Savannah becomes a significant facilitator of economic development and the potential target for further interbasin transfers, especially in Georgia.

Southeastern Natural Sciences Academy initiated a two year comprehensive study within the Middle Savannah watershed, with emphasis on the Augusta urban corridor, in January 2006 to supply the much needed data to address the current and future issues regarding water quality within the Savannah River. This study was not only designed to address the dynamics of dissolved oxygen and oxygen demanding substances entering and leaving the Middle Savannah, but also metals fluxes and biological processes within the watershed that take place over the entire hydrograph. This paper represents a portion of the first 6 months of collected Eulerian and Lagrangian data.

METHODS

We used a mass balance approach toward understanding river processes within this study. To achieve that goal, we partitioned the main channel of the Savannah River, from River Mile 215 to River Mile 148, into 7 segments so we could assess fluxes between shorter river segments. We also assessed inputs from the three main tributaries to the Savannah River that were located within the study reach, Stevens Creek, Horse Creek, and

Butler Creek. The study reach encompassed the length of the Augusta urban corridor which extends from River Mile 207 to River Mile 185 (Fig. 1).

In order to characterize the complex physical, chemical, and biological dynamics that occur within the river, we employed methods which incorporate both Eulerian and Lagrangian perspectives. The Eulerian viewpoint was assessed by deploying multiparameter sondes at stationary locations in the thalweg of the mainstem channel and within the main tributaries (Stevens Creek, Horse Creek, and Butler Creek) within the Middle Savannah watershed. The sondes (YSI 6600 EDS, Yellow Springs, CO) were programmed to record data at 15 minute intervals and were outfitted with the following probes: temperature, specific conductance (Sp cond), pH, redox, dissolved oxygen (DO), turbidity, and chlorophyll a. Each sonde was precalibrated and post calibrated according to the manufacturer. Data outside of the 10% postcalibration window were not used in this analysis.

The Lagrangian viewpoint was used for assessing constituent fluxes between stream reaches. Travel times between stream reaches were calculated using DO peaks observed within the sonde data and continuous flow data provided by the USGS gauging station located at the New Savannah Bluff Lock & Dam. DO peaks were generated by photosynthesis and aeration and attenuation of the peaks resulted from respiration, chemical oxygen demand, loss to the atmosphere, and dispersion.

Water chemistry samples were collected using a vertically integrated, flow weighted sampler when the flow allowed for such use (>1 m/s), otherwise samples were taken from the entire water column using a pump and end-weighted tube. Most samples were collected within the Lagrangian scheme and accuracy of travel time estimations were verified with Eulerian DO trends. Samples were stored on ice in the field until arrival at the lab. Samples were homogenized in the lab with a churn splitter and poured into prelabeled preserved and unpreserved bottles. Samples were stored on ice until transport to the analytical lab. All samples were collected and analyzed according to standard protocols.

RESULTS

Preliminary Eulerian results showed that, on average, temperature (Fig. 2) and specific conductance (Fig. 3) increased steadily from river mile 215 to river mile 148 with the highest variability for both parameters at the downstream station.

The overall trend for pH (Fig. 4) showed no net change from River Mile 215 to 148 but pH increased by nearly 1 unit at River Mile 202 and was most variable at that location

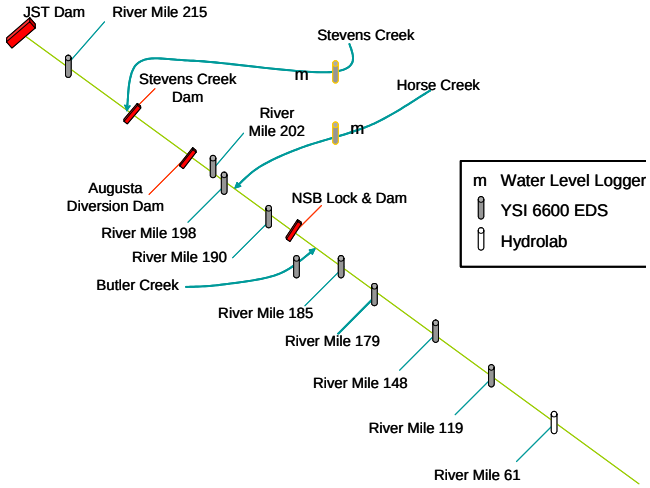

Figure 1. Study reaches within the Savannah River.

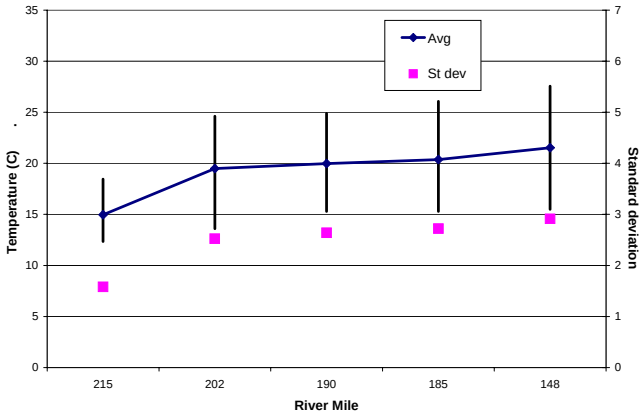

Figure 2. Temperature statistics from several river stations from April 2006 through July 2006.

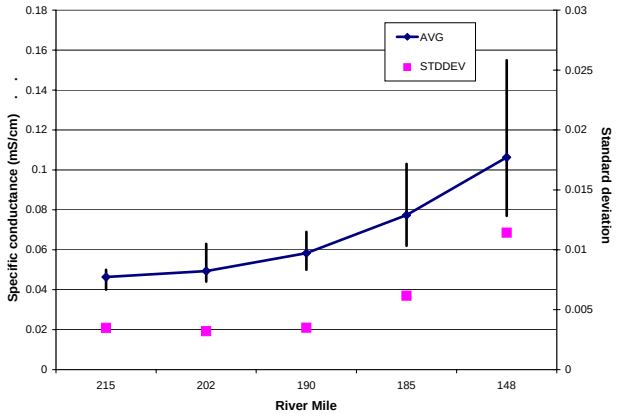

Figure 3. Specific conductance statistics from several river stations from April 2006 through July 2006.

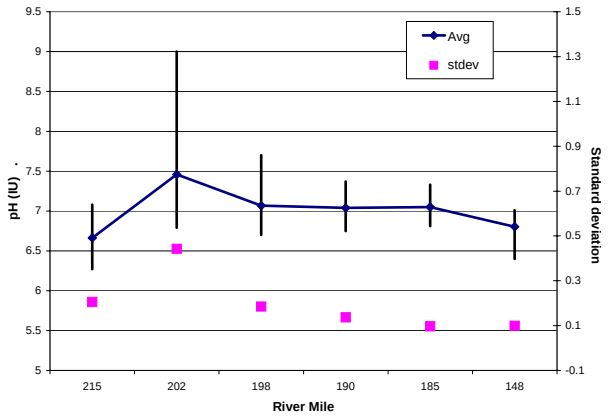

Figure 4. pH statistics from several river stations within the first 6 months of the study.

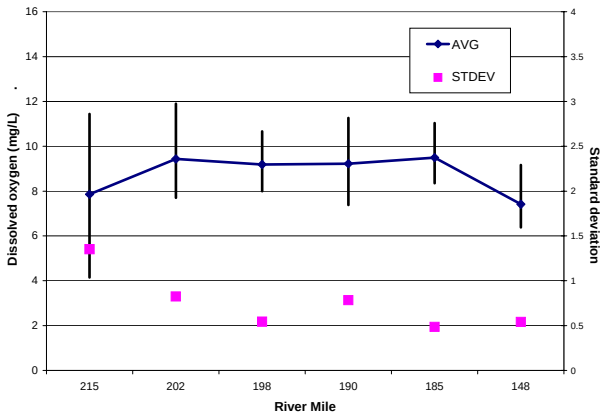

Figure 5. Dissolved oxygen statistics from several river stations within the first 6 months of the study.

The overall trend for dissolved oxygen (Fig. 5) showed a net loss of ~0.5 mg O_2/L from River Mile 215 to 148 but increased by an average of 1.5mg O_2/L at River Mile 202 and remained elevated through River Mile 185.

Lagrangian chemistry sampling results for the May sampling event showed that most constituents increased from river Mile 215 to River Mile 148. Constituents which contributed to the observed increase in specific conductance were found to be dominated by the following relatively conservative ions: sodium, sulfate, alkalinity (as CO_3), chloride, potassium, calcium, iron, and manganese (Table 1). Total organic carbon increased from River Mile 215 to 148 and was almost entirely in the dissolved form. This increase was equivalent to ~700 kg C added to the river over that reach, none of which was characterized as a biologically oxygen demanding substance (BOD_5) but may have been characterized as an oxygen demanding substance under harsher conditions (Chemical Oxygen Demand) (Table 2).

Table 1. Chemistry results for the May 2006 sampling event (metals).

	River Mile 215 (mg/L)	River Mile 148 (mg/L)	Difference (mg/L)	Percent cont. to total conductivity change
Alkalinity (as CaCO3)	16	26	10	15.53
Arsenic	0	0	0	
Cadmium	0	0.000047	0.000047	
Calcium	1.9	3.6	1.7	6.59
Chloride	2.5	8.5	6	13.14
Chromium	0	0	0	
Copper	0.0017	0.0049	0.0032	
Iron	0.02	0.44	0.42	1.17
Lead	0.00017	0.0002	0.00003	
Magnesium	1.2	1.2	0	
Manganese	0.013	0.058	0.045	0.13
Nickel	0	0.0046	0.0046	
Ortho-phosphorus	0.04	0.13	0.09	
Potassium	2.3	7.6	5.3	10.52
Selenium	0.00053	0.00034	-0.00019	
Silicon	4.3	3.7	-0.6	
Sodium	3.4	14	10.6	35.80
Sulfate	2.4	13	10.6	17.13
Zinc	0.0028	0.006	0.0032	
				100%

Table 2. Chemistry results for the May 2006 sampling event (carbon and nitrogen).

	River Mile 215 (mg/L)	River Mile 148 (mg/L)
BOD, 5 day	0	0
Carbonaceous BOD, 5 day	0	0
COD (low-level)	0	9.7
DOC	2.3	3.5
TIC	4.6	2.3
TOC	2.4	3.7
TKN	0.32	0.6
Dissolved Nitrate-Nitrite - N	0.18	0.27
Dissolved Ammonia - N (phenate)	0.11	0.17

SUMMARY

Water within the Savannah River, downstream from the Thurmond Dam, originates as water withdrawn from ~25 m below the surface of Thurmond Lake. As a result, water entering the Augusta corridor is fairly dilute and nutrient poor with most of the organic carbon in the dissolved phase, which is typical for impounded rivers. As the water traversed the Augusta corridor (River Mile 207-185), nearly 50% of the observed specific conductance increase was added to the river with the other 50% added from River Mile 185 to 148 (within the free flowing river reach). In addition, 60% of the observed dissolved organic carbon increase occurred within the Augusta corridor (specifically River Mile 185) while the other 40% was added within the free flowing reach. None of the available carbon was considered to be a threat to dissolved oxygen concentrations (BOD_5 was below the detection limit) but DO concentrations may have been threatened by chemical constituents (COD). However, the Augusta shoals reach (River Mile 202) showed a significant increase in average DO concentrations. Since the DO increase was accompanied by an increase in pH, we believe photosynthesis within the shoals was the dominant mechanism. Despite the potential oxygen demand due to COD, the Augusta corridor was responsible for a net increase in average DO concentrations due to the shoals. Below River Mile 185, average DO concentrations decreased to 0.5 mg/L below the River Mile 215 concentrations.

These preliminary data suggest that the Augusta corridor potentially does not pose a threat to Savannah River DO concentrations. These data also suggest that processes below River Mile 185 contribute to DO demand and increased conductivity. Near River Mile 180, the Savannah River returns to a natural free flowing system where erosion of floodplain bank material occurs. The role of this ancient material on Savannah River water quality should be considered.