DISTRIBUTION AND ABUNDANCE OF THREE ENDEMIC FISHES IN SHOALS OF THE UPPER FLINT RIVER SYSTEM

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Abstract. Many shoal habitats in the Piedmont of Georgia have been destroyed by reservoir construction, and the remaining are still threatened. To understand relations between aquatic biota and habitat conditions in shoals, we estimated fish densities in shoals differing in physical characteristics (e.g. size and bed material) throughout a 50 km reach of the upper Flint River (Meriwether, Pike, Upson, and Talbot counties) during 2001 and 2002. Our surveys show that the Flint shoal fauna includes five fishes endemic to the Apalachicola River system, and that abundances of at least three of the endemic fishes (Halloween darter – *Percina* sp., bluestripe shiner – *Cyprinella callitaenia*, shoal bass – *Micropterus cataractae*) vary substantially among shoals. We are using fish abundance and associated habitat data to build models useful for predicting effects of flow alteration on endemic fishes in the upper Flint River.

INTRODUCTION

Containing approximately 322 kilometers of undammed water, the Flint River is one of the longest free flowing rivers in Georgia. It is also one of 42 rivers in the United States with greater than 200 km of unimpeded flow (Benke, 1990). The Flint also contains some of the last remaining shoal series in the state of Georgia. Shoal habitat (shallow, rocky reaches) was once a common feature of rivers across the southeastern United States, but the combined effects of channelizing and damming have left most of Georgia's shoals buried under sediment and reservoirs.

The headwaters of the Flint River emerge from a concrete culvert just north of the Hartsfield International Airport in Atlanta and then flow under several runways and through six industrial parks. As the waters flow through Clayton and Fayette counties, they pass through a series of swamps. Approximately 167 km from its headwaters, the river crosses the Fall Line, leaving the Piedmont and continuing down the Coastal Plain. The watershed encompasses 21,902 km^2 (Frick, 1996). Five hundred sixty-five km from its birth, the Flint joins the Chattahoochee River at Lake Seminole. Together these rivers form the Apalachicola River system, which drains a combined 51,262 km^2 into the Gulf of Mexico (Marella, 1993).

With rapid growth of Atlanta and surrounding areas, the Flint is facing many threats including water withdrawal and fragmentation. As of 2000, the files of the Georgia Environmental Protection Division indicated that >110 million gallons per day (mgd) could be withdrawn for municipal use at 11 sites in the watershed above the confluence of Line Creek and the Flint River. By comparison, the estimated 7Q10 for the Flint River at the Line Creek convergence is approximately 21 mgd. With greater than five times the 7Q10 allowed to be withdrawn, we have the capacity to dry up the Flint River during low flow periods. Four water supply reservoirs have been constructed in the upper Flint basin in the past two decades (GDNR, 2001). Currently, there are another two reservoirs planned in the upper Flint region. The city of Griffin has an approved reservoir on Still Branch, and an additional reservoir is in the planning stages on Line Creek (GDNR, 2001).

Within the free flowing, upper 322 km of the Flint is a stretch of river from Gay-Flat Shoals Road to Highway 19 that contains a series of shoals (Figure 1). At least five fishes endemic to the Apalachicola drainage occur in this reach: *Cyprinella callitaenia* (bluestripe shiner), *Hybopsis* sp. cf. *H. winchelli* (undescribed clear chub), *Moxostoma* sp. cf. *M. poecilurum* (greyfin redhorse), *Micropterus cataractae* (shoal bass), and *Percina* sp. (halloween darter). All of these fishes are known to occur in shoals, but habitat use patterns have only been studied for *Percina* sp. and *M. cataractae* (Hill 1994, Allen and Wheeler 2002).

The shoals also provide habitat for a variety of State and Federally endangered and threatened species. State protected wildlife includes: two endangered birds (federally listed as threatened [1] and endangered [1]); one threatened reptile; two threatened and two rare

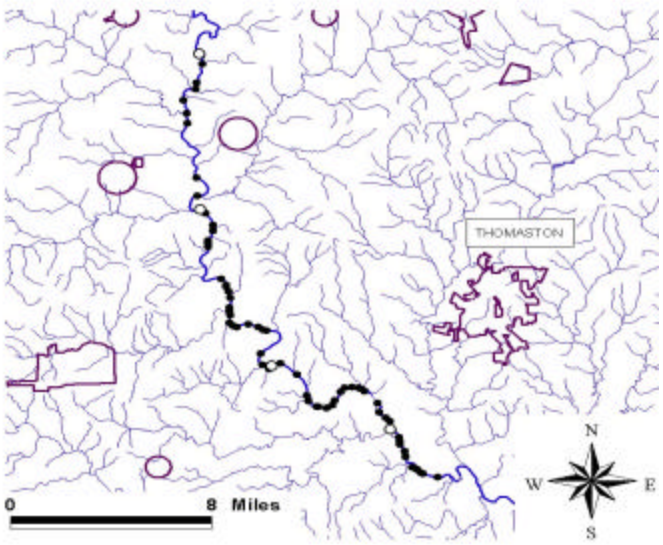

Figure 1. The Flint River shoals reach showing nearby towns. The upper most open dot represents Flat Shoals, next is Camp Thunder Boy Scout Camp, Sprewell Bluff, and Big Lazar Wildlife Management Area. Black dots represent all other identified shoals.

fishes; and one threatened and three endangered mussels (federally listed as threatened [1] and endangered [3]).

Our study objectives are to understand relations between aquatic biota and habitat conditions in the shoals, thereby providing information to be used for management and conservation.

METHODS

Field

We floated the upper Flint River, from Gay-Flat Shoals Road (Pike Co.) to PoBiddy Road (Upson Co.) and recorded locations (with a GPS) and lengths of individual shoals. Shoals were categorized by size (<100 m and >100 m), and then eight sites were randomly chosen within each category. We measured habitat variables and sampled fishes in the 16 selected shoals during July and August of 2002.

Gradients were obtained by using either an electronic total station or autolevel. We usually measured gradient over the total shoal length, except in long shoals, where gradient reach sometimes exceeded the reach sampled for fishes. Gradients have not yet been measured for two sites (the Sprewell Bluff and Hwy 36 shoals). Fishes were sampled at randomly selected coordinates throughout each shoal. The number of samples (range 30-70) was dependent upon shoal length. Each sample was approximately 1.5 m x 2.0 m in area. Fishes were collected using a backpack electric shocker and seine; captured fish were either measured and released or euthanized in Tricaine Methanesulfonate and preserved in 10 % Formalin for lab identification. Habitat measurements were also taken at each sample. These parameters included depth, velocity, percent vegetation (visual estimation), and dominant particle size (dps; phi scale).

Data analysis

At each shoal the average depth, phi, velocity, and % vegetation (primarily *Podostemum* sp., riverweed) were computed. Bedrock and sand were assigned phi values of -10.5 and 2, respectively. Dominant particle size data were used to estimate proportion sand, gravel, cobble, boulder, and bedrock. Catch per unit effort of *Percina* sp., *C. callitaenia*, and *M. cataractae* were also calculated.

Each variable was tested for normality using a Kolmogorov-Smirnov or Shapiro-Wilk test and transformed if necessary. Gradient and CPUE of fishes were log transformed (ln+1), and proportion of dominant particle sizes were arcsine transformed (arcsine-square root). Variables were plotted against one another to examine for nonlinear relationships. Pearson or Spearman correlation coefficients were computed using SAS version 8 for Windows.

RESULTS

We recorded the locations and approximate lengths of 30 individual shoals in the surveyed reach. Shoals ranged from approximately 25 to 500 meters in length, and the river width ranged from approximately 80 to 250 meters with intermittent islands.

Shoals in the Flint display a range of habitat characteristics and are not equal in relative fish abundances (Figure 2). Shoals differ in terms of fish abundances, dominant substrate, % *Podostemum* and gradient. For example, *M. cataractae* were plentiful only at Flat Shoals (the most upstream shoal), and *Percina* sp. dominated Sprewell Bluff, while appearing rare at FS #4 and #5. Dominant substrate ranged from complete bedrock at Flat Shoals to 43% cobble at Sprewell Bluff and 63% gravel at Shoal 36.

The correlation analysis revealed several relationships among habitat variables, and between fish and habitat variables. Shoals with higher gradient tended toward higher percent cover by *Podostemum* ($r=0.55$, $p=0.0401$), and lower average depths ($r=-0.76$, $p=0.0017$). There were no significant correlations between gradient and average velocity, average phi, or

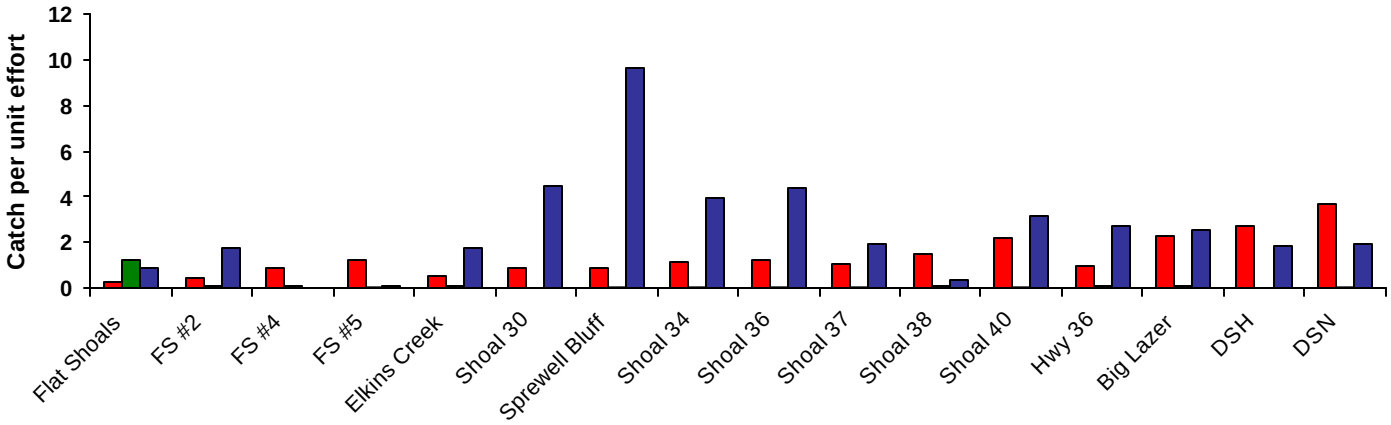

Figure 2. Catch per unit effort of *Cyprinella callitaenia* (red), *Micropterus cataractae* (green), and *Percina* sp. (blue) in 16 shoals in the Flint River, ordered from upstream to downstream. Shoals were sampled during July-August 2002.

the dominant particle size variables. CPUE of *Percina* sp. increased with higher percent *Podostemum* and decreased with higher average depth (r=0.72, p=0.0024 and r=-0.62, p=0.0103, respectively). Examination of the CPUE of *Percina* sp. vs. gradient showed a nonlinear relationship, with highest CPUE values at intermediate gradients. Catch per unit effort of *C. callitaenia* increased with increasing proportion cobble (r=0.55, p=0.0275). Catch per unit effort of *M. cataractae* was strongly non-normal, with the value for Flat Shoals (1.27 fish per sample) exceeding by 10 times values at all other shoals. We did not find significant correlations between CPUE for *M. cataractae* and any of the habitat variables (Spearman correlations, p>0.3).

DISCUSSION

The Flint River supports a variety of animals including endemic species such as the shoal bass. Our quantitative data show that the shoals are different in terms of habitat composition and fish assemblages. With much of the Piedmont of Georgia under the water of reservoirs, shoals are an endangered habitat, and should be the focus of management concerns for the upper Flint.

The variation in abundances of different fishes among shoals implies the need to consider effects of management strategies (land use, water development) throughout the shoals reach of the upper Flint River. The Georgia Department of Natural Resources conducted a fish survey on the upper Flint River during March-November 1984 (Ellis and Clark, 1986). They similarly found among-shoal differences, including an increase in *C. callitaenia* in the downstream direction and large among-shoal variation in *Percina* sp. abundances (originally identified as *P. nigrofasciata*, M. Freeman, unpublished data). Spatial variation in assemblages emphasizes the need to preserve suitable habitat conditions throughout the shoals reach to conserve the complete fauna. Conserving shoal fauna means management for good habitat, protecting the entire reach not just one or two of the shoals.

Ongoing analysis to relate patterns in fish assemblages and abundances of key species to other habitat variables will hopefully provide more insight to the complex relationship between the shoals and their inhabitants.

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