EFFECTS OF SAND DREDGING ON CHANNEL MORPHOLOGY, HABITAT, AND WATER QUALITY IN URBAN DEKALB COUNTY STREAMS

Jennifer Keyes¹, C. Rhett Jackson² and Ben Jackson³

AUTHORS: ¹Graduate Student, ²Assistant Professor, and ³Professor, Warnell School of Forest Resources, University of Georgia, Athens, GA 30602.
REFERENCE: Proceedings of the 2001 Georgia Water Resources Conference, held March 26-27, 2001, at the University of Georgia. Kathryn J. Hatcher, editor, Institute of Ecology, the University of Georgia, Athens, Georgia.

Abstract. DeKalb County, Georgia, has instituted a dredging program to reduce sediment loads and increase channel conveyance. Limited data existed on the effects of dredging in Piedmont streams at the time this study was commissioned. This study is being conducted as a joint agreement between DeKalb County and the U.S Army Corps of Engineers to evaluate the effects of dredging in urban streams with sand beds and high sediment loads. Two sites were selected for this study, one active dredge site and one future dredge site. Upstream and downstream measurements have been collected and analyzed at the active dredge site for the last two years. Preliminary data analysis suggests that the channel reaches downstream of the active dredge site are moving toward a coarser particle-size distribution and a slightly higher frequency of pools and riffles.

INTRODUCTION

DeKalb County, Georgia, has contracted a dredging company to remove the sediment from stream channels to increase the flood-capacity, to serve as habitat remediation, and to reduce the amount of non-point source pollution to downstream waters. There are several physical effects on streams caused by dredging activities: change in channel morphology, locally increased water velocity and scour, headcutting, streambed modification, enhanced fine particle deposits, remobilization of contaminants in the sediment, and increased turbidity (Rivier and Seguier, 1985). The presence and degree of all these effects are dependent upon local site conditions and dredging methodology. While dredging is deleterious in most aquatic environments, we hypothesize that dredging may provide habitat benefits in urban Piedmont streams with high sediment loads.

This study is being conducted as a joint agreement between DeKalb County and the U.S. Army Corps of Engineers (USACE) to answer questions regarding the desirability of dredging as a removal process for sediment-laden streams, in addition to helping the USACE set protocols on dredging permits.

BACKGROUND

The effects of sand dredging on biota have been studied with mixed results. Bardarik et al. (1971) found no effect on fish and invertebrate communities from dredging activities in the Allegheny River, but Howard (1995) reported intense effects to benthic organisms and severe violations of water quality standards as a result of instream dredging operations in a fifth-order stream in southeastern Mississippi. Hansen et al (1983) found an overall reduction in the amount of sediment in the water column and an increase in aquatic habitat in Michigan. The ability to survive in actively dredged conditions has been shown to vary among species (Griffith and Andrews, 1981), indicating that the various findings between studies may not only be due to site conditions and dredging methodology but also to the type of species sampled.

Habitat is often the factor limiting diversity and abundance of aquatic species (Sullivan, 1987; Edwards, 1996). Pools temporarily formed or deepened by dredging can provide important fish habitat (Hansen et al, 1983). Furthermore, a reduction in sediment can have a positive effect on fish by reducing deposition on spawning beds (Hansen et al, 1983) and by creating riffle habitat.

The parameters that have been analyzed for this project but have not necessarily been completed are:

- Distribution of habitat units
- Distribution of particle-size
- Cross-sections
- Turbidity
- Basic water quality parameters
- Water chemistry/heavy metals
- Bedload/scour estimates associated with storms
- Temperature within pools, riffles, and glides
METHODS

Two streams within DeKalb County were chosen for this study based on the presence of an existing dredge site on the North Fork of Peachtree Creek and a proposed dredge site on South River. The North Fork of Peachtree Creek combines with the South Fork to form Peachtree Creek, a tributary of the Chattahoochee River. This part of the stream is located in the northern part of DeKalb County, Georgia, along the I-85 corridor. South River, a tributary of the Ocmulgee River, is located in the southwest corner of DeKalb County. Both of these watersheds are heavily urbanized and have flashy hydrographs.

Both Peachtree Creek and South River have dynamic channels that are characterized by a high frequency of sand bars and human debris, steep, frequently eroding banks with exposed tree roots, and vegetated riparian zones.

The locations, types, and timing of dredging operations were chosen for economic and engineering reasons without scientific input. Therefore, ecosystem monitoring was designed to best quantify and characterize dredging effects under these circumstances. There are few baseline data for the active dredge site at Peachtree Creek and only baseline data and no post-dredging data, at this time, for the inactive dredge site at South River.

Upstream and downstream sampling sites were established for each stream. At Peachtree Creek, there was one site located upstream from the dredge and one site located downstream. At South River, there were one upstream and two downstream sites. The ability to establish two downstream sites allowed us to evaluate the effect of distance from the dredge on various parameters.

Sediment was dredged from the channel using a wet-pit mining technique. This process removes the sand as slurry directly from the stream channel. The water and coarse aggregate are separated from the sand in a trommel. The separated water is piped to clarification ponds to settle suspended sediment before it is returned to the stream.

Instream habitats were evaluated using a modified Hankin and Reeves (1998) channel survey methodology. Surveys included modified Wolman pebble counts (known as zig-zag pebble counts, Bevenger and King, 1995), large woody debris counts, and habitat classifications of pools, riffles, and glides. Classifications included area and frequency of each habitat. Particle-size distributions were also determined using a modified Stokes' law methodology (Miller and Miller, 1987), which categorizes particles less than 2 mm.

A survey was performed at each sample site and extended upstream for 300 meters (approximately 15 times the channel width). Surveys were performed annually for two years.

Variations in temperature between pools, riffles, and glides were documented using Hobo Stowaway Tidbit Temperature loggers (Onset Computer Corp). Two of these dataloggers were placed in each type of habitat: large pool, medium pool, riffle, and glide.

Channel morphology was evaluated using channel cross-sections. Four cross-sections were performed within a 50-meter section of stream channel in which the dredge operates. Furthermore, another three cross-sections were established upstream and four downstream from the active dredge at Peachtree Creek. The cross-sections were repeated annually for two years to document channel changes.

Scour chains were used to monitor scour that results from storm events. Scour chains were constructed with golf-sized whiffle balls, wire, a pointed steel tip, and steel tubing. The steel tip provides a means of driving the whiffle balls into the stream channel with the steel tubing that was then removed. The number of whiffle balls exposed after a storm event indicated the amount of scour (Nawa and Frissell, 1993).

Bedload estimates were determined by surveying the volume of the hole created by dredging and resurveying that volume after two consecutive storm events.

Water quality was evaluated using turbidity, specific conductance, pH, and dissolved oxygen during high and low flows and with and without dredging in operation. These measurements were taken using either Hydrolab Datasonde 4 or Solomat 520 C. Upstream samples were taken approximately 150 meters upstream from the dredge and downstream samples were taken approximately 300 meters downstream from the dredge.

Water samples were collected for chemical analysis using a DH-48 depth-integrated sampler. Samples were collected under three different stream conditions: low-flow without dredging; low-flow with dredging; and high-flow without dredging. Water samples were analyzed for common heavy metals and phosphorus on an Inductively Coupled Plasma (ICP) mass spectrometer. Three replicate water samples were collected at each site and at the dredge site. In addition, three replicate sediment samples were collected at each site, digested, and analyzed on the ICP.
RESULTS

An examination of the particle-size distribution in Peachtree Creek, where there has been relatively active dredging, revealed a difference in downstream particle-size distribution between the two years of monitoring. In the first year of monitoring at the downstream site (PT3), 90.0% of the active channel particles were finer than 2 mm. In the second year of monitoring, 72.3% of the particles were finer than 2 mm (Figure 1). During the same time period, there did not appear to be a difference in the upstream particle-sizes. In the first year of monitoring at the upstream site (PT2), 87.3% of the particles were finer than 2 mm and in the second year 86.9% were finer than 2 mm (Figure 1).

The distribution of habitat units at the active dredge site demonstrated some variation from the first sampling to the second year of sampling (Figure 2). In 1999, both of the sampling sites contain few riffles. Approximately a year later, the downstream site (PT3) went from less than 1% riffles by area to 6.3% riffles and the upstream site (PT2) increased from less than 1% to 1.3%. The number of pools decreased from 4.5% at the upstream site the first year of sampling to less than 1% the second year. The number of pools composing the downstream habitat increased slightly from 14.1% to 15.6%.

Cross-sections taken on Peachtree Creek in 1999 were not marked properly and therefore comparisons between the two years were difficult to make. In general, the cross-sections downstream did appear to be deeper in January of 2001 than they had been in December of 1999.

A tremendous amount of bedload moves during storm events and in between storm events in Peachtree Creek. The bedload movement for a 22 day period, July 17 to August 8, 2000, with two storm events was estimated to be 356 metric tonnes. During a storm event, there are frequently periods of scour and deposition. The average scour depth from one storm event, in Peachtree Creek, was estimated to be 12.75 inches.

There was not a large difference in turbidity readings taken downstream of the dredge site during active dredging (Figure 3). The average turbidity during active dredging was 13.3 NTU. The average turbidity during non-dredging, prior to 1:00 PM on January 18th, 2001 when a storm occurred, was 13.2 NTU. A large storm started on January 18th, 2001 and continued off and on until the equipment was removed from the stream on the 19th. Precipitation data recorded in twenty-four hour increments indicated that 0.13 inches of rain fell on January 17th, 1.00 inches on January 18th and 1.55 inches on January 19th, 2001.
Continuous temperature measurements taken in September 2000 demonstrated well-mixed flows in the upstream and downstream reaches. There were no temperature differences between pool, glide, and riffle habitat units within a reach. There was a uniform 1°C difference between the upstream and downstream reach, which we attribute to riparian conditions. The lack of a substantial temperature change suggests that the deeper habitat created by dredging will not provide additional temperature refugia for aquatic organisms.

DISCUSSION

Preliminary data supports the hypothesis that sediment removal creates deeper habitats and coarser particle-size distributions downstream. No observable nick point has formed upstream of the dredge site but cross-sections and personal observations have demonstrated the dynamic nature of these urban channels. Surprisingly, turbidity during active dredging did not appear to increase. Storms play a dominant role in determining most of the channel characteristics in these streams. The effects of dredging appear to be minimal in comparison to the impacts created during storm events.

ACKNOWLEDGMENTS

This research is funded by DeKalb County through the University of Georgia Cooperative Extension Services. Dean Williams is the project manager for DeKalb County.

REFERENCES


