

Angler Survey on the South River and South Fork Shenandoah River - 2016

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Purpose of 2016 Angler Survey

Angler surveys were conducted on the South River in 2005 and 2011 to determine angler knowledge of the fish consumption advisory that was initially posted in 1977. Considering the fish consumption advisory for mercury extends downstream through the South Fork Shenandoah River to Front Royal, the 2016 angler survey was designed to include both the South River and South Fork Shenandoah River. The South River Science Team (SRST) outreach program strives to inform anglers and the general population of the fish consumption advisories on these rivers. The results of the 2016 angler survey illustrate the fish consumption advisory knowledge of anglers throughout the entire advisory section. It also was useful in collecting angling preferences, effort, pressure, fish harvest and general satisfaction of river users.

Introduction

The South River and South Fork Shenandoah River in northwestern Virginia (Figure 1) are heavily used by anglers and recreational enthusiasts. The South River begins in southern Augusta County near Greenville, VA and flows north through Waynesboro and Grottoes where it meets the North River to form the South Fork Shenandoah River. The South Fork Shenandoah River has been recognized nationally for its Smallmouth Bass fishery. The South Fork flows north 97 river miles until it is joined by the North Fork Shenandoah at Front Royal to form the Shenandoah River. The Shenandoah River Watershed is considered fairly influential in the Chesapeake Bay Watershed. The South River and South Fork Shenandoah River both bring considerable economic revenue to surrounding localities. The South River offers several fishable stocked trout fishing opportunities in the Waynesboro area and the South Fork Shenandoah River offers multiple species for angling including Sunfish, Largemouth Bass, Channel Catfish, Muskellunge and most notably Smallmouth Bass. Only trout in South River and Muskellunge in the South Fork Shenandoah River are stocked annually. Access to the South Fork Shenandoah River is considered good with access points generally every 5 - 10 river miles. Access to the South River is mostly limited to local government properties near Waynesboro and Grottoes.

Industrial effluent has impacted the Shenandoah River and its tributaries since the early 1900's. The presence of mercury contamination in fish tissue was discovered in the 1970's. In 1977 fish consumption advisories were established and listed by the Virginia Department of Health on both the South River and South Fork Shenandoah River. The elevated levels of mercury in fish tissue have restricted the consumption of wild fish species by anglers in the South Fork Shenandoah River and

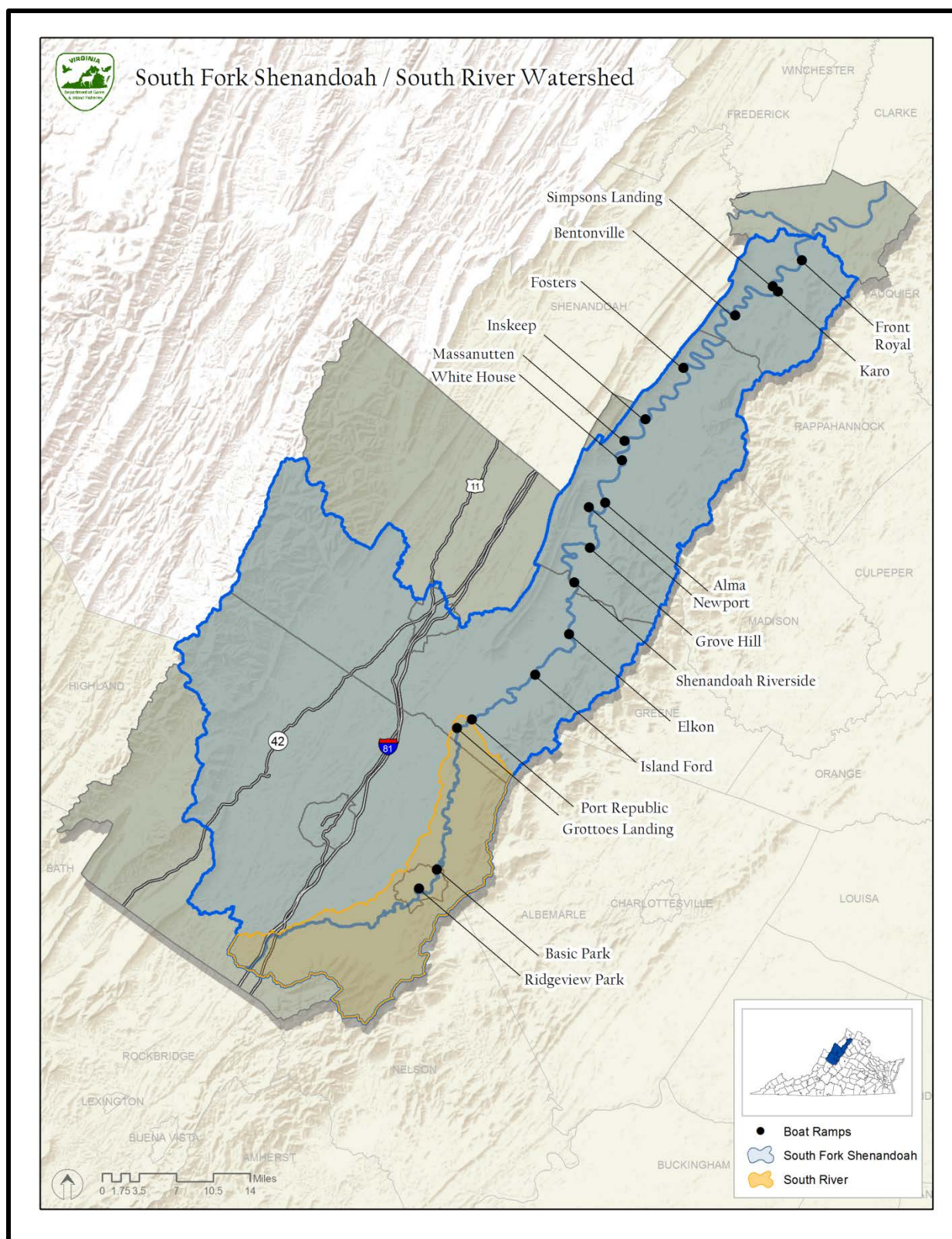


Figure 1. Location of South River and South Fork Shenandoah River Watersheds.

consuming any fish from the South River is not recommended. In 2000, the SRST was developed to review the mercury contamination issue and have since completed and continue to implement mercury contamination research and remediation measures.

The Virginia Department of Game and Inland Fisheries (VDGIF) has a long history of conducting angler surveys on larger river systems throughout the Commonwealth. However, given the limited access and size there was not an angler survey conducted on the South River until 2005, then a follow up survey was implemented in 2011. These surveys were initiated by the SRST to determine angler knowledge of the fish consumption advisories. Some of the results of these surveys are presented and compared to the 2016 survey in this report.

The South Fork Shenandoah River has had angler surveys conducted from the 1960's to present. However, some of the earlier surveys did not collect the same data as surveys in the last 20 years. Therefore, fewer comparisons from recent surveys to older surveys are available. In 1997 VDGIF District Fisheries Biologist Darrell Bowman designed a very extensive angler survey of the South Fork Shenandoah and Shenandoah Rivers. It was a roving (on-water kayak/canoe) survey that covered from April 1st through October 31st. Aerial flights were also used to help validate the accuracy of on-water angler counts. This was an excellent survey that gathered useful baseline information.

In 2008, the South Fork Shenandoah anglers were again surveyed by VDGIF. This time an access point survey design was chosen. This method consists of a creel clerk being stationed at one public access point for the entire survey day (10 different public access points were surveyed throughout the project). VDGIF biologists knew that bank and wade anglers would be underestimated as well as anglers that access the river only from private property. These assumptions became reality as the data from the 2008 survey was compared to the 1997 roving survey. The number of anglers interviewed was 50% less than the roving survey. While biologists felt confident about some of the information obtained from the 2008 access point survey, it was decided that future angler surveys would follow to design of the 1997 roving survey. Consistent survey designs have been instrumental in assisting biologists in comparing trend data over time.

In 2011 another roving survey was conducted on the South Fork Shenandoah River. To ensure comparisons among the 1997, 2011 and some of the data from other past surveys the 2016 survey was conducted as a roving survey. This was also done for the 2016 South River angler survey in order to compare with the 2005 and 2011 surveys. Results presented in this report are compared among the South Fork Shenandoah River and the South River for 2016 and among past years for each river individually.

Methods

The roving angler survey design was used to count and interview anglers on both rivers in 2016. Past angler surveys have indicated that the majority of angling pressure on rivers takes place from May through August. Therefore, the 2016 surveys for both rivers ran from May 1st through September 5th. The end of the survey went until September 5th to include Labor Day weekend river users. Sampling days were randomly chosen among weekdays and weekend days, with a higher probability being given to weekend days. The survey day was broken into two 6-hour time periods (AM-9:00am to 3:00pm; PM-3:00pm to 9:00pm). A higher probability was chosen for selecting the PM time period as anglers that had been fishing for several hours were more valuable to interview. River reaches were selected based

on past surveys and the distance the creel clerks could float in the time period. Four college students were hired as creel clerks and used kayaks to conduct the survey. Only one river reach was floated per survey day for each river and all anglers encountered were asked a series of interview questions for the South River and the South Fork. The clerks interviewed anglers in boats, wading, and on the bank. Anglers that could not be interviewed for various reasons were counted. Clerks also recorded the number of non- anglers they witnessed using the river during the survey float. These were typically individuals in canoes, kayaks, tubes, or just swimming/wading in the river. Creel clerks conducted the surveys no matter weather conditions. However, some scheduled days were missed on both rivers due to dangerously high flows. All interview data were entered into Microsoft EXCEL and SAS was used for statistical analysis.

The South River surveys in 2005 (14 days per month avg.) and 2011 (12 day per month avg.) both averaged over 10 surveys per month. In 2016 the river was scheduled to be surveyed 18 times per month (except September) to obtain statistically valid data. Five river reaches were selected to survey from Constitution Park in Waynesboro to Port Republic boat landing (Table 1). Probabilities were set higher for Reach number one near Constitution Park and Reach number five near Grand Caverns and Grottoes as they were more likely to have anglers present due to trout stocking. Anglers were asked a set of questions specific to South River (Appendix A).

Table 1. South River reaches sampled during the 2016 angler survey.

Reach No.	Reach Name	River	River Miles	Probability
1	DuPont to Dooms	South	5	0.25
2	Dooms to Crimora	South	5	0.2
3	Crimora to Wesley Church	South	4.5	0.15
4	Wesley Ch. to G. Caverns	South	5.8	0.15
5	G. Caverns to Port Rep.	South	4.2	0.25

The South Fork Shenandoah angler surveys in 1997 and 2008 covered 11 days per month and the 2011 survey was scheduled for 12 days per month. In 2016 the river was scheduled to be surveyed 22 times per month (except September) to obtain statistically valid data. Ten river reaches were selected to survey from Island Ford to Luray Avenue in Front Royal (Table 2). Uniform probabilities were used when randomly selecting survey reaches. Some of the reaches were identical to the reaches used in the 1997 survey and 9 of 10 reaches were identical to the 2011 survey on the South Fork. Anglers were asked a set of question specific to the South Fork Shenandoah River (Appendix B).

Table 2. South Fork Shenandoah River reaches sampled during the 2016 angler survey.

Reach No.	Reach Name	River	River Miles
1	Island Ford to Elkton	South Fork	6.9
2	Elkton to Shenandoah	South Fork	6.6
3	Shenandoah to Grove Hill	South Fork	8.9
4	Newport to Whitehouse	South Fork	8.5
5	Luray Dam Pool	South Fork	3.0
6	Inskeep to Bealers Ferry	South Fork	7.0
7	Bealers Ferry to Seakford	South Fork	7.5
8	Compton to Bentonville	South Fork	10.0
9	Bentonville to Karo	South Fork	8.4
10	Karo to Front Royal	South Fork	6.6

South River Results

South River - Creel Clerk Effort

A roving angler survey was conducted on South River (Waynesboro to Port Republic) from May 1st to September 5th, 2016 covering approximately 24.5 river miles. The creel clerks spent 46 days on the river interviewing anglers in 2016. August was most heavily sampled, with 13 trips; May and September had a limited number of samples. Unsafe river conditions during May limited the number of days that could be sampled and the end of the survey in September only included the Labor Day weekend. During the five month period, 90 angling party interviews were conducted and 70 recreational (other than fishing) parties were documented. A total of 170 individuals were counted; 100 were fishing and 70 were enjoying other forms of river recreation.

South River - Angler Effort

Angler effort (fishing pressure) was estimated at 14,434 angler trips for a total of 25,242 hours of fishing pressure. The average time spent fishing by an angler before being interviewed was 1.75 hours during this survey. There was roughly 33% less fishing pressure in 2016 compared to 2005. Fishing pressure was greatest in May and July. Anglers targeting Smallmouth Bass fished mainly in May and July while trout anglers focused their efforts mostly in May. Fishing from the bank or wading was most popular at 86% of the effort in 2005. This percentage reduced slightly to 79% in 2016, most likely due to the increased popularity of kayaks. The most sought after species was Smallmouth Bass (60%) followed by Largemouth Bass (15%) and then trout (11%). A breakdown of targeted species is illustrated in Figure 2. These results have changed slightly since 2011 when the majority of anglers targeted anything biting.

South River - Angler Characteristics

The dominant angler type on South River in 2016 was an adult with an average age of 38, Caucasian (86%) and male (85%). The next largest ethnic groups were African Americans (9%) and Hispanics (5%). These results are similar to past surveys.

When asked which County or City they were from 49% of anglers answered Augusta County while 43 % were from Rockingham County. Waynesboro residents contributed 16% to the Augusta County total and Grottoes residents contributed 13% to the Rockingham County total. Only 4% were from out of state. The majority (93%) of anglers used spinning gear, while 6% used fly fishing gear and 1% a combination of both gear types. Most anglers (39%) fished South River more than 20 times a year and 26% only fished 1 – 5 times annually.

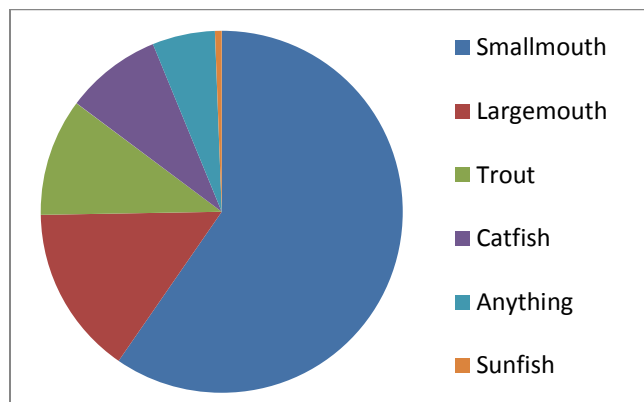


Figure 2. South River angler species preference

What did anglers like about fishing South River? The majority (46%) stated it was a combination of scenery, fishing quality and close to home. Thirty-six percent said they enjoyed fishing South River strictly because it was close to home and 11% fished the area for the scenery. When asked what they disliked about angling in South River, 56% stated pollution and 44% stated other reasons. Eleven percent stated that fishing quality was poor. Angler satisfaction with the South River fishery was good with 89% of anglers indicating they were either “satisfied, moderately satisfied, to greatly satisfied.”

South River - Fish Consumption Advisory

One of the main objectives of this study was to determine angler knowledge of the fish consumption advisory that has been imposed on South River (downstream of the DuPont footbridge) since 1977. When asked if they keep their catch only 2% strictly harvested fish and 19% said they practiced a combination of harvest and release. The remaining 79% said they released all fish they caught in 2016 compared to 73% in 2011 and 77% in 2005. The percent of anglers harvesting fish reduced from 25% in 2011 to only 2% in 2016. Of those that released their catch, 55% stated that they practiced catch-and-release fishing, while 28% stated it was from the advisory warnings. In 2005 only 8% of anglers stated they released their catch due to the advisory compared to 14% in 2011. The remaining 17% stated either the fish were too small, they didn't eat fish or for other reasons. Those that harvested some fish and released other typically harvested trout species. This was an observation and not quantitatively captured. Eighty three percent of anglers who harvested fish shared their catch with family and friends. Total catch for all species was estimated at 111,051 for the 2016 survey. Most fish (99%) were released.

Eighty-seven percent of the fishing public knew about the consumption advisory and, when asked whether they knew what the advisory stated, 96% answered correctly. These numbers have steadily increased over the last three angler surveys. Angler knowledge of a consumption advisory on the river increased from 76% in 2005 to 87% in 2011 and remained at 87% in 2016. A more notable increase was angler knowledge that the advisory pertained specifically to mercury. In 2005 only 39% of anglers knew the advisory pertained to mercury. In 2011 that increased to 73% and climbed even higher to 96% in 2016 (Figure 3).

When anglers were asked how they knew about the advisory, 54% got their information from word of mouth and 42% from signage posted along the river. The other 4% received their information from brochures, websites and by other means. In 2005 and 2011 the majority of anglers indicated they obtained their information from signage posted along the river and word of mouth was second.

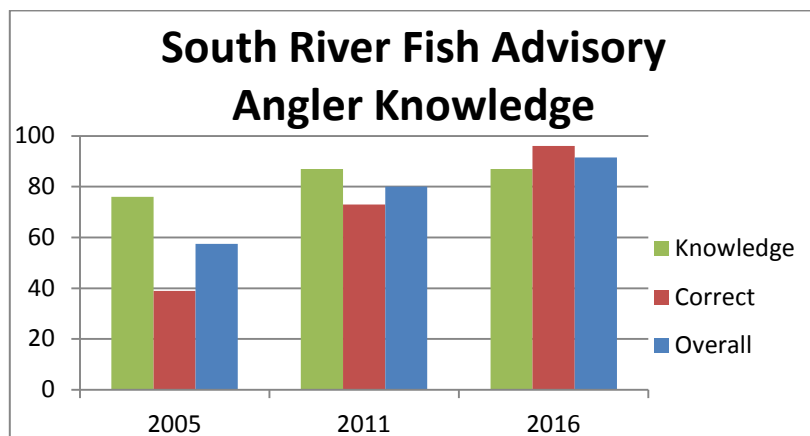


Figure 3. Angler knowledge of the fish consumption advisory on the South River.

South River - Angler Expenditures

Placing a dollar value on a fishery is extremely difficult. Fishermen were asked two questions about their spending habits regarding South River: How much they spent per day on all commodities and How much of that they contributed within 20 miles of the river? Figure 4 summarizes the estimated amount, by month, of angling dollars spent on gas, food, bait, lodging, equipment rental, and other items. The highest amount was spent in July, followed by May and June. The estimated total spent by South River anglers over the survey period in 2016 was \$198,810. Seventy-one percent (\$141,155) was spent within 20 miles of the river, further emphasizing how the river supports the local economy.

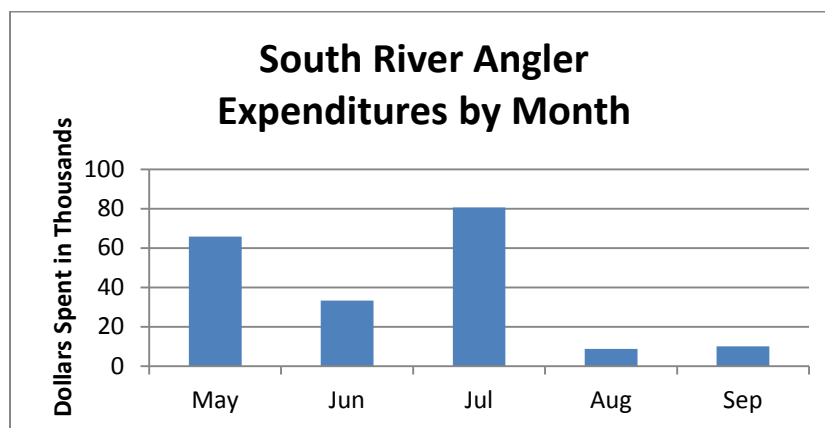


Figure 4. Estimated angler expenditures on South River during the 2016 survey.

South River - Other Users

The primary intent of this survey was to determine angler knowledge of the fish consumption advisory and to estimate fishing pressure and other angling information to help fisheries biologists improve management of the fishery resource. However, a secondary objective was to estimate the number of non-anglers that recreate on the South River. South River attracts many types of recreational users other than anglers. The survey team documented 70 recreational parties that were canoeing, kayaking, other boats (often tubes), swimming or those that fell into the other category. Some of the other category were researchers and college students for classes. Kayakers made up the largest percentage (39%) of non-anglers recreating on the river with other boats (often tubes) making up 27%. The number of non-angling river users was estimated over the course of the survey. A total estimate of 2,542 non-anglers recreated on the South River during the survey. The economic value of these users will be presented in another report.

South River - Smallmouth Bass

Smallmouth Bass were the most sought after species by anglers in 2016 receiving 60% of the fishing effort. Biologists often look at the catch rate (No. fish caught per hour of fishing) as an indicator of the fishing quality. Fisheries professionals across the country consider a good catch rate for some sportfish species to be 1-2 fish per hour. The catch rate for Smallmouth Bass in 2016 was excellent at 4.8 bass per hour which was much greater than 2005 (1.6) or 2011 (0.8) (Figure 5). An estimated 81,515 Smallmouth Bass were caught during the 2016 survey which is an increase from 68,551 in 2005. The majority (86%) were <11" with 14% being in the 11-14" range. There were very few Smallmouth Bass caught greater than 14 inches during the survey. The Smallmouth Bass fishery in the South River could be considered a catch-and-release fishery since 100% of the smallmouths caught by anglers were released during the survey. Obviously the creel clerks didn't interview every angler fishing the river in 2016 and VDGIF acknowledges that some Smallmouth Bass harvest may have occurred that was missed. In 2005 creel

clerks recorded 84 Smallmouth Bass harvested and in 2011 the number dropped to only five Smallmouth Bass. The catch-and-release practice among bass anglers fishing the Shenandoah River Watershed has steadily increased since the 1970's.

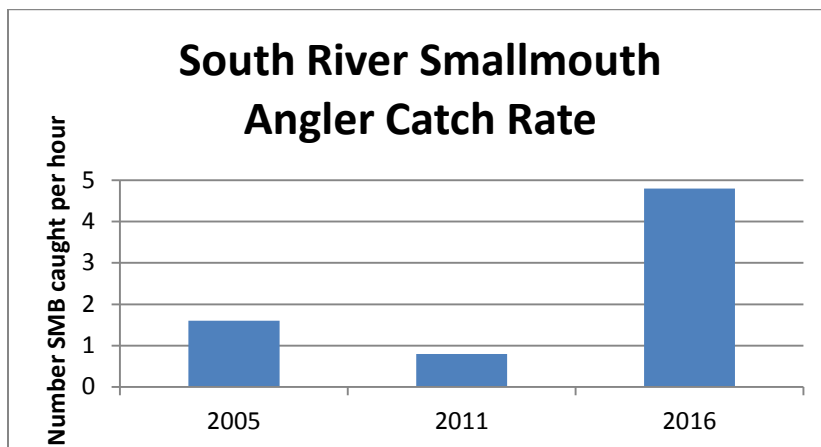


Figure 5. Smallmouth Bass angler catch rate in 2005, 2011 and 2016.

South River - Largemouth Bass

The South River contains a small Largemouth Bass fishery to complement the Smallmouth Bass. The majority of Largemouth Bass are found in the deeper pools. Fifteen percent of the overall fishing effort was directed toward Largemouth Bass in 2016. An estimated 3,349 Largemouth Bass were caught and released by anglers in 2016. Creel clerks did not interview anyone that indicated that they had harvested a largemouth during the survey. As with Smallmouth Bass, it appears that the Largemouth Bass fishery in the South Fork is also predominately catch-and-release.

South River - Trout Fishing

Trout anglers made up 11% of the fishing effort in 2016. The majority (58%) of these anglers were interviewed in the Grand Caverns and Grottoes section of the river. Only three trout anglers were interviewed after May 30th. Angler catch rate of trout was good at 2.3 fish per hour. An estimated 1,184 trout were caught during the 2016 survey period. This number would likely be much higher if a year around survey is conducted on the South River.

South River - Other species

The total catch for all species was estimated at 111,049 fish. The only fish observed harvested were a few trout. Other fish species that were caught by anglers on the South River in 2016 include: Sunfish, Fallfish, White Sucker, Bluehead Chubs and Channel Catfish.

South Fork Shenandoah River Results/Discussion

South Fork - Creel Clerk Effort

A roving angler survey was conducted on South Fork Shenandoah River (Port Republic to Front Royal) from May 1st – September 5th during 2016. Similar roving surveys were conducted in 1997 and 2011 while an access survey was conducted in 2008. Roving surveys were determined to have a better estimation of angler information and will be used in future surveys. There were 287 anglers interviewed over 72.8 miles of the 97 river miles in 2016. The survey reaches in 1997, 2011 and 2016 were very similar. The creel clerks spent 71 days interviewing anglers on the South Fork Shenandoah River in 2016.

July and August were the most heavily sampled, with 21 and 18 trips respectively. May and September had a limited number of samples. Unsafe river conditions during May limited the number of days that could be sampled that month and the end of the survey in September only included the Labor Day weekend. During the five month period there were 957 individuals observed recreating that were not fishing. A total of 1,337 individuals were counted, 380 were fishing and 957 were enjoying other forms of river recreation.

South Fork - Angler Effort

Angler effort (fishing pressure) was estimated at 50,828 angler trips for a total of 98,223 hours of fishing pressure. The average time spent fishing by an angler before being interviewed was 1.93 hours. Fishing pressure increased roughly 18% in 2016 when compared to 2011 on the South Fork. Higher fishing pressure in 1997 is due to extra months sampled. The average fishing pressure over the last three surveys from 2008, 2011 and 2016 is 87,381 hours. So fishing pressure seems to have remained stable over the last 8 years despite periodic fish mortality events (Figure 6).

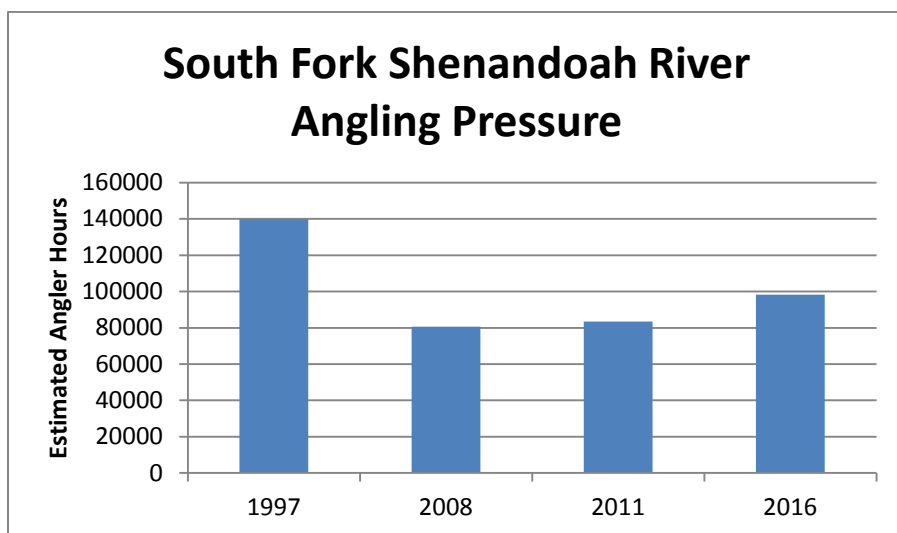


Figure 6. Angler pressure in hours for 1997, 2008, 2011 and 2016

Anglers fishing from the bank or wading comprised 46% of the effort in 1997 and 2011. This percentage reduced slightly to 41% in 2016. The majority (44%) of anglers said the number of their fishing trips had remained the same over the past few years. Thirty-five said their trips had increased while only 14% said they had declined. Six percent were out for their first fishing trip on the South Fork. Of those anglers indicating a decrease in trips the majority (79%) said it was due to less free time. Only 2% of anglers were fishing with a guide. The most sought after species was Smallmouth Bass (67%) followed by Largemouth Bass (12%) and generalist (9%). Seven percent of the anglers were targeting Channel Catfish. The Channel Catfish estimate is likely low because we do not conduct nighttime angler surveys when Channel Catfish are most likely targeted. A breakdown of the species that anglers targeted in 2016 is expressed in (Figure 7). Interviewing anglers electronically through websites or social media may be able to capture Channel Catfish data more accurately in the future.

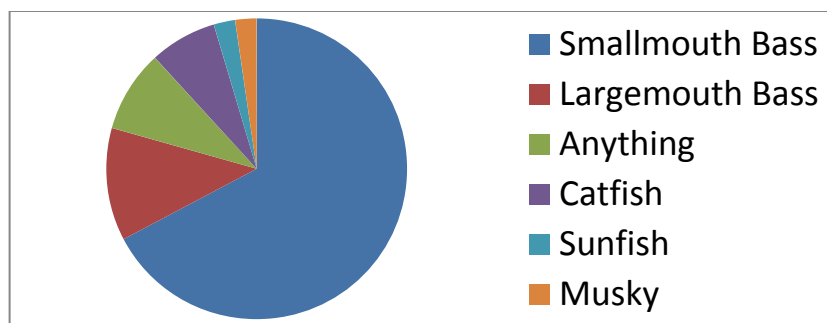


Figure 7. South Fork Shenandoah River angler species preference

South Fork - Angler Characteristics

The dominant angler type on South Fork in 2016 was an adult with an average age of 42, Caucasian (92%) and male (89%). The next largest ethnic groups were Hispanics (5%) and African Americans (3%). These numbers are similar to the 1997 angler survey and the 2016 South River survey.

The South Fork Shenandoah River could be classified as a “local” fishery as the majority (85%) of the anglers interviewed were Virginia residents. When asked which County or City they were from 23% of anglers answered Rockingham County while 20 % were from Page County and 15% were from Warren County. Non-resident anglers contributed 15% to the survey total with 43% originating from Maryland. Most anglers were fishing from watercraft (59%) with 41% of anglers wading or fishing from the bank. This was opposite of South River and may be due to better river access for canoes and kayaks on the South Fork. The bank or boat fishing numbers are similar to the previous surveys in 1997, 2008 and 2011 with a few more boat anglers over time. In 2008 angler satisfaction was fair on the South Fork at 75%. In 2011 this percentage increased to 89%. South Fork angler satisfaction again increased in 2016 with 94% of the anglers interviewed indicating they were either “satisfied, moderately satisfied, to greatly satisfied.”

South Fork - Fish Consumption Advisory

One of the main objectives of this study was to determine angler knowledge of the fish consumption advisory that has been imposed since 1977 on South Fork Shenandoah River from Port Republic to Front Royal. In 2016 when anglers were asked if they keep their catch only 1% said they harvested fish, all other anglers practiced catch-and-release. When asked why they practice catch-and-release 56% said it was an ethical choice, 22% believes it helps the population, 13% don’t eat fish and 8% stated it was due to the fish consumption advisory. Only one angler said it was due to fish mortality events. While the fish consumption advisory was the main reason why anglers practiced catch-and-release in the South Fork during the 2008 survey (83%), that reason declined to 46% in 2011 and to only 8% in 2016. Although when asked another similar question in the 2016 survey 28% of anglers said the advisory would keep them from harvesting fish.

Only 75% of the South Fork fishing public knew about the consumption advisory compared to 87% on the South River. More anglers (85%) indicated that they were aware of the fish consumption advisory on the South Fork in 2011. The overall number has increased from 46% in 1997 to 75% in 2016 (Figure 8). It’s worth noting that 15% of anglers interviewed on the South Fork were from out of state and only 43% of these anglers were aware of the consumption advisory. Only 40% of Hispanic anglers were aware of the fish consumption advisory. However, only one Hispanic angler that was not aware of the advisory was considered a local angler.

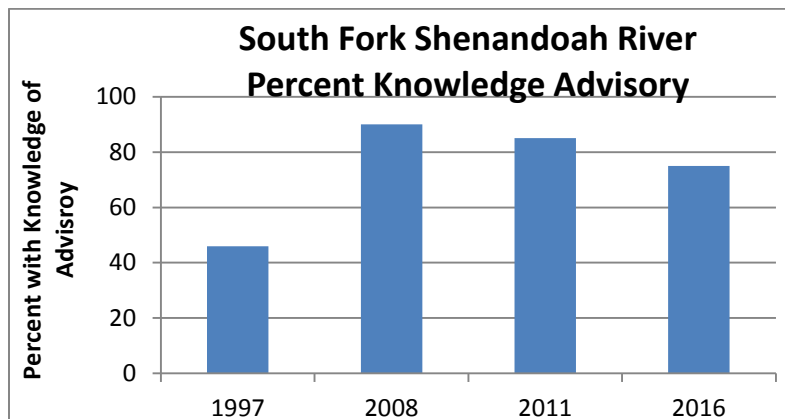


Figure 8. Percent of anglers with knowledge of fish consumption advisory on the South Fork Shenandoah River.

When anglers were asked how they knew about the advisory, 46% received their information from word of mouth, 45% from signage posted along the river and 7% stated they knew of the advisory through the internet. The other 2% received their information from brochures, newspaper and by other means.

South Fork - Angler Expenditures

In 2016 anglers were asked how much money they spent on their fishing trip. That would include expenses for gasoline, food, bait, tackle, canoe rental, lodging etc. Anglers were asked two questions about their spending habits regarding the South Fork Shenandoah River: 1) How much they spent per day on all commodities and 2) How much of that was spent within 30 miles of the river? The highest amount was spent in June, followed by July and August (Figure 9). The estimated total spent by anglers on the South Fork during the survey period was \$2,744,161. Eighty percent was spent within 30 miles of the river, further defining the local economic impact (\$2.2 million) the fishery contributes.

The South Fork Shenandoah River fishery is very important economically to the Commonwealth and localities. Non-anglers that recreate on the South Fork greatly outnumber fishermen. Additional data about recreational users of the South Fork needs to be analyzed before a better estimate of the economic value of this natural resource can be determined.

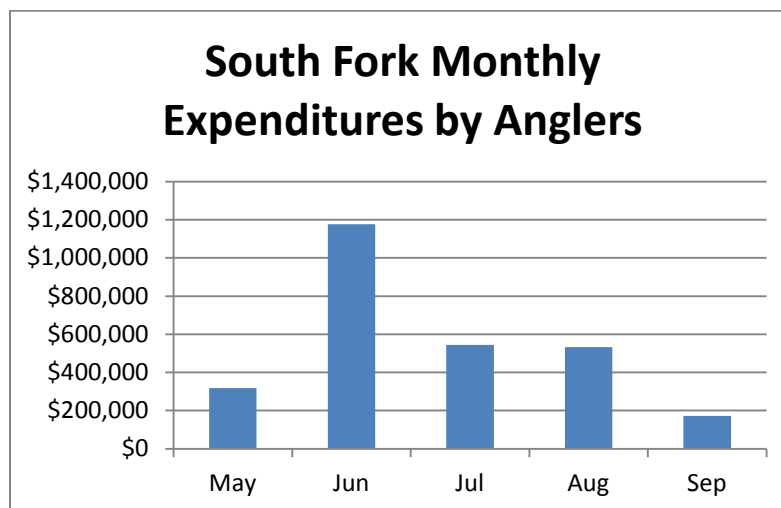


Figure 9. Estimated angler expenditures on South Fork Shenandoah River during the 2016 survey.

South Fork - Other Users

The primary intent of this survey was to determine fish consumption advisory knowledge, to estimate fishing pressure and collect other angling information to help fisheries biologists improve management of the fishery resource. The South Fork Shenandoah River is a huge recreation destination for many Virginia residents and non-residents. Its proximity to the booming Northern Virginia population makes it a hotspot for recreation. Therefore, a secondary objective was to estimate the number of non-anglers that recreate on the South Fork Shenandoah River. Creel clerks were asked to count boats (canoes, kayaks, tubes, jon-boats etc.) and individual people using the river that were not fishing (boating, swimming) each survey day. During the survey period, an estimated 4,595 canoes, 6,830 kayaks, and 8,051 other boats (mostly tubes) carrying non-anglers used the South Fork during the survey period (Figure 10). Adding individuals observed swimming or wading to the people in boats brought the total estimated number of non-anglers recreating in the South Fork during the survey period to 28,701. This number was generated from creel clerks observing 957 non-anglers during the survey. These non-anglers were interviewed by the creel clerks. Results of the economic impact these recreational river users are having on the Commonwealth's economy will be illustrated in a separate report.

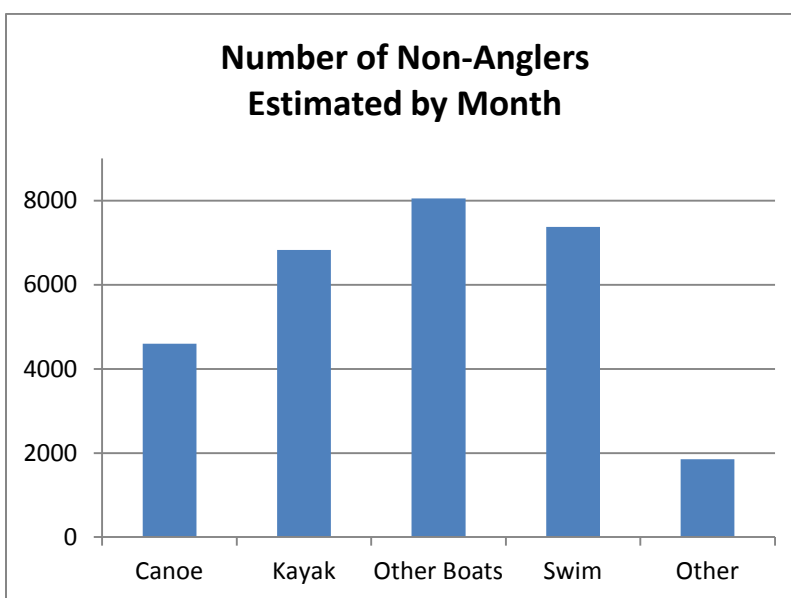


Figure 10. Estimated number of non-angling recreational users on the South Fork Shenandoah River during the 2016 survey.

South Fork - Smallmouth Bass

Smallmouth Bass were the most sought after species by anglers in 2016 receiving 67% of the fishing effort. Smallmouth Bass have remained the preferred species by anglers since the 1997 survey. Biologists often look at the catch rate (No. fish caught per hour of fishing) as an indicator of the fishing quality. The catch rate for Smallmouth Bass in 2016 was 2.3 bass per hour. This has remained relatively consistent since 1997 (Figure 11). An estimated 177,042 Smallmouth Bass were caught during the 2016 survey. The majority 75% were <11" with 19% being in the 11-14" range. Only 6% of the smallmouth caught and released were >14" in length. The sizes and sometimes numbers of Smallmouth Bass caught by anglers in a given year is often a good "picture" of the fish currently in the population. Figure 12 illustrates the size of smallmouth caught in previous angler surveys and Figure 13 indicates how the 2016 catch relates to the size structure of the bass population measured by biologists through electrofishing.

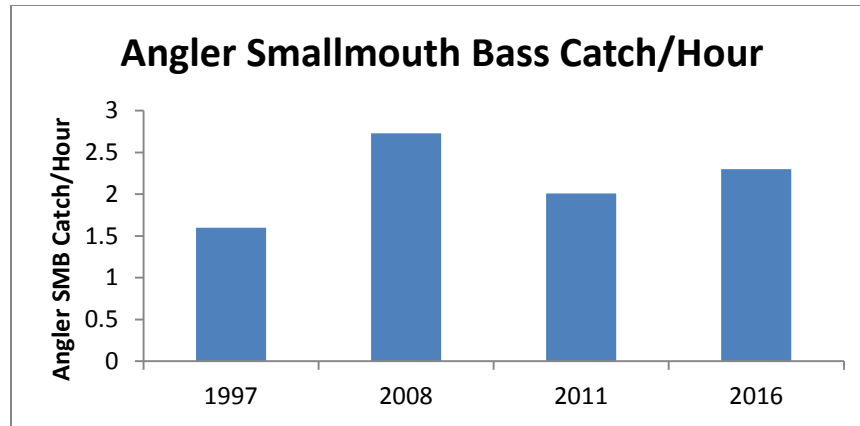


Figure 11. Smallmouth Bass angler catch rate in 1997, 2008, 2011 and 2016 on the South Fork Shenandoah River.

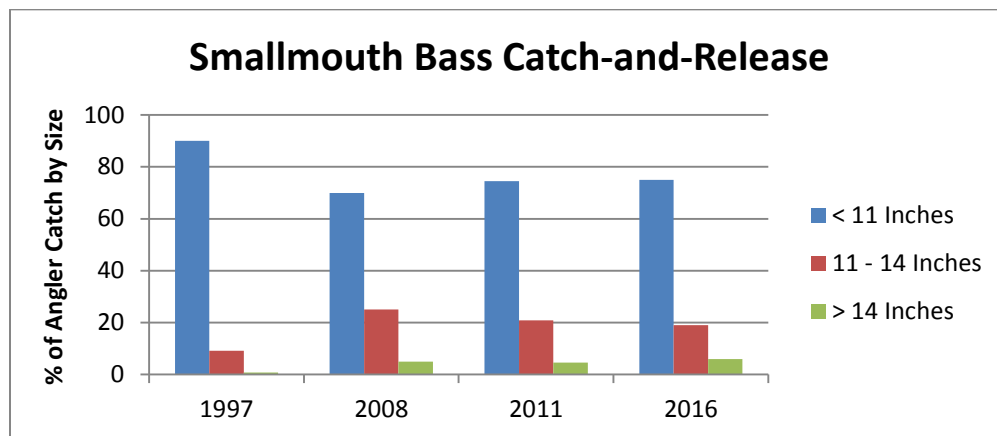


Figure 12. Size of Smallmouth Bass caught and released in 1997, 2008, 2011 and 2016 during the angler surveys on the South Fork Shenandoah River.

The Smallmouth Bass fishery in the South Fork Shenandoah could be considered a catch-and-release fishery since 100% of the catch was released during the 2016 survey. Again, VDGIF acknowledges that not all anglers on the river were interviewed during 2016 so there may have been some harvest that was not recorded, but creel clerks did not observe any Smallmouth Bass harvested. In 2011 almost all of the Smallmouth Bass caught (99%) were released. The catch-and-release practice among bass anglers fishing the South Fork Shenandoah River has steadily increased for varied reasons since the 1970's.

Smallmouth Bass anglers were asked what they would consider being the “perfect day” on the South Fork. We then gave them a series of scenarios indicating the number of fish they caught and the largest smallmouth captured. Forty-two percent of Smallmouth Bass anglers said that their “perfect” day fishing the South Fork Shenandoah would be to catch 5 Smallmouth Bass with the largest being 20 inches long. These results were very similar to the 2011 survey. In 2008 anglers indicated that catching 15 Smallmouth Bass with the largest being 18 inches would be a “perfect” fishing day. Smallmouth Bass anglers were also asked what they considered to be the minimum size of a “quality-size” Smallmouth Bass. They were given multiple choices from 10 to >18 inches. The vast majority of smallmouth anglers indicated bass 10-14 inches are preferred, with most centering on 12 inches. This has remained consistent over the last three angler surveys.

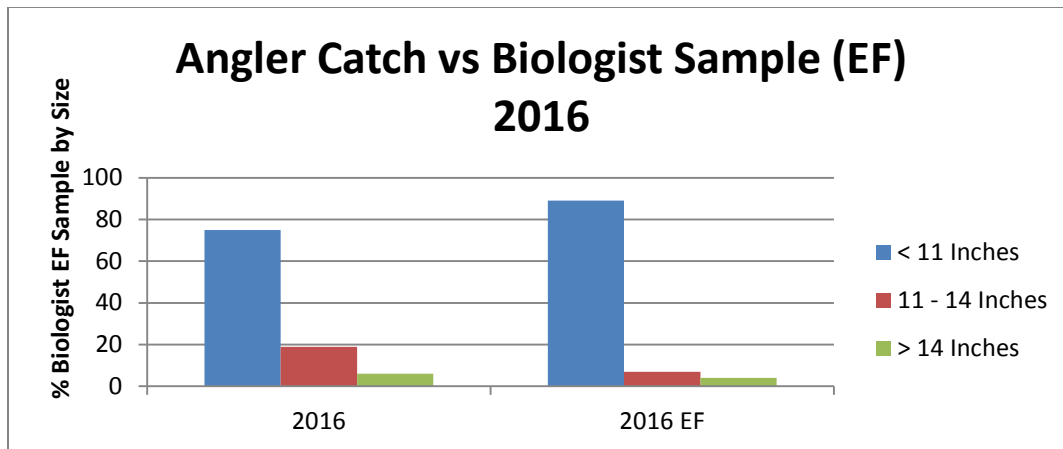


Figure 13. Comparison of 2016 angler catch-and-release of Smallmouth Bass size and biologist electrofishing sample of Smallmouth Bass size.

South Fork - Largemouth Bass

Unlike other smallmouth rivers across Virginia, the South Fork Shenandoah River harbors a sizeable Largemouth Bass fishery. The Largemouth Bass population has been steadily increasing since the 1970's and currently can comprise 50% of the total black bass population in some reaches of the South Fork. The majority of Largemouth Bass are found in the deeper pools and impounded pools upstream of dams on the South Fork. Twelve percent of the overall fishing effort was directed toward Largemouth Bass in 2016. An estimated 12,134 Largemouth Bass were caught and released by anglers in 2016. Creel clerks did interview a few anglers that indicated that they had harvested a largemouth during the survey. The estimated number of Largemouth Bass harvested during the survey was 327 which was only 2.6% of the total catch. Anglers targeting Largemouth Bass caught just over one fish per hour (Figure 14). As with Smallmouth Bass, it appears that the Largemouth Bass fishery in the South Fork is also predominately catch-and-release.

South Fork - Sunfish

Several species of sunfish are represented in the South Fork Shenandoah River. The two most common sunfish species are the Redbreast Sunfish and Bluegill. Abundance of Rock Bass, pumpkinseed sunfish, and green sunfish is generally lower. The 2016 survey estimated the sunfish catch to be 24,629 during the survey. Sunfish harvest was fairly light with 86% being released. Fishing effort directed at catching sunfish was 2.3% in 2016.

South Fork - Channel Catfish

While catfish can be caught during daylight hours, most anglers fish for them after dark when they are more active. Since the 2016 angler survey was conducted during the day, the estimates for catfishing pressure, catch and harvest is heavily underestimated. VDGIF has never conducted an angler survey at night predominantly due to logistical and safety reasons. An estimated 3,386 Channel Catfish were caught during the survey period, with a large number 51% being harvested. The catch rate for catfish was very good at 2.1 fish per hour. Seven percent of the overall fishing pressure was directed toward catfish in 2016. As expected, the majority of catfish anglers were fishing from shore.

South Fork - Muskellunge

VDGIF began stocking muskellunge in the South Fork Shenandoah River over 20 years ago to provide a “trophy” component to the fishery. A muskellunge habitat survey was conducted on the South Fork in the mid 1990’s and annual stockings in the best habitat locations have occurred in the past 15 years. While fish are typically stocked annually, there is some level of natural reproduction occurring. During the past 8 years biologists have studied the Musky population in the South Fork Shenandoah River to estimate the contribution of stocked muskellunge to the population. Approximately 66% of Musky in recent VDGIF surveys come from annual stockings. Therefore, an estimated 34% of Musky collected in the sample spawned naturally in the river. In 2016, an estimated 316 muskellunge were caught by anglers (all were released). Approximately 2% of the overall fishing effort was directed toward muskellunge on the South Fork in 2016. All anglers were asked if they had caught or fished for Musky in the past five years. Eleven percent of the anglers interviewed said that they had caught a Musky in the past five years. Fourteen percent indicated they had fished for Musky in the past 5 years on the South Fork. VDGIF also has anecdotal information that fishing for muskellunge has increased in popularity on the South Fork over the last decade. However, the current angler survey methods do not provide adequate information for VDGIF’s muskellunge management needs. As with nighttime Channel Catfish anglers VDGIF will also continue to pursue other ways of gathering Muskellunge angler and effort data.

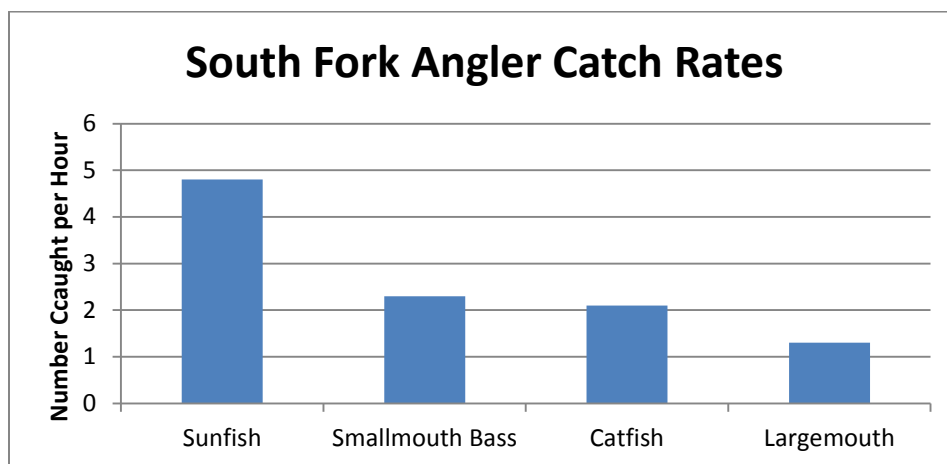


Figure 14. Angler catch rates by species they were targeting

South Fork - Other species

The total catch for all species was estimated at 220,016 fish. Most fish were released, but the most heavily harvested species were sunfish and Channel Catfish, respectively. Other fish species that were caught by anglers in 2016 include: black crappie, Fallfish, White Sucker, and Yellow Bullhead. There was no harvest reported for any of these species and they only contributed one percent of the total catch for all species.

Acknowledgements

I would like to thank creel clerks Collin George, Hunter Ritchie, Jessie Doyle, Lindsey Carpenter and Tony Villeda for their diligence, commitment, and professionalism while conducting this angler survey. They were always reliable, communicated well, and did an outstanding job! I wish them well in their future endeavors. Lastly, this project would not have been possible without the funding provided by DuPont and working with James Madison University for creel clerk administration services.

Appendix A

2016 South River Angler Survey Questionnaire

Date: _____ Interview #: _____ Time: _____ Reach: _____ Verbal Consent _____
Completed Trip: (circle one) Yes / No Actual Age _____

First Interview Y N

Is N ask 1-4 and 19-25

1) How long have you been fishing today? _____ hours

2) How much longer do you plan on fishing? _____ hours

3) Fishing from: a) bank/wade b) powered boat c) kayak d) raft e) canoe f) Other _____

4) Fishing with a guide? Y N

5 In general, how satisfied are you with fishing in the South River?

1 2 3 4 5 (circle one)
Not very Extremely

6) What type of fish are you hoping to catch? If they state "anything" or "doesn't matter" circle *Anything* below and ask them which they would prefer to catch. (circle one) Smallmouth Bass / Trout / Sunfish-Bream-Rockbass-Crappie / Catfish / Largemouth Bass / *Anything* / Other _____

7) Are you: a) Spin Fishing b) Fly Fishing c) Combination

8) Do you keep, release or a combination of keep and release the fish you catch? ___ Keep ___ Release
___ Combination **If Release, go to Question 12.**

****Only ask these questions if they answer Keep or Combination to Question 8.**

9) Do you eat the fish you keep? Yes No **If No, then go to Question 11.**

10) In general, how many and what type of fish from the South River do you eat each month? ___ Smallmouth

Bass ___ Trout ___ Sunfish/Bream/Crappie ___ Rockbass ___ Catfish ___ Largemouth Bass ___ Other

11) When you keep fish from this river do you share your catch with family or friends? Yes No

****Only ask these questions if they answer Release to Question 8.**

12) How many fish have you released today? ___ Smallmouth Bass ___ Trout ___ Sunfish/Bream/Crappie
___ Rockbass ___ Catfish ___ Largemouth Bass ___ Other

13) **Ask which of the following reasons do you release the fish?** (circle one) Catch-and-Release Angler / Health
Advisory / Too Small Already Limited Out / Other

****Resume asking questions to angler.**

14) Do you know there is a fish consumption advisory on this river? Yes No

If no, explain the advisory, hand the angler a brochure explaining the advisory and continue to Question 17.

15) **If Yes to number 14:** How do you know about the fish advisory? (circle one) Facebook / Social Media
Posted Advisory Signs / Word of Mouth / Newspaper / Radio / Brochure / Website / Other

16) If Yes to number 14: Do you know what the fish advisory in the river is for?

Answered Correctly / Answered Incorrectly

17) Why do you like to fish the South River? (circle one) Quality of Fishing / Scenery / Close to Home
All of the Above / Other

18) What do you not like about the South River? (circle one) Quality of Fishing / Too Crowded
Pollution / Other

19) How much money did you spend on this fishing trip just today? _____ Give examples: this may include gas, food, drink, bait, lodging, etc.

20) Of this amount, how much did you spend in the immediate area (within 20 miles)? _____

21) How many times per year do you fish on South River?
(circle one) 1 – 5 / 6 – 10 / 11 – 20 / >20

22) Where are you from? City/County _____ State _____ ZIP code _____

Don't Ask – Just answer 23 – 25 on appearance and interview knowledge.

23) (circle one) Male or Female

24) Ethnicity (circle one): White Hispanic Black Arabian Eastern Europe (Russian) Asian Other

25) How many Smallmouth Bass did you catch and release today?

A) _____ <11" B) _____ 11-14" C) _____ >14"

How many other fish did you catch and release today?

If you harvested **any** fish, can we please measure them? If no, that's OK.

Species	No. Caught & Released	Species	No. Harvested	Size (mm)

SMB = Smallmouth Bass LMB = Largemouth Bass RDB = Redbreast Sunfish ROB = Rock Bass

BLG = Bluegill PKS = pumpkinseed BLC = black crappie CCF = Channel Catfish YEB = Yellow Bullhead

WAE = walleye MUE = Musky AME = American eel FAF = Fallfish WHS = White Sucker

NHS = N. hogsucker SHR = shorthead redhorse CAP = common carp RBT = Rainbow Trout BRT = Brown Trout

BKT = Brook Trout

Comments:

Appendix B

2016 South Fork Shenandoah River Survey Angler Questionnaire

Date: _____ Interview #: _____ Time: _____ Reach: _____ Verbal Consent _____
Completed Trip: (circle one) Yes / No Actual Age _____

First Interview Y N

If N ask 1-4 and 25 - 33

1) How long have you been fishing today? _____ hours

2) How much longer do you plan on fishing? _____ hours

3) Fishing from: a) canoe b) powered boat c) kayak d) raft e) bank/wade f) Other _____

4) Fishing with a guide? Y N

5) Has your number of fishing trips increased, decreased, or remained the same in the last few years?
_____ Increased _____ Decreased _____ Remained the same _____ First time ever fishing
Shenandoah River

Only ask question 6 if they answered "Decreased" for question number 5.

6) What is the **main** reason for this decline? (choose only one) **Only give them these choices if they cannot come up with any reasons of their own.**

_____ Fish Consumption Advisory _____ Fish Kill/Disease _____ Less Free Time _____ Other Reason

7) What type of fish are you hoping to catch? If they state "anything" or "doesn't matter" circle *Anything* below and ask them which they would **prefer** to catch. (circle one) Smallmouth Bass / Sunfish-Bream-Rockbass-Crappie / Catfish / Largemouth Bass / Musky / *Anything* / Other _____

**** Only ask questions 8-10 to anglers who said they were fishing for Smallmouth Bass**

8) Of the following scenarios, which would be the best fishing day for you?

_____ I caught 50 Smallmouth Bass, the biggest one was 10 inches long?

_____ I caught 30 Smallmouth Bass, the biggest one was 14 inches long?

_____ I caught 15 Smallmouth Bass, the biggest one was 18 inches long?

_____ I caught 5 Smallmouth Bass, the biggest one was 20 inches long?

9) What do you consider to be the minimum size of a quality Smallmouth Bass?

a) 10" b) 12" c) 14" d) 16" e) 18" or > (circle one)

10) Would you harvest any legal-size Smallmouth Bass? Y N

11) Do you know there is a fish consumption advisory on this river? Y N

If no, explain the advisory, hand the angler a brochure explaining the advisory and continue to Question 14

12) **If Yes to number 11:** How do you know about the fish advisory? (circle one) Facebook / Social Media
Posted Advisory Signs / Word of Mouth / Newspaper / Radio / Brochure / Website / Other

13) Do these fish consumption advisories keep you from eating fish from the SF Shenandoah River? Y N

14) Do you ever harvest fish from the SF Shenandoah River? Y N

15) Do you practice catch-and-release of legal-size fish? Y N

16) If Yes, ask which of the following? (circle one) a) Practice the Ethic b) Don't Eat Fish
c) Think it helps the population d) Health Consumption Advisories e) Fish Kill Issues

17) Have you caught any Musky on the SF in the last 5 years, even if you were not fishing for them? Y N

18) Have you fished just for Musky on the SF Shenandoah River in the last 5 years? Y N

Yes: Go to questions 19-24 No: Go to question 25

19) How many days in a year do you fish just for Musky? _____

20) How many hours do you fish for Musky on an average trip? _____

21) Over the past 5 years has your Musky catch rate on the SF Shenandoah River:

Increased Decreased Remained the Same Don't Know / Not Sure

22) Over the past 5 years has your Musky encounter/follow rate on the SF Shenandoah River:

Increased Decreased Remained the Same Don't Know / Not Sure

23) Do you harvest any Musky you catch? Y N

24) How satisfied are you with the Musky fishery in the SF Shenandoah?

Low 1 2 3 4 5 High (circle one)

25) What Virginia County do you live in? _____ ZIP code _____

26) If you are a non-resident, what state do you call home? _____ ZIP code _____

27) How much money did you spend on this fishing trip just **today**? _____ Give examples: this may include gas, food, drink, bait, lodging, etc.

28) Of this amount, how much did you spend in the immediate area (within 30 miles)? _____

29) In general, how satisfied are you with fishing in the SF Shenandoah River?

1 2 3 4 5 (circle one)

Not very

Extremely

Don't Ask – Just answer 29 – 31 on appearance and interview knowledge.

30) (circle one) Male or Female

31) Ethnicity (circle one): White Hispanic Black Arabian Eastern Europe (Russian) Asian Other

32) How many Smallmouth Bass did you catch and release today?

A) _____ <11" B) _____ 11-14" C) _____ >14"

How many other fish did you catch and release today?

If you harvested **any** fish, can we please measure them? If no, that's OK.

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