North Fork Watershed Project

2010 Brook Trout Habitat Study

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Evan Supak and Athey Lutz

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brooktrout@northforkwatershed.org

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Introduction

The brook trout (*Salvelinus fontinalis*), is the only trout (Salmonid) species native to Appalachia. Historically, the species was abundant in cold water streams from Maine to Georgia, but it has since been eliminated from much of its range due to human influence from logging, mining, development, agriculture, atmospheric deposition, and introduction of non-native trout species. Brook trout are valuable as indicators of stream health, requiring cold, clear, oxygen rich water and a rich aquatic macroinvertebrate community to survive (Page and Burr 1991). Efforts are underway to preserve and restore brook trout habitat for both ecological integrity and for recreational opportunity. The brook trout is highly sought by anglers for its beauty and wildness.

The main purpose of our monitoring project is to identify the potential of headwater streams in the Blackwater River watershed to support brook trout populations. By identifying potential brook trout streams and the impairments which currently prevent brook trout inhabitation, the study will provide a scientific background for developing projects to restore brook trout within the watershed. The study period was during the hottest, driest part of the year. This allowed us to measure the presence of adequate cold, summer flow for trout survival, which will primarily be the limiting factor in a streams ability to support brook trout. In addition, the background data collected in this study will become part of a statewide database so it can be used to track changes in stream health and assess the impacts of proposed or occurring land use changes. The project has given us more data on the Blackwater River watershed, which has helped improve our understanding of the watershed's health and issues, and given us more data for our watershed mapping project and education programs. The project has also provided volunteers with the opportunity to learn about watershed science and become involved in a local watershed group.

Measures were taken to ensure that the data collected was as accurate, precise, complete, representative, and comparable as possible. Save Our Streams sampling protocols were closely followed.

Study Area

Our monitoring sites were located on 5 primary study streams, and 8 secondary streams. The primary study streams included the following: Snyder Run, Big Run, Devils Run, Maxwell Run, and Lindy Run. Big Run is located approximately 5 miles Southwest of Thomas. The study reach on Big Run was located at (39°06'33"N, 79°34'16"W). Devils Run is located approximately 1 mile South, Southwest of Davis. The study reach on Devils Run was located at (39°07'16"N, 79°27'21"W). Lindy Run is located approximately 3.7 miles Southwest of Davis, WV. The study reach on Lindy Run was located at (39°05'52"N, 79°31'25"W). Maxwell Run is located approximately 5.6 miles West of Thomas, WV. The study reach on Maxwell Run was located at (39°09'46"N, 79°36'18"W). Snyder Run is located approximately 1.2 miles West of Thomas. The study reach on Snyder run was located at (39°08'49"N, 79°31'06"W).

Secondary study streams included the following: Glade Run, Middle Run, Long Run, Shays Run, Engine Run, Sand Run, Tank Run, and Wimer Run. Sand Run is located approximately 2 miles North of Thomas, WV. Our water quality monitoring site on Sand Run was located at (39°10'36"N, 79°30'52"W). Glade Run is located approximately 1.7 miles North of Thomas. Our water quality monitoring site on Glade Run was located at (39°10'22"N, 79°29'35"W). Middle Run is located 1.8 miles West, Southwest of Thomas. Our water quality monitoring site on Middle Run was located at (39°07'47"N, 79°31'12"W). Long Run is located approximately 3 miles West, Southwest of Thomas. Our water quality monitoring site on Long Run was located at (39°07'34"N, 79°31'06"W). Shays Run is located approximately 2.5 miles Southwest of Davis. Our water quality monitoring site on Shays run was located at (39°06'16"N, 79°29'57"W). Engine Run is located approximately 2 miles Southwest of Davis. Our water quality monitoring site on Engine run was located at (39°06'17"N, 79°29'17"W). Tank Run is located approximately 0.7 miles South of Davis. Our water quality monitoring site on Tank Run was located at (39°07'05"N, 79°28'20"W). Wimer Run is located approximately 1 mile East, Southeast of Davis. Out water quality monitoring site on Wimer Run was located at (39°07'31"N, 79°26'44"W).

Methods

For our habitat study, we used the Level 1 stream sampling methods in accordance with the West Virginia Department of Environmental Protection Save Our Streams volunteer stream monitoring manual, which has been adapted from the U.S. Environmental Protection Agency volunteer stream monitoring manual. The WV DEP Save Our Streams abridged manual can be found online at http://www.dep.wv.gov/WWE/getinvolved/sos/Pages/methodsmanual.aspx. Although we originally planned on delineating two 100 yard reaches on each main study stream, we were only able to complete one study reach per stream due to limitations in available volunteer labor. The location of each reach was determined using a Magellan Meridian Platinum handheld GPS unit; the latitude and longitude of each site was then recorded to each corresponding data sheet. Sampling on the secondary study streams consisted of monitoring chemical characteristics (temperature; pH; conductivity; dissolved oxygen; TDS; salinity).

Sampling on the primary study streams was much more intensive and includes the following methods:

Chemical:

Chemical characteristics (pH, conductivity, dissolved oxygen, TDS, salinity, temperature) were measured with a Hanna Instruments model HI-9828 Multiparameter testing unit, away from the bank in the main current of the stream and towards the bottom of each reach. While taking water quality measurements, monitoring occurred upstream from the person sampling to minimize disturbance. Care was also taken to ensure that the streambed was disturbed as little as possible while wading.

Biological:

It is best to sample for macroinvertebrates in the spring and fall. Sampling during these seasons generally produces larger organisms that are easier to identify. Sampling can be conducted during the summer; however, summer sampling will produce smaller organisms that may be hard to identify. It is very imperative to conduct annual macroinvertebrate sampling at the same time each year; considering invertebrate community composition changes from season to season. Ideally a sample would be taken during each of the seasons to gain a better understanding of the changes taking place in the macroinvertebrate communities from season to season.

We collected macroinvertebrate samples after water quality monitoring to minimize disturbances which could have affected monitoring data. Three sections within each 100 yard reach were sampled for macroinvertebrates. The sampling areas were located in riffle sections of the study reach. We used a two-pole kick net with a mesh size of 500 micrometers for macroinvertebrate collection. Kick nets are roughly 3 foot by 3 foot nets with 3 foot wooden supports on two sides. Each sampling site was approached from downstream, and sampling was conducted at the downstream location first to minimize disturbance to other sampling locations upstream. One person held the kick net at a 45 degree angle to the river bed, with the net tight against the stream bottom. A second person disturbed the substrate in a 3 foot by 3 foot square immediately upstream of the net for approximately 3 minutes. Large rocks within the section were picked up and rubbed by hand to dislodge any macroinvertebrates attached to the rocks. Once the section had been properly disturbed, the net was removed with a forward scooping motion to ensure samples remain in the net. The net was rinsed with clean stream water into a 250 µm strainer placed over a 5 gallon bucket. The process was then repeated for the remaining two sites.

All organisms collected were then composited into one master sample representative of the entire stream. The material left in the strainer was picked through for macroinvertebrates. Once picked from the sample, the macroinvertebrates were identified to the appropriate order level with the help of a magnifying glass and identification key. The organisms were sorted and placed in a sorting tray grouped by order. The number of each type of organism found was recorded on the field data sheet for each study reach. Each different order of invertebrate was assigned an abundance code depending on the number found in the sample. A group is considered rare (R) if less than 5 individuals are found within the sample. A group is considered common (C) if there are between 5 and 50 individuals found within the sample. And finally a group is considered abundant (A) if there are greater than 50 individuals found within the sample. The abundance rating was converted into corresponding numbers: (A = 6; C = 3; R = 1). Our macroinvertebrate samples were assessed using three metrics: biotic index, total taxa, and EPT taxa.

There are several steps which must be taken to calculate the biotic index. First, we multiplied the abundance number by the tolerance value for each invertebrate group to obtain a tolerance score. The abundance scores and tolerance score were then totaled. The total tolerance was divided by the total abundance to obtain the biotic index. Total taxa is simply the total number of invertebrate orders identified. EPT taxa is a calculation of the number of kinds of macroinvertebrates from the orders Ephemeroptera, Plecoptera, and Trichoptera. Each of the three metrics were assigned a point value designated on the Save Our Streams datasheet, which were then added together to produce the stream score.

Physical:

Once the macroinvertebrate sampling was completed on each study reach, we also conducted a habitat assessment in the study reach for each stream. The steps included identifying the physical characteristics, local watershed characteristics, and completing a visual biological survey. The stream bottom was surveyed using a zigzag pebble count method. Starting downstream, the person completing the sample walked in a zigzag pattern from bank to bank. At every step, the person reached down to the tip of their boot and recorded the size of the first pebble that they came in contact with. This continued until 100 pebbles were measured. The percent of substrate size class was then calculated. We recorded the presence and amount of logs and large woody debris. The presence and amount of organic material (twigs and leaves) was also determined. The general appearance of the water was then observed, focusing on the color, turbidity, and appearance of any stratified precipitates. The odor of the water was recorded, which can indicate the presence of sewage, chlorine, or excessive algae growth. The presence and amount of surface foam was recorded. Algae color, abundance, and growth habitat was observed. The color of the substrate in the streambed was recorded as well.

The current weather, as well as the weather during the past 48 hours was recorded. The percent of stream shading was measured by visual estimation. Average width and depth of the stream were measured while taking out discharge readings. Embeddedness, or the extent to which rocks are sunken into the silt, sand, or mud, were measured in a riffle section on an optimal (<10%), suboptimal (10-30%), marginal (30-60%), or poor (>60%) rating. The presence of sediment deposition, bank stability, and riparian buffer width were measured and rated optimal, suboptimal, marginal, or poor. Each data sheet includes diagrams to help estimate which rating to select. To measure discharge, we measured the stream width in a run section of our reach using a measuring tape and we delineated a transect line. The study transect was divided into several subsections, the number and size of which depended on the actual width of the stream. We measured velocity with a Geopacks Flowmeter model MFP51 at the middle of each subsection. The Geopacks Flowmeters output is measured in counts per minute, which we later converted into cubic feet per second. Next, we multiplied the subsection area by the average velocity for each subsection to determine discharge. The discharge for each subsection was then added together to produce the total stream discharge.

Results

Big Run:

During water quality testing on Big Run, we found that it presented the lowest pH value out of the five primary study streams. Although we were able to test water quality at different locations along Big Run, the main study site was only sampled once due to limited accessibility to the location. The pH level at our study site was 3.73, or over 20 times more acidic than a comparable stream with a pH of 7.0. Dissolved oxygen levels of 6.06 mg/L were recorded. The temperature of Big Run was recorded at 17.47° C. Conductivity, total dissolved solids, and salinity were recorded at 36 µS/cm, 18 ppm, and 0.02, respectively. The water quality data for each study stream can be found in appendix A of this document. The discharge of Big Run during our sample date was 1.146 cubic feet per second. Big Run had a cross section area of 2.5 square feet at our sample site. Channel width at our sample site was 5 feet, with an average depth of 0.48 feet. The pebble count for Big Run was conducted by the measurement of 100 pebbles along the streambed and was found to have an index of 3.13. Silt/Clay substrate (<.062 mm) was found in only 1% of the study reach. Sand substrate (.062 mm-2 mm) was found in 15% of the study reach. Fine gravel substrate (3 mm-24 mm) was found in 27% of the study reach. Coarse gravel substrate (25 mm-64 mm) was found in 3 % of the study reach. Cobble substrate (65 mm-255 mm) was found in 24% of the study reach. Boulder substrate (256 mm-2048 mm) was found in 23% of the study reach. Bedrock substrate was found in 4% of the study reach. Woody debris was found in 3% of the study reach. Complete pebble count data can be found in appendix B of this document. Three macroinvertebrate samples were taken on Big Run and composited into one master sample. 14 different taxa were present in our sample, 8 of which represented the Ephemeroptera, Plecoptera, or Trichoptera (EPT) orders. Mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), net-spinning caddisflies (*Trichoptera*), dragonflies (*Anisoptera*), riffle beetles (*Elmidae*), black flies (*Simuliidae*), crane flies (*Tipulidae*), crayfish (*Decapoda*), and aquatic worms (*Oligochaeta*) were all present in the Big Run macroinvertebrate sample. The biotic index for Big Run was 4.72. The total taxa score, EPT taxa score, and biotic index were complied to achieve a stream integrity score of 21, a suboptimal integrity rating. Complete macroinvertebrate data for each stream can be found in appendix C of this document.

The water clarity on Big Run was clear, with no color. The water had no distinct odors. We observed a slight amount of surface foam. Dark green algae were observed throughout the streambed, matted and hairy growths were present. Habitat conditions such as embeddedness, sediment deposition, bank stability, and riparian buffer width were measured. The stream had a marginal embeddedness, meaning fine sediments surrounded 30-60% of the spaces between the gravel, cobble and boulders. Sediment deposition features were present in 20-40% of the reach, leading to a suboptimal rating. Bank stability was suboptimal on both sides of the study reach. Banks are moderately stable with infrequent areas of erosion. The banks were generally in good shape but may be susceptible to erosion at very high flows. The riparian buffer width was optimal on the left bank of the stream with >60 ft of undisturbed vegetation, but poor on the right bank due to forest road 18 which is a mere five feet from the stream in certain sections of the study reach. The overall habitat condition score for Big Run was 21; a suboptimal rating.

Devils Run:

Unlike Big Run, we were able to take water quality readings at Devils Run on two occasions. The average pH level at our study site was 6.47. The average level of dissolved oxygen in the stream was 8.125 mg/L. The average temperature of Devils Run was 15.81° C. Average conductivity, total dissolved solids, and salinity were recorded at 42 µS/cm, 21 ppm, and 0.02, respectively. The discharge of Devils Run during our sample date was 0.099 cubic feet per second. Devils Run had a cross section area of 2.14 square feet at our sample site. Channel width at our sample site was 4.2 feet, with an average depth of 0.51 feet. The pebble count for Devils Run was conducted by the measurement of 100 pebbles along the streambed and was found to have an index of 2.72. Silt/Clay substrate (<.062 mm) was found in 2% of the study reach. Sand substrate (.062 mm-2 mm) was found in 12% of the study reach. Fine gravel substrate (3 mm-24 mm) was found in 24% of the study reach. Coarse gravel substrate (25 mm-64 mm) was found in 12% of the study reach. Cobble substrate (65 mm-255 mm) was found in 24% of the study reach. Boulder substrate (256 mm-2048 mm) was found in 16% of the study reach. Bedrock substrate was not found in the study reach. Woody debris was found in 10% of the study reach. Three macroinvertebrate samples were taken on Devils Run and composited into one master sample. 14

different taxa were present in our sample, 9 of which represented the Ephemeroptera, Plecoptera, or Trichoptera (EPT) orders. Mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), net-spinning caddisflies (*Trichoptera*), common net spinners (*Hydropsychidae*), dragonflies (*Anisoptera*), riffle beetles (*Elmidae*), crane flies (*Tipulidae*), crayfish (*Decapoda*), and aquatic worms (*Oligochaeta*) were all present in the Devils Run macroinvertebrate sample. The biotic index for Devils Run was 4.26. The total taxa score, EPT taxa score, and biotic index were complied to achieve a stream integrity score of 21, a suboptimal integrity rating. The water clarity on Devils Run was clear, with no color. The water had no distinct odors. We found no evidence of surface foam. Matted brown algae were observed scattered on rocks throughout the streambed. Habitat conditions such as embeddedness, sediment deposition, bank stability, and riparian buffer width were measured. The stream had suboptimal embeddedness, meaning fine sediments surrounded 10-30% of the spaces between the gravel, cobble and boulders. Sediment deposition features were present in 20-40% of the reach, leading to a suboptimal rating. Bank stability was suboptimal on both sides of the study reach. Banks are moderately stable with infrequent areas of erosion. The banks were generally in good shape but may be susceptible to erosion at very high flows. The riparian buffer with was optimal on both left and right stream banks with >60 ft of undisturbed vegetation. The overall habitat condition score for Devils Run was 25; a suboptimal rating.

Lindy Run:

The average pH level at our study site was 4.02. The average level of dissolved oxygen in the stream was 6.725 mg/L. The average temperature of Lindy Run was 17.39° C. Average conductivity, total dissolved solids, and salinity were recorded at 39 µS/cm, 19.5 ppm, and 0.02, respectively. The discharge of Lindy Run during our sample date was 1.288 cubic feet per second. Lindy Run had a cross section area of 3.17 square feet at our sample site. Channel width at our sample site was 7 feet, with an average depth of 0.42 feet. The pebble count for Lindy Run was conducted by the measurement of 101 pebbles along the streambed and was found to have an index of 3.28. Silt/Clay substrate (<.062 mm) was not found in study reach. Sand substrate (.062 mm-2 mm) was found in 8% of the study reach. Fine gravel substrate (3 mm-24 mm) was found in 24% of the study reach. Coarse gravel substrate (25 mm-64 mm) was found in 10% of the study reach. Cobble substrate (65 mm-255 mm) was found in 35% of the study reach. Boulder substrate (256 mm-2048 mm) was found in 21% of the study reach. Bedrock substrate was not found in the study reach. Woody debris was found in 3% of the study reach. Three macroinvertebrate samples were taken on Lindy Run and composited into one master sample. 12 different taxa were present in our sample, 8 of which represented the Ephemeroptera, Plecoptera, or Trichoptera (EPT) orders. Mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), case building caddisflies (*Trichoptera*), common net spinners (*Hydropsychidae*), riffle beetles (*Elmidae*), non-biting midges (*Chironomidae*), crayfish (*Decapoda*), and aquatic worms (*Oligochaeta*) were all present in the Lindy Run macroinvertebrate sample. The biotic index for Lindy Run was 5.0. The total taxa score, EPT taxa score, and biotic index were complied to achieve a stream integrity score of 19, a suboptimal integrity rating. The water clarity on Lindy Run was clear, with a brownish color. The water had no distinct odors. We found no evidence of surface foam. Matted dark green algae were observed scattered on rocks throughout the streambed. Habitat conditions such as embeddedness, sediment deposition, bank stability, and riparian buffer width were measured. The stream had optimal embeddedness, meaning fine sediments surrounded <10% of the spaces between the gravel, cobble and boulders. Sediment deposition features were present in 20-40% of the reach, leading to a suboptimal rating. Bank stability was suboptimal on both sides of the study reach. Banks are moderately stable with infrequent areas of erosion. The banks were generally in good shape but may be susceptible to erosion at very high flows. The riparian buffer with was optimal on both left and right stream banks with >60 ft of undisturbed vegetation. The overall habitat condition score for Lindy Run was 28; an optimal rating.

Maxwell Run:

The average pH level at our study site was 7.47. The average level of dissolved oxygen in the stream was 7.73 mg/L. The average temperature of Maxwell Run was 20.39° C. Average conductivity, total dissolved solids, and salinity were recorded at 66 µS/cm, 33 ppm, and 0.03, respectively. The discharge of Maxwell Run during our sample date was 0.253 cubic feet per second. Maxwell Run had a cross section area of 1.38 square feet at our sample site. Channel width at our sample site was 4.6 feet, with an average depth of 0.30 feet. The pebble count for Maxwell Run was conducted by the measurement of 100 pebbles along the streambed and was found to have an index of 3.53. Silt/Clay substrate (<.062 mm) was not found in the study reach. Sand substrate (.062 mm-2 mm) was found in 3% of the study reach. Fine gravel substrate (3 mm-24 mm) was found in 25% of the study reach. Coarse gravel substrate (25 mm-64 mm) was found in 17% of the study reach. Cobble substrate (65 mm-255 mm) was found in 30% of the study reach. Boulder substrate (256 mm-2048 mm) was found in 9% of the study reach. Bedrock substrate was found in 14% of the study reach. Woody debris was found in 2% of the study reach. Three macroinvertebrate samples were taken on Maxwell Run and composited into one master sample. 20 different taxa were present in our sample, 11 of which represented the Ephemeroptera, Plecoptera, or Trichoptera orders. Mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), net-spinning caddisflies (*Trichoptera*), common net spinners (*Hydropsychidae*), riffle beetles (*Elmidae*), water pennies (*Psephernidae*), aquatic beetles (*Coleoptera*), hellgrammites (*Corydalidae*), crane flies (*Tipulidae*), watersnipe flies (*Athericidae*), water mites (*Hydrachnida*), crayfish (*Decapoda*), and aquatic worms (*Oligochaeta*) were all present in the Maxwell Run macroinvertebrate sample. The biotic index for Maxwell Run was 4.24. The total taxa score, EPT taxa score, and biotic index were complied to achieve a stream integrity score of 27, an optimal integrity rating. The water clarity on Maxwell Run was clear, with no color. The water had no distinct odors. We found no evidence of surface foam. No forms of algae were observed. Habitat conditions such as embeddedness, sediment deposition, bank stability, and riparian buffer width were measured. The stream had optimal embeddedness, meaning fine sediments surrounded <10% of the spaces between the gravel, cobble and boulders. Sediment deposition features were present in <20% of the reach, leading to an optimal rating. Bank stability was suboptimal on the left bank and optimal on the right bank of the study reach. The left bank is moderately stable with infrequent areas of erosion. The left bank was generally in good shape but may be susceptible to erosion at very high flows. The riparian buffer with was optimal on both left and right stream banks with >60 ft of undisturbed vegetation. The overall habitat condition score for Maxwell Run was 31; an optimal rating.

Snyder Run:

The average pH level at our study site was 7.48. The average level of dissolved oxygen in the stream was 6.51 mg/L. The average temperature of Snyder Run was 21.18° C. Average conductivity, total dissolved solids, and salinity were recorded at 111 µS/cm, 55.5 ppm, and 0.055, respectively. The discharge of Snyder Run during our sample date was 5.48 cubic feet per second. Snyder Run had a cross section area of 7.45 square feet at our sample site. Channel width at our sample site was 11.5 feet, with an average depth of 0.70 feet. The pebble count for Snyder Run was conducted by the measurement of 100 pebbles along the streambed and was found to have an index of 3.25. Silt/Clay substrate (<.062 mm) was found in 4% of the study reach. Sand substrate (.062 mm-2 mm) was found in 8% of the study reach. Fine gravel substrate (3 mm-24 mm) was found in 22% of the study reach. Coarse gravel substrate (25 mm-64 mm) was found in 7% of the study reach. Cobble substrate (65 mm-255 mm) was found in 18% of the study reach. Boulder substrate (256 mm-2048 mm) was found in 24% of the study reach. Bedrock substrate was found in10% of the study reach. Woody debris was found in 7% of the study reach. Three macroinvertebrate samples were taken on Snyder Run and composited into one master sample. 19 different taxa were present in our sample, 10 of which represented the Ephemeroptera, Plecoptera, or Trichoptera (EPT) orders. Mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), net-spinning caddisflies and case-building caddisflies (*Trichoptera*), common net spinners (*Hydropsychidae*), dragonflies (*Anisoptera*), riffle beetles (*Elmidae*), hellgrammites (*Corydalidae*), alderflies (*Sialidae*), non-biting midges (*Chironomidae*), crane flies (*Tipulidae*), water mites (*Hydrachnida*), crayfish (*Decapoda*), and aquatic worms (*Oligochaeta*) were all present in the Snyder Run macroinvertebrate sample. The biotic index for Snyder Run was 3.97. The total taxa score, EPT taxa score, and biotic index were complied to achieve a stream integrity score of 27, an optimal integrity rating. The water clarity on Snyder Run was clear, with no color. The water had no distinct odors. We found a slight occurrence of surface foam. No algae were observed in the stream. Habitat conditions such as embeddedness, sediment deposition, bank stability, and riparian buffer width were measured. The stream had suboptimal embeddedness, meaning fine sediments surrounded 10-30% of the spaces between the gravel, cobble and boulders. Sediment deposition features were present in 20-40% of the reach, leading to a suboptimal rating. Bank stability was optimal on the left bank, and poor on the right bank of the study reach. The right bank of Snyder Run borders an abandoned rail grade that is unstable and susceptible to washout. The riparian buffer with was optimal on both left and right stream banks with >60 ft of undisturbed vegetation. The overall habitat condition score for Snyder Run was 25; a suboptimal rating.

Engine Run:

The average pH level at our water quality monitoring site was 3.83. The average level of dissolved oxygen in the stream was 6.665 mg/L. The average temperature of Engine Run was 16.75° C. Average conductivity, total dissolved solids, and salinity were recorded at 35.5 µS/cm, 17.5 ppm, and 0.02, respectively.

Glade Run:

The average pH level at our water quality monitoring site was 7.26. The average level of dissolved oxygen in the stream was 6.665 mg/L. The average temperature of Glade Run was 22.78° C. Average conductivity, total dissolved solids, and salinity were recorded at 84 µS/cm, 42 ppm, and 0.045, respectively.

Long Run:

The average pH level at our water quality monitoring site was 2.77. The average level of dissolved oxygen in the stream was 8.09 mg/L. The average temperature of Long Run was 18.48° C. Average conductivity, total dissolved solids, and salinity were recorded at 568 µS/cm, 284 ppm, and 0.31, respectively.

Middle Run:

The average pH level at our water quality monitoring site was 3.23. The average level of dissolved oxygen in the stream was 8.445 mg/L. The average temperature of Middle Run was 16.77° C. Average conductivity, total dissolved solids, and salinity were recorded at 554 µS/cm, 272.5 ppm, and 0.315, respectively.

Sand Run:

The average pH level at our water quality monitoring site was 7.0. The average level of dissolved oxygen in the stream was 4.965 mg/L. The average temperature of Sand Run was 19.84° C. Average conductivity, total dissolved solids, and salinity were recorded at 61 µS/cm, 30.5 ppm, and 0.035, respectively.

Shays Run:

The average pH level at our water quality monitoring site was 3.80. The average level of dissolved oxygen in the stream was 6.18 mg/L. The average temperature of Shays Run was 18.33° C. Average conductivity, total dissolved solids, and salinity were recorded at 36.5 µS/cm, 18 ppm, and 0.02, respectively.

Tank Run:

The average pH level at our water quality monitoring site was 3.85. The average level of dissolved oxygen in the stream was 6.985 mg/L. The average temperature of Tank Run was 16.57° C. Average conductivity, total dissolved solids, and salinity were recorded at 30 µS/cm, 15 ppm, and 0.01, respectively.

Wimer Run:

The average pH level at our water quality monitoring site was 4.07. The average level of dissolved oxygen in the stream was 7.915 mg/L. The average temperature of Wimer Run was 16.26° C. Average conductivity, total dissolved solids, and salinity were recorded at 17.5 μS/cm, 8.5 ppm, and 0.01, respectively.

Discussion

The Eastern Brook Trout Joint Venture (2006) identified several major disturbances to native brook trout streams. They found that poor land management practices have disturbed up to 59% of subwatersheds. Forestry practices were found to disturb up to 54% of subwatersheds. Acid deposition was found as a disturbance in 30% of subwatersheds. These figures do not add to the 59%, because multiple disturbances could be affecting each watershed.

The majority of the streams that we studied in this project are not in a condition to support wild brook trout populations, largely due to pH impairment. Brook trout are very resilient, and have been found to occupy streams with pH levels as low as 4.0. The pH tolerance range of brook trout is 4.0-9.5, but pH levels of 6.5-8.0 seem to be optimal (Raleigh 1982). Acid precipitation has been found to impact 25% of WV brook trout streams. (Petty and Thorne 2005) Following is a stream by stream discussion of the limiting factors of each stream to support brook trout, the causes of these impairments, and potential restoration activities to reverse the impairments. The discussion for each stream is organized by the level of impairment, with the most impaired streams being discussed first.

Lindy Run:

Lindy Run is listed on the 2010 West Virginia 303(d) list of impaired streams (WV DEP 2010) for pH impairment along its entire length. This is consistent with the data we collected in the field which showed an average pH of 4.02 to be the only major impairment to the stream. The cause of this pH impairment is likely due to acid rain deposition, natural geological and biological factors, and historical lumbering. Acid precipitation is caused by the reaction of atmospheric moisture and oxygen with sulfur dioxides and nitrogen oxides, which are a result of fossil fuel combustion. These elements combine to form weak concentrations of sulfuric and nitric acid (EPA 2007). Once acid precipitation reaches the ground, it reacts with the soil. The acid precipitation can be neutralized if the soil has an adequate buffering capacity. In the early 1900's, the Lindy Run watershed was clearcut and then burned. This would have caused loss of topsoil and organic material, and loss of bank stability and alteration to stream channel due to instability. Although the forest has regrown, the lost soil has not had time to regenerate and this leaves a very thin quartz mineral soil which does not have the buffering capacity to filter acid rain. Therefore Lindy Run and nearby watersheds have a high susceptibility to acidification. The watershed has natural tannic acid originating from the abundant hemlock, spruce, laurel and rhododendron forest; it is these natural acids that gave the Blackwater its name. Red, Laurel, Engine, Tank, and Shay's Run are adjacent watersheds with similar biology, geology and history which showed similar pH impairments.

One of the most proven treatments for low pH in trout streams is the addition of limestone sand directly to the headwater sections of the stream. The addition of limestone fines increases pH levels and improves the buffering capacity of acid impaired streams. This is typically a short term solution that requires regular limestone dumping which requires a continuous funding source. The addition of limestone sand can also increase sedimentation in the streams, which may lead to negative impacts on macroinvertebrate communities in the mixing zone of a treated stream. (McClurg et al. 2007). Despite its limitations, this treatment has been successfully used to restore brook trout populations on nearby Red and Laurel Runs. Road access from Forest Service roads and adjacent liming operations on Red and Laurel Run make this a feasible treatment for Lindy Run contingent upon funding sources. If limestone is used to remediate these streams in the future, it should be placed as high as possible in the watershed to minimize disturbances, and maximize the area of improved water quality. Reintroduction of local genotype brook trout would be needed following pH improvements. A more permanent treatment option is the land application of lime in the watershed to help improve the long term buffering capacity of the soil, and therefore improve pH levels in streams and groundwater, but this practice can be very expensive (Dodds 2002).

Big Run:

Big Run is also listed on the 2010 West Virginia 303(d) list of impaired streams (WV DEP 2010) for pH impairment along its entire length. This is consistent with our field work which found a pH of 3.73. The historical, geological and biological factors described in the Lindy Run section are similar for Big Run and are likely causes of the pH impairment. In addition Big Run has historic coal mining sites in its headwaters which contribute acid mine drainage and it passes through a large bog which likely contributes to the acidity. The stream has the habitat structure, and water temperature and quantity to support brook trout but pH must first be addressed.

Liming treatment options are the same for Big Run as described above for Lindy Run. It also has nearby Forest Service road access that can be used for liming operations. Reclamation of the

Abandoned Mine Land (AML) sites in the Big Run headwaters is another treatment option which could reduce acidity. There are currently projects being planned by the State DEP's Abandoned Mine Reclamation Division to reclaim some of the AMLs in the Big Run watershed. Further analysis of the extent of the impact of these AML sites on Big Run and the scope of planned restoration projects will be needed. Lindy Run is perhaps the most degraded of the primary study streams. These two streams exhibit very low pH levels. The low pH in these streams could be attributed to several factors: the presence of tannic acids in the watershed, acid rain deposition, and the low buffering capacity of sandstone soil. Brook trout are very resilient, and have been found to occupy streams with pH levels as low as 4.0. The pH tolerance range of brook trout is 4.0-9.5, but pH levels of 6.5-8.0 seem to be optimal (Raleigh 1982). Acidification can also increase the concentration and toxicity of aluminum, which has been found to cause damage to gills in fish (Dodds 2002). A section of Big Run originates in a bog, which could contribute to the acidic nature of the stream. The low pH levels present in several of our study streams could be mitigated by the addition of limestone to the watershed. Most typically, limestone sand is introduced directly to the headwater sections of the stream. Addition of limestone fines can increase pH levels and improve the buffering capacity of acid impaired streams, although this is typically a short term solution. Limestone can also be added to the watershed to help improve the long term buffering capacity of the soil, and therefore improve pH levels in streams and groundwater, but this practice can be very expensive (Dodds 2002). The addition of limestone to Big Run and Lindy Run would have a positive impact on stream pH and buffering capacity. Both streams are in relatively close proximity to forest roads, which could be used to for the transportation of limestone sand to potential dump sites. The addition of limestone sand can also increase sedimentation in the streams, which may lead to negative impacts on macroinvertebrate communities in the mixing zone of a treated stream. (McClurg et al. 2007). If limestone is used to remediate these streams in the future, it should be placed as high as possible in the watershed to minimize disturbances, and maximize the area of improved water quality.

Snyder Run:

Snyder Run is included on the 303(d) listing for pH along its entire length, but data from our study and from the North Fork Watershed Projects monthly monitoring indicate the pH is within the 6-9 acceptable pH range of WV water quality standards. We found Snyder Run exhibited relatively good water quality, but the structure and stream shading seem to be limiting factors. Our study reach on Snyder Run was located in an area which exhibited adequate stream shading and pool formation, but the majority of the stream channel on Snyder Run consists of wide, shallow riffles and is exposed to a fair amount of sunlight, which leads to elevated water temperatures and lack of pools for brook trout habitat. Destabilized banks and lack of access to a flood plain are also problems on this stream.

Historically the Snyder Run watershed was extensively logged and used for mining. It has the remnants of several old dams and bridges along its length and the impacts of past industrial activity likely contribute to the current degraded stream habitat structure, lack of riparian shading, and destabilized banks. To make Snyder Run suitable for brook trout, shading along Snyder Run would have to be increased by planting overstory species along the riparian buffer. Further restoration could include construction of Natural Stream Design (NSD) structures and introduction of large woody debris to improve the amount and depth of pools, improve access to the floodplain, increase diversity of velocity and depth, increase habitat for invertebrates, increase potential spawning locations, and provide fish with suitable cover (Kohler and Hubert

1999). Any projects involving large woody debris placement, NSD structures, or floodplain alteration require further extensive study and hydrologic modeling.

Devils Run:

Devils Run exhibits the most potential for the possible reintroduction of brook trout. The water quality in Devils Run is indicative of possible brook trout habitat. Dissolved oxygen, pH, and temperature levels are all within the tolerances of brook trout. Devils Run shares several similarities to Lindy run, including structure, substrate types, and plant species composition. The fact that Devils Run exhibits a more neutral pH could be attributed to large amounts of limestone gravel located on WV Route 32, which parallels Devils Run for the entirety of its length. This introduction of limestone gravel and fines into the watershed improves the buffering capacity of Devils Run, leading to higher pH levels and minimizing the affect of acid deposition. Brook trout can tolerate temperatures between 0-23.8° C, but temperatures between 11-16° C are optimal for growth and survival (Raleigh 1982).

Brown trout (*Salmo trutta*) were observed in Devils Run during our study, which most likely traveled upstream from the Blackwater River where they are stocked regularly in the spring and fall. Brown and rainbow trout could serve as competition to a wild brook trout population for food and cover, but the small size of Devils Run could favor the brook trout. The installation of a fish barrier could be used to keep brown and rainbow trout (*Oncorhynchus mykiss*) out of Devils Run in the event of brook trout introduction, but this would also effectively cut off the migration of all other non-game fish species upstream. Devils Run contains deep, well shaded pools with the presence of under-cut banks, which would provide excellent cover for brook trout (Raleigh

1982). The stocking of native genotype brook trout to Devils Run would be the only step necessary to restore a brook trout population.

Maxwell Run:

Maxwell Run was found to be very healthy, although the temperature readings were somewhat high for a brook trout stream. Maxwell Run is located within the Horseshoe Run watershed. We chose to study Maxwell Run because it is located within an intact brook trout watershed according to the Eastern Brook Trout Joint Venture. Maxwell Run would serve as our control study stream, giving us an example to compare the sample results of the impacted streams. Brook trout have been located in Maxwell Run during the past, but we were unable to observe any during our time conducting habitat surveys. The majority of Maxwell Run is extensively shaded, but there has been recent clear cutting activity in its headwaters, which could be contributing to the high temperature readings and increase in fines as you move upstream. Restoration of the riparian buffer in the clear cut could help bring the temperatures back down to acceptable levels. The presence of giant stoneflies (*Pteronarcyidae*), which are very intolerant, indicates pristine water quality in Maxwell Run (Bouchard 2004).

Our main goal was to establish baseline scientific data on several tributary and headwater streams in the Blackwater River watershed to indentify factors limiting brook trout survival. We found two streams (Big Run and Lindy Run) with suitable water temperature and habitat that have a low pH that could be treated through limestone sand dosing if funding can be found. We found Devils Run to have suitable habitat and water quantity and quality including pH and temperature that could support brook trout if they are reintroduced. We found Snyder Run to have suitable water quantity but elevated water temperature due to poor riparian shading and wide shallow stream channel. Snyder Run may be more suitable to warm water smallmouth bass (*Micropterus dolomieu*) management rather than a brook trout reintroduction. The next steps are to contact the appropriate government agencies; evaluate the feasibility of funding and implementing these restoration projects, and the collection of any additional needed data.

Acknowledgements

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Study Area Map

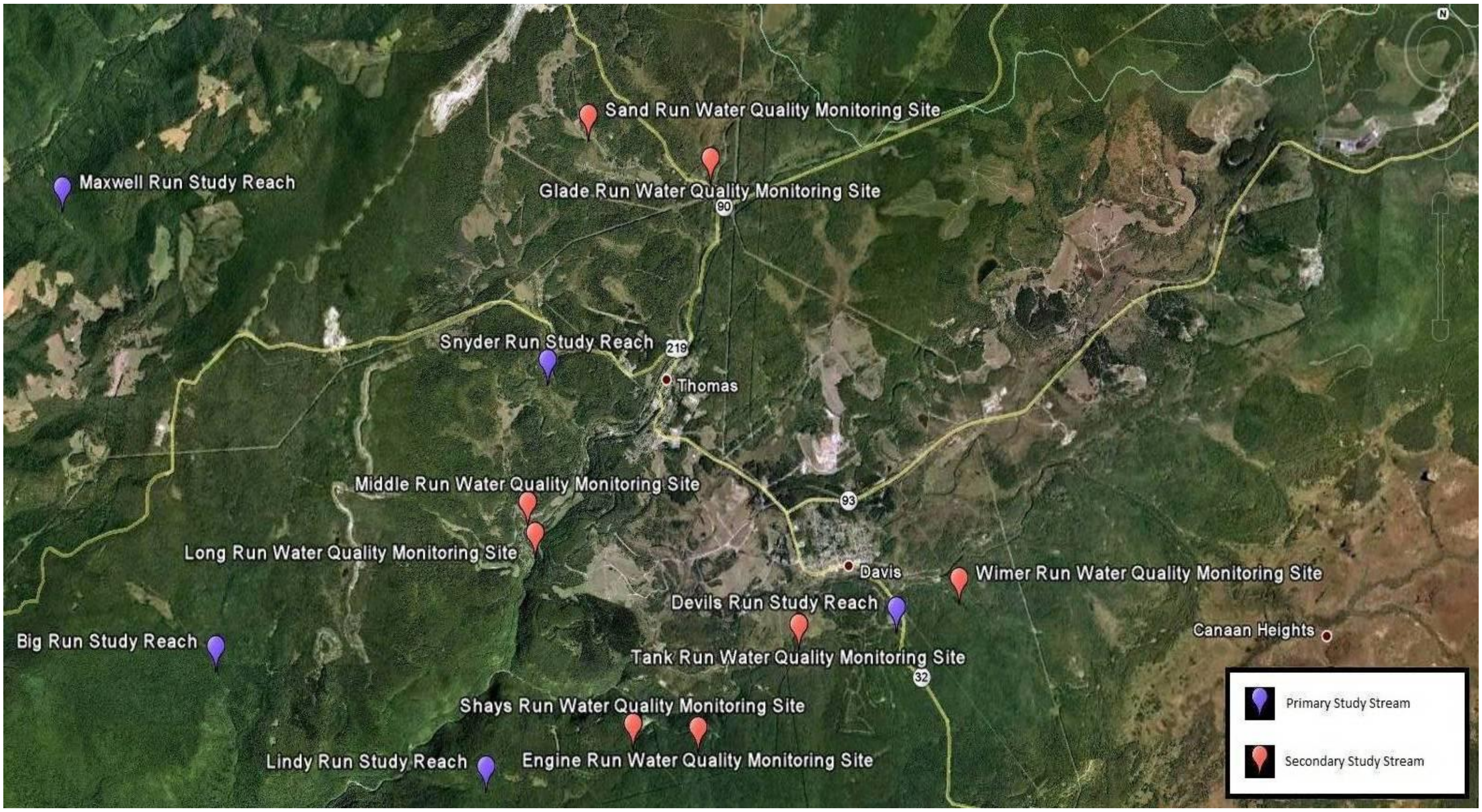


Figure 1. Map of the study area showing satellite image, primary study streams, and secondary study streams (Google 2010). An interactive version of this map may be found at the following URL.

(Not compatible with Firefox)
(http://www.frontiernet.net/~mesupak/NorthForkWatershedProjectBTHS.html)

Appendix A: Water Quality Data

PRIMARY	Date	Latitude	Longitude	Conductivity (µS/cm)	TDS (ppm)	Salinity	Dissolved Oxygen (DOmg/L)	pH	Temperature (° C)
BIG RUN	7/28/2010	39°06'33"N	79°34'16"W	36	18	0.02	6.06	3.73	17.47
DEVILS RUN	6/30/2010	39°07'16"N	79°27'21"W	48	24	0.02	7.54	6.51	16.66
	7/14/2010			36	18	0.02	8.71	6.42	14.96
LINDY RUN	6/25/2010	39°05'52"N	79°31'25"W	36	18	0.02	6.08	3.82	16.71
	8/45/2010			42	21	0.02	7.37	4.21	18.07
MAXWELL RUN	7/8/2010	39°09'46"N	79°36'18"W	68	34	0.03	7.81	7.55	19.03
	8/16/2010			64	32	0.03	7.65	7.38	21.75
SNYDER RUN	7/7/2010	39°08'49"N	79°31'06"W	176	88	0.09	7.12	7.87	19.76
	8/6/2010			46	23	0.02	5.9	7.09	22.59

SECONDARY	Date	Latitude	Longitude	Conductivity (µS/cm)	TDS (ppm)	Salinity	Dissolved Oxygen (DOmg/L)	pH	Temperature (° C)
ENGINE RUN	6/25/2010	39°06'17"N	79°29'17"W	36	18	0.02	6.5	3.85	16.83
	8/15/2010			35	17	0.02	6.83	3.80	16.66
GLADE RUN	6/30/2010	39°10'22"N	79°29'35"W	74	37	0.04	7.31	7.17	21.86
	8/15/2010			94	47	0.05	5.29	7.35	23.70
LONG RUN	6/28/2010	39°07'34"N	79°31'06"W	652	326	0.36	7.74	2.66	16.82
	8/13/2010			484	242	0.26	8.44	2.87	20.13
MIDDLE RUN	6/28/2010	39°07'47"N	79°31'12"W	497	245	0.29	7.28	3.22	15.82
	8/13/2010			611	300	0.34	9.61	3.24	17.72
SAND RUN	6/30/2010	39°10'36"N	79°30'52"W	69	35	0.04	5.31	6.75	20.43
	7/13/2010			53	26	0.03	4.62	7.24	19.24
SHAYS RUN	6/25/2010	39°06'16"N	79°29'57"W	38	19	0.02	6.06	3.79	18.29
	8/15/2010			35	17	0.02	6.3	3.80	18.37
TANK RUN	6/25/2010	39°07'05"N	79°28'20"W	30	15	0.01	7.05	3.80	15.66
	8/15/2010			30	15	0.01	6.92	3.90	17.47
WIMER RUN	6/30/2010	39°07'31"N	79°26'44"W	18	9	0.01	7.72	4.01	15.34
	8/15/2010			17	8	0.01	8.11	4.13	17.17

Appendix B: Stream Macroinvertebrate Data

Big Run Macroinvertebrate Data

Insect groups		Abundance	Kinds	TV	TS
Ephemeroptera	Mayflies	6	3	3	18
Plecoptera	Stoneflies	6	3	2	12
Trichoptera	Case-building caddisflies			3	0
Trichoptera	Net-spinning caddisflies	3	2	4	12
Rhyacophilidae	Free-living caddisfly			3	0
Hydropsychidae	Common netspinner			5	0
Anisoptera	Dragonflies	3	1	4	12
Zygoptera	Damselflies			7	0
Elmidae	Riffle beetle	1	1	4	4
Psephenidae	Water penny			3	0
Coleoptera	Other aquatic beetles			7	0
Hemiptera	True bugs			8	0
Corydalidae	Fishfly/Hellgrammite			3	0
Sialidae	Alderfly			6	0
Collembola	Springtails			6	0
Chironomidae	Non-biting midges			8	0
Simuliidae	Black fly	1	1	6	6
Tipulidae	Crane fly	3	1	4	12
Athericidae	Watersnipe fly			3	0
Diptera (other)	Other true flies			7	0
Non-insect groups		Abundance	Kinds	TV	TS
Hydrachnida	Water mite			6	0
Decapoda	Crayfish	3	1	5	15
Isopoda	Aquatic sowbug			7	0
Amphipoda	Scud/Sideswimmer			5	0
Veneroida	Clams			6	0
Unionidae	Mussel			4	0
Prosobranchia	Operculate snails			5	0
Pulmonata	Non-operculate snails			7	0
Oligochaeta	Aquatic worms	6	1	10	60
Hirudinea	Leeches			10	0
Turbellaria	Flatworms			7	0
	Totals	32	Total TS	151	

Comments:

Metrics	Calculated Values	Point Values	Metric Point Scale **10**	**7**	**5**	**3**
Total Taxa	14	7	> 18	18 - 13	12 - 8	< 8
EPT Taxa	8	7	> 10	10 - 7	6 - 4	< 4
Biotic Index	4.72	7	< 4.0	4.0 - 5.0	5.1 - 6.0	> 6.0
Stream Score		**21**	Integrity Rating Scale			
timothy.d.craddock@wv.gov			Integrity Rating		**Suboptimal**	
			> 24 Optimal	24 - 19 Suboptimal	18 - 12 Marginal	< 12 Poor

Devils Run Macroinvertebrate Data

Insect groups		Abundance	Kinds	TV	TS
Ephemeroptera	Mayflies	3	3	3	9
Plecoptera	Stoneflies	6	3	2	12
Trichoptera	Case-building caddisflies			3	0
Trichoptera	Net-spinning caddisflies	6	2	4	24
Rhyacophilidae	Free-living caddisfly			3	0
Hydropsychidae	Common netspinner	3	1	5	15
Anisoptera	Dragonflies	1	1	4	4
Zygoptera	Damselflies			7	0
Elmidae	Riffle beetle	6	1	4	24
Psephenidae	Water penny			3	0
Coleoptera	Other aquatic beetles			7	0
Hemiptera	True bugs			8	0
Corydalidae	Fishfly/Hellgrammite			3	0
Sialidae	Alderfly			6	0
Collembola	Springtails			6	0
Chironomidae	Non-biting midges			8	0
Simuliidae	Black fly			6	0
Tipulidae	Crane fly	3	1	4	12
Athericidae	Watersnipe fly			3	0
Diptera (other)	Other true flies			7	0
Non-insect groups		Abundance	Kinds	TV	TS
Hydrachnida	Water mite			6	0
Decapoda	Crayfish	3	1	5	15
Isopoda	Aquatic sowbug			7	0
Amphipoda	Scud/Sideswimmer			5	0
Veneroida	Clams			6	0
Unionidae	Mussel			4	0
Prosobranchia	Operculate snails			5	0
Pulmonata	Non-operculate snails			7	0
Oligochaeta	Aquatic worms	3	1	10	30
Hirudinea	Leeches			10	0
Turbellaria	Flatworms			7	0
	Totals	34	Total TS	145	

Comments:	Metrics	Calculated Values	Point Values	Metric Point Scale			
				10	**7**	**5**	**3**
	Total Taxa	14	7	> 18	18 - 13	12 - 8	< 8
	EPT Taxa	9	7	> 10	10 - 7	6 - 4	< 4
	Biotic Index	4.26	7	< 4.0	4.0 - 5.0	5.1 - 6.0	> 6.0
	Stream Score		**21**	Integrity Rating Scale			
	timothy.d.craddock@wv.gov			Integrity Rating		**Suboptimal**	
				> 24 Optimal	24 - 19 Suboptimal	18 - 12 Marginal	< 12 Poor

Lindy Run Macroinvertebrate Data

Insect groups		Abundance	Kinds	TV	TS
Ephemeroptera	Mayflies	6	3	3	18
Plecoptera	Stoneflies	3	3	2	6
Trichoptera	Case-building caddisflies	1	1	3	3
Trichoptera	Net-spinning caddisflies			4	0
Rhyacophilidae	Free-living caddisfly			3	0
Hydropsychidae	Common netspinner	3	1	5	15
Anisoptera	Dragonflies			4	0
Zygoptera	Damselflies			7	0
Elmidae	Riffle beetle	1	1	4	4
Psephenidae	Water penny			3	0
Coleoptera	Other aquatic beetles			7	0
Hemiptera	True bugs			8	0
Corydalidae	Fishfly/Hellgrammite			3	0
Sialidae	Alderfly			6	0
Collembola	Springtails			6	0
Chironomidae	Non-biting midges	3	1	8	24
Simuliidae	Black fly			6	0
Tipulidae	Crane fly			4	0
Athericidae	Watersnipe fly			3	0
Diptera (other)	Other true flies			7	0
Non-insect groups		Abundance	Kinds	TV	TS
Hydrachnida	Water mite			6	0
Decapoda	Crayfish	3	1	5	15
Isopoda	Aquatic sowbug			7	0
Amphipoda	Scud/Sideswimmer			5	0
Veneroida	Clams			6	0
Unionidae	Mussel			4	0
Prosobranchia	Operculate snails			5	0
Pulmonata	Non-operculate snails			7	0
Oligochaeta	Aquatic worms	3	1	10	30
Hirudinea	Leeches			10	0
Turbellaria	Flatworms			7	0
	Totals	23	Total TS	115	

Comments:

Metrics	Calculated Values	Point Values	Metric Point Scale			
			10	**7**	**5**	**3**
Total Taxa	12	5	> 18	18 - 13	12 - 8	< 8
EPT Taxa	8	7	> 10	10 - 7	6 - 4	< 4
Biotic Index	5.00	7	< 4.0	4.0 - 5.0	5.1 - 6.0	> 6.0
Stream Score		**19**	Integrity Rating Scale			
timothy.d.craddock@wv.gov			Integrity Rating		**Suboptimal**	
			> 24 Optimal	24 - 19 Suboptimal	18 - 12 Marginal	< 12 Poor

Maxwell Run Macroinvertebrate Data

Insect groups		Abundance	Kinds	TV	TS
Ephemeroptera	Mayflies	6	4	3	18
Plecoptera	Stoneflies	6	4	2	12
Trichoptera	Case-building caddisflies			3	0
Trichoptera	Net-spinning caddisflies	3	2	4	12
Rhyacophilidae	Free-living caddisfly			3	0
Hydropsychidae	Common netspinner	3	1	5	15
Anisoptera	Dragonflies			4	0
Zygoptera	Damselflies			7	0
Elmidae	Riffle beetle	3	1	4	12
Psephenidae	Water penny	1	1	3	3
Coleoptera	Other aquatic beetles	3	1	7	21
Hemiptera	True bugs			8	0
Corydalidae	Fishfly/Hellgrammite	3	1	3	9
Sialidae	Alderfly			6	0
Collembola	Springtails			6	0
Chironomidae	Non-biting midges			8	0
Simuliidae	Black fly			6	0
Tipulidae	Crane fly	3	1	4	12
Athericidae	Watersnipe fly	3	1	3	9
Diptera (other)	Other true flies			7	0
Non-insect groups		Abundance	Kinds	TV	TS
Hydrachnida	Water mite	1	1	6	6
Decapoda	Crayfish	3	1	5	15
Isopoda	Aquatic sowbug			7	0
Amphipoda	Scud/Sideswimmer			5	0
Veneroida	Clams			6	0
Unionidae	Mussel			4	0
Prosobranchia	Operculate snails			5	0
Pulmonata	Non-operculate snails			7	0
Oligochaeta	Aquatic worms	3	1	10	30
Hirudinea	Leeches			10	0
Turbellaria	Flatworms			7	0
	Totals	41	Total TS	174	

Comments:

Metrics	Calculated Values	Point Values	Metric Point Scale			
			10	**7**	**5**	**3**
Total Taxa	20	10	> 18	18 - 13	12 - 8	< 8
EPT Taxa	11	10	> 10	10 - 7	6 - 4	< 4
Biotic Index	4.24	7	< 4.0	4.0 - 5.0	5.1 - 6.0	> 6.0
Stream Score		**27**	Integrity Rating Scale			
timothy.d.craddock@wv.gov			Integrity Rating		**Optimal**	
			> 24 Optimal	24 - 19 Suboptimal	18 - 12 Marginal	< 12 Poor

Snyder Run Macroinvertebrate Data

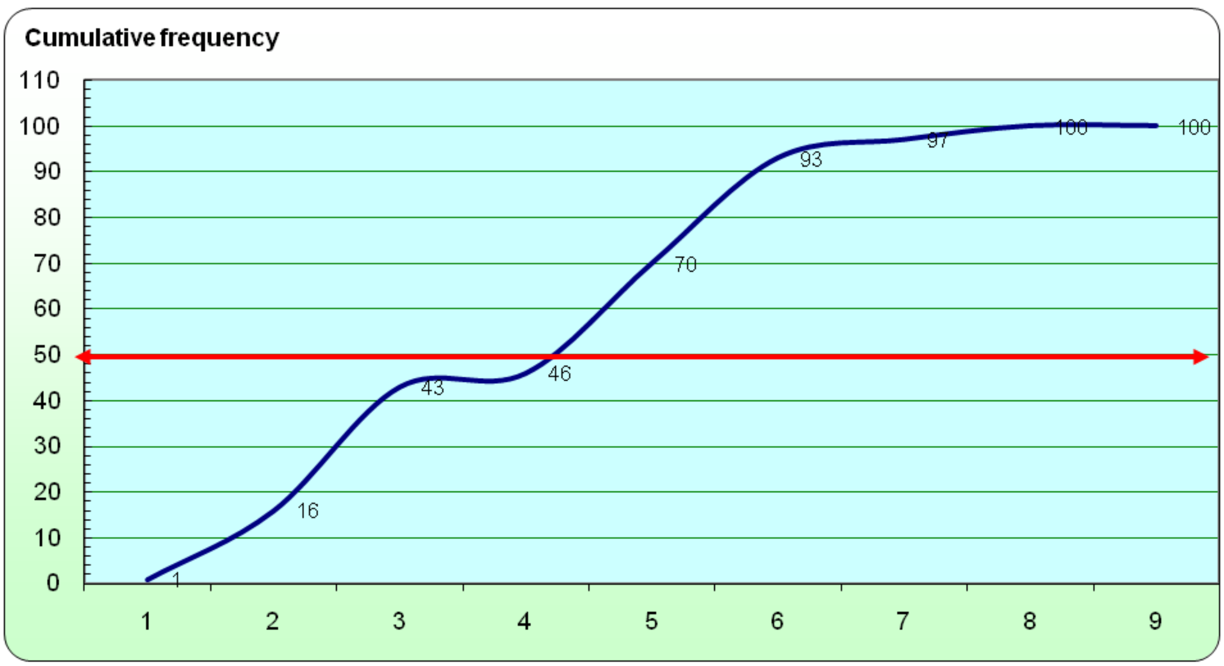
Insect groups		Abundance	Kinds	TV	TS
Ephemeroptera	Mayflies	6	4	3	18
Plecoptera	Stoneflies	6	3	2	12
Trichoptera	Case-building caddisflies	1	1	3	3
Trichoptera	Net-spinning caddisflies	3	1	4	12
Rhyacophilidae	Free-living caddisfly			3	0
Hydropsychidae	Common netspinner	6	1	5	30
Anisoptera	Dragonflies	1	1	4	4
Zygoptera	Damselflies			7	0
Elmidae	Riffle beetle	3	1	4	12
Psephenidae	Water penny			3	0
Coleoptera	Other aquatic beetles			7	0
Hemiptera	True bugs			8	0
Corydalidae	Fishfly/Hellgrammite	3	1	3	9
Sialidae	Alderfly	1	1	6	6
Collembola	Springtails			6	0
Chironomidae	Non-biting midges	1	1	8	8
Simuliidae	Black fly			6	0
Tipulidae	Crane fly	3	1	4	12
Athericidae	Watersnipe fly			3	0
Diptera (other)	Other true flies			7	0
Non-insect groups		Abundance	Kinds	TV	TS
Hydrachnida	Water mite	1	1	6	6
Decapoda	Crayfish	1	1	5	5
Isopoda	Aquatic sowbug			7	0
Amphipoda	Scud/Sideswimmer			5	0
Veneroida	Clams			6	0
Unionidae	Mussel			4	0
Prosobranchia	Operculate snails			5	0
Pulmonata	Non-operculate snails			7	0
Oligochaeta	Aquatic worms	1	1	10	10
Hirudinea	Leeches			10	0
Turbellaria	Flatworms			7	0
	Totals	37	Total TS	147	

Comments:	**Metrics**	Calculated Values	Point Values	Metric Point Scale			
				10	**7**	**5**	**3**
	Total Taxa	19	10	> 18	18 - 13	12 - 8	< 8
	EPT Taxa	10	7	> 10	10 - 7	6 - 4	< 4
	Biotic Index	3.97	10	< 4.0	4.0 - 5.0	5.1 - 6.0	> 6.0
	Stream Score		**27**	Integrity Rating Scale			
	timothy.d.craddock@wv.gov			Integrity Rating		**Optimal**	
				> 24 Optimal	24 - 19 Suboptimal	18 - 12 Marginal	< 12 Poor

Appendix C: Stream Pebble Count Data

Big Run Pebble Count Data

Size class	Size range	Point values	Pebble count data		Reach %	Cumulative frequency
			Count	Score		
Silt/clay	< .062	0.0	1	0	1	1
Sand	.062 - 2	1.0	15	15	15	16
Fine gravel	3 - 24	2.0	27	54	27	43
Coarse gravel	25 - 64	3.0	3	9	3	46
Cobble	65 - 255	4.0	24	96	24	70
Boulder	256 - 2048	5.0	23	115	23	93
Bedrock		6.0	4	24	4	97
Woody debris	Not included in the index calculations		3		3	100
Artificial materials					0	100
timothy.d.craddock@wv.gov		Totals	100	313	100	% Fines
		Index	3.13			16

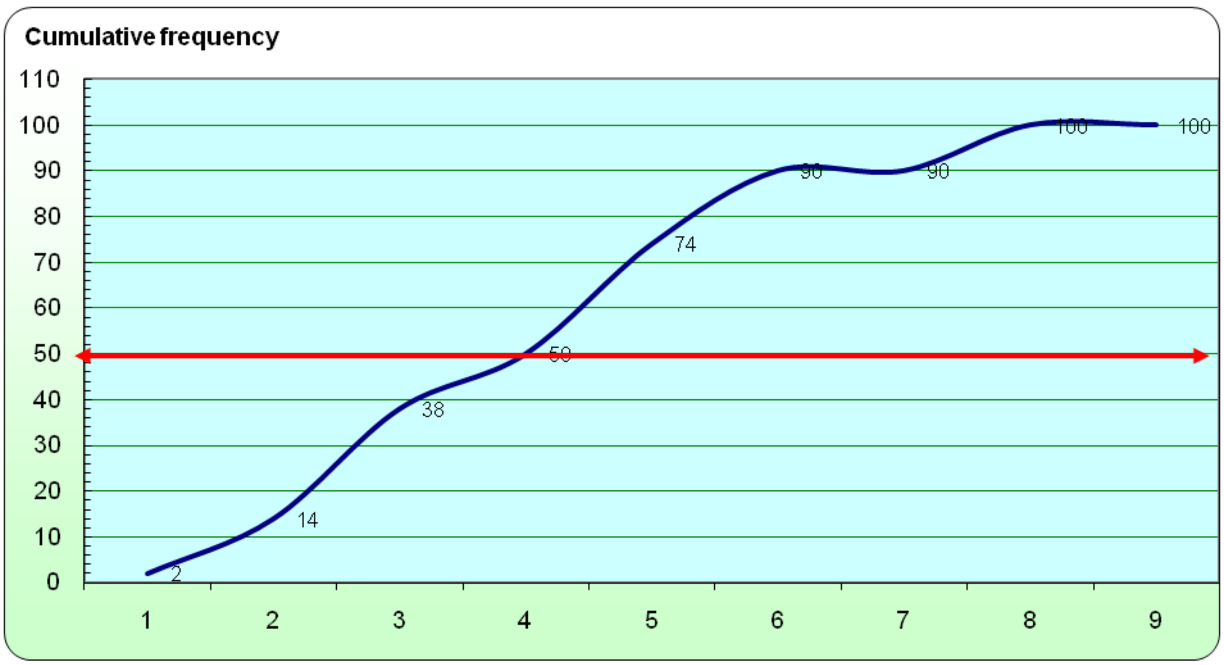


(1) Silt/clay (2) Sand (3) Fine gravel (4) Coarse gravel (5) Cobble (6) Boulder (7) Bedrock

http://www.epa.gov/watertrain/stream_class/24rt.htm

Devils Run Pebble Count Data

Size class	Size range	Point values	Pebble count data		Reach %	Cumulative frequency
			Count	Score		
Silt/clay	< .062	0.0	2	0	2	2
Sand	.062 - 2	1.0	12	12	12	14
Fine gravel	3 - 24	2.0	24	48	24	38
Coarse gravel	25 - 64	3.0	12	36	12	50
Cobble	65 - 255	4.0	24	96	24	74
Boulder	256 - 2048	5.0	16	80	16	90
Bedrock		6.0		0	0	90
Woody debris	Not included in the index calculations		10		10	100
Artificial materials					0	100
timothy.d.craddock@wv.gov		Totals	100	272	100	% Fines
		Index	2.72			14

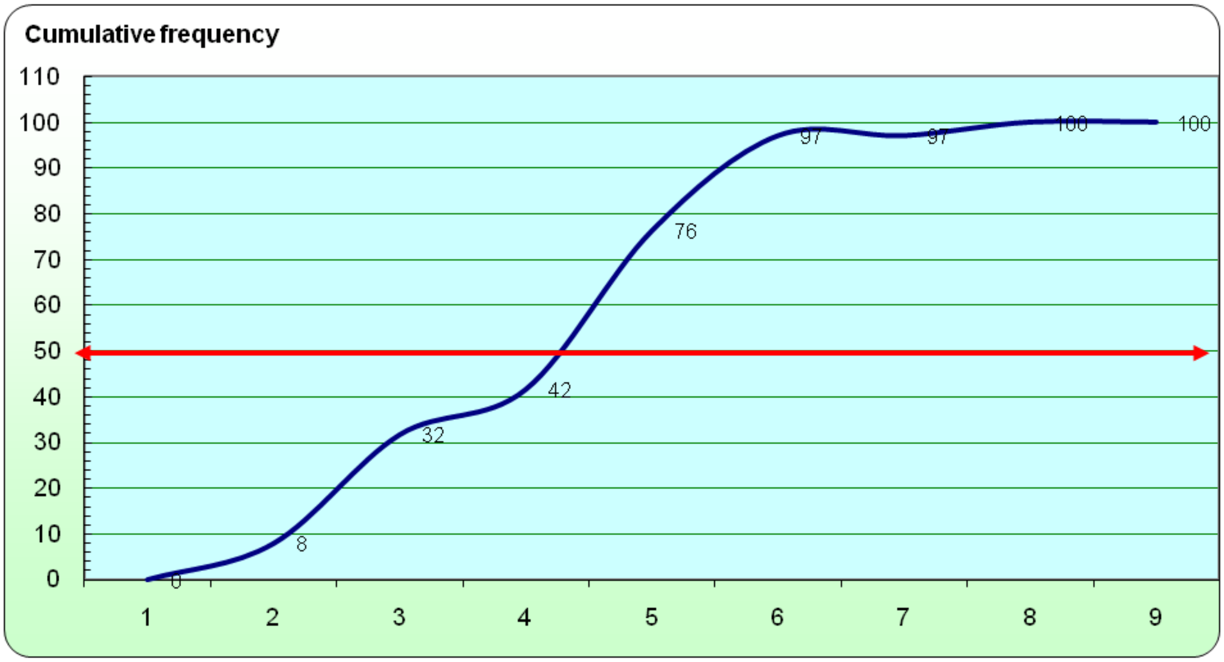


(1) Silt/clay (2) Sand (3) Fine gravel (4) Coarse gravel (5) Cobble (6) Boulder (7) Bedrock

http://www.epa.gov/watertrain/stream_class/24rt.htm

Lindy Run Pebble Count Data

Size class	Size range	Point values	Pebble count data		Reach %	Cumulative frequency
			Count	Score		
Silt/clay	< .062	0.0	0	0	0	0
Sand	.062 - 2	1.0	8	8	8	8
Fine gravel	3 - 24	2.0	24	48	24	32
Coarse gravel	25 - 64	3.0	10	30	10	42
Cobble	65 - 255	4.0	35	140	35	76
Boulder	256 - 2048	5.0	21	105	21	97
Bedrock		6.0	0	0	0	97
Woody debris	Not included in the index calculations		3		3	100
Artificial materials			0		0	100
timothy.d.craddock@wv.gov		Totals	101	331	100	% Fines
		Index	3.28			8

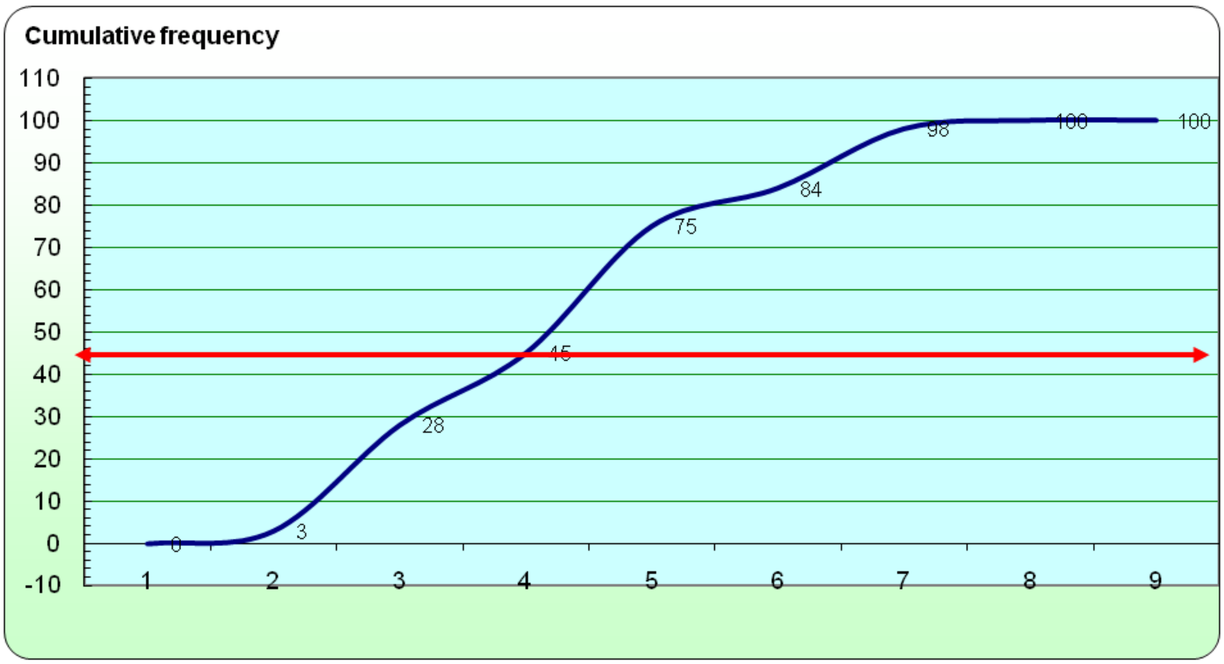


(1) Silt/clay (2) Sand (3) Fine gravel (4) Coarse gravel (5) Cobble (6) Boulder (7) Bedrock

http://www.epa.gov/watertrain/stream_class/24rt.htm

Maxwell Run Pebble Count Data

Size class	Size range	Point values	Pebble count data		Reach %	Cumulative frequency
			Count	Score		
Silt/clay	< .062	0.0	0	0	0	0
Sand	.062 - 2	1.0	3	3	3	3
Fine gravel	3 - 24	2.0	25	50	25	28
Coarse gravel	25 - 64	3.0	17	51	17	45
Cobble	65 - 255	4.0	30	120	30	75
Boulder	256 - 2048	5.0	9	45	9	84
Bedrock		6.0	14	84	14	98
Woody debris	Not included in the index calculations		2		2	100
Artificial materials					0	100
timothy.d.craddock@wv.gov		Totals	100	353	100	% Fines
		Index	3.53			3

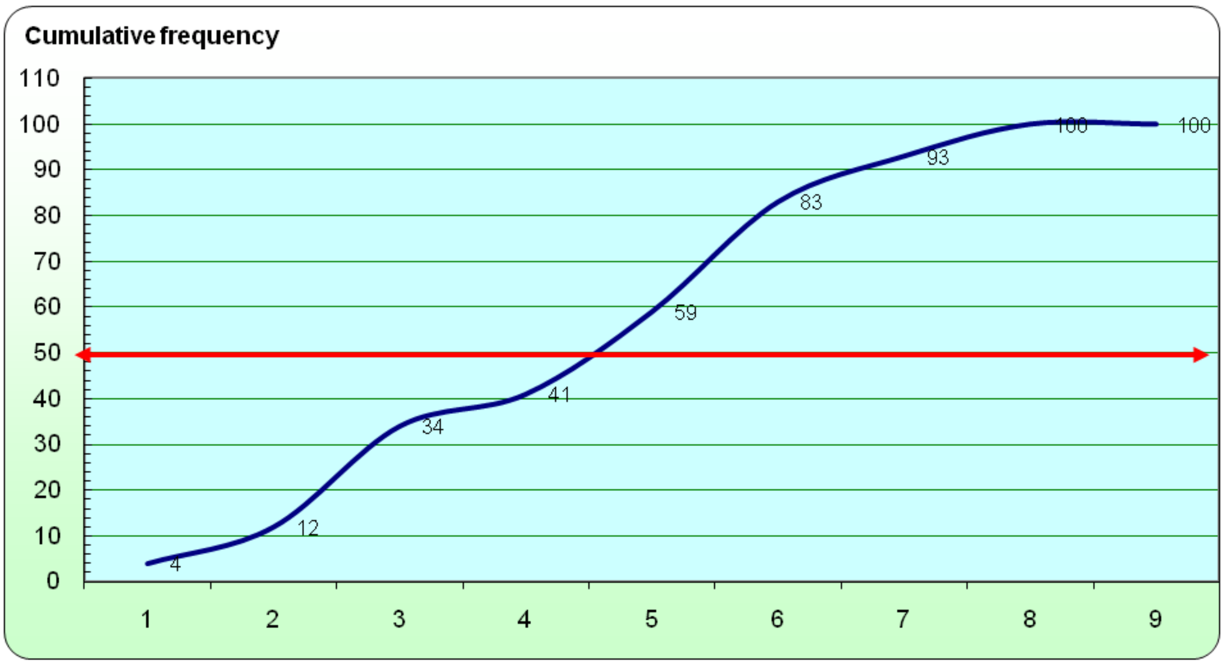


(1) Silt/clay (2) Sand (3) Fine gravel (4) Coarse gravel (5) Cobble (6) Boulder (7) Bedrock

http://www.epa.gov/watertrain/stream_class/24rt.htm

Snyder Run Pebble Count Data

Size class	Size range	Point values	Pebble count data		Reach %	Cumulative frequency
			Count	Score		
Silt/clay	< .062	0.0	4	0	4	4
Sand	.062 - 2	1.0	8	8	8	12
Fine gravel	3 - 24	2.0	22	44	22	34
Coarse gravel	25 - 64	3.0	7	21	7	41
Cobble	65 - 255	4.0	18	72	18	59
Boulder	256 - 2048	5.0	24	120	24	83
Bedrock		6.0	10	60	10	93
Woody debris	Not included in the index calculations		7		7	100
Artificial materials					0	100
timothy.d.craddock@wv.gov		Totals	100	325	100	% Fines
		Index	3.25			12



(1) Silt/clay (2) Sand (3) Fine gravel (4) Coarse gravel (5) Cobble (6) Boulder (7) Bedrock

http://www.epa.gov/watertrain/stream_class/24rt.htm