A STUDY OF INVERTEBRATES ALONG A GRADIENT OF FLOODPLAINS IN THE ALTAMAHA RIVER WATERSHED

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Abstract. The objective of this on-going study is to develop a theoretical framework to explain the graded change of invertebrate assemblages in riverine floodplain wetlands from the headwaters to the lower river reaches. We predict that floodplains in the upper reaches of the watershed will have flood pulses linked to local storm events and will be short in duration, and thus invertebrate assemblages will be dominated largely by movements of opportunistic riverine or terrestrial organisms into the wetlands. Downstream communities will consist increasingly of obligate wetland invertebrates since inundation periods become longer and more predictable in the lower reaches of the watershed, allowing sufficient time for wetland communities to develop. To test this hypothesis, we are examining invertebrate populations at nine floodplain sites in the Oconee/Altamaha River Watershed along a continuum of streams and rivers from low to high discharge.

Floodplain invertebrates are essential in modifying, storing and transporting organic matter in and between wetland and riverine systems. Unfortunately, the wetland habitats upon which these invertebrates depend are among Georgia's most threatened. The information developed from this study will contribute towards informing management decisions affecting invertebrates and other animals in floodplains of the Southeast.

INTRODUCTION

Historically, the flooding of riverine systems has been considered a disturbance. Flooding was seen as negatively impacting flora and fauna, and as a hazard to humans (Resh *et al* 1988, Hildrew 1998). However, ecologists now view flooding as an essential interaction between a river and its floodplain that enhances biological productivity and maintains diversity (Junk *et al* 1989, Ward 1989, Bayley 1995, Sparks 1995, Toth *et al* 1995, Benke 2001).

Various theories describing the ecological functioning of riverine systems have been proposed in recent years. Most prominent is The River Continuum Concept (Vannote *et al* 1980), which focuses on the relative importance of allochthonous and autochthonous inputs into the river channel, and largely ignores interactions between the river and its floodplains. In contrast, The Flood-Pulse Concept (Junk *et al* 1989) predicts that in large, floodplain-associated rivers, organic matter produced and consumed on the floodplain has a greater effect on aquatic and riparian community structure than the organic matter that is produced in upstream reaches and transported into the system.

Both of these frameworks provide important insight into the function of riverine ecosystems, but neither addresses longitudinal variation among floodplain habitats. We believe floodplain habitats are intimately linked to both lateral pulses and longitudinal flow, and that the change in pulse and flow characteristics along a continuum of discharge in a watershed has important ecological consequences to the floodplain biota.

The objective of this study is to describe the graded change of invertebrate assemblages in riverine floodplain wetlands from the headwaters to the lower reaches. We predict that floodplains in the upper reaches of the watershed will have flood pulses linked to local storm events, be short in duration and unpredictable, and thus will be dominated largely by riverine or terrestrial invertebrates moving opportunistically into the wetlands. Downstream communities will consist increasingly of obligate wetland invertebrates because inundation periods here are longer and more predictable, allowing sufficient time for wetland communities to develop.

STUDY SYSTEM AND SITES

The study system for this research is the Oconee/Altamaha Watershed of Georgia. The headwaters of this drainage system are located in north-central Georgia, and its waters flow through the Piedmont onto the Atlantic Coastal Plain of south Georgia. Floodplains in the river corridor span greater than 90 miles in length and range between one and six miles in width (TNC and USEPA, 2000). They consist of some of Georgia's last remaining bottomland hardwood forests and cypress swamps.

We chose the Oconee/Altamaha Watershed as our study system for two reasons. First, this river corridor has been designated as a significant natural resource, and efforts are being made to preserve the system. Thus, study sites could be positioned throughout the watershed in relatively undisturbed forested floodplains on land owned and protected by government agencies or private organizations. Second, because the few dams occurring in the watershed are not managed for flood control, the flood pulses into the wetlands are nearly natural and are allowed to inundate the floodplains.

We located our nine sites in floodplains of the watershed along a continuum of streams and rivers with low to high discharge (Figure 1).

- Site 1 is near an unnamed tributary of Sandy Creek in the Upper Oconee River basin.
- Site 2 is off the main stem of Upper Sandy Creek.
- Site 3 is on the floodplain of Sandy Creek below the confluence with East Sandy Creek.
- Site 4 is off the North Fork of the Oconee River at the confluence with Sandy Creek.
- Site 5 is on the floodplain of the main stem of the Oconee river, about 10 km above Lake Oconee.
- Site 6 is located on the Oconee River about 50 km below the Lake Sinclair dam.
- Site 7 is on the upper Altamaha River immediately below the confluence of the Oconee and Ocmulgee Rivers.
- Site 8 is on the middle Altamaha River below the confluence with the Ohoopee River.
- Site 9 is located on the lower Altamaha River, immediately above the area influenced by tidal action.

All nine sites occur on protected natural areas. Sites 1 – 4 are located in Sandy Creek Park and Nature Center, and the remainder of the sites occur on either federal, state or private preserves.

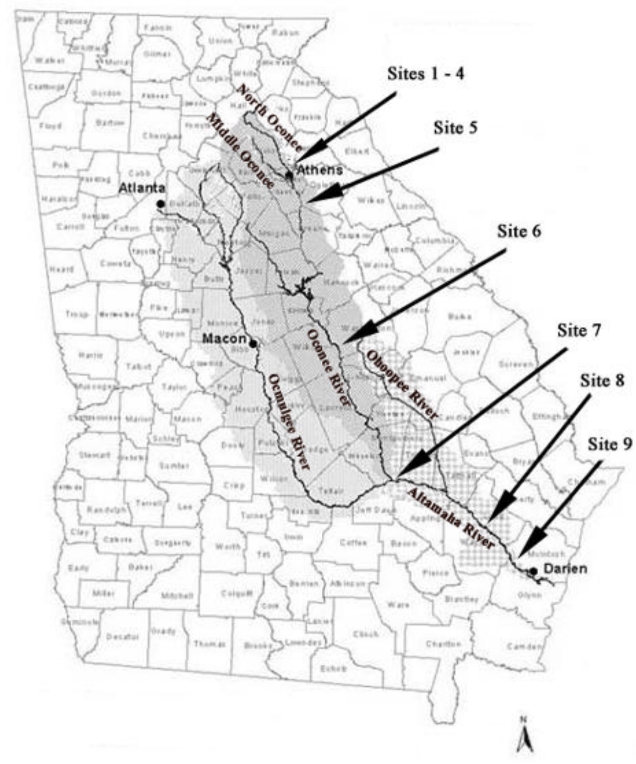

Figure 1. Study sites in the Oconee/Altamaha Watershed.

METHODS

Hydrology

For sites 4 – 9 on the North Oconee, Oconee and Altamaha Rivers, US Geological Survey data from gauges located near the sites are being used to assess discharge, base flow and duration of flooding. Because Sandy Creek and its tributaries are not gauged, extent and timing of inundation is being monitored by project personnel.

Because low lying areas of the floodplains can flood independently of over-bank flow, we cannot rely solely on channel data to indicate patterns of floodplain inundation. For this reason, we placed HOBO temperature recorders into low-lying sloughs in the lower four floodplains to monitor daily surficial temperature. When flooding occurs in the sloughs, the recorders are submersed, temperature fluctuations become dampened, and this allows us to determine when and for how long flooding occurs.

Water Chemistry and Soils

During inundation, we measure the following water chemistry parameters: pH, conductivity, nitrates, phosphates and dissolved oxygen.

The hydric status of soils at each site is being assessed based on color, consistency and odor, as described by the US Army Corps of Engineers Wetland Delineation Manual (1987).

Invertebrate Sampling

Once floodplains become inundated, sites are sampled every 4 – 6 weeks until they dry. A Hess sampler (860 cm^2) is used to quantitatively sample invertebrates. Because core-type samplers cannot be used in deep water, samples are collected only in areas < 40 cm in depth. Four random replicates are collected and combined into single samples. Samples are preserved in alcohol and returned to the lab where they are rinsed and divided into > 1 mm and < 1 mm aliquots. Invertebrates are removed from the debris and identified to genus. These data are being examined for among-site variation in the proportion of obligate wetland invertebrate taxa, trophic status, diversity and biomass.

DATA ANALYSES

Data analysis focuses on three objectives:

1. Our main objective is to quantify gross patterns of change in invertebrate assemblages along the upstream-downstream gradient. As such, data are being analyzed to relate river discharge with invertebrate response by fitting the habitat response variables of hydroperiod, chemistry, and invertebrates to linear and non-linear models with discharge as the independent variable.
2. In addition to examining the data longitudinally, we are comparing annual invertebrate variation in a dry versus wet year. Because the 2002 study season was a drought year, inundation was driven mainly by precipitation and minimal overbank flow occurred (only 2 of 9 floodplains showed overbank flow). In contrast, 2003 was a wetter El Niño year, and most floodplains have received inputs of river or stream water. Contrasting the two years will permit us to assess the importance of overbank flow to invertebrates.
3. Finally, invertebrate data will also be analyzed within each study year to assess seasonal changes in the fauna.

The study is projected to be completed in the spring of 2004.

RELEVANCE

The Altamaha River Watershed drains approximately a quarter of the state of Georgia. It supports greater than 80% of Georgia's $80 million commercial fishery and roughly one third of the $350 million recreational fishing industry (www.altamahariverkeeper.org). The river flows through some of the last remaining hardwood bottomlands, cypress swamps and tidal marshes in the South (www.darientel.net) and provides habitat for over 100 rare, threatened and endangered species, seven of which are unique to the ecosystem (www.altamahariverkeeper.org). According to the Georgia Department of Natural Resources, the area around the Altamaha River Delta supports about 55,000 species of seabirds and shorebirds. The Altamaha and its surrounding areas have been designated by the Western Hemisphere Shorebird Reserve Network as one of only 40 major reserves for shorebirds (www.altamahariver.net), and by The Nature Conservancy as one of 75 "Last Great Places" in the world. The Altamaha is clearly one of Georgia's most important natural resources.

However, due to increasing development, the watershed has become threatened. Recently the national conservation group, American Rivers, named the Altamaha as one of the nation's most endangered rivers. Understanding the ecological functioning of this important ecosystem is vital to its preservation.

Decisions are being made now on how to mitigate damage to floodplains in systems like the Oconee/Altamaha watershed. Projects such as the Savannah River Basin Comprehensive Plan are working to restore flood pulses to the lower Savannah River. Basic information on the ecology of floodplains is needed to inform these and other management decisions.

This study will help to generate a theoretical framework to explain how flood pulses affect ecological functions and invertebrate communities along a longitudinal gradient. Furthermore, since the Oconee/Altamaha watershed has relatively natural flood pulses and intact complexes of floodplains, data gathered from this study will be useful as reference data in comparisons of more impacted systems such as the Savannah River watershed.

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