Keeping you up to date on South River Science Team activities **Summer 2003**

At A Glance:
Pictures of the Puzzle: Conceptual System Models

When scientists are faced with understanding a complex environmental issue, they often construct a picture of the puzzle that illustrates how a contaminant behaves in an ecosystem. In the case of the South River, this illustration is called a conceptual system model (CSM). CSMs show what is known about sites, what is not known, and what additional information is needed. It is also a powerful yet simple tool for piecing together different types of information about an area or river system and attempting to determine how the information fits together. As such, CSMs help scientists develop theories or hypotheses about how the contaminants may move through water, sediment, soil, plants, and animals. Currently, the South River Science Team has nearly 12 working hypotheses that are guiding their work.

To answer these questions and test the hypotheses, the team uses the CSM to direct field work and gather needed information. As more information is collected, the CSM is modified to reflect the new information and understanding. Hypotheses that prove to be incorrect are revised in light of the new information, and new theories are developed along with new questions to be answered. Perhaps most importantly, the CSM provides a common framework from which the team, community groups, and the public can understand and discuss site information.

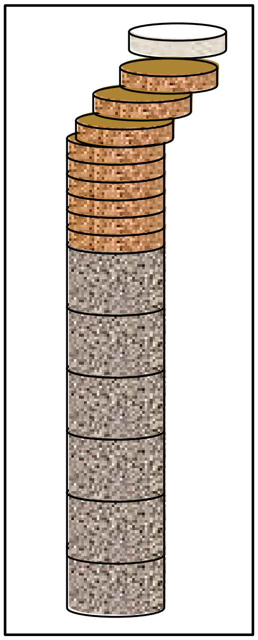
A CSM can be constructed in several ways depending on the amount of information available and the needs of the scientists. Some CSMs can be simple drawings and flow charts, identifying broad classes of contaminant sources (i.e., ways the contaminants are getting into the environment) and whether humans, plants, or animals are being exposed to them. Other CSMs are large, complicated figures illustrating the connectivity among contaminants, their sources (e.g., wastewater discharges, landfills, historical activities), and how they get into and move within the system.

The South River Science Team has been working on a CSM for the South River since early 2001. Currently, the CSM for the South River is complex and contains a substantial amount of the historical and recently collected information. The CSM for the South River helps to focus team discussions and decisions. The greatest challenge for the team is developing a thorough understanding of the mercury cycle in the South River and how fish accumulate mercury. This understanding is necessary before fish consumption advisories can be reduced or eliminated.

In This Issue…

Tech Corner:
Sediment Cores Used to Date Mercury Contributions to South River

The South River Science Team is conducting a study that focuses on understanding the history of mercury inputs into South River. Fresh mercury in shallow sediments is susceptible to methylation, a transformation process that under certain circumstances may dissipate mercury. It is important to know whether significant amounts of mercury enter the river and settle in the shallow sediments or whether the mercury in the river is deeply buried. The South River Science Team is studying vertical sediment cores and looking at the patterns of mercury with depth to determine a history of contributions into the river environment over time. This work is particularly useful for identifying historical mercury contributions because mercury binds to soil particles, which are then deposited as part of the river bottom.



Example of core sectioning.

Based on the advice of the panel of experts retained by the South River Science Team, a project was initiated in the fall of 2002 to examine the patterns of mercury with depth

The field team collecting a sediment core at a South River location.

in sediments. The first task was finding appropriate areas on the river where sediments might have deposited and lain undisturbed for the past 50 to 75 years. This was difficult because the South River is rocky and does not typically develop large areas of sediment. A survey of the river suggested that an area just upstream of Dooms Dam was a likely spot of long-term and deep sediment deposition. After gaining permission to work on the property adjacent to the site, the team brought a boat and coring equipment to collect 3 to 6 foot long tubes of sediment with as little disturbance as possible. The cores were cut into thin slices (see figure to left), and each slice was analyzed for mercury and a "marker element" called cesium 137 (Cs^{137}). The latter marker element, which is not an industrial contaminant, is present in soils and sediments at trace levels. Because it is known when Cs^{137} was deposited into the sediment, this information can be used to determine when the sediment was deposited. In the case of the sediments of South River, it is known that the primary mercury contributions occurred between 1929 and 1950. With measurements of both mercury and the marker element, there is sufficient information to verify the mercury depositional history.

The results from a core collected behind Dooms Dam indicate that the highest concentration of the marker element, corresponding to about 1963, is found at a depth of about 19 inches below the sediment water interface (i.e., the area where the sediment and water meet). Below this depth, the concentration depletes rapidly. Although the team has not finished analyzing the core, these results indicate that this core was collected from undisturbed sediments, and that sediments below about 28 inches were likely deposited before 1955. (Knowing that the core is apparently undisturbed allows the mercury deposits to be dated.) Mercury contributions into the South River ceased after 1950. This information verifies previous knowledge about the history of mercury inputs into the South River. Samples from the core also indicate that the most recently deposited sediments (those near the top of the core) continue to have mercury levels that are *(continued on page 4)*

From the Team…
Mercury Monitoring Using Clams

In November 2002, the South River Science Team initiated a study to monitor mercury in the South River using the freshwater clam, *Corbicula fluminea*, commonly known as the Asiatic clam. This clam was introduced to the United States accidently, and its presence has become widespread in freshwater systems around the country. To date, all monitoring activities have focused primarily on water, sediment, and fish tissue samples. Although fish tissue samples have been used to monitor mercury in the river, fish migrate over great distances and, therefore, the mercury concentrations in the fish tissue may not be representative of the area where the fish was caught. Asiatic clams can process several hundreds of gallons of water in their lifetimes and, because they are stationary as adults, the water they filter comes from a localized area in the river. In 2000, the U.S. Environmental Protection Agency verified that clams were "…good accumulators of heavy metals…and…they may reflect local contaminant concentrations more accurately than more mobile crustacean and finfish species."

Clams being collected from the South River.

Clams being shucked and tissue samples collected in the laboratory.

In a study that was led by James Madison University staff and students and with the help of the Virginia Department of Environmental Quality and the Virginia Department of Game and Inland Fisheries, clams were collected from 18 locations along the South River. The goal of the study was to determine if the clams were appropriate to use to monitor mercury in the river. The clams were shucked and tissue samples were collected. Analytical results indicated that Asiatic clams are suitable for biomonitoring. For more information about the clam monitoring on the river, contact Tom Benzing at (540) 568-2794 or <benzintr@jmu.edu>.

Did You Know?
Tidbits About the Shenandoah Valley

How much do you know about where you live? You drive along the rivers and through the towns in the Shenandoah Valley, perhaps unaware of the great history within. Here are a few tidbits of history to test your knowledge of the area.

1. The song "Oh Shenandoah, I hear you call me" is thought to have originated on the American Frontier from mountain men, French voyageurs, or perhaps Missouri river boatmen.
2. The name Shenandoah is believed derived from that of an Indian tribe, the Senedos, of Shawnee-Algonquian extraction.
3. The first evidence of inhabited structures in North America was unearthed along the North and South Forks of the Shenandoah River near Front Royal, Virginia.
4. Flat boats called "gundalows" up to 90 feet long navigated the rivers from Grottoes to Harpers Ferry carrying items such as iron and flour produced by the river valley furnaces and mills. The Shenandoah navigation was nearly 300 miles long.
5. Gundalows were sold for their lumber at their destinations and became parts of buildings; the vaulted ceiling on the top floor of the Philip Coons Building on Shenandoah Street in downtown Harpers Ferry (now part of Harpers Ferry National Historical Park) is made from gundalow wood.

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TechCorner: Sediment Cores
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about 10 times the background level for this part of Virginia. This is a relatively low level of mercury. Although it poses no direct hazard through human contact, the mercury level is high enough to accumulate in fish, which is a concern. Now the team is examining where this mercury in more recently deposited sediments may be originating. Results will help identify how these sources may be controlled.

Did You Know?: Tidbits
(continued from page 3)

6. For more than a hundred years after Shenandoah County became settled (1730), the German language was spoken.
7. On September 28, and 29, 1870, floodwaters decimated the entire developed portion of Shenandoah. Between 30 and 60 buildings were completely destroyed or washed away as the water of the South Fork of the Shenandoah River billowed its way through town.
8. In 1795, residents on the South River petitioned the government to require mill owners to remove their dams or build sluices so that fish could swim upstream.

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