# THE IMPORTANCE OF SPECIFIC CONDUCTIVITY FOR ASSESSING ENVIRONMENTALLY IMPACTED STREAMS

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**Abstract**. From over two years of quarterly monitoring in the Upper Oconee Watershed, three streams consistently had good to excellent water quality based on their biological index scores and two had poor water quality. Among all the physical and chemical measurements that were routinely made, specific conductivity best distinguished these two types of streams. The minimally impacted streams invariably had relatively low specific conductivities (~50µS/cm), whereas the two highly impacted streams had more variable and higher conductivity values. This observation was used to identify other polluted streams in the area and to trace pollution sources.

## INTRODUCTION

For over two years, the Upper Oconee Watershed Network (UOWN) has been conducting quarterly monitoring of streams and rivers in the Upper Oconee Watershed, primarily in Athens-Clarke County (ACC). Both *in situ* chemical and physical measurements that included temperature, specific conductivity, pH, dissolved oxygen, and turbidity along with biological index scores were determined on eleven streams. Biological index scores are based on the diversity and abundance of macroinvertebrate species and provide a good way for assessing the overall water quality of streams (GAAS, 2001).

Among the eleven quarterly monitoring sites, three are minimally impacted whereas two are highly impacted by pollution. This distinction is based on the general environmental setting of the streams and their biological index scores. The other six monitored streams are impacted to varying degrees between these two extremes.

After reviewing our chemical and physical data, it became apparent that specific conductivity is the parameter that best differentiated the minimally and highly impacted streams in the ACC area. Other chemical and physical parameters, such as pH, DO, turbidity, and temperature were not distinct or consistently different.

This report presents specific conductivity data and biological index scores for these five streams and goes on to show how specific conductivity measurements were used to identify other highly impacted streams. Finally this paper describes how specific conductivity measurements can be used to locate pollution sources. This same approach is probably useful for examining many streams and rivers in the Georgia Piedmont.

## DATA

Three streams minimally impacted by urban pollution in the ACC area include Bear Creek tributary, Sandy Creek, and Hardeman Creek. All three lie within forested environments away from the urbanized areas of the city of Athens. The range, average biological index scores, and number of measurements made for these streams are: Bear Creek tributary: 17-32, 22, 8; Sandy Creek: 10-25, 20, 8; and Hardeman Creek: 21-26, 23, 8. On the basis of their average biological index scores, water quality is rated as good to excellent (AAS manual, 2001).

The two highly impacted streams include Carr Creek and Brooklyn Creek. The source of pollution of Carr Creek is contaminated groundwater from a fertilizer plant. Much of Brooklyn Creek lies within the older, urban center of Athens. Here, pollution is probably from numerous non point sources. The range and

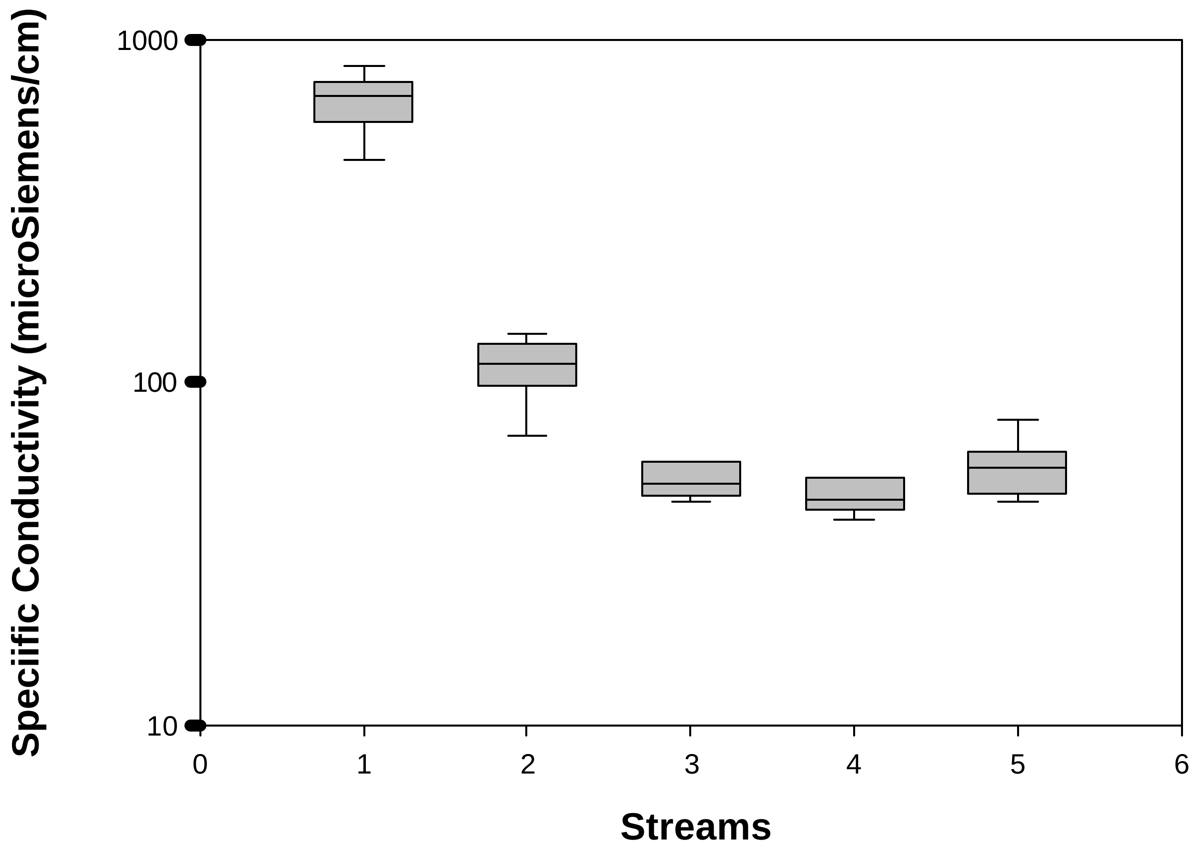


**Figure 1. Box and whisker plot showing specific conductivity data for the streams described in this paper. The boxes display the median (horizontal line), maximum 75 percentile and minimum 25 percentile values. The ends of the vertical line show maximum and minimum values. Stream sites and number of measurements (in parentheses) are: 1= Carr Creek (9); 2= Brooklyn Creek (10); 3= Hardeman Creek (9); 4= Bear Creek Tributary (11); 5= Sandy Creek (10).**

average biological index scores and number of measurements for these two streams are: Carr Creek: 0 – 2, 1, 8; and Brooklyn Creek: 1-10 , 5, 7. On the basis of their average biological index scores, the water quality of both streams is poor.

The range and median values of specific conductivity for these five streams is presented in Figure 1.

## INTERPRETATION OF SPECIFIC CONDUCTIVITY DATA

Specific conductivity is a measure of the capacity of water to conduct electricity and thus is a very convenient way to estimate the total dissolved ionic species in solution. Specific conductivity, however, varies with the composition of the dissolved ions and thus only approximates the total dissolved ion concentration (Hem, 1992).

Figure 1 shows that the three minimally impacted streams (sites 3, 4, and 5) have relatively low and uniform specific conductivities. This in large part probably reflects the groundwater contribution to these streams. In the Piedmont, groundwater acquires much of its dissolved ions from weathering of bedrock. Since much of the Piedmont and Blue Ridge provinces of Georgia are underlain by silica-rich igneous and metamorphic rocks that weather slowly, the amount of dissolved ions in most groundwaters in this region of the state is relatively low. This contrasts with groundwaters found in many sedimentary rocks (Hem, 1992), which are common in the Coastal Plain and Valley and Ridge provinces of Georgia.

The highly impacted streams (sites 1 & 2 in Figure 1) have both elevated and variable specific conductivities (especially Carr Creek). The elevated specific conductivities of these two streams almost certainly indicate the presence of pollutants. The large variability in specific conductivity of Carr Creek (site 1) probably reflects differing proportions of high conductivity pollutants mixing with lower conductivity waters originating from other sources. One groundwater sample from the fertilizer plant adjacent to this stream measured in 1993 had a specific conductivity of 2,030 μS/cm (UOWN, 2001). The elevated conductivities of Brooklyn Creek are probably due to a number of non point sources.

## POLLUTION SOURCE TRACING

The ease of measuring specific conductivity provides a way for tracing the source of many types of pollution. To test this idea, student class projects were made in the spring of 2002 on both Carr Creek and Brooklyn Creek. In both cases, numerous specific conductivity measurements were made along portions of both streams during a single day. For Brooklyn Creek, this survey revealed that specific conductivity values "jumped" in two relatively short segments. This pattern was interpreted to reflect the input of pollution at these localities. No specific visible sources of pollution, however, were observed in these sections. For Carr Creek, the specific conductivity values were consistently high adjacent to and below the abandoned fertilizer factory but dramatically lower upstream. This pattern highlighted the steady input of pollution over a relatively small section of the stream adjacent to the fertilizer plant.

## FOLLOWUP INVESTIGATIONS

Every year in April, UOWN organizes a community-wide event called River Rendezvous. During this event, volunteers sample many streams throughout the watershed. Samples collected during this event are routinely measured for specific conductivity. During River Rendezvous in 2002, data was obtained from over 60 streams.

After reviewing the data, it became apparent that several hitherto unexamined streams in the ACC area had relatively high specific conductivities (> 150 μS/cm). During subsequent quarterly monitoring events, specific conductivity and macroinvertebrate data were obtained for two of these streams. The first, Tanyard Creek on the UGA campus, had a specific conductivity of 150 μS/cm and a biological index score of 6. The second, an unnamed stream crossing Barber Street in Athens, had a specific conductivity of 272μS/cm and a biological index score of 4. On the basis of their biological index scores, both streams had poor water quality and both have specific conductivities that were at least three times higher than the minimally impacted streams.

## SUMMARY AND CONCLUSIONS

Data acquired from over two years of quarterly monitoring show that in the ACC area two highly impacted streams with poor water quality as judged by their biological index scores had relatively high specific conductivities. In contrast, three streams with low specific conductivities had biological index scores indicating good or excellent water quality. No other routinely measured parameter such as temperature, dissolved oxygen, pH and turbidity showed such consistent differences between streams with poor and excellent water quality.

It appears from these studies that specific conductivity is a good way to assess the impact of urban pollution in streams in the Georgia Piedmont. Conductivity measurements are easy to make. Meters are relatively inexpensive, ranging from small hand held instruments costing about $50 to more sophisticated meters that cost about $300. Such instruments are easy to calibrate, calibration standards are inexpensive, and when once calibrated, most instruments require only periodic (once of week or less) checking. For all these reasons, we urge other watershed groups and the Georgia Adopt-A-Stream program to incorporate conductivity measurements as a routine part of their monitoring programs.

## SELECTED REFERENCES

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