South Fork Shenandoah River
2010

Overview

The South Fork Shenandoah River begins at the confluence of the North River and South River near Port Republic and flows north 97 miles to meet the North Fork Shenandoah at the Town of Front Royal. The South Fork Shenandoah watershed covers 1,659 square miles. Surface runoff from the western slope of the Blue Ridge Mountains, parts of the Allegheny Mountains, Massanutten Mountain, and ground water from the karst regions of the Shenandoah Valley and Page Valley make up the flow of the river. The South Fork is a fifth order stream and averages around 100ft in width. The substrate of the river varies from bedrock to cobble and boulder. Several species of rooted aquatic vegetation are found throughout the river. This vegetation can become quite dense during the summer months. The South Fork is typically low gradient, but does produce some class I and class II rapids. There are three low-head hydropower dams located on the South Fork Shenandoah. Dams at Shenandoah, Newport, and Luray are owned by Allegheny Power and operated as run-of-the-river hydropower projects.

The South Fork Shenandoah is a very popular destination for canoeists. The close proximity of the river to urban areas of Virginia and the aesthetic beauty of the valley attract thousands of river users each year. Several canoe outfitters operate on the South Fork and canoe/tube traffic can be heavy on certain sections of the river during the summer months. Twenty (25) public access points along the entire length of the river creates the opportunity to plan many different float trips of varying distances. Except for the public access points, small sections of George Washington National Forest land on the west bank of the river, and several miles of Shenandoah River State Park near Bentonville (Warren County), the majority of the land bordering the river is private property.

Fish Disease and Mortality Investigations

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 dieing 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.

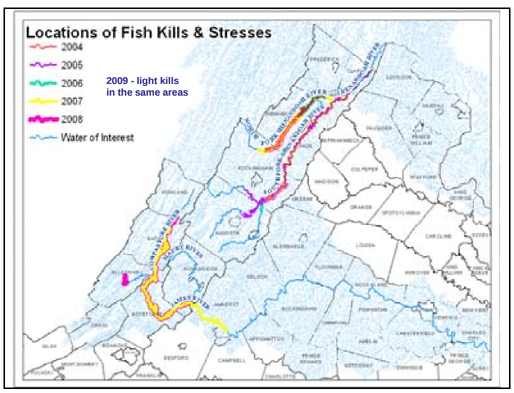

Figure1. Location of fish mortality and disease events 2004-2009.

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 (Figure 3). 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 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 or by visiting 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 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. VDGIF 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. Detailed 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 VDGIF website 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 a 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 at 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˚ 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 United States Geological Survey (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 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.*

Status of the Fishery

<u>Smallmouth Bass</u>

The one question that anglers and concerned citizens have asked since the beginning of these fish mortality and disease episodes is what has been the impact on the fish population. In the initial years of these events there was higher mortality observed and biologists estimated that fish losses were quite high. Fish biologists stressed that these were estimates and that the severity of the mortality and disease was not uniform throughout the rivers that were affected. However, several factors have allowed these fish populations to recover faster than anticipated. The most significant of these being excellent smallmouth reproduction between 2004 and 2007 (Figure 9). The years 2004 and 2007 were two of the best spawning years in the past decade in the Shenandoah River. Virginia biologists have documented that river flow in the spring/early summer is what determines the success of the smallmouth bass spawn. It also only takes a small number of successful spawning fish to keep the population viable. While researchers have recently verified that juvenile smallmouth bass are carrying the bacteria *Aeromnas salmonicida,* these fish do not appear to show signs of disease. Biologists have also not been able to document baby bass mortality associated with these episodes. Natural reproduction is what “drives” the river smallmouth bass populations in Virginia. The relative abundance of larger fish in the population is directly related to spawning success in previous years (Figures 10 & 11). Anglers can “ride the wave” of a strong spawn for several years as these fish grow into desirable sizes. Two and three year old smallmouth are the bass most frequently caught by anglers fishing the Shenandoah and James River.

On average it takes a smallmouth bass five years to reach 14 inches in the South Fork Shenandoah River. This explains the lag of a few years following a strong spawn when the numbers of larger fish increase in the population. This is easier to see in the Shenandoah graph (Figure 10) than in the James River graph (Figure 11). The opposite is true when there are several years in a row with below average spawning success. 1999-2002 were drought years and 2003 was an extremely wet year. This five year time period produced very few smallmouth bass. Because of the lack of fish entering the population the numbers of larger fish started to decline in 2003 and 2004. When the first fish mortality event hit the South Fork Shenandoah in 2005 adult smallmouth bass numbers were already on a decline. Focus on how the adult smallmouth bass population responded to the fish mortality episode on the SF Shenandoah in 2005 (Figure 10) and the James River in 2007 (Figure 11). One can see that both adult populations plummeted during the worst mortality years. However, notice how these populations have recovered and are near or well above the average over the last 10-15 years. Another important thing to take away from these data graphs is the consistent low proportion of large smallmouth in the population. The impacts of the fish mortality can be seen in the bigger fish sizes, but it is much less noticeable. Readers may also notice that 2002 was the best year to catch larger smallmouth bass in both the James and the Shenandoah River. This is due to consistent spawning in the early 1990's and a mega spawn in 1997. While electrofishing catch rates of larger smallmouth bass are quite variable on both the Shenandoah and James River, biologists have estimated that the mortality events have taken about 5-10% of the larger bass from the population per year.

Angler-creel survey data is also used to validate what biologists see in their electrofishing data. DGIF conducted a creel survey on the South Fork Shenandoah River in 2008 and the angler catch rate for smallmouth bass was 2.7 fish per hour. Comparing this to a catch rate of in 1.6 fish per hour in1997 one can see how the fishery changed in a decade. Angler satisfaction was also high (75 %) for the 101 anglers surveyed on the South Fork Shenandoah River in 2008. The electrofishing data suggests that the overall smallmouth bass population in the Shenandoah and upper James River have only been marginally affected by the recent fish mortality and disease episodes. The most noticeable difference to anglers would be a modest reduction in large bass (>16"). However, the size structure of the smallmouth bass population in the South Fork Shenandoah River during fall 2009 was excellent with a high proportion of fish being of angler preferred size (Figure 12). Excellent reports from anglers in 2009 also was an indication that the abundance of quality size smallmouth bass was on the increase in the South Fork Shenandoah River. It must be noted that this electrofishing data represents the smallmouth bass population as a whole. This information was generated by combining electrofishing data from multiple sites throughout these rivers. Smallmouth bass population statistics can vary for different individual reaches of river.

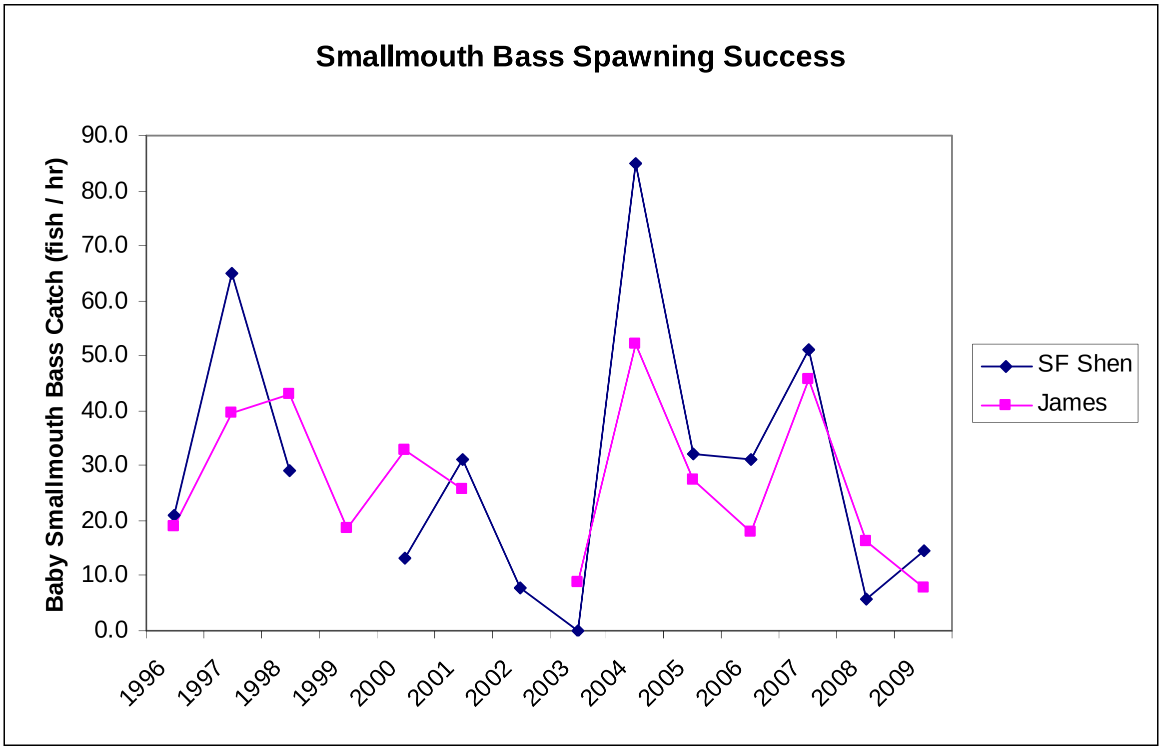

Figure 9. Smallmouth bass spawning success in the SF Shenandoah and James River.

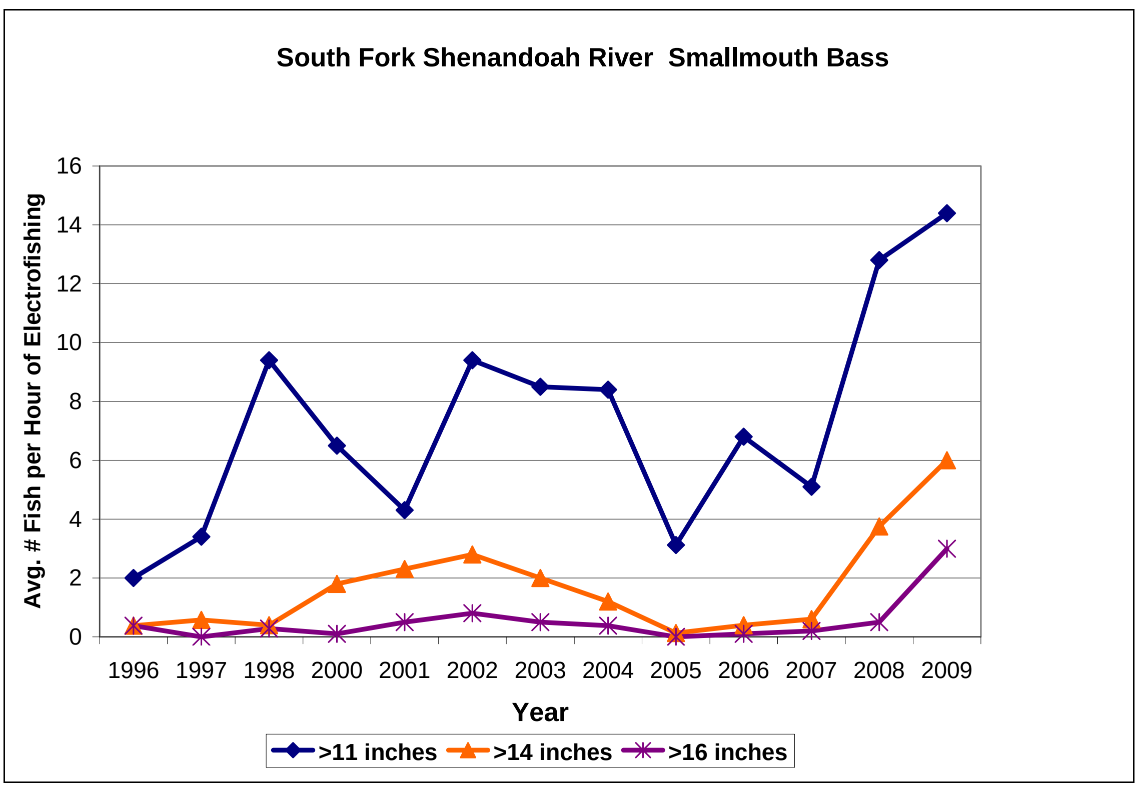

Figure 10. Electrofishing catch rate of different sizes of smallmouth bass from the SF Shenandoah River.

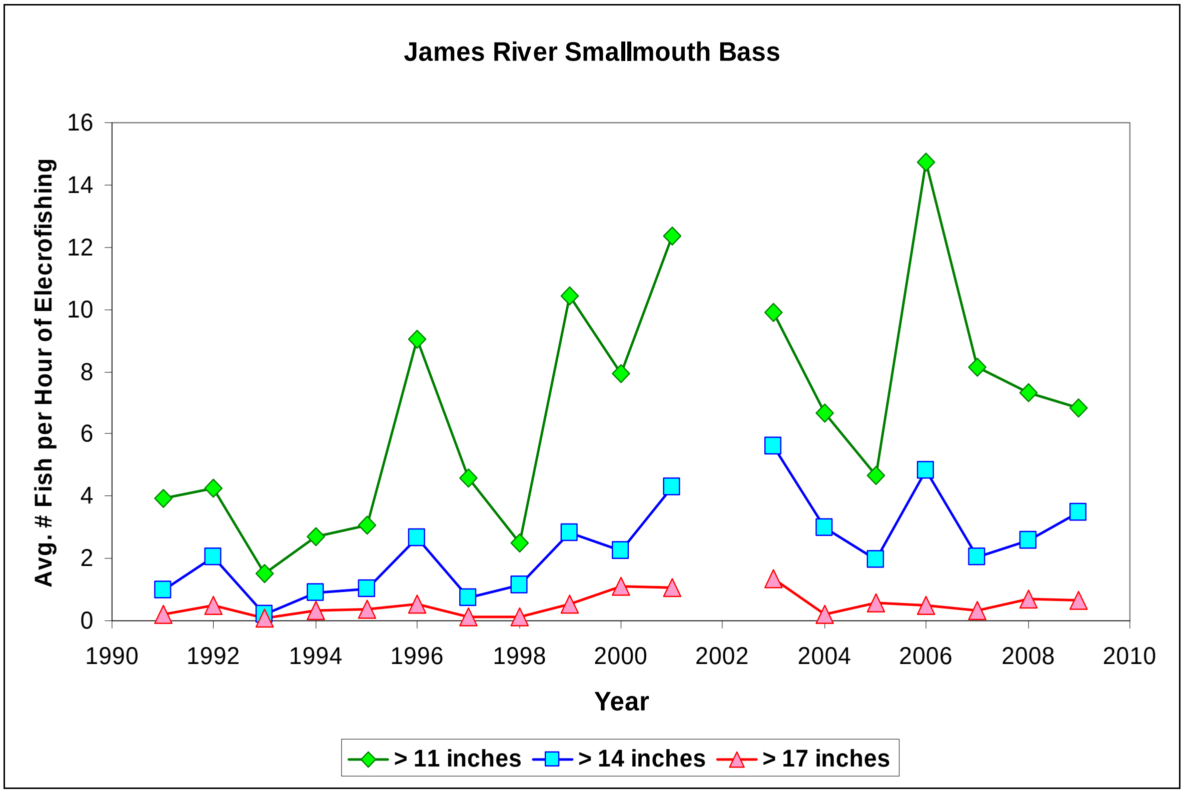

Figure 11. Electrofishig catch rate of different sizes of smallmouth bass from the upper James River.

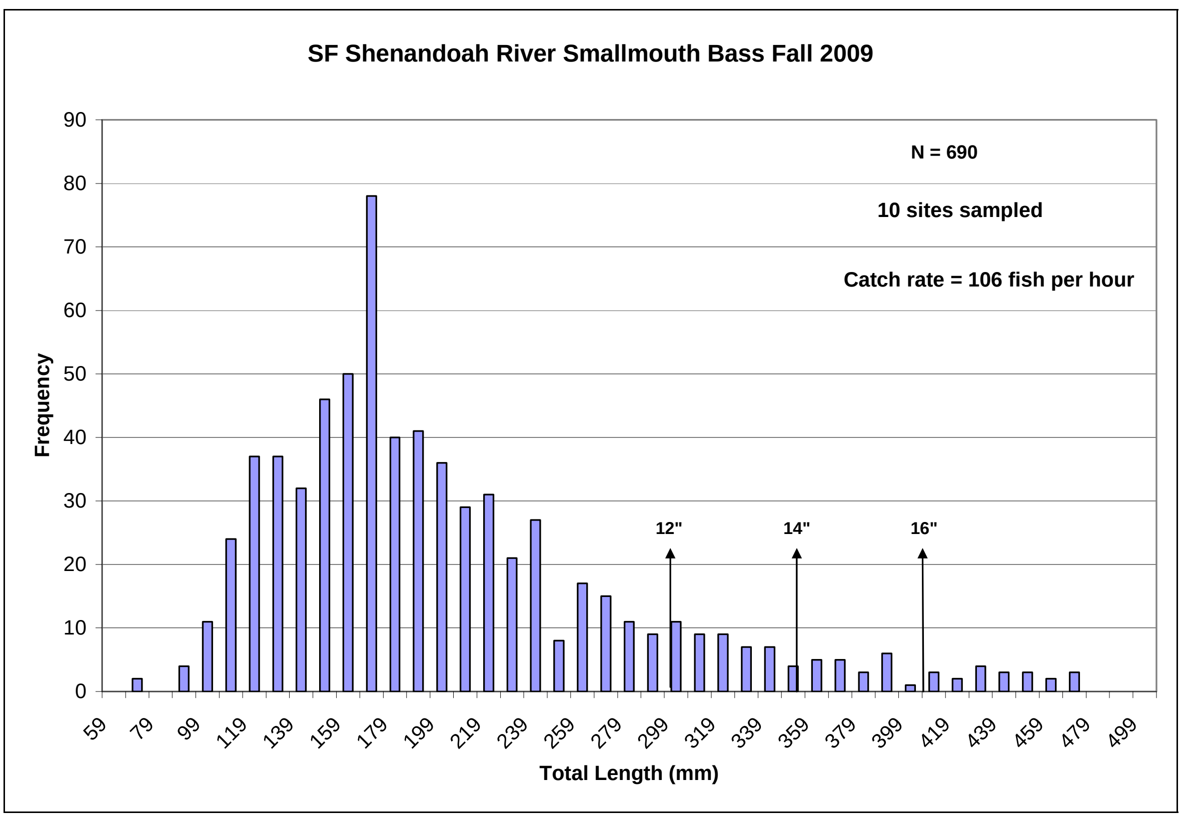

Figure 12. Length frequency distribution of smallmouth bass from the SF Shenandoah River Fall 2009.

Largemouth Bass

Largemouth bass do not gain as much attention as there cousin the smallmouth bass, but the South Fork Shenandoah harbors a very good largemouth population (Figure 13). Largemouth bass are most common in the slower, deeper pool habitat areas of the river. Any large pool, including the power pools created by the hydropower dams, contain fishable populations of largemouth bass. Good numbers of quality-size largemouths are available to anglers. Largemouth bass of up to seven pounds have been collected by biologists from the South Fork in recent years. Looking at a recent angler/creel survey conducted by the VDGIF, largemouth bass are being underutilized by anglers. If you are interested in largemouth bass, target your efforts near woody debris in the pools of the river. Most any offering of artificial or natural bait should entice a largemouth.

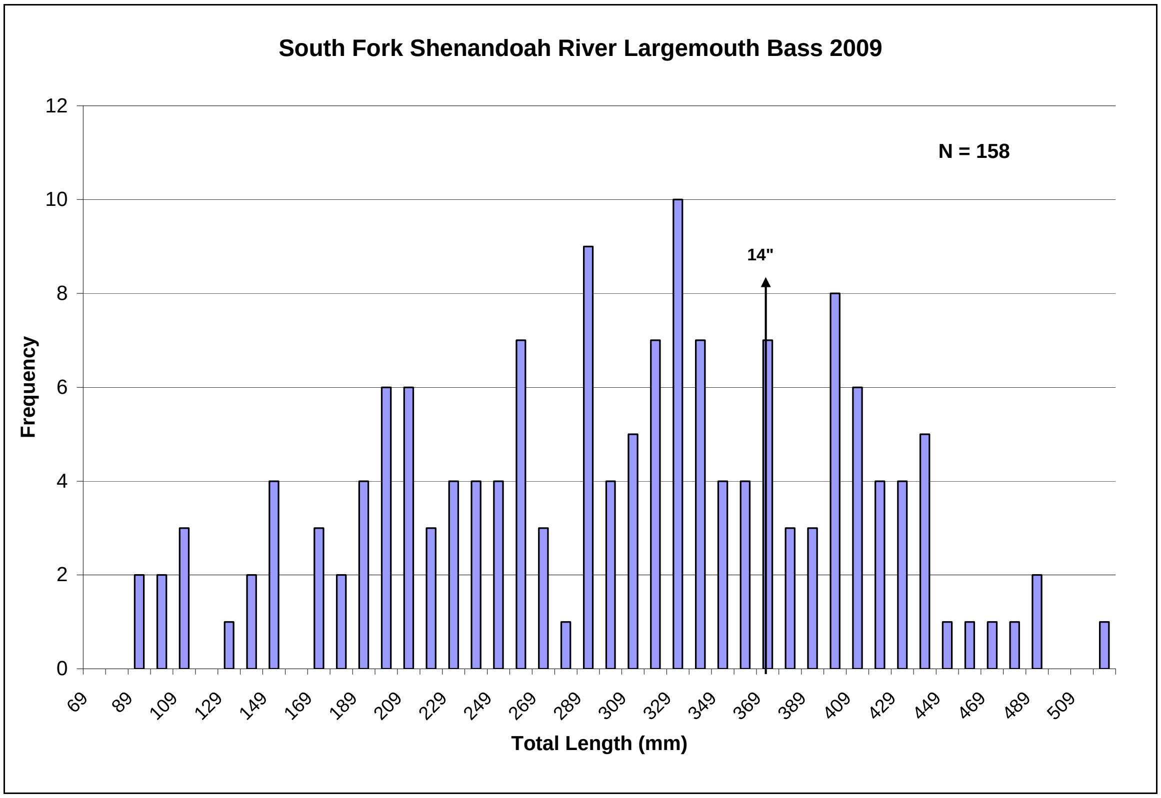

Figure 13. Length frequency distribution of largemouth bass in the SF Shenandoah River Fall 2009.

Sunfish

The South Fork Shenandoah is home to several sunfish species. Redbreast sunfish, bluegill, and green sunfish are the most common Rock bass can also be included in the sunfish group, but their numbers are quite low. Biologists and anglers have observed a drastic reduction of rock bass in the river over the past 10-15 years. DGIF has no explanation. Pumpkinseed sunfish are also present, but in very low numbers.

Redbreast sunfish are the most abundant sunfish species inhabiting the South Fork. They can be found in all types of habitat throughout the river. Usually where there is one many others will be in close proximity. Any type of structure (large boulders, woody debris, edges of vegetation mats) will hold redbreast. Unlike the other sunfish species, redbreast will also occupy areas of the river with faster currents. Redbreast in the 6-7 inch range can make for some exciting fishing. Anglers can catch redbreast on small artificials and live bait. These sunfish can be quite aggressive and catching them on larger artificial lures is common. Redbreast sunfish numbers have been on the increase the past two years (Figure 14) and the population appears to not have been impacted by the recent disease and mortality episodes.

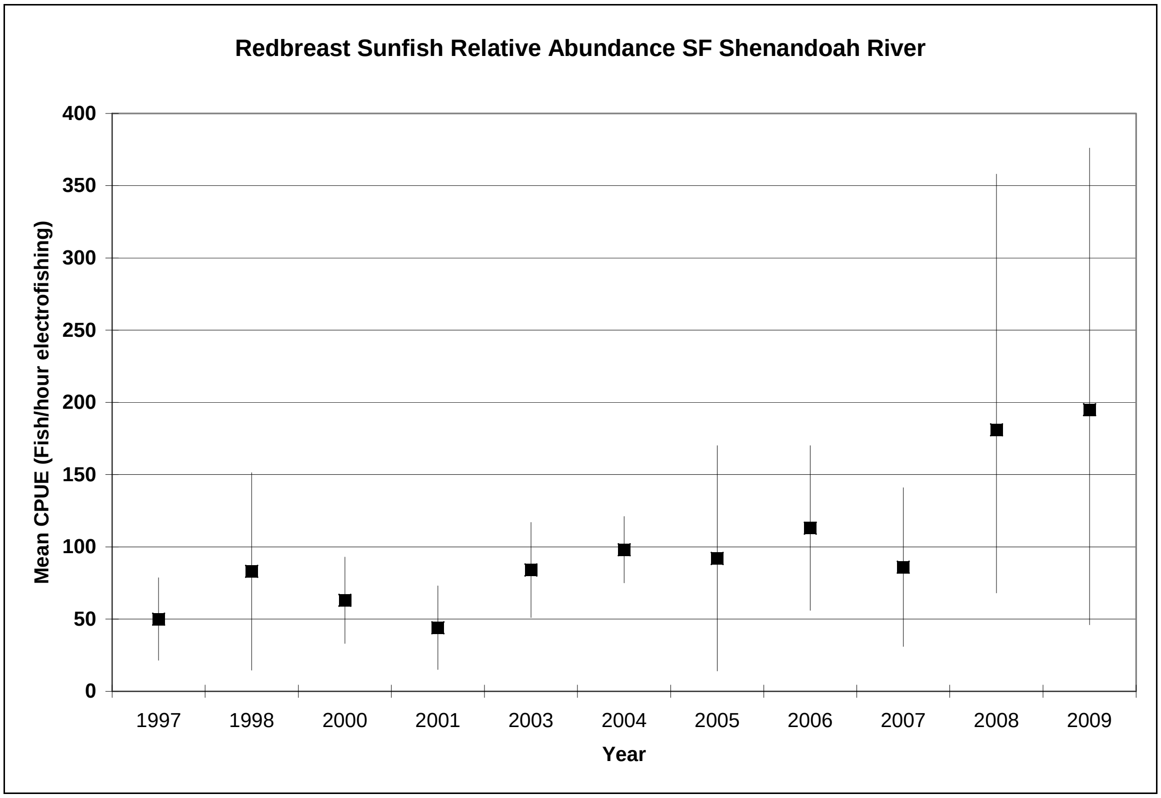

Figure 14. Electrofishing catch rate of redbreast sunfish in the SF Shenandoah River. Vertical bars indicate the variation in catch between sites each year.

Crappie

Both black and white crappie inhabit the South Fork. The black crappie is the more dominant of the two species. Crappie are predominantly found only in the large pools of the South Fork. The pools formed by the hydropower dams at Shenandoah, Newport and Luray have the highest concentrations of crappie. However, they can be found in any pool throughout the river. Anglers should target woody debris in these pools when fishing for crappie.

Muskellunge

The VDGIF annually stocks fingerling-size musky at 10+ sites on the South Fork Shenandoah. For decades Department biologists assumed that musky did not naturally reproduce in the Shenandoah River and needed to be stocked to sustain the fishery. However, biologists and anglers have seen an increase in the musky population in recent years. DGIF has undertaken a project to determine the extent of natural reproduction of musky in the Shenandoah River. All fingerling musky stocked are now being tagged with a micro-wire tag that each fish will carry throughout their life. As musky are captured by biologists they will be able to determine if the fish has been stocked or is wild. Adult musky are also being tagged with passive integrated transponder tags (PIT) so biologists can learn more about musky growth rates, mortality rates and movements. Targeted musky electrofishing by biologists has revealed a larger population than DGIF once realized. Capturing these elusive fish is difficult, and makes it difficult to get a true picture of the population size. There may be multiple musky in individual pools in the South Fork Shenandoah River. These fish prefer longer deeper pools in the river, but can be found almost anywhere. Anglers should focus on areas where structure is present adjacent to the main channel when hunting muskies. Musky are "ambush" predators and often lie just off the main current waiting to strike prey that swims/floats along. Also remember that these fish are a "cool-water" species, and unlike other species are active during the coldest months of the year.

Channel Catfish

Channel catfish are plentiful throughout the entire South Fork Shenandoah. Catfish numbers increase as you move downriver into bigger water. The large pools in the river are the best place to find channel cats. Recent sampling conducted by VDGIF biologists indicated a healthy population dominated by quality-size (2-5 lb) channel cats. Cats up to 10 lbs and above are not uncommon.

Other fish species

American eel, white sucker, margined madtom, northern hogsucker, common carp, fallfish, yellow bullhead, brown bullhead, and shorthead redhorse are additional fish species commonly found in the South Fork Shenandoah River.

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