



At A Glance: South River Monitoring Programs and Activities

The Virginia Department of Environmental Quality (DEQ) stream monitoring programs have been in place across the state and in the Shenandoah drainage for decades. Parameter coverage includes basic field water chemistry [pH, dissolved oxygen (DO), temperature], nutrients, and metals. Historic and current monitoring data can be viewed on DEQ's web site at <http://www.deq.state.va.us/water/monitoring.html>. Special monitoring for mercury in water, fish, and sediments in the South River and the South Fork Shenandoah River began in the 1970s and continues today as a long-term special project. This project is supported

by a trust fund set up through an agreement between DuPont and the Commonwealth of Virginia in the 1980s and is slated to continue through 2080. On a regular basis, fish, surface water, and sediments are collected and analyzed for mercury. To date, some 7,000 fish samples (including sunfish, small and largemouth bass, rock bass, suckers, and catfish samples) have been collected and analyzed. The results are available at <http://www.deq.state.va.us/rivers/mercury.html>.

In addition to these monitoring programs, the Friends of the Shenandoah River have been conducting water sampling and analysis two times a month for the last 12 years at about 180 sites on the South Fork of the Shenandoah River and tributaries. Data have been collected on changes in pH, DO, turbidity, and basic nutrients and are available at <http://www.fosr.org>. Coupled with the monitoring programs, these studies provide a more complete picture of the river's health and quantitative information that can be used in decision making.

Similar to the fish sampling (see "From the Team...Virginia Tech

Conducts Fish Diet Study on page 3), scientists at James Madison University and Eastern Mennonite University collected and analyzed samples of the Asiatic clam *Corbicula fluminea* from the South River. This work was conducted to examine whether organisms other than fish might be useful indicators of mercury levels in the river system. Because this work is closely associated with that of the fish tissue monitoring program, the scientists involved have made presentations to the South River Science Team in an effort to coordinate and compare biological data. Thus far, the results of the *Corbicula* studies closely follow those obtained from the fish sampled in the South River.

The members of the South River Science Team have reviewed and discussed monitoring data from past studies and are working to provide input to the DEQ and other organizations about ongoing and expanded monitoring efforts.

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Tech Corner: Remediation Techniques for Mercury

Cleanup approaches for aquatic systems like the South River are limited in number, as explained by the National Academy of Sciences' recent report on environmental dredging. The basic triad of sediment remedial strategies consists of monitored natural recovery, capping with clean materials, and digging up and disposing of sediments. These are the only approaches that have been widely applied in the United States. Mercury is perhaps the most troublesome of the aquatic contaminants, and the one for which no known remedy has been completely successful. In the early 1980s, the Commonwealth of Virginia approved a plan for the South River that included eliminating all known



A damselfly takes a rest on the banks of the South River this summer.

mercury sources, followed by a long-term program of public advisories, natural recovery, and monitoring. The program to monitor mercury levels in fish, sediments, and water has been in place for approximately 20 years and will continue for at least the next 80 years. The South River Science Team's ultimate goal for the river is to reduce the levels of mercury in fish, thereby removing the hazard to other animals that eat the fish and eliminating the need for fish consumption advisories on the river. Achieving this long-term goal is a multistep process and one that must consider the complexities of mercury contamination.

The option of removing the sediments in the South River was studied in the early 1980s when an engineering firm was asked to present ideas. The proposal was set aside for the following primary

two reasons:

- There was scant assurance that such action would reduce the mercury found in fish, much less reduce it to "natural background" levels.
- The process would be destructive and disruptive to the ecological habitat of the river.

Since then, dig and haul efforts in other aquatic bodies have shown that removal and disposal alone cannot achieve cleanup goals when addressing mercury-contaminated sediments. The reality is that even very small amounts of mercury are sufficient to cause elevated fish levels such as those observed on the South River. Knowing this limitation, scientists on most mercury cleanup teams are focusing on more subtle actions in solving these problems:

- **Re-examining Sites**
Older sites are being re-examined to be certain that all of the original mercury sources have been halted. In some cases, small but significant leaks have been found and have been corrected. Groundwater capture and treatment, sewer cleaning, rock grouting, bank armoring, and soil excavation are some of the less invasive corrective actions that have been taken. The South River Science Team is currently re-examining the South River in this way.
- **Understanding Methylmercury**
Scientists now recognize that mercury in its familiar liquid metallic form is not the form of mercury that accumulates in fish and other organisms. In aquatic environments, liquid metallic mercury is transformed into methylmercury and this, in turn, accumulates throughout the food chain (see the Spring 2002 issue for more information regarding methylmercury). The transformation from liquid metallic mercury to methylmercury requires a complex biological process that is sensitive to sunlight, temperature, and other influences. Scientists are working to understand these biological processes, with the goal of halting or limiting the production of methylmercury. The South River Science Team's Expert Panel keeps the team up to date on the most recent information regarding methylmercury and provides feedback on how this information should direct the team's activities at the South River.

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From the Team... Virginia Tech Conducts Fish Diet Study

Diet is potentially the greatest factor affecting the bioaccumulation of mercury (Hg) in fish. Bioaccumulation is the process involving the transfer of a chemical from water and food to an organism. As the chemical moves through the food web, it becomes concentrated in larger organisms, such as predatory fish species. In fish, Hg is primarily present in the form of methylmercury (MeHg).

In January 2002, Virginia Tech researchers began a 2½-year study investigating the relationship between food habits and Hg accumulation in fish from the South River and South Fork. The fish species being studied include channel catfish, redbreast sunfish, smallmouth bass, and white sucker. These species were selected because they represent several trophic levels (bottom feeders, foragers, and predators) and are abundantly available, commonly consumed, and easily identifiable. These species are also routinely monitored by the Virginia Department of Environmental Quality for Hg and MeHg concentrations as part of its 100-year Hg monitoring plan. Major objectives of this study are as follows:

- Determine diet composition of the target fish species.
- Assess Hg and MeHg concentrations in common food items of the target fish species.
- Predict future Hg and MeHg trends in the target fish species using a bioaccumulation model.
- Evaluate seasonal and sexual Hg variations in the target fish species.

In April and July 2002, 14 sites along the South River and South Fork and three sites on the North River (reference reach) were sampled for target fish species age zero through adult. Stomach contents and otoliths (ear bones) were collected from all fish for diet composition and age analyses. Some of the more common food items identified so far include mayflies, caddisflies, crayfish, and forage fish (see figure). Additional fish sampling events are scheduled for October and December 2002.

The second phase of the study begins in Spring 2003 and includes sampling of common food items of the target fish species and analyses for total Hg and MeHg. The results will be entered into a

Bioaccumulation and Aquatic System Simulator to predict future Hg and MeHg trends in the target fish species.



A greedy smallmouth bass with a margined madtom caught in its mouth. The margined madtom, a member of the catfish family Ictaluridae, is a common food item of the smallmouth bass.

This study will help scientists gain a better understanding of the Hg and MeHg bioaccumulation processes occurring in the Shenandoah River system. In addition, results will help identify potential future bioindicators (organisms used to monitor Hg levels), determine if reported Hg concentrations are accurate, and assist in identifying viable options to reduce mercury accumulation in fish.

For more information, contact Greg Murphy at gmurphy@vt.edu, Dr. Don Orth at dorth@vt.edu, or Dr. Tammy Newcomb at newcombt@vt.edu.

Did You Know? South River: Home to Diverse Fish Community

Fifty-eight species of fish, 40 of which are native, have been recorded in the Shenandoah River watershed (Jenkins and Burkhead, 1994). Viewing the overall fish population of the South River, the casual observer will see predominantly sunfish, suckers, and black bass. Common sunfish species present in the South River include the pumpkinseed, green sunfish, redbreast sunfish, bluegill, and rock bass. Sunfish eat primarily aquatic and terrestrial invertebrates, but will also feed on small crustaceans and fish. The two most common sucker species found in the South River are the white sucker and the northern hog sucker. Suckers feed by vacuuming the river bottom for invertebrates and detritus.

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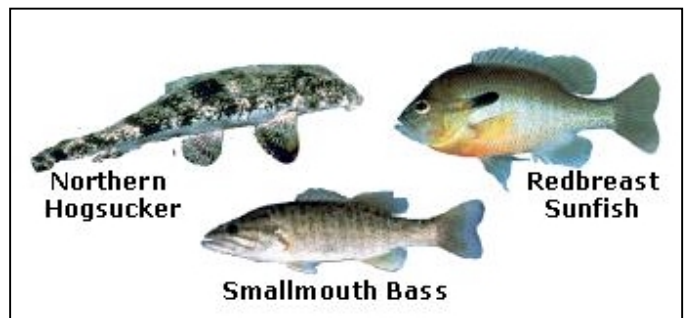
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For now, the South River Science Team supports the original decision of monitored natural recovery as the primary solution for the river. However, in the future, it may be determined that natural recovery may need to be supplemented with other approaches applied in a tailored fashion at specific locations.

For additional information on the successes and failures of mercury site cleanups, read “Mercury-Contaminated Industrial and Mining Sites in North America: An Overview with Selected Case Studies” by R.R. Turner and G.R. Southworth in the 1999 book *Mercury Contaminated Sites* edited by R. Ebinghaus and others and available through most university libraries. Dr. Ralph Turner, co-author of this book, is a member of the South River Science Team Expert Panel.

Did You Know?: Diverse Fish
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Smallmouth and largemouth bass are the two “top” predators found throughout the South River. Smallmouth bass are the most common of the two and are very popular with anglers. Bass feed on invertebrates, crayfish, and other fish. Additional species inhabiting the South River include the common carp, American eel, fallfish, bluehead chub, yellow bullhead, mottled sculpin, and shiners. The Virginia Department of Game and Inland Fisheries stocks brown and rainbow trout into portions of the South River to provide recreation fishing.



Three fish that are common in the South River. Photographs by Jenkins and Burkhead, 1994. Funding provided by Phillips Petroleum and the American Fisheries Society.

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