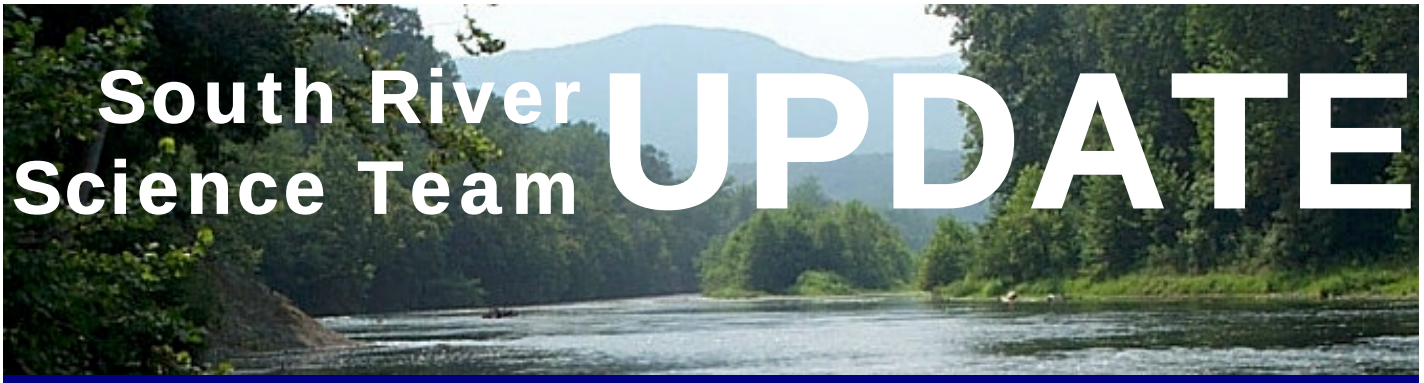


South River Science Team UPDATE

Keeping you up to date on South River Science Team activities — Spring 2004

At A Glance: Local Universities Contribute to Science Team Activities

The South River Science Team has tapped into the resources and knowledge base of local universities to help with the team's focus of filling data gaps and better understanding mercury behavior (see shaded box, below right). Professors and students from James Madison University (JMU), Eastern Mennonite University (EMU), Virginia Tech, and the Universities of Maryland and Delaware provide valuable field and laboratory support and gain practical project experience. Although the projects are varied, all efforts involve professors and students applying their knowledge of local river conditions. Key efforts are outlined as follows.

Fish Diet Study (Virginia Tech: 2002-2004): An investigation of the relationship between fish diet and mercury accumulation in fish from the South River and South Fork (see "From the Team" for details).

Clam Study (JMU and EMU: 2003-2004): A two-part study to determine if river clams accumulate mercury and can be used to better understand mercury behavior in the river system.

Erosion and Sedimentation Study (University of Delaware: 2004-2005): A followup study from the water budget evaluation discussed in the "Tech Corner" article investigating recent processes (e.g., Hurricane Isabel) on river erosion and sedimentation.

Crop Study (JMU: 2003-2004): A study in which university personnel provide technical and field support to the vegetable garden research project at the Augusta Forestry Center in Crimora.

Mercury Behavior (University of Maryland: 2004): A controlled laboratory study that examines potential mercury and methylmercury release during soil and sediment disturbance (mercury methylation was discussed in the Summer 2002 issue).

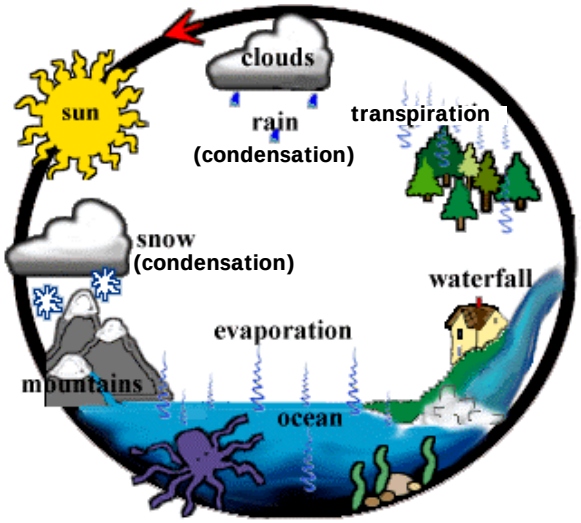
In This Issue…

About this Newsletter…

In the Fall 2000, the South River Science Team was formed to serve as a focal point for technical issues concerning mercury in the South River and downstream waterways. The Science Team is a cooperative effort between the Virginia Department of Environmental Quality, Department of Health, and the Department of Game and Inland Fisheries and representatives from academia, citizens groups, the Environmental Protection Agency, and DuPont. The Science Team provides technical direction for the mercury monitoring program and ensures that there is effective communication provided to the users of the river. The Science Team's goal is to understand why mercury in South River fish has not decreased over time and to identify potential solutions to improve the situation.

TechCorner:
The Water Cycle of the South River Basin

The water cycle is the journey water takes as it circulates from land to sky and back again. The cycle occurs through the processes of evaporation, transpiration, condensation, and precipitation. Evaporation occurs when the sun heats the earth's surface water and turns it into vapor or steam. Plants emit water in the form of vapor in a process called transpiration. Condensation occurs when the water vapor in the air gets cold and changes back into liquid, forming clouds. When water has condensed to the point that the air cannot hold it anymore, precipitation occurs and water falls back to earth in the form of rain, hail, sleet, or snow. Then, the water collects on land or in the ocean. If the water falls on land, it either soaks into the earth and is taken up by plant roots or becomes part of the groundwater system. A portion of the precipitation stays on the surface and flows overland into rivers, lakes, or oceans. Then, the cycle begins again. It is estimated that 100 million billion gallons of water a year are cycled on earth through this process.



The water cycle.
(Modified from USEPA)

Obviously, water cycles in a specific area vary with location and weather, but quantifying the movement of water in a particular watershed and understanding the cycle can provide important information. For the environmental scientist, the movement of water can provide an understanding of how contaminants move in the system. For example, water in rivers can carry solids in the form of silts, clays and organic matter to which contamination is attached. Contamination can also be transported in a dissolved form in rivers or groundwater. A water budget balances the water coming into the system (as precipitation) with the water leaving the system (as evaporation, river flow, and consumption by people and animals).

To better understand and quantify the movement of water in the South River Basin, the South River Science Team conducted a water budget evaluation this summer. The South River Watershed covers 235 square miles from the river source near Greenville to the confluence of the South River with the North River in Port Republic. The total length of the South River is about 53 miles. This evaluation focused on characterizing the general hydrology in the basin, determining a range of groundwater contribution to the South River flow, and evaluating the potential for underground springs.

The team used two approaches to achieve these objectives. Existing river flow data from the U.S. Geological Survey gauging stations from the 1950s to 2002, previous studies and reports, and VADEQ discharge and withdrawal permits were used to determine river flow. State climatic data were used to verify the calculations drawn from the existing river flow data. Mean annual statistics were used to evaluate both existing data and state climatic data and resolve any discrepancies between the two data sets.

Evaluation results showed that river flow data and climatic data are comparable. Groundwater discharges to the river make up approximately 30% to 50% of total river flow. Average precipitation is 35.5 inches per year and evapotranspiration (combined evaporation and transpiration rate) is estimated to be 19.5 inches per year of the total 35.5 inches/year precipitation. About 16.3 inches per year wind up in the river from tributaries, overland runoff and groundwater contributions.

But the water budget evaluation is only the first step. With average daily flow in the river greater than the calculated mean approximately 30% of the time, the river is considered a flashy stream. Thus, individual rain events may be more significant to the transport of contamination than average flow rates. To evaluate the effect of individual rain events, the team plans to study the response of the river flow on an event-related scale.

From the Team… Virginia Tech Conducts Fish Diet Study

In January 2002, researchers at Virginia Tech began studying mercury accumulation and its relationship to food habits of channel catfish, redbreast sunfish, smallmouth bass, and white sucker in the South River and South Fork Shenandoah River. Understanding this relationship is important because diet is the greatest source of mercury accumulation in fish.

During 2002, research activities focused on determining diet composition of the selected fish species. Fish ranging from juveniles to adults were sampled in spring, summer, fall, and winter by electrofishing at 18 locations in the South River, South Fork Shenandoah River, and North River (reference reach without mercury contamination). A total of 1,276 fish were collected and analyzed for diet composition. Overall, the diet of the selected fish species observed in this study followed similar patterns to those observed in other studies conducted in North America and in the southeastern United States. Fish fed upon a variety of diet items such as aquatic earthworms, aquatic and terrestrial insects, clams, crayfish, detritus, filamentous algae, fish, and snails. Important differences in diet were observed between fish species, river reaches, seasons, and sizes of fish. This information will be important for explaining pathways of mercury accumulation by the selected fish species.

Aquatic invertebrate sampling in the South River.

Mayfly larvae collected in the South River.

Once diet items were known, the next research focus was to collect diet items for mercury concentration analysis. Ten target diet items were selected from each study reach based on importance in the diet among all of the selected fish species. The final list of diet items consisted of a diverse group of aquatic organisms such as mayflies, caddisflies, crayfish, common shiners, fantail darters, and margined madtoms. Diet items were sampled in spring, summer, and fall at five locations in the South River, South Fork Shenandoah River, and North River. Preliminary results indicate that mercury concentrations in diet items show similar patterns to those observed in the selected fish species. Final analytical results will be received by December 2003.

Results from diet composition analyses and mercury concentration analyses of diet items along with other existing data will be used to predict mercury concentrations in the selected fish species based on alternative management scenarios aimed at remediating the South River and South Fork Shenandoah River. Management scenarios will be evaluated using the Bioaccumulation and Aquatic System Simulator, a bioaccumulation model developed by the U.S. Environmental Protection Agency. Final results of this study will provide resource managers with an enhanced understanding of the mercury bioaccumulation processes occurring in fish in the South River and South Fork Shenandoah River, so that assessment and

(continued on page 4)

From The Team: Fish Diet Study
(continued from page 3)

measurement endpoints can be determined which are essential for establishing remedial and restoration goals. For more information pertaining to this study, please contact Greg Murphy at <gmurphy@vt.edu>.

Did You Know? Birds of the South River Virginia Watershed

In some of our day-to-day activities outdoors, we encounter, but may take for granted, the numerous birds that inhabit our backyards, parks and other areas. As they fly from one area to another, birds disseminate undigested seeds and eggs of important plants and animals, and thereby fill an important role in the ecosystem. Birds are also important because they can help detect subtle changes in ecological conditions in those areas they inhabit. Rachel Carson's groundbreaking book, *Silent Spring*, highlighted the reproductive plight of birds that consumed fish contaminated with the widely used pesticide DDT. Many now recognize that her book was the beginning of modern environmental toxicology and illustrated the need for humans to pay closer attention to the plants and animals in their environment.

Because the condition of birds can reflect the health of the ecosystem, members of the South River Science Team have been reviewing bird census data collected by local bird watching groups and state agencies. In studies conducted by local bird watching groups and state agencies, it was observed that from 90 to 150 species of birds frequent, nest, feed, or rest in the South River watershed. This is a good number of species and provides evidence that the bird populations and, thus, the ecosystem are in relatively good health. From studies conducted in birds that eat mercury-contaminated fish, it is known that certain birds are more sensitive to mercury in their diet than others. Birds that primarily eat fish for example, do not appear to be as sensitive to the effects of mercury compared to birds that eat a wide variety of foods including fish, insects and other types of animals. Currently the team is discussing whether or not additional studies or review is needed to more fully evaluate the health of fish-eating bird populations within the South River watershed.

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To be added or deleted from our distribution list, contact Kathy Adams at (302) 892-8301.

South River Science Team
Attn: Kathy Adams, Technical Writer
P.O. Box 80027 (Bldg. 27/1231)
Wilmington, DE 19880-27

CONTACTS:

Virginia Dept. of Environmental Quality
Don Kain, (540) 574-7815
dgkain@deq.state.va.us

Virginia Dept. of Game and Inland Fisheries
Paul Bugas, (540) 248-9360
pbugas@dgif.state.va.us

Virginia Dept. of Health
Doug Larsen, (540) 332-7712
douglas.larsen@vdh.virginia.gov

DuPont
Mike Liberati, (302) 892-7421
michael.r.liberati@usa.dupont.com

INVISTA
Brenda Kennell, (540) 946-1320
brenda.l.kennel@invista.com