A Comparison of Macroinvertebrate Communities within Two Southeastern Rivers

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Abstract. As part of ongoing continuous monitoring projects on the Savannah and Ogeechee Rivers quarterly macroinvertebrate assessments were initiated in the spring of 2014. Hester-Dendy samplers were placed along ~140 miles of each river. After 30 days, samplers were collected. Macroinvertebrates were measured and identified to the lowest practical taxonomic level and classified into functional feeding groups to allow for an assessment of trophic relationships within communities. Macroinvertebrate abundance (ind./m^2) and biomass (mg/m^2) were calculated. In addition, differences between samples were also assessed by comparing common metrics used in the biological assessment of streams in the region (i.e. richness, diversity, composition, and biotic integrity). Total macroinvertebrate abundance was higher within Ogeechee River sites averaging 1,458±192 ind./m^2 compared to 674±188 ind./m^2 for Savannah River sites, with collector-gatherers abundance accounting for much of this increase. Longitudinal trends of abundance remained relatively stable within the Ogeechee River. In contrast, abundances within the Savannah consistently trended upward from 344 ind/m^2 at the uppermost sampling site to their peak of 1363 ind/m^2 at the furthest downstream site. There were similar longitudinal trends in both rivers; with collector-gatherers decreasing, as collector-filters and scrapers increase downstream. Diversity and EPT taxa also increase at downstream sites. In addition, sites upstream in both rivers consistently had lower amounts of macroinvertebrate biomass. A notable dissimilarity between these rivers would be the lack of shredders in the Savannah.

INTRODUCTION

Habitat and biological communities in streams are closely linked (Raven et al. 1998). Habitats that occur in flowing waters incorporate all aspects of the physical and chemical constituents of the stream in any given area. These habitats influence the composition of the biological communities and provide the templet on which life-history strategies are evolved (Steinmann 1907, Southwood 1977, 1988). At a flow-through time scale, spatial variations occur longitudinally due to the hierarchical nature of rivers (Minshall 1988). This "aging of water" is partially due to the transport of biota and the by-products of their activities in a downstream direction (Fisher et al. 1982). In addition to biological influences, geological, lithological, and hydrological settings influence stream habitat at large scales; whereas substrate, depth, velocity, and input of organic matter play important roles at a local scale (Hieber et al. 2002). Thus, what occurs in a particular segment of river is not only influenced by local conditions, but is a reflection of what went on in time before the water and its load reached that given point (Margalef 1960, Vannote et al. 1980). The resulting variations in habitat will be reflected in which taxa from a regional pool are present at a given location.

As rivers enter the Southeastern Coastal Plain they become wider, deeper, flow slower, and increase in sinuosity. These systems are characterized by sandbars, sloughs, and extensive floodplain swamps. Sand and silt are the dominant substrate and these rivers generally carry a heavy sediment load. While these common habitat features act as major constraints determining the pool of macroinvertebrate taxa that can inhabit Southeastern Coastal Plain systems, other characteristics may be used to differentiate between the rivers and streams that occur in this ecoregion. These include origin of water, discharge, size, depth and land use. These factors influence turbidity, water velocity, dissolved oxygen, pH, salinity, temperature, organic carbon, and nutrient concentrations. These scaled habitat features can be viewed as nested filters through which species in the regional pool must 'pass' to be present at a given site, consequently dictating local distributions of organisms and ultimately assemblage composition (Tonn 1990, Poff 1997, Hieber et al. 2002).

This study is part of ongoing monitoring projects within the Savannah and Ogeechee River Basins. These projects include continuous monitoring of temperature, dissolved oxygen, pH, and specific conductance using mutiparameter water quality sondes; discrete chemistry sampling for various dissolved constituents; and quarterly macroinvertebrate sampling. The goal of this portion of these programs was to compare and contrast longitudinal changes in macroinvertebrate assemblages between two neighboring rivers. These rivers differ in their origins of water, discharge, size, and land use. We expected that these different characteristics would influence the longitudinal changes in habitat within each river, and that the macroinvertebrate assemblages would reflect these changes.

METHODS

Ogeechee River

The Ogeechee is a medium sized river primarily located in the Coastal Plain of Georgia with its mouth ~30 km south of Savannah. Land use within the basin is 71% forested, 11% non-forested wetlands, 18% agriculture, and 1% urban, with most urban areas occurring near the coast (GDNR 2001a, Smock et al 2005). Mean discharge near its mouth is about 115 m^3 s^{-1} (Smock et al 2005), but varies seasonally from 10 m^3 s^{-1} in summer-autumn to >200 m^3 s^{-1} in winter-spring (Benke and Wallace 2015). During times of high water its mostly forested floodplain can stay inundated with water for months. It has no major impoundments on its main stem and retains substantial snag habitat in its main channel. Because of these characteristics it has been suggested as recent as 2005 that the Ogeechee would probably be as close to a reference river of its size remaining in the region (Wallace et al. 1987, Smock et al. 2005, Benke and Wallace 2015).

Savannah River

The Savannah is a large river that forms much of the border between Georgia and South Carolina. It empties into the Atlantic Ocean near Savannah, GA. The river flows through three physiographic regions – the Appalachian Plateau, Piedmont Province, and Coastal Plain. Land uses within the basin are 65% forested, 22% agriculture, 4% urban, and 9% other (Smock et al. 2005).

The Savannah River has three major impoundments that start near the headwaters where the Seneca and Tugaloo Rivers join. These impoundments end 120 river miles downstream at the J. Strom Thurman Dam and were primarily constructed for flood control and hydroelectric power generation (USACE 1996, Moak et al. 2010). In addition, ~21 km below Thurman Dam three other dams impact river flow ending ~55.5 km downstream at the New Savannah Bluff Lock & Dam (NSBLD). The river becomes free flowing downstream of the NSBLD. Flow patterns have also been influenced by down-river dredging, channelization, and navigational cuts (Hale and Jackson, 2003, Moak et al. 2010). Mean discharge 98 km above its mouth is 319 m^3 s^{-1} (Smock et al. 2005). This discharge is largely regulated by the Thurmond Dam.

Sampling Sites

Four sampling sites within the Coastal Plain ecoregion were chosen on each river (Fig.1). In addition, two sites between Thurman Dam and NSBLD were selected to assess the influence of these structures on macroinvertebrate communities. Study Sites were selected based on several criteria including accessibility, safety, security, and proximity to major source inputs (e.g., creeks, municipal/industrial discharges, etc.). Sites are designated by River Mile (RM) as referenced to National Oceanographic and Atmospheric Administration nautical charts.

Macroinvertebrate Sampling

Macroinvertebrates were collected using Hester-Dendy multi-plate samplers. Two samplers were deployed at each site, one near the left and right river banks. Samplers were suspended 1 foot below the water surface using floats and were retrieved after a deployment of ~30 days. Macroinvertebrates were measured, identified to genus, and classified into functional feeding groups to allow for an assessment of trophic relationships within communities.

Macroinvertebrate abundance (ind./m^2) was estimated, and biomass (mg/m^2) was calculated using published length-mass regressions (Benke et al. 1999). In addition, differences between sites were also assessed by comparing common metrics used in the biological assessment of wadeable streams in the region (i.e. richness, diversity, composition, and biotic integrity).

In order to better understand the “aging of water” on longitudinal changes in macroinvertebrate communities, a Lagrangian sampling regime was used. The goal of this scheme was to have the samplers exposed to the same masses of water as they move downstream. The first samplers were deployed on the Savannah River at RM 214 on April 13, 2014 and the last samplers were retrieved at RM 61 on May 19, 2014. Sampling began at RM 224 on the Ogeechee River on June 16, 2014 and ended at RM 80 on August 5, 2014. The difference in travel time between the rivers accounts for the longer sampling period on the Ogeechee.

RESULTS

In total, 2,741 macroinvertebrates were collected, distributed in 27 families and 54 taxa. Macroinvertebrate abundance was higher on the Ogeechee River with sampling sites averaging 1458±192 ind./m^2, compared to 674±188 ind./m^2 for the Savannah River. Longitudinal trends of abundance remained relatively stable within the Ogeechee River. In contrast, abundances within the Savannah consistently trended upward from 344 ind./m^2 at the uppermost sampling site to their peak of 1363 ind./m^2 at the furthest downstream site. Macroinvertebrate biomass in the Savannah River averaged 1,317±652 mg/m^2, compared to 942±189 mg/m^2 in the Ogeechee River.

Assemblage Composition

The three most dominant taxa in the Savannah River were *Maccaffertium* (23%), Cricotopus sp. (13%), and *Tvetenia* (Chironomidae) (11%), accounting for 47% of individuals. The dominant taxa in the Ogeechee River were *Cricotopus sp.* (17%), *Maccaffertium sp.* (16%), and *Polypedilum sp.* (12%), accounting for 45%. Sixteen taxa were shared by both rivers. Thirty eight taxa were exclusive, with fourteen of these only occurring in the Savannah River, and twenty four only in the Ogeechee River.

The dominant taxon within each river varied longitudinally, with the two sites above NSBLD on the Savannah River dominated by *Cricotopus sp.*, accounting for 86% of the community at RM 214 and 50% at RM 190. Two miles below NSBLD at RM 185 *Tvetenia* became the dominant taxon comprising 77% of the community. As the sites move further downstream *Maccaffertium sp.* become dominant at RM 148 (28%) and RM 119 (44%). At the lowest sampling site RM 61 *Hydropsyche sp.* (Hydropsychidae) became dominant, accounting for 38% of the community.

The dominant taxon at RM 204 on the Ogeechee River was *Polypedilum sp.* at 47%. Downstream at RM 162 *Cricotopus sp.* (31%) became dominant, with *Maccaffertium sp.* becoming most abundant at RM 119 and RM 80, accounting for 22% of individuals at each site. The percent Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa increased in a downstream trend in both rivers. In the Savannah River, EPT taxa at RM 214 was at 0% and

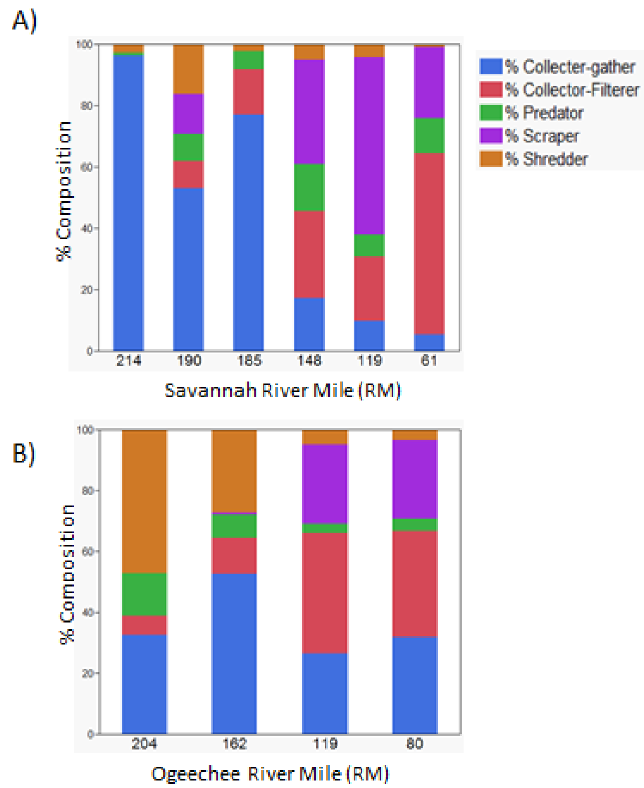

Figure 1: Percent composition of each Functional Feeding Group (FFG) at sampling sites within; A) Savannah River, and B) Ogeechee River.

trended up until reaching 92% at RM 61 (Fig. 3A). Similarly, on the Ogeechee River %EPT was low at the two upper sites accounting for only 6% at RM 204 and 4% at RM 162, and then increased to 68% at RM 119 and 51% at RM 80 (Fig. 3B).

Functional Feeding Groups

In the Savannah River collector-gatherers were dominant at the two sites upstream from NSBLD, and just downstream at RM185 (between 53-96%). Scrapers became dominant downstream accounting for 34% of the community at RM 148, and 58% at RM 119. Collector-Filters became dominant at the lowest site accounting for 59% at RM 61 (Fig. 1A). On the Ogeechee River, RM 204 was dominated by Shredders, accounting for 47% of the community. At RM 162 Collector-gathers became dominate accounting for 52% of the community. The two lower sites then become dominated by Collector-Filterers, accounting for 39% at RM 119 and 35% at RM 61 (Fig. 1B).

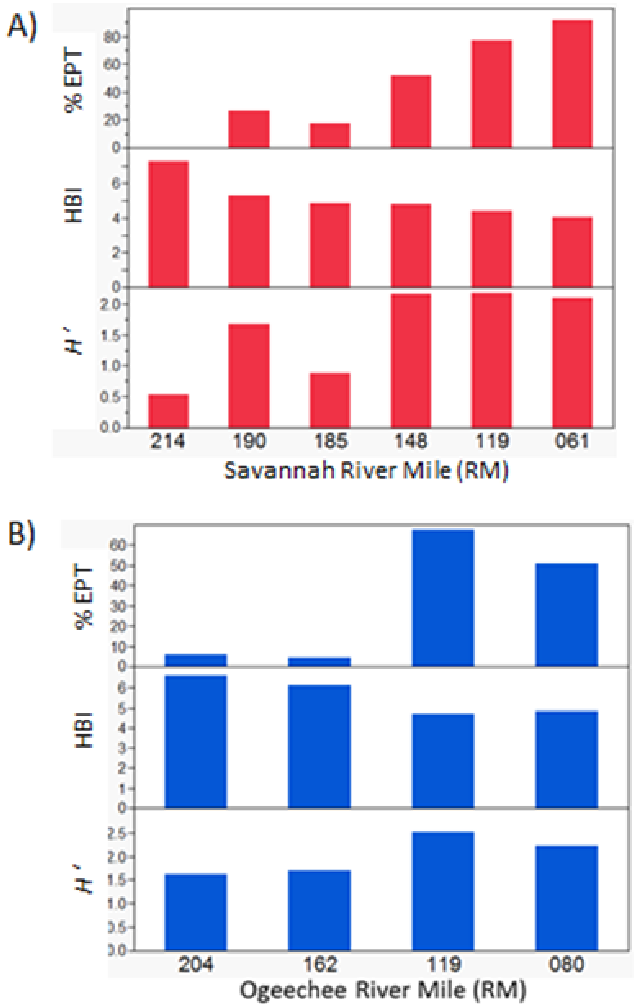

Figure 2: Percent Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa; Hilsenhoff Biotic Integrity Index; and Shannon-Wiener Diversity Index (*H'*) for the: A) Savannah River, and B) Ogeechee River.

Diversity and Biotic Integrity

Diversity, as measured by the Shannon-Wiener Index (*H'*), was lowest at the uppermost sampling sites within each river; Savannah's RM 214 (*H'*=0.54), and Ogeechee's RM 204 (*H'*=1.63). The most diverse sites on the Savannah River were RM 119 and RM 148, with both having an *H'* score of 2.16. The most diverse site on the Ogeechee was RM 119 with a score of 2.51. (Fig. 2)

The biotic integrity estimates, as calculated with the Hilsenhoff Biotic Integrity Index (HBI), for sites on the Savannah steadily improved downstream, with RM 214=7.27 and RM 61=4.04. The Ogeechee River showed a similar trend with RM 204=6.59, then improved to 4.69 at RM 119, ending with 4.85 at RM 80. (Fig. 2)

DISCUSSION

There were temporal differences in sampling between the two rivers. With macroinvertebrates having varied life cycles we must be cautious in comparing macroinvertebrate communities between river basins. However, Moak et al. (2010) found that longitudinal changes in macroinvertebrate communities within the Savannah River stayed consistent over a two year period of time. As such, a comparison of how macroinvertebate communities change longitudinally within each river is a useful first step in this ongoing research.

Although water quality within the Savannah River is generally good (Smock et al. 2005, Moak et al. 2010), ecologically the river has been modified. The influence of dams on river systems and the subsequent changes in habitat have been well documented (Petts 1979, 1984; Ward and Stanford 1983, 1995). In the Savannah River, the sites upstream and just downstream from these structures show signs of their effect, generally having lower abundance, biomass, %EPT taxa; and not scoring as well on diversity and biotic integrity metrics. However, these indices progressively improve with distance away from NSBLD indicating a recovery in the macroinvertebrate communities. Since water quality isn't an issue, changes in food resources are likely driving these improvements.

The two upper sites RM 204 and RM 162 on the Ogeechee River were comparable, having similar FFG compositions, few EPT taxa, and having similar scores on diversity and biotic integrity. The two lower sites (RM 119 and RM 80) were also very similar, both showing an increase in collector-filterers and improved scores on diversity and biotic integrity. The two upper sites having abundant shredders, and then the downstream shift to collector-filterers also indicate that food resources are driving the changes in community.

There were similar longitudinal trend in both rivers; with collector-gatherers decreasing, as collector-filters and scrapers increase downstream. Diversity and EPT taxa also increase at lower sites. In addition, sites upstream in both rivers consistently had lower amounts of macroinvertebrate biomass. A notable dissimilarity between these rivers would be the lack of shredders in the Savannah.

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