CURRENT CONDITIONS OF HISTORICAL MUSSEL HABITAT IN THE FLINT RIVER BASIN, GEORGIA

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Abstract. Streams of the Flint River Basin (FRB) remain as viable habitat for many freshwater species and harbor some of the most diverse mussel assemblages in the Southeast. However, land use changes, hydrologic alterations, and declines in native fish species have adversely affected mussel diversity and abundance throughout the region. Protection of rare and sensitive mussels requires the development of timely conservation strategies, supported by knowledge of current riparian and instream habitat conditions that impact their survival and recovery. We examined habitat conditions and selected water quality parameters at 81 stream sites that have historically supported populations of freshwater mussel species in the Basin. Higher nutrient, sediment, and bacterial concentrations were observed in the upper portion (Piedmont) of the Basin, which is characterized by higher gradient streams and percentages of urban land use. Sites in the lower section of the Basin (Fall Line Hills and Coastal Plain) maintained better quality riparian habitat including a larger buffer zone width, greater bank stability, and more vegetative cover. Overall, mussel habitat quality appeared good throughout the Basin. Physicochemical parameters and riparian habitat quality were influenced both by regional geologic differences and patterns of human activity.

INTRODUCTION

Freshwater mussel assemblages in the Flint River Basin (FRB) of southwestern Georgia are among the most diverse in the southeastern Coastal Plain of North America. Historically, 29 species of mussels existed in the Flint River system. Surveys conducted between 1991 and 1993 found that several Flint River tributaries within the Coastal Plain (lower FRB) continue to harbor diverse mussel faunas, numbering from 9 to 16 species, including several endangered species (Brim Box and Williams, 2000). However, only 22 of the 29 species originally found in the basin were observed during the 1991-1993 survey.

Over the past century, land use changes, river fragmentation, hydrologic alterations and declines in native fish species have adversely affected mussel diversity and abundance throughout the southeastern United States. Currently, about 13% of the 269 mussel species originally found in the Southeast are presumed extinct. Another 42% are considered endangered or threatened, 18% of special concern, and only 25% are stable (Neves et al., 1997).

In the future, mussels in the FRB may experience additional serious threats. Reduced instream flows pose an imminent threat to FRB mussels. Water supply reservoirs and instream withdrawals are increasingly necessary to serve a state population that has increased by 26% over the past decade (US Census Bureau, 2000). To exacerbate matters, the southeastern United States recently endured a severe drought (1999-2001) during which streamflow was further depleted to meet water demands for agricultural, urban, and industrial uses. Serious declines in native mussel populations were observed at sites where streamflow ceased during the drought (Golladay et al., 2004).

Streams of the Flint River system, particularly those that flow through the Coastal Plain portion of the Basin, remain as viable habitat for many freshwater mussel species. However, many of these species may not withstand future land use changes or decreases in instream flows. Protecting rare and sensitive mussels in the lower FRB will require creative and timely conservation strategies. The development of such strategies depends on knowledge of habitat conditions, patterns of riparian land use, and water quality that impact mussel survival in streams of the Basin. In developing conservation and recovery plans for native mussel species, riparian and instream habitat restoration has been identified as a critical conservation priority in the lower FRB (U.S. Fish and Wildlife Service, 2003). Necessary to the implementation of conservation actions is an assessment of the current condition of streams within the FRB.

This paper contains the results of a cooperative project between The Joseph W. Jones Ecological Research Center and the U.S. Fish and Wildlife Service (USFWS). The purpose was to provide a synoptic survey of habitat conditions and selected water quality parameters at sites

that have historically supported populations of rare and endangered freshwater mussel species in the FRB.

SITE DESCRIPTION AND METHODS

Study Area

Eighty-one stream sites within the Flint River Basin were sampled in this study. The Flint River watershed encompasses 8,460 square miles of Georgia's Piedmont (Upper Flint), Fall Line Hills (Middle Flint), and Coastal Plain (Lower Flint) physiographic districts.

Habitat surveys and Water Quality Analysis

Sites for habitat surveys were selected based on the historical presence of rare and/or endangered mussel populations (Brim Box and Williams, 2000). Habitat assessments were conducted using both the USFWS and EPA rapid habitat assessment protocols. Most surveys were conducted during stable base-flow periods during fall 2004 to winter 2005. Surface water quality samples were collected to determine levels of sediment and particulate inorganic matter, NO_3-N, NH_4-N, SRP soluble reactive phosphorus (SRP), total organic carbon (TOC), dissolved oxygen, pH, alkalinity, and fecal coliform bacteria.

Data Analysis

Two multivariate techniques, cluster analysis and principal components analysis (PCA) were used to visualize the data and determine if similarities existed between sites and water quality measurements. The following variables were used for both analyses: pH, Total Suspended Solids (TSS), fecal coliforms, PO_4, NO_3, NH_4, TOC, conductivity, and alkalinity. Streams were grouped according to physiographic region (Piedmont, Fall Line Hills, and Coastal Plain) and designated with separate symbols.

RESULTS

Water Quality

Average values and ranges of all water quality measurements were summarized according to geologic region (Table 1). Nutrient concentrations did not indicate major impairment of water quality with ammonium and phosphate concentrations being uniformly low throughout the system (Table 1). Compared to all sites, some relatively high nitrate concentrations (> 1 mg/l) were evident in the Fall Line Hills and Coastal Plain, but all sites showed nitrate concentrations below Georgia's drinking water standard for nitrate (10mg/L). Elevated nitrate in the Coastal Plain is likely caused by fertilizer application and migration of excess nitrate through groundwater flow pathways into streams (Couch et al., 1996).

Mean dissolved oxygen concentrations were well above half saturation and similar among the three geologic regions (Table 1). However, there were two instances in the Fall Line Hills and Coastal Plain regions when some streams were essentially anoxic (<1mg/L). There appeared to be a cluster of streams in the Vidalia Uplands where low dissolved oxygen concentrations were evident. These occurrences were of special concern and are discussed in more detail below.

Stream Habitat Parameters

In general, riparian habitat appeared to be favorable within the Basin. Total scores from the EPA habitat assessment ranged from 73 to 191 with greatest variability occurring in Coastal Plain streams although all regions showed a wide range of scores. For total score, 98% of sites ranked in the upper 50^{th} percentile and 60% were in the upper quartile. Average total scores were similar for each region; however sites in the Piedmont had slightly lower average scores.

Values for each individual parameter also varied by region, yet most parameters showed high average scores except for habitat parameters 1 (Epifaunal Substrate / Available Cover), 2 (Pool Substrate Characterization / Embeddedness), 3 (Pool Variability / Velocity / Depth), and 7 (Channel Sinuosity / Frequency of Riffles). Lower averages in these parameters suggest poorer streambed heterogeneity and abundance of available structure and habitat for mussels, many species of which prefer specific habitat types (Brim Box and Williams, 2000).

Streams of Concern

A site of concern was defined as showing one or more chemical or habitat parameters that could potentially threaten or jeopardize the quality of mussel habitat (see the final FWS report for further detail). A 'hit' for a site was either an extremely high or low value for chemical water quality (as determined by the outlier analysis from the PCA ordination) or the presence of poorer habitat characteristics determined from the FWS habitat evaluations (i.e. the forest condition of a site was 'cleared' versus 'heavily forested') and EPA assessments (scores below the 50^{th} percentile).

71% of sites sampled within the Piedmont (Upper Flint) were listed for some habitat or water quality concern. One stream in particular, Line Creek, had 3 sites with concerns both for water quality and adjacent land use within the riparian area. Within the Fall Line Hills region (Middle Flint), 56% of sites were listed, with two streams, the Kinchafoonee and Muckalee, showing multiple parameters of concern for riparian land use and epi

Table 1. Mean (Minimum-Maximum) Flint River Basin Water Quality Variables by Geologic Region.

Variables	Coastal Plain	Fall Line Hills	Piedmont
Water Temperature (C°)	17.3 (11.0-26.7)	19.7 (12.7-28.5)	21.4 (12.8-23.6)
pH (S.U.)	7.53 (5.88-8.04)	7.32 (6.45-8.16)	7.49 (7.17-7.84)
Alkalinity (mg $CaCO_3$/L)	67.0 (3.3-191.8)	30.9 (6.7-120.3)	26.4 (19.6-33.0)
Suspended Solids(mg/L)	4.4 (0.73-12.4)	8.2 (1.2-22.7)	8.5 (3.3-23.4)
F.coliform (cfu/100mL)	182 (5-1091)	127 (0-690)	240 (0-1017)
NH_4-N (µg/L)	0.03 (0-0.27)	0.04 (0-0.12)	0.04 (0.01-0.07)
PO_4-P (µg/L)	0.01 (0-0.09)	0.01 (0-0.06)	0.04 (0.002-0.24)
NO_3-N (µg/L)	0.64 (0-3.42)	0.50 (0-1.56)	0.35 (0.03-1.57)
TOC (mg/L)	6.91 (1.79-20.51)	6.61 (1.22-21.45)	10.0 (4.99-13.39)
Dissolved Oxygen (mg/L)	7.4 (0.38-9.89)	6.86 (0.05-9.41)	7.04 (5.66-9.46)
Conductivity (S)	0.15 (0.03-0.44)	0.08 (0.02-0.25)	0.08 (0.03-0.13)

faunal substrate composition quality as well as major areas of active erosion.

The Coastal Plain region listed 69% of the sampled sites including two streams of concern. One in particular, Mill creek, had 15 hits with concerns of altered riparian zone habitat (cleared), evident erosion, and rather high fecal coliform levels. Kiokee creek also showed concerns, specifically for channelization, active erosion and sediment deposition, and pool substrate variability. Both Muckalee and Kinchafoonee creeks were again noted as streams of concern for this region, as well as Ichawaynochaway for evident erosion and sediment deposition.

DISCUSSION

Examination of streams that historically supported mussel habitat within the Flint River Basin showed that overall current water quality and habitat conditions were adequate to support freshwater mussel populations.

However, specific sites and streams are in need of further examination and attention. Our results also revealed that physicochemical parameters and riparian habitat quality were influenced both by regional geologic differences and differing patterns of human activity.

Higher nutrient, sediment, and bacterial concentrations were observed in the Piedmont (upper Flint), which is characterized by higher gradient streams and greater percentages of urban land use. Many sites showed concerns for overall bank stability and bank erosion, with the lowest average EPA habitat assessment scores. A majority of the sites sampled in this region were also listed for some water quality or habitat concern, and we recommend two streams that may warrant resurveying for mussels, White Water and Line Creeks.

Sites in the lower section of the Basin (Fall Line Hills and Coastal Plain) maintained better quality riparian habitat including a larger buffer zone width, greater bank stability, and more vegetative cover. Stream sites in the Fall Line Hills, however, did show higher levels of suspended solids, nitrate and phosphates. Kinchafoonee and Muckalee Creek showed major concerns in both of these regions for suspended solids and active areas of erosion, in addition to poorer epifaunal substrate composition, land disturbances and minimal vegetative cover in the riparian area. Threats from low dissolved oxygen concentrations were also apparent in this region, and attention to those aforementioned stream sites is also warranted. Importantly, these streams represent some of the remaining sites of known mussel diversity and abundance and should be priorities for restoration and conservation efforts (Golladay et al, 2004). Many of these streams support at least one federally endangered mussel species.

Known for its diversity and rich mussel assemblages, the Flint River Basin has been shown to experience declines in distribution and population numbers due to habitat alteration and drought effects (Golladay et al., 2004). Data from this study represent only a snapshot of the Basin's tributaries for historic mussel presence, yet we believe it provides beneficial information to identify streams that may warrant resurveying for mussel species assemblages. Overall, few sites seemed severely impaired, however these streams may harbor threatened or endangered mussel species (see Brim Box and Williams, 2000).

For further information about this study and a copy of the report see www.jonesctr.org

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