



## Shenandoah and James River Fish Disease and Mortality Investigations 2010

Chronic spring-time fish mortality and disease events have occurred in the Shenandoah River 2004-2009, and in the upper James River 2007-2009 (Figure 1). These episodes have not been uniform in location or severity over these time periods. Adult smallmouth bass, redbreast sunfish and rock bass have been the primary fish affected. However, several additional species have also been inflicted. Affected fish typically exhibit open sores or “lesions” on the sides of their bodies (Figure 2). Some dead and dying fish have no visibly external abnormalities. Other external symptoms include: dark patches of skin, raised bumps, loss of scales, split or eroded fins, and discolored/eroded gills.

Determining the cause of these mortality and morbidity events has proven to be extremely difficult. Scientists have conducted in-depth studies on fish health, pathogens, water quality, and contaminant exposure. The fact that these events have occurred in two separate watersheds that differ in many ways has added to the complexity of understanding the cause.

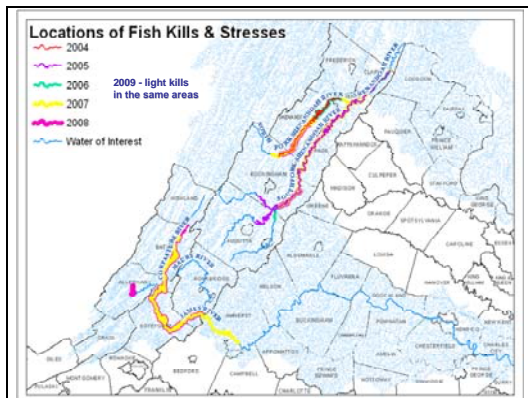


Figure 1. Location of fish mortality and disease events 2004-2009.



Figure 2. Adult smallmouth bass with lesion.

From the research and monitoring conducted to date, there has not been any conclusive evidence that water quality variables or chemical contaminants were directly responsible for these fish mortality/morbidity events. Contaminant levels were measured in the rivers affected as well as some rivers where these fish mortality/disease events were not occurring. Contaminant levels were measured at both base-flow and during runoff events (Figure 3). Passive chemical samplers were deployed to absorb chemicals just as a fish would over a given period of time in the river (Figure 4). However it must be noted that not every possible chemical compound was measured, and that the toxic concentration of

many chemical compounds are unknown. It is also not well understood how some chemical compounds could “interact” with one another and become toxic to fish. More research is needed in this area. Detailed findings from water quality and contaminant monitoring projects can be obtained from the Virginia Department of Environmental Quality’s Valley Region Office (DEQ) or by visiting the website [www.deq.state.va.us/info/srfishkill](http://www.deq.state.va.us/info/srfishkill)

Some chemical compounds and heavy metals have been shown to suppress the immune system of certain aquatic organisms. These contaminants are referred to as “endocrine disruptors”. Natural and synthetic forms of the hormone estrogen also fit into this category. Estrogenic activity was measured in water samples taken throughout the Shenandoah River and its tributaries at levels that could cause biological effects in fish. However, at this time there has been no definitive or conclusive evidence that chemicals are negatively affecting the immune system of fish in the Shenandoah or James River and contributing to the mortality/disease events. Researchers with the United States Geological Survey (USGS) are still actively engaged in understanding how certain contaminants may influence the immune system of fish. This research includes fish taken from Virginia rivers as well as other rivers in the Chesapeake Bay Watershed. The Virginia Department of Game and Inland Fisheries (DGIF) continues to work with these scientists by providing fish samples.



Figure 3. Taking a water sample for analysis.



Figure 4. Placing a passive chemical sampler in the river.

Fish health investigations to date have included: histopathology (Figure 6), parasitology, bacteriology, virology, and blood analysis (Figure 5). This information has been collected from the affected rivers, over multiple years, and also from “reference” rivers where these mortality/disease events have not been occurring. Fish health samples have been analyzed by several Universities, the United States Fish and Wildlife Service’s Northeast Fish Health Lab, and the United States Geological Society’s Eastern Fish Health Lab. While researchers have collected a plethora of fish health data, linking the disease and mortality episodes to a single cause has been elusive. Some research findings are described in the Virginia Tech University final report “Investigation into Smallmouth Bass Mortality in Virginia’s Rivers” (Orth et al. 2009) and can be found on the DGIF website [www.dgif.virginia.gov/fishing/fish-kill/](http://www.dgif.virginia.gov/fishing/fish-kill/)



Figure 5. Taking a blood sample from a live adult smallmouth bass.



Figure 6. Collecting histopathology samples from a smallmouth bass.

Researchers looked to aquatic insects as a possible way to understand the cause of the problem in the Shenandoah River Watershed. The Entomology Department at Virginia Tech was contracted by DGIF in 2006 to conduct a comprehensive evaluation of the aquatic macroinvertebrates in the Shenandoah River Watershed. Unfortunately, the study did not detect the cause of the fish mortality and disease problems. However, the main finding was that the Shenandoah River's aquatic insect community is indicative of an agricultural based watershed, is more vibrant than the New River in Virginia and the Susquehanna River in Pennsylvania, and is more diverse and healthy than it was back in the 1960's. Virginia Tech's final macroinvertebrate report can be viewed on the website [www.dgif.virginia.gov/fishing/fish-kill/](http://www.dgif.virginia.gov/fishing/fish-kill/)

DGIF and DEQ have recently (2008-2010) been focusing on a particular biological pathogen as the main cause of the disease/mortality episodes. The bacterium *Aeromonas salmonicida* (Figure 7 & 8) is the only variable common to all the fish mortality/disease locations. The bacteria has been cultured from adult and juvenile smallmouth bass and several other fish species from the affected rivers. It has not been found on fish in other Virginia rivers where the disease episodes are not occurring. The bacteria is considered a "cold-water" fish pathogen since it cannot survive water temperatures  $> 74^{\circ}$  F. The bacteria has been cultured from multiple fish species throughout the world, but it most commonly causes disease in trout and salmon. Bacteriologists with the USGS have determined that this bacteria can act as a "primary" pathogen and does not necessarily require the fish to be stressed from other factors before becoming diseased. However, as mentioned earlier, other researchers are investigating immune function viability in fish and whether certain environmental variables can affect the virulence of the bacteria. USGS researchers have identified that coldwater tributaries entering the river and large springs upwelling in the river are "reservoirs" of this bacteria where it can survive year-round.

While scientists conclude that they will probably never be able to determine neither where specifically this bacteria came from nor when it may have been introduced into these rivers, learning more about this pathogen could lead to understanding the root cause of the problem. Work is ongoing in 2010 to determine how the bacteria gets distributed

throughout the river, the number of potential reservoirs, and how much river (distance) can be affected by a single reservoir of bacteria. Additional questions that researchers hope to answer concerning this bacteria include: 1) What is the spatial distribution of the disease in these rivers? 2) Why are certain species of fish more susceptible to the disease than others? 3) What is the main vector of disease transmission (fish to fish contact or through water/fish contact)? 4) Why is disease not as prominent in juvenile fish as it is in adults? 5) Are fish becoming more resistant to the bacteria over time? 6) Do certain environmental parameters influence the virulence of the bacteria? 7) What is the average percentage of smallmouth bass and sunfish (throughout the river) that are carrying the bacteria and becoming diseased?



Figure 7. Swabbing fish for bacteria.



Figure 8. Culture of *Aeromonas salmonicida*.

- Several manuscripts involving the above mentioned research have been submitted and are currently under review by major fish health journals.
- Additional manuscripts detailing the above mentioned research are planned to be submitted to major fish health journals in the near future.