BASEFLOW PHYSICOCHEMICAL WATER QUALITY IN TWO HEADWATER STREAMS

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Abstract. Urbanization effects on headwater stream hydrology is understudied. Urban development alters the timing, duration, and quality of stream flows and subsequently downstream discharges. Small order streams collectively contribute significant material and energy to downstream larger order streams. Baseflow in headwater streams is reflective of integrated watershed health acts as a forcing on stream ecosystems. The goal of this study was to compare baseflow water quality in an urbanized watershed (Tanyard Creek) and in a rural watershed (Richland Creek). Baseflow water quality parameters that were measured in Tanyard Branch and Richland Creek specific conductance, pH, and temperature utilizing the Oakton probe at sampling locations. USGS WaterWatch monitoring data was retrieved for the gauging station at Richland Creek (USGS station 02394682 at Old Dallas Road, Dallas, GA). Specific conductivity and pH were consistently higher in Tanyard Creek than Richland Creek, which may be a result of urban development.

INTRODUCTION

In the United States alone, 75% of the population resides in urban areas, which impairs 130,000 km of streams (Paul et al. 2001). Physicochemical water quality in urban streams is poorly studied when compared to headwaters in less developed areas despite. Stream channelization, piping, channel armoring, altered bankflow, and effluent discharges (intended or unintended) impact physicochemical water quality in urban headwaters in the channel (Leopold 1968, Paul et al. 2001). While periodic pulses and channel processes drive much of the ecology in headwater streams baseflow sets limiting physical conditions on stream biota (Danehy et al. 2017). Baseflow also reflects watershed health by integrating the effects of groundwater geochemistry, impervious cover on recharge, upland contaminant spills, and anthropogenic land development practices (Miller et al. 2015, Hoghooghi et al. 2016, Aulenbach et al. 2017).

Specific conductivity, pH, and temperature are water quality parameters that can be used to measure stream impairment. These parameters are also simple and easy to measure in the field but can also be correlated to other parameters that are more complex and difficult to measure (Zeng and Rasmussen 2005). Additionally, these physicochemical parameters can be used as variables in mixed modeling for identifying source waters and hydrograph separation (Rahman et al. 2015).

Tanyard Creek is an impaired stream on the UGA campus that is currently a restoration target for the Watershed UGA program. Prior to restoration baseline data is being established on the physical, chemical, and biological water quality of Tanyard Creek. Accordingly, our objective was to establish a baseline and compare baseflow of Tanyard Creek to a nearby reference stream – Richland Creek. We aim to investigate the feasibility of using specific conductivity, pH, and temperature as monitoring parameters for Tanyard Creek that are also being recorded by the USGS in real time at Richland Creek.

Our objective was to compare the specific conductivity, pH and temperature of an urban headwater stream and a rural headwater stream. A secondary objective was to establish a longitudinal profile of specific conductivity, pH and temperature longitudinal profile along Tanyard Creek. Project objectives are in support of establishing baseline data for the University of Georgia campus waters which are currently restoration targets of the Watershed UGA initiative (watershed.uga.edu).

METHODS

Site Description

Tanyard Creek is a small, urbanized headwater stream that flows through the University of Georgia Campus (Figure 1). Typical of urban streams, Tanyard Creek has substantial (>75%, estimated during field work) channelization and several covered reaches (notably the stream flows below Sanford Stadium on the UGA campus). Richland Creek is a small headwater stream in the rural piedmont of Georgia near Dallas, Georgia (Figure 2). The Dallas area has ~10% of the population as the Athens area (U.S. Census data) and streams typically experience little if any anthropogenic management.

Data Collection and Analysis

Specific conductivity, pH and temperature data were collected using an Oakton probe at the same time of day (1300-1600 EST) in weekly intervals during two sampling periods for Tanyard Creek. The first sampling period was through late August to November 2016 and the second period was between January and April 2017. Data for the same parameters in Richland Creek were downloaded from the USGS WaterWatch program online data repository.

RESULTS

Mean pH and temperature were similar for the two streams, but slightly higher for both parameters in Tanyard Creek (Figure 1 and 2). The mean specific conductivity of Tanyard Creek is 100 µS higher than Richland Creek, Figure 3.

Mean pH gradually increased longitudinally from the beginning of discernable flow to the Oconee River (Figure 4). Specific conductivity also increased from the headwater (Site 1) to the point where it merges with Cloverhurst Creek (Site 3) where it remained consistent until discharging to the Oconee (Site 5) (Figure 5).

DISCUSSION

A potential explanation for the greater specific conductivity and pH in Tanyard could be concrete leaching, which can cause pH to rise about two pH units and electrical conductivity to double (Grella et al., 2014). Tanyard Branch has abundant concrete culverts and in places has a completely concrete channel. The effects of concrete are likely much higher during extended baseflow conditions because there is no runoff dilution of stream water. However, runoff from this urban watershed can also be a source water quality impairment.

Many reaches of Tanyard Creek run underground in culverts and lack exposure to direct sunlight which could be a reason that overall temperatures were not higher than in Richland. Generally a temperature difference should show higher temperatures due to higher air temperatures in the "urban heat island" (Somers et al. 2013). The resulting greater thermal energy in urban areas should be observed in streams even during baseflow, where urban streams are warmer than rural streams (Somers et. al 2013), but with Tanyard Branch spanning underground for long spans it nullifies the "urban heat island" phenomena.

Our preliminary data indicates that collective effects of urbanization in Tanyard Creek watershed contribute to greater specific conductivity, pH and temperature during baseflow. We believe that instituting more stream vegetation and adding cover to open reaches of Tanyard Creek could help alleviate these water quality impairments. Organic matter addition to the stream channel may also alleviate water quality impairments. Additionally, we suggest a more in depth investigation of Tanyard Creek and Lily Branch to better understand the baseline water quality in these two campus streams.

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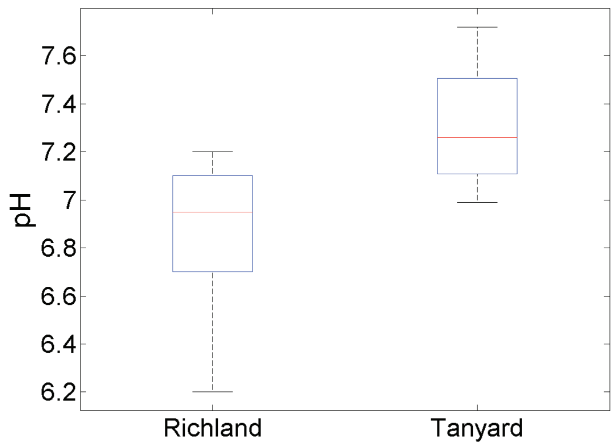

Figure 1. Similar mean pH values were observed at Richland Creek and Tanyard Creek.

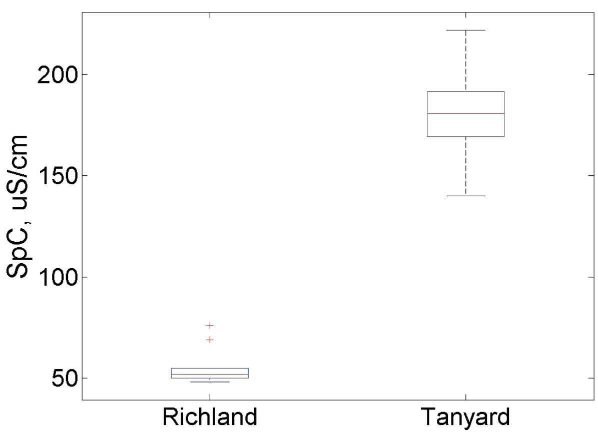

Figure 2. Mean specific conductivity in Tanyard Creek was generally between 2-4 times that of Richland Creek.

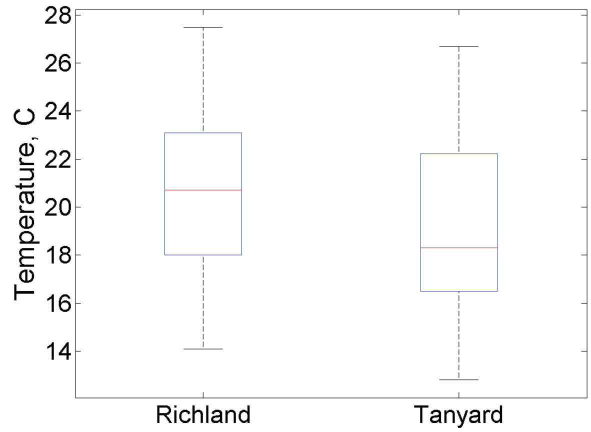

Figure 3. Similar mean temperatures values were observed at Richland Creek and Tanyard Branch.

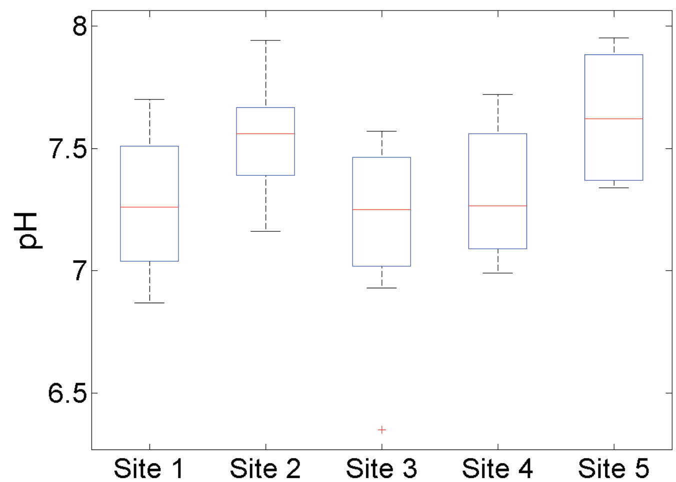

Figure 4. Longitudinal pH values along Tanyard Creek from upstream to downstream.

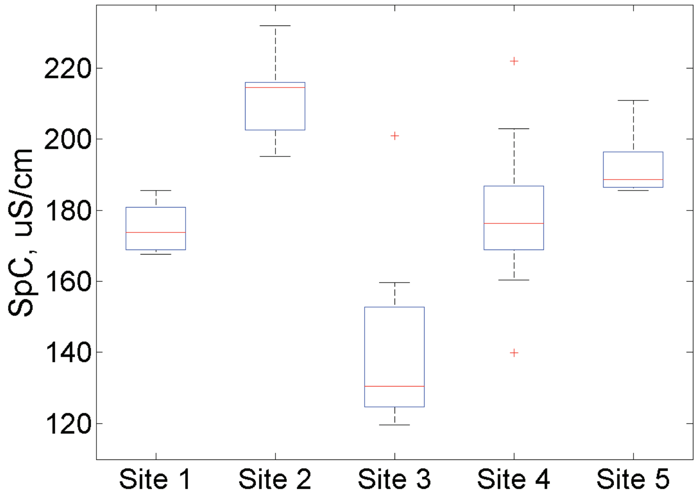

Figure 5. Longitudinal specific conductivity values along Tanyard Creek from upstream to downstream.

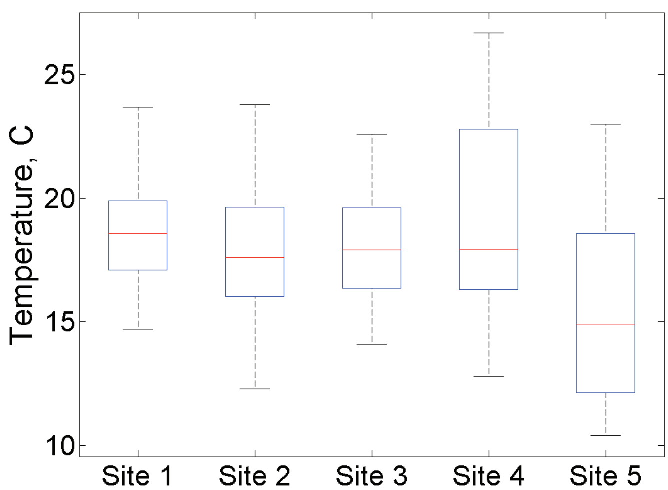

Figure 6. Longitudinal temperature values along Tanyard Creek from upstream to downstream.