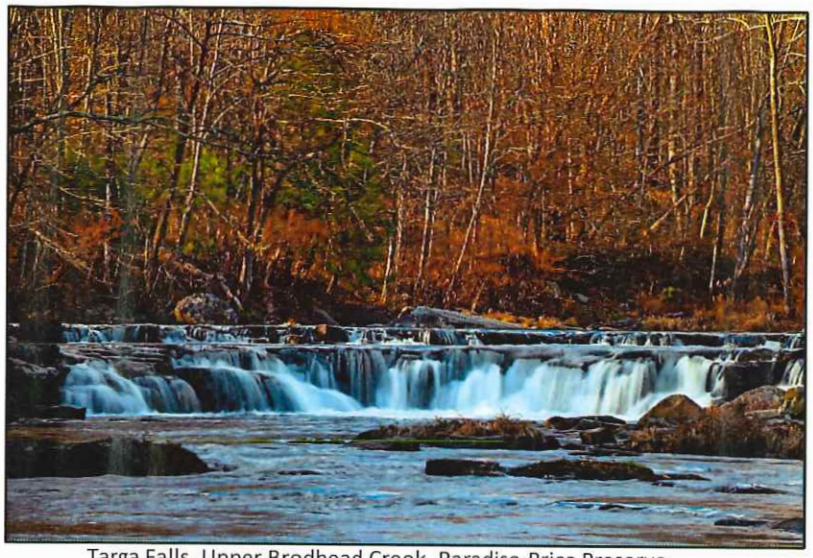
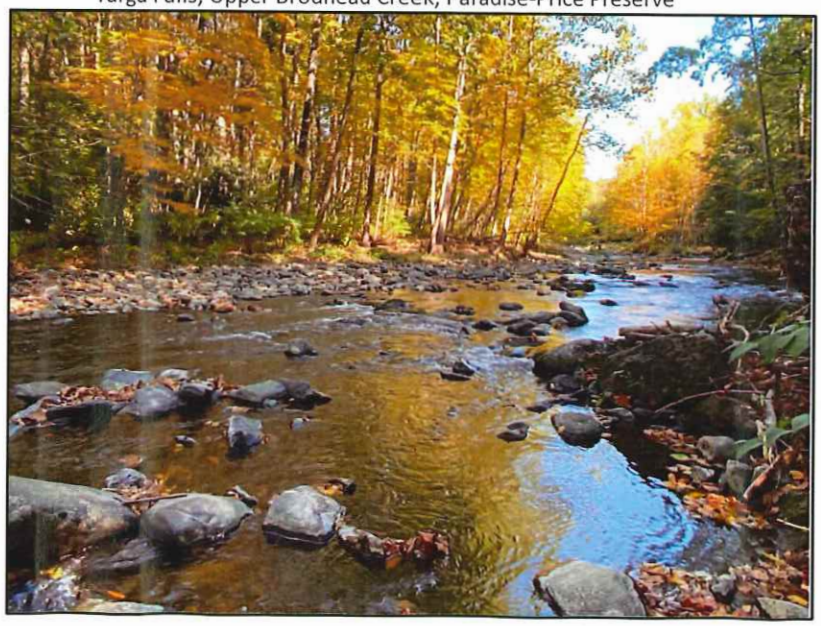
COMMONWEALTH OF PENNSYVLANIA ENVIRONMENTAL QUALITY BOARD

PETITION FOR THE RE-DESIGNATION OF A SEGMENT OF BRODHEAD CREEK MONROE COUNTY, PA



Targa Falls, Upper Brodhead Creek, Paradise-Price Preserve



Brodhead Watershed Association

PO Box 339, Henryville, PA, 18332

COMMONWEALTH OF PENNSYLVANIA
ENVIRONMENTAL QUALITY BOARD

PETITION FORM

I. PETITIONER INFORMATION

A. Name — Brodhead Watershed Association

B. Mailing Address — 1539 Cherry Lane Road
East Stroudsburg, PA 18360

C. Telephone Number

D. Date

II. PETITION INFORMATION

A. Petitioner requests the Environmental Quality Board to:

_____ Adopt a regulation

____X_____ Amend a regulation (Citation PADEP Chapter 93 Designation of a segment of Brodhead Creek to Exceptional Value - EV)

_____ Repeal a regulation

B. Why is the petitioner requesting this action from the Board? (Describe problems encountered under current regulations and the changes being recommended to address the problems. State factual and legal contentions and include supporting documentation that establishes a clear justification for the requested action)

The Brodhead Watershed Association requests that a segment of Brodhead Creek from the Middle Branch headwater to the confluence with Paradise Creek be re-designated exceptional value (EV) from its current designation as high quality waters (HQ) based on the fact that the data on existing water quality is superior to criteria applicable to its current designation. Recent water quality data, included in macroinvertebrate, water chemistry, and fish studies presented in appendices, suggest that water quality in the segment of Brodhead Creek under this petition compares favorably to that in Pennsylvania's EV waters. The majority - approximately seven miles - of this stream segment are owned by Brodheads Forest and Stream Association, Brodhead Flyfishers, Parkside Angling Association, Pocono Bluestone, and Brodhead Hunting and Fishing Association. The trout fishing clubs have a rich history with several dating back to the

late 19th and early 20th centuries. A great deal of effort and expense has been invested by the clubs to enhance and protect habitat and stabilize erosion. Two segments of this stream on Paradise-Price Preserve and Pasold Farm Preserve have been protected through open space purchases and are popular public wild trout fisheries. This part of Brodhead Creek is particularly beautiful with natural waterfalls on the Paradise-Price Preserve and Brodhead Flyfishers and a step falls on Parkside Angling Association. Except for a small area of residential development in the village of Canadensis, the stream has a well forested riparian corridor which preserves water quality and aesthetic character.

There are potential threats to the excellent water quality of Brodhead Creek. For instance, a large tract of land adjacent to the stream, which was formerly Alpine Mountain Ski Area, is currently for sale and could be developed in such a way as to negatively impact existing water quality, aquatic insects, and fisheries. In one riparian area, streamside trees have been removed illegally on property of Parkside Angling Association to allow a view corridor to this land. Less than the most judicious development of this property could result in destabilizing slope side soils, and leaching of potential pollutants into Brodhead Creek.

An Exceptional Value designation would help to insure that future development in the watershed would leave the excellent water quality of this part of Brodhead Creek unimpaired. There is currently a resurgence of development in the Pocono area. With socio-economic justification, the water quality of Brodhead Creek could be degraded by development under its current High Quality Coldwater Fishery designation.

The Brodhead is an exceptional recreational resource and continues to support a population of wild trout which provides angling opportunities for the public as well as neighboring landowners. It is arguably the most historic American trout fishery. In the nineteenth and early twentieth centuries, virtually all the notable anglers visited the Brodhead, including four United States Presidents, Broadway stars, prizefighters, artists and notable angling writers. Today this section of the Brodhead is visited annually by over a thousand anglers on both public and private water, all of this a result of the water quality which harbors excellent populations of wild trout. Two public sections in this part of the Brodhead at Paradise-Price Preserve and Pasold Farm Preserve are particularly popular public fisheries. The Brodhead is popular for kayaking, canoeing, hiking, bird watching, etc. Downstream nearer Stroudsburg, the Brodhead provides a major source of exceptional drinking water provided by Brodhead Creek Regional Authority. There are numerous conservation projects (conserving woodlands and threatened species) on riparian lands subject to this petition.

In addition to the public access at the Paradise -Price Preserve and Pasold Farm in the Brodhead under petition, there is approximately eight miles of the fishery accessible to the general public downstream of the Paradise Creek junction. From the ForEvergreen Nature Preserve below the junction to the confluence with the Delaware River, the Brodhead is a heavily utilized trout fishery. Fisheries surveys indicate that a large percentage of recruitment of catchable size wild trout in the lower Brodhead comes from

the upper segment of the stream (Appendix G). Protection of the existing water quality of the upper Brodhead will assure continued recruitment of wild trout to the entire Brodhead fishery.

In the greater Brodhead Watershed, there are a number of streams or stream segments identified as impaired (303d list, 6/19/15): Sambo Creek, Forest Hills Run, Lake Creek, Little Pocono Creek, a segment of McMichaels Creek, Unnamed Tributary to Brodhead (Cranberry Run), Unnamed Tributary to Brodhead near Stroudsburg, and a segment of Brodhead Creek. With this amount of water quality compromised, The Brodhead Watershed Association feels that waters such as the upper Brodhead Creek exhibiting exceptional water quality should be maintained at current levels precluding any allowable degradation.

C. Describe the persons, businesses and organizations likely to be impacted by this proposal.

The public generally, as well as landowner organizations, will continue to reap positive benefits of preserving the existing water quality of Brodhead Creek with an EV designation of the upper segment. The Brodhead's public and private waters, which draw anglers from far and wide, will continue to offer excellent fisheries to large numbers of anglers who add considerably to the local economy. Restaurants, sporting goods dealers, campgrounds, and hotels have benefited for decades from locals and visitors coming to the Brodhead. Riparian landowners' concern for protection of the Brodhead is evidenced by several having recently put conservation easements on riparian properties, including Brodhead Hunting and Fishing Association, Pocono Bluestone (Ferenbach), and Bart and Vivian Bartolocci.

Maintaining the existing water quality of the upper Brodhead would also be an important component in preserving the quality of the Brodhead below the junction with Paradise Creek. Below the junction, through Stroudsburg and below to its confluence with the Delaware, the Brodhead provides an outstanding public recreational fishery. This section of the creek is heavily used by local recreationists and those from surrounding areas such as Philadelphia, New York, and New Jersey. Adding to the popularity of the public Brodhead is a greenway with a loop trail, several streamside parks, and ForEvergreen Nature Preserve established through the stewardship of Stroud Township. Sections of the Brodhead are heavily stocked by the PA Fish & Boat Commission but also harbor a population of wild brown trout. Therefore, it is classified Cold Water Fishery to the confluence with the Delaware. Shortly below the junction, ForEvergreen Nature Preserve provides a reach of the Brodhead as a year-round, no-kill, non-stocked, fishery with abundant good size wild trout, making it attractive to both locals and visitors.

Depending on the type of development that may occur on the property, an Exceptional Value designation of the Brodhead would require enhanced treatment of wastewater. In the Barrett Township section of the creek, some land adjacent to the Brodhead Creek is zoned industrial. However, there are no plans for development of these parcels so that an Exceptional Value designation would cause no

hardship to the landowner. It is the opinion of the Brodhead Watershed Association that properties in the upper Brodhead Drainage should be developed in such a way as to have no degrading effect on the existing water quality

D. Does the action requested in the petition concern a matter currently in Litigation?

Action requested in this petition does not concern any matter currently in litigation to the best of the petitioner's knowledge.

E. Supporting material

Description of the Brodhead Creek Watershed upstream of its confluence with Paradise Creek.

From the confluence with Paradise Creek upstream, the watershed drains an area of 70.6 square miles. According to the United States Geological Survey's SteamStats report of 2011 - 2012, the drainage area characteristics were as follows:

Percentage of area covered by forest	88.6 percent
Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.45 percent
Percentage of developed (urban) land from NCLD 2011 classes 21-24	6.14 percent
Percent of area of storage (lakes, ponds, reservoirs, wetlands)	9.02 percent
Total length of all mapped streams (1:24,000-scale) in the basin	108.36 miles

The portion of the Brodhead Watershed upstream of the confluence with the Paradise is within Monroe County. It flows from north to south through Barrett Township, Price Township, and a small portion of Stroud Township near the confluence. This segment, from the headwater tributaries to the confluence with Paradise Creek is shown on the Buck Hill, Skytop, and East Stroudsburg USGS 7.5 minute quadrangles (Figure 1-3). A short distance north of Canadensis, Buck Hill Creek, The Middle Branch, and the Leavitt Branch join to form The Brodhead. From that point, it flows approximately 10.5 miles to the Paradise junction. The properties through which it flows include the following with approximate stream miles:

Parkside Angling Association (fishing club) -	4 miles
Brodheads Forest and Stream Association (fishing club) -	1 mile

Brodhead Flyfishers (fishing club) - 1.5 miles

Brodhead Hunting and Fishing Association (fishing club) - 1 mile

Pocono Bluestone (leased for fishing by Parkside) - 1 mile

Smaller residential, a few commercial, and
2 open space preserve properties - 2 miles

Buck Hill Falls and Skytop Lodge have a wastewater discharges on Buck Hill Creek and Leavitt Branch headwaters, respectively. Leavitt Branch drains Mountain lake on the property of Skytop Lodge The main stem Brodhead, through the stream reach in this petition, has no wastewater treatment plant discharges. In this watershed, the following tributaries have segments designated Exceptional Value Waters: Buck Hill Creek, Stony Run, Spruce Cabin Run, Poplar (Laurel) Run, and Mill Creek. A petition has been submitted and accepted to reclassify Mill Creek to EV from the existing EV segment to the Brodhead.

After Buck Hill Creek, Middle Branch, and Leavitt Branch join in close proximity north of Canadensis to form the Brodhead, several tributaries add to the flow before the Paradise confluence. Just south of Canadensis, the brown water Goose Pond Run enters from the northeast. Then Mill Creek enters from the northwest. Mill Creek and its tributary Rattlesnake Creek originate in State Game Land 221. It flows through the small village of Mountainhome and adjacent to land preserved by Natural Lands Trust before entering the Brodhead. Farther downstream, Stony Run and Poplar/Laurel Run, both Exceptional Value streams, enter from the northeast. Stony Run is the longest tributary draining Browns Lake approximately 6.5 miles to the northeast and supplemented by Mud Run flowing trough a portion of Delaware State Forest. Poplar Run flows through Delaware State Forest Land. Pine Mountain Run flows from Lake Manzaneto and drops through a steep little gorge where it becomes an excellent little cold water stream. Finally Leas Run is a small tributary entering at the upper reach of Brodheads Forest And Stream Association. Except for leas Run with fish population unknown, all the aforementioned tributaries are wild trout streams harboring brook and brown trout.

Following is contact information for the Municipalities through which this segment of Brodhead Creek flows:

Barrett Township, 993 Route 390, Cresco, PA 18326 phone 570-595-2602
Supervisor Pamela Gardsy, Chairperson

Price Township, 10 Barren Road, E. Stroudsburg, 18302 phone 570-421-2497
Supervisor Robert Wilson, Chairman

Stroud Township, 1211 North 5th Street, Stroudsburg, PA 18360 phone 570-421-3362
Supervisor Christine Wilkins, Chairperson

Maps

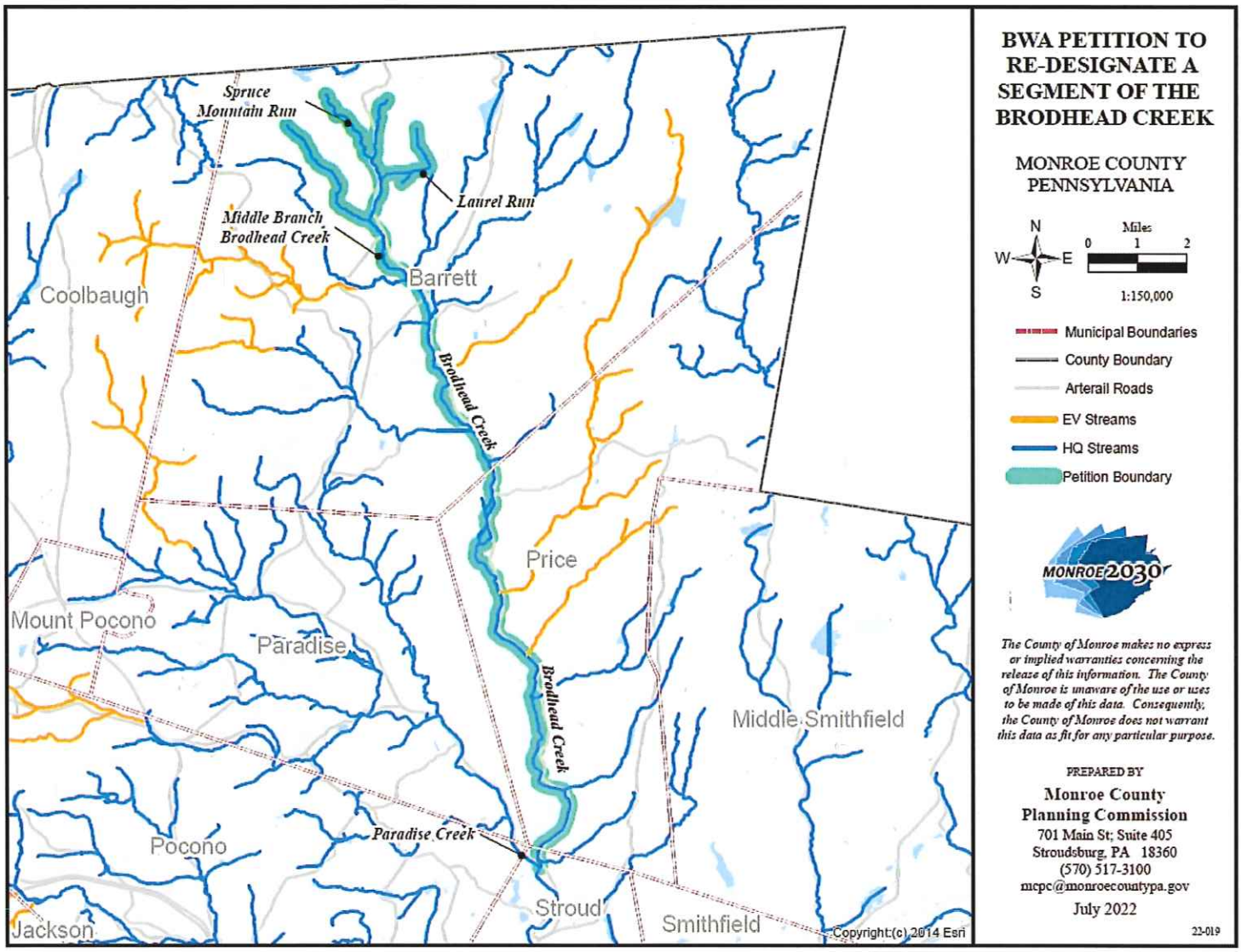


Figure 1. Map delineating the stream segment requested for re-designation under this petition.

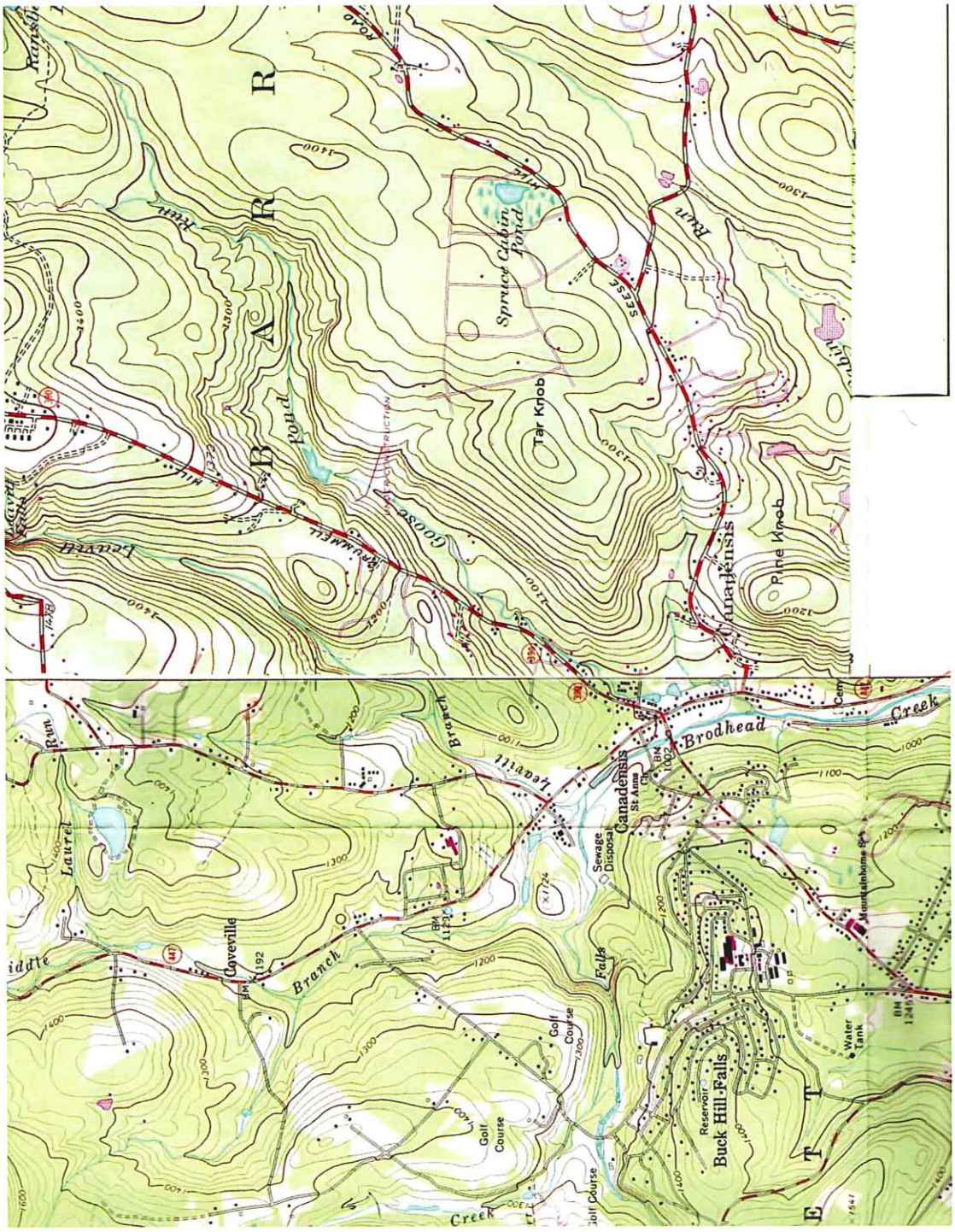


Figure 2. Brodhead Creek headwaters from USGS 7.5 minute Buck Hill Falls quadrangle.

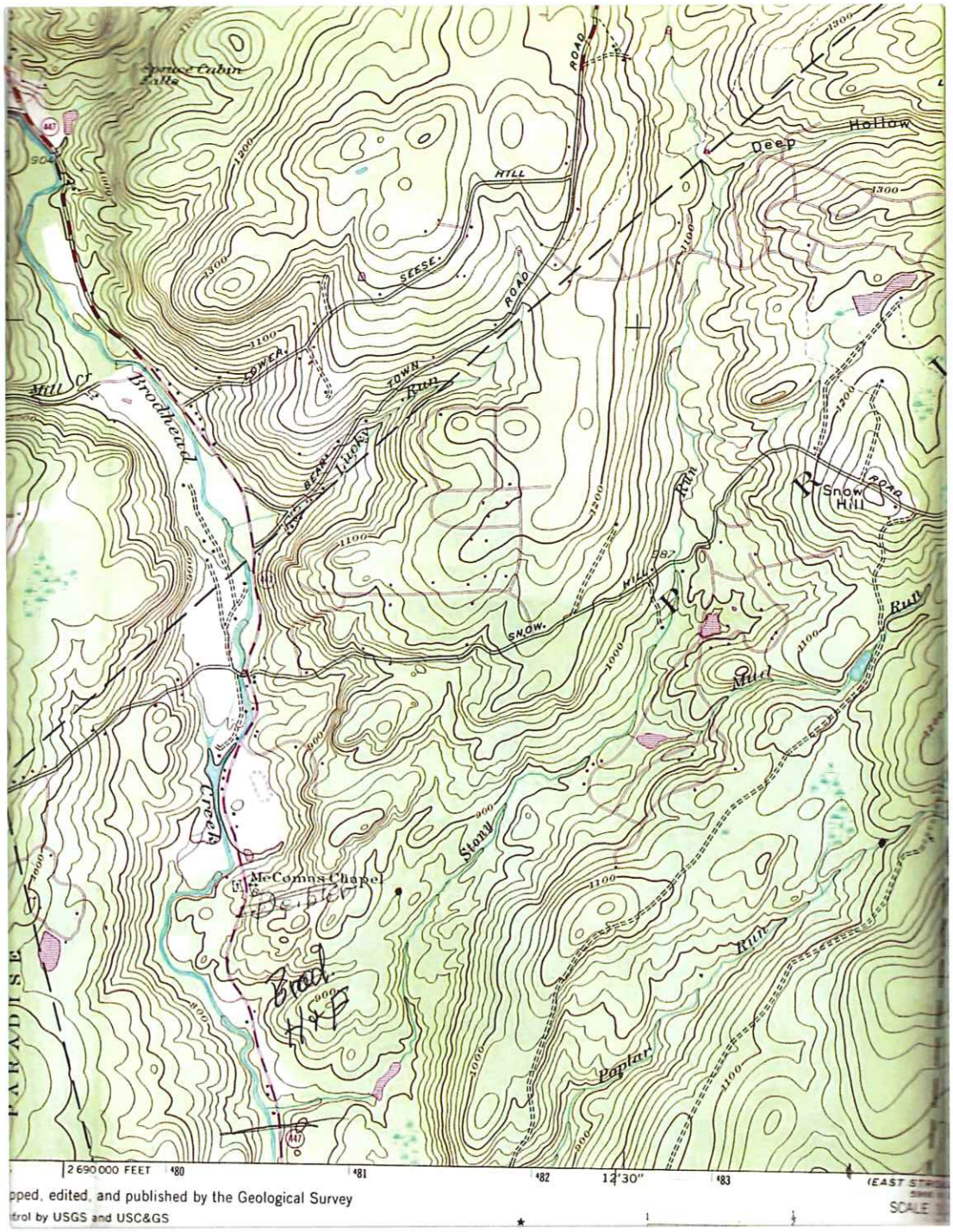


Figure 3. Brodhead Creek from USGS 7.5 minute Skytop quadrangle.

Figure 4. Brodhead Creek from USGS 7.5 minute East Stroudsburg quadrangle.

Current Designated Uses

Brodhead Creek upstream of its confluence with Paradise Creek is listed in Drainage List C in 25 Pa. Code 93.9c, where it is designated High Quality Cold Water Fishery with Migratory Fishes, HQ-CWF, MF. The current designated use would allow for degradation of the existing exceptional quality.

Requested Designated Uses

The requested designation for Brodhead Creek upstream of the confluence with Paradise Creek is Exceptional Value with Migratory Fishes, EV, MF. This designation would protect the existing water quality.

Available Technical Data: Benthic Macroinvertebrates, Fishes, and Water Chemistry.

Benthic macroinvertebrate, water chemistry, and fish surveys conducted by Monroe County and Aquatic Resource Consulting from 2019 to 2022 have yielded results attesting to the exceptional water quality of Brodhead Creek upstream from its confluence with Paradise Creek. Macroinvertebrate analysis and IBI scores are provided for 7 stations within the Brodhead above the junction with Paradise Creek (Figure 4). Macroinvertebrate data from 2 stations in Monroe County's Water Quality Study are provided for a two year span 2020- 2021. Recent fish survey data is provided from one site in the reach (Figure 4).

Benthic Macroinvertebrates

Benthic Macroinvertebrates of Brodhead Creek at Parkside Anglers March 30, 2019 (Appendix A).

At the request of Parkside Angling Association, Aquatic Resource Consulting (ARC) sampled two stations on the section of Brodhead Creek under petition. Both stations exhibited superior IBI scores indicative of exceptional water quality. The upper station was a short distance below the Spruce Cabin Run tributary with a drainage area of 34.1 Square miles. Index of Biotic Integrity (IBI) scores were 95.9 and 99.7 for small and large stream metrics, respectively. The lower station was a short distance above the Pine Mountain Run tributary with a drainage area of 61.8 square miles. The large stream metric IBI score was 96.4.

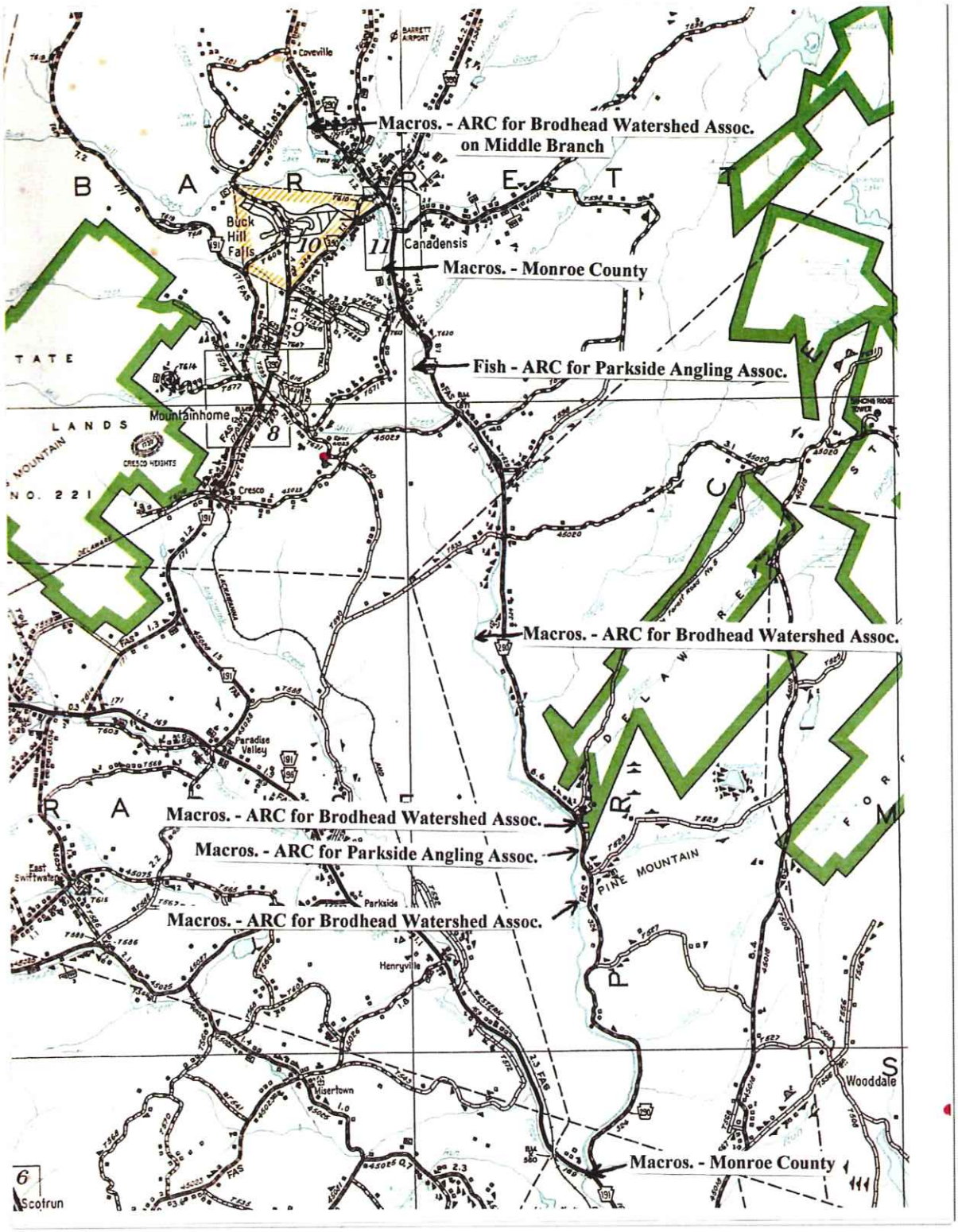


Figure 5. Map showing stations on Brodhead Creek sampled by Monroe County and Aquatic Resource Consulting (ARC) for benthic macroinvertebrates (macros.) and fish.

Monroe County Water Quality Survey, 2020, 2021, (Appendix B)

Monroe County's water quality survey in 2020 included two stations on upper Brodhead Creek. The lower Station BRODCR22 was just above the junction with Paradise Creek and the upper station BRODCR27 and 27R was approximately 9 miles upstream from the junction with Paradise Creek. The upper station was on the Pasold Farm Preserve 170 meters northeast of the parking area. At the upper station, two samples were taken with one serving as a reference (R) for quality assurance. With a drainage area of 30.1 square miles, both large and small stream metrics were calculated. Index of Biotic Integrity (IBI) scores were 97.4 large stream and 86.8 small stream for BRODCR27 and 97.2 large stream and 86.8 small stream for BRODCR27R.

The lower station (BRODCR22) was a short distance above the confluence with Paradise Creek near the Route 191 crossing. With a drainage area of 70.6 square miles, the large stream metric IBI score was 95.0. Both stations exhibited excellent water quality.

Table 1.
Macroinvertebrate IBI scores from two Brodhead Creek stations in Monroe County's Water Quality Study, 2020 and 2021.

DATE	BRODCR22 Above Confluence With Paradise Cr. Drainage Area 70.6	BRODCR27 Pasold Farm Station Drainage Area 30.1	BRODCR27 R Pasold Farm Station Drainage Area 30.1
2020	Large Stream **95.0**	Small Stream **86.8** Large Stream **97.4**	Small Stream **81.9** Large Stream **91.6**
2021	Large Stream **96.5**	Small Stream **79.5** Large Stream **91.5**	Small Stream **79.5** Large Stream **91.5**

Monroe County's 2021 water quality survey included the same two stations on upper Brodhead Creek that were surveyed in 2020. Two samples were taken at the upper station on the Pasold Farm Preserve (BRODCR 27 and 27R). with one serving as a reference for quality assurance. With a drainage area of 30.1 square miles, both large and small stream metrics were calculated. Index of Biotic Integrity (IBI) scores were 91.6 large stream and 81.9 small stream for BRODCR27 and 91.5 large stream and 79.5 small stream for BRODCR27R. For Station BRODCR22 a short distance above the confluence with a drainage area of 70.6 square miles, the large stream IBI was 96.5.

Benthic Macroinvertebrates of Brodhead Creek for the Brodhead Watershed Association, December 1, 2021 (Appendix C).

At the request of Brodhead Watershed Association, ARC sampled benthic macroinvertebrates at one site on Brodhead Creek on December 1, 2021. The station was located approximately 100 meters below the confluence with the Pine Mountain Run tributary. With a drainage area 65.6 square miles at the station, large stream metric calculations produced an exceptional IBI score of 95.7

Benthic Macroinvertebrates of Brodhead Creek on property of Brodhead Hunting and Fishing Association for Brodhead Watershed Association, April 16, 2022 (Appendix D).

At the request of Brodhead Watershed Association, ARC sampled benthic macroinvertebrates of Brodhead Creek on property of Brodhead Hunting and Fishing Association above the Stony Run tributary on April 16, 2022. Invertebrates were very abundant. The drainage area of 46 square miles was closest to the area for large stream metrics for which the IBI score was an excellent 95.6. Small stream metrics were also calculated yielding an IBI score of 90.0.

Benthic Macroinvertebrates of Middle Branch, headwater to Brodhead Creek for Brodhead Watershed Association, April 26, 2022 (Appendix E).

ARC sampled benthic macroinvertebrates of the Middle Branch headwater to Brodhead Creek in April of 2022. This small stream had a drainage area of 5.01 square miles. Macroinvertebrates were very abundant. The sample had a small stream IBI score of 91.2.

Benthic Macroinvertebrates of Brodhead Creek below Poplar Run for Brodhead Watershed Association, May 10, 2022 (Appendix F).

ARC sampled benthic macroinvertebrates of Brodhead Creek at a station below the Poplar/Laurel Run tributary to provide baseline data downstream of potential development of riparian property and areas zoned industrial. With a drainage area of 61.2 square miles, large stream metrics were applicable yielding an IBI score of 93.8.

Electrofishing Survey of Brodhead Creek on the Deibler Section of Parkside Angling Association, October 9, 2020 (Appendix G).

For Parkside Angling Association, Aquatic Resource Consulting conducted two electrofishing passes in a 482 foot section of Brodhead Creek starting approximately 200 meters below the confluence with Spruce Cabin Run tributary. Results indicated an excellent population of wild trout providing an exceptional sport fishery. A total of 43 trout were collected on the first pass and 35 on the second. Of the 78 trout captured, 9 were judged to be stocked. Of the wild trout collected 3 were young-of-year brook trout. The remainder were brown trout. Of the wild trout, 37, or 47.3 % were young-of-year,

indicating excellent natural reproduction. Of the trout collected, 20 were considered to be catchable size (>10 inches) with sizes ranging up to 19.1 inches.

Water Chemistry (Appendix H)

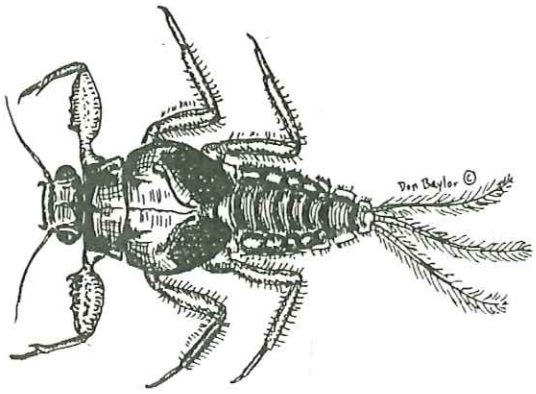
Water chemistry data for this segment of Brodhead Creek is available from Monroe County's water quality study in 2020. Water chemistry data reflected cool clean conditions typical of unimpaired freestone streams. Chemical data was from the same stations used for macroinvertebrates. The lower station was near the junction with Paradise Creek (BRODCR22) and the upper station approximately 9 miles farther upstream at Pasold Farm (BRODCR27 and 27R). Water chemistry was typical of clean unimpaired freestone Pocono streams. Both stations were low in nutrients with excellent dissolved oxygen. Alkalinity was typically low and pH ranged from 6.5 to 6.7. Specific Conductance and Total Dissolved Solids values were low.

APPENDIX A

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK

AT PARKSIDE ANGLERS

MARCH 30, 2019



Submitted by:

Don Baylor

For
Aquatic Resource Consulting

521 Quail Ridge

Stroudsburg, PA 18360

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK
MARCH 30, 2019

BACKGROUND

On March 30, 2019, Aquatic Resource Consulting (ARC) biologist Don Baylor sampled benthic macroinvertebrates at two stations on Brodhead Creek on the property of Parkside Anglers. The purpose was to evaluate water quality.

Aquatic macroinvertebrates are preferred indicators of stream water quality because of their limited mobility, one to three year life cycles, and specific sensitivities to pollutants. Clean streams usually support numerous species of invertebrates, theoretically evenly represented numerically. Impairment may be indicated by low taxa richness, shifts in community balance toward dominance of pollution-tolerant forms, or overall scarcity of invertebrates (Plafkin, et al. 1989). In order to assure an accurate assessment, recent work in bio-monitoring stresses the use of several parameters, or metrics, to measure different components of the community structure.

EXECUTIVE SUMMARY

On March 30, 2019, the Index of biotic Integrity (IBI) scores for two stations on Parkside Angling Association's sections of Brodhead Creek were reflective of exceptional water quality and well above the Pennsylvania Department of Environmental Protection benchmark for Aquatic Life Use attainment in riffle/run streams. The upstream Station 1 from the Zimmer section of the Deibler stretch scored 95.9, and the downstream Station 2 below Stump Pool on the LaBar stretch scored 96.4. Although samples were semi-quantitative, macroinvertebrates appeared to be quite abundant at both stations.

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK
MARCH 30, 2019

METHODS

Macroinvertebrate sampling methods followed those recommended by the US Environmental Protection Agency Protocol III (Plafkin, et al., 1989) with the latest modifications adopted by the PA Department of Environmental Protection (PA DEP) for riffle/run freestone streams (PA DEP, 2012). At each station, 6 samples were taken with a D-frame kick net (Wildlife Supply Company #425-D5) of 500u nitex from riffle /run habitat in a one hundred meter stretch. Samples were taken by placing the net against the substrate and disturbing by foot the substrate in an area approximating one square meter above the net. Organisms and debris were composited for each station in a plastic container and preserved in alcohol for transport to the laboratory. Habitat was evaluated at each station using DEP's Water Quality Network Habitat Assessment forms for riffle/run streams. Twelve habitat parameters were ranked on a scale of 1-20 and combined for a total habitat score.

In the laboratory, samples were rinsed in a USGS No. 35 sieve and placed in a white pan marked with a grid to delineate 28 squares measuring two inches on a side. Organisms were then picked from randomly selected grids until 200 organisms +/- 20% were obtained. Organisms were identified to the lowest taxonomic level practicable, enumerated, and assigned a pollution tolerance value (PA DEP, 2009).). Pennsylvania DEP has established different metric standardization scores and Aquatic Life Use benchmarks for larger and smaller riffle/run freestone streams. Metrics included Total Taxa Richness, Ephemeroptera + Plecoptera + Trichoptera Taxa Richness (EPT), Modified Beck's Index, Hilsenhoff Biotic Index, Shannon Diversity Index, , and Percent Sensitive Individuals. A description and brief rationale for each of the metrics follow:

1. **Total Taxa Richness** – is an index of diversity. The number of taxa (kinds) of invertebrates indicates the health of the benthic community through measurement of the variety of species present. Generally, number of species increases with increased water quality. However, variability in natural habitat (stream order and size, substrate composition, current velocity) also affects this number.

2. **Ephemeroptera, Plecoptera, and Trichoptera Taxa Richness (PT 1-4)**. Mayflies, stoneflies, and caddisflies, collectively referred to as EPT, are generally considered pollution sensitive (Plafkin et al. 1989). Thus, the total number of taxa within the EPT insect groups is used to evaluate community balance. This metric has been modified to include only the EPT taxa with pollution tolerance values of 1-4. Healthy biotic conditions are reflected when these taxa are well represented in the benthic community.

3. **Modified Beck's Index** is a weighted count of taxa with pollution tolerance values of 0, 1, or 2. This metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of pollution sensitive taxa. It is calculated by multiplying by 3 the number of taxa with a pollution tolerance value of 0, multiplying by 2 the number of taxa with a pollution tolerance value of 1, and multiplying by 1 the number of taxa with a pollution tolerance value of 2. The three values are added to yield the Modified Beck's Index score.

4. **Hilsenhoff Biotic Index** – is a direct measure of organic pollution in streams. The biotic index value is the mean tolerance value of all organisms in a sample. Tolerance values range from 0.00 to 10.00; the higher the value, the greater the level of pollution indicated.

Table 1.
Evaluation of water quality using biotic index values (Hilsenhoff, 1987)

BIOTIC INDEX	WATER QUALITY	DEGREE OF ORGANIC POLLUTION
0.00-3.50	Excellent	None Apparent
3.51-4.50	Very Good	Possible Slight
4.51-5.50	Good	Some
5.51-6.50	Fair	Fairly Significant
6.51-7.50	Fairly Poor	Significant
7.51-8.50	Poor	Very Significant
8.51-10.00	Very Poor	Severe

5. **Shannon Diversity Index** measures taxonomic richness and evenness of numbers of individuals across the taxa of a subsample. This metric is expected to decrease in values with increased anthropogenic stress to a stream ecosystem, reflecting loss of pollution-sensitive taxa and predominance of a few pollution-tolerant taxa.

6. **Percent Sensitive Individuals** is the percentage of individuals in the subsample with pollution tolerance values of 0-3. It is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK
MARCH 30, 2019

INDEX CALCULATION

An overall index is used to integrate information from these various metrics and standardize them into one score. The values for any standardized core metric are set to a maximum value of 100, with values closer to zero corresponding to increasing deviation from the expected reference condition and progressively higher values corresponding more closely to the biological reference condition. The adjusted standardized metric values for the six core metrics are averaged to produce an index of biotic integrity (IBI) score ranging from 0-100. The following table shows metric standardization equations and index calculations for the sub-sample from Station 1 on Brodhead Creek using DEP's riffle/run freestone stream values for streams with smaller drainage areas.

Table 2.
Metric standardization and index of biotic integrity calculations for the benthic macroinvertebrate sample from Station 1 on Brodhead Creek, March 30, 2019.

Metric	Standardization Equation	Observed Metric Value	Standardized Metric Score	Adjusted Standardized Metric Score Maximum =1.00
Total Taxa Richness	Observed value / 33	31	0.939	0.939
EPT Taxa Richness	Observed Value/ 19	20	1.053	1.000
Modified Beck's Index	Observed value/38	38	1.000	1.000
Hilsenhoff Biotic Index	10-observed value/ (10-1.89)	2.307	0.949	1.000
Shannon Diversity Index	Observed value / 2.86	2.81	0.983	0.983
Percent Sensitive Individuals	Observed value / 84.5	74.63	0.883	0.883
Average of adjusted standardized core metric scores x 100 = IBI score large stream				**95.9**

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK
MARCH 30, 2019

SAMPLING STATIONS

Two Stations were sampled for benthic macroinvertebrates on Parkside Angling Asociation's sections of Brodhead Creek:

Station 1 - a riffle area in the Zimmer area of Deibler Stretch near the upper extent of Parkside's portion of Brodhead Creek at latitude 41.10595 and longitude -75.22171. Station 1 is a short distance below the mouth of Spruce Cabin Run.

Station 2 - a riffle area below Stump Pool on the Madison stretch of the lower Parkside section of the Brodhead Creek at latitude 41.17131 and longitude -75.24839. Station 2 is a short distance above the mouth of Pine Mountain Run.

Figure 1. Station 1 sampled for benthic macroinvertebrates on March 30, 2019 on the upper portion of Parkside property on Brodhead Creek.

Figure 2. Station 2 sampled for benthic macroinvertebrates on March 30, 2019 on the lower section of Parkside property on Brodhead Creek.

RESULTS AND DISCUSSION

Benthic Macroinvertebrate Community

Table 2 shows the taxa, numbers, and biotic index pollution tolerance value (PT) for the samples. Table 3 shows the core metric values, standardizing equations, Adjusted Standardized Metric Scores, and IBI scores for the samples from two stations on Parkside Anglers Association's property on Brodhead Creek. PA DEP applies large stream metrics to streams with a drainage area of 50 or more square miles and small stream metrics to streams with a drainage area of 25 square miles or less. Station 1 on upper Parkside had a drainage area of 34.1 square miles so both metrics were calculated. Station 2 on lower Parkside had a drainage area of 61.8 square miles so large stream metrics were applied. Drainage areas were obtained from USGS Stream Stats Report.

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK, MARCH 30, 2019

Table 3. Taxa, numbers, and pollution tolerance values (PT) for the benthic macroinvertebrate sample from Brodhead Creek at Parkside Angling Association March 30, 2019.

TAXA	STATION 1 UPSTREAM	STATION 2 DOWNSTREAM	PT
Ephemeroptera (mayflies)			
Epeorus spp.	15	29	0
Ephemerella spp.	36	25	1
Drunella spp.	-	1	1
Eurylophella spp.	-	1	4
Seratella spp.	1	2	2
Isonychia spp.	4	4	3
Paraleptophlebia spp.	29	18	1
McCffertium spp.	3	4	3
Baetis spp.	29	44	6
Trichoptera (caddisflies)			
Rhyacophila spp.	8	10	1
Brachycentrus spp.	8	-	1
Lepidostoma spp.	1	-	1
Chimarra spp.	2	1	4
Diplectrona spp.	1	-	0
Ceratopsyche spp.	7	6	5
Cheumatopsyche spp.	5	1	6
Micrasema spp.	-	1	2
Neophylax spp.	-	4	3
Glossossoma spp.	-	1	0
Plecoptera (stoneflies)			
Acroneuria spp.	9	4	0
Agnetina spp.	1	3	2
Paragnetina spp.	1	-	1
Isoperla spp.	7	10	2
Nemoura spp.	2	-	2
Taenionema spp.	1	-	3
Arcynopteryx spp.	11	-	2
Oemopteryx spp.	-	6	3
Tallaperla spp.	-	1	0
Perlodidae	1	-	2
Chloroperlidae	1	-	0

Table 3. continued			
Diptera (true flies)			
Chironomidae	7	17	6
Prosimulium spp.	3	13	2
Hexatoma spp.	4	1	2
Atheryx spp.	2	-	2
Coleoptera (beetles)			
Psephenus spp.	2	1	4
Promoresia spp.	1	-	2
Megaloptera (helgrammites)			
Nigronia spp.	2	1	2
Odonata (Dragonflies)			
Ophiogomphus spp.	3	2	3
TOTAL ORGANISMS	**205**	**211**	

Station 1 had IBI scores of 95.9 (small stream metrics) and 99.7 (large stream metrics). Station 2 had an IBI score of 96.4 using large stream metrics. These scores reflect exceptional water quality. The sections of the Brodhead sampled are classified by PA DEP as High Quality Cold Water Fisheries. The IBI scores are in the range expected in Exceptional Value Waters. Both stations had an abundance of intolerant taxa resulting in optimal scores for EPT Taxa Richness and Beck's Index at each and EPT Taxa Richness at Station 1 and Hilsenhoff Biotic Index at Station 2 (Table 4). IBI scores were near-optimal at Station 1 for Total Taxa Richness, Shannon diversity, Hilsenhoff biotic Index, and Percent Sensitive Individuals. At Station 2, scores for Shannon diversity and Percent Sensitive Individuals were near-optimal.

At Station 1, the predominant taxon was *Ephemerella spp.* an intolerant mayfly. At Station 2 the moderately tolerant mayflies of *Baetis spp.* predominated but were balanced by an abundance of intolerant mayfly, stonefly and caddisfly organisms. At each station, the preponderance of organisms were from the intolerant mayfly, stonefly, and caddisfly groups. On march 30, 2019, invertebrate samples form Parkside property on Brodhead Creek represented exceptional water quality inhabited by an abundance of organisms and numerous taxa reflecting no negative impacts.

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BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK, MARCH 30, 2019

Table 4.
Metric standardization and Index of Biotic Integrity calculations for benthic macroinvertebrate samples from Brodhead Creek on March 30, 2019.

METRIC	STATION 1 UPSTREAM		STATION 2 DOWNSTREAM	
	VALUE	ADJUSTED STANDARDIZED METRIC SCORE (small stream)	VALUE	ADJUSTED STANDARDIZED METRIC SCORE (large stream)
Total Taxa Richness	31	0.939	27	0.871
EPT Taxa Richness (0-4)	20	1.053	18	1.125
Beck's Index (version 3)	38	1.000	22	1.000
Shannon Diversity	2.81	0.983	2.63	0.920
Hilsenhoff Biotic Index	2.307	0.949	2.78	1.039
Percent Sensitive Individuals (0-3)	74.63	0.883	66.35	0.995
IBI Score Large Stream		99.7		96.4
IBI Score Small Stream		95.9		

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Hilsenhoff, William L. 1987. An improved biotic index of organic stream pollution. Great lakes Entomologist. 20(1):31-39.

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Plafkin, J. L. et al. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. EPA/440/4-98/001. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, D.C. 20460.

APPENDIX B

Macroinvertebrate and chemistry data for Brodhead Creek from Monroe County Water Quality Study 2020

Benthic Macroinvertebrates of Brodhead Creek from Monroe County's Water Quality Survey in 2020.				
TAXA	**PT**	**BRODCR 22**	**BRODCR 27**	**BRODCR 27R**
Coleoptara (beetles)				
Stenelmis spp.	5	7	-	3
Psephenus spp.	4	19	9	2
Ancyronyx spp.	2	1	-	-
Diptera (true flies)				
Chironomidae	6	30	52	35
Limnophora spp.	6	4	8	5
Blepharicera spp.	0	-	4	1
Tipula spp.	4	-	-	1
Hexatoma spp.	2	-	1	1
Hemerodromia spp.	6	-	-	8
Atherix spp.	2	1	-	-
Antocha spp.	3	4	1	1
Simulium spp.	6	1	1	3
Prosimulium spp.	2	-	1	-
Ephemeroptera (mayflies)				
Epeorus spp.	0	4	37	17
Maccaffertium spp.	3	10	5	9
Stenacron spp.	4	1	-	-
Ephemerella spp.	1	41	31	57
Eurylophella spp.	4	2	-	-
Drunella spp.	1	17	2	2
Seratella spp.	2	2	9	1
Paraleptophlebia spp.	1	-	9	15
Cinygmula spp.	1	-	-	1
Rithrogena spp.	0	-	-	4
Isonychia spp.	3	3	2	2
Diphetor spp.	6	-	-	3
Baetis spp.	6	-	5	-
Acentrella spp.	4	-	7	5

Benthic Macroinvertebrates of Brodhead Creek from Monroe County's Water Quality Survey in 2020 (continued).				
Megaloptera (helgrammites)				
Sialis spp.	6	1	-	-
Nigronia spp.	2	1	1	-
Odonata (dragonflies)				
Gomphidae spp.	4	2	-	-
Boyeria spp.	2	1	-	-
Stylogomphus spp.	4	1	2	-
Oligochaeta (earthworms)	10	-	3	2
Plecoptera (stoneflies)				
Leuctra spp.	0	1	6	-
Amphinemura spp.	3	-	1	-
Acroneuria spp.	0	3	2	1
Paragnetina spp.	1	2	-	-
Agnetina spp.	1	-	1	-
Suwalia/Sweltsa spp.	0	-	-	3
Trichoptera (caddisflies)				
Chimarra spp.	4	1	-	-
Dolophilodes spp.	0	1	6	3
Neophylax spp.	3	-	2	2
Ceratopsyche spp.	5	7	6	3
Cheumtopsyche spp.	6	15	2	7
Rhyacophila spp..	1	5	134	6
Psilotreta spp.	0	3	-	-
Brachycentrus spp.	1	1	-	-
Goera spp.	0	2	-	-
Pycnopsyche spp.	4	-	-	1
Polycentropus spp.	6	-	-	6

Total		206	232	212
Drainage Area		70.6	30.1	30.1
Total Taxa Richness		34	31	32
Shannon Diversity Index		2.74	2.71	2.69
EPT Taxa Rixhness		18	17	17
Hilsenhoff Biotic Index		3.24	2.84	2.92
% Sensitive Individuals		51.5	59.1	60.4
Modified Beck's Index		36	32	31
IBI Small Stream		88.3	86.8	86.8
IBI Large Stream		95.0	97.2	97.4

Macroinvertebrate and chemistry data for Brodhead Creek from Monroe County Water Quality Study 2021

Benthic Macroinvertebrates of Brodhead Creek from Monroe County's Water Quality Survey in 2021.				
TAXA	**PT**	**BRODCR 22 Above Paradise Creek Junction**	**BRODCR 27 Pasold Farm Preserve**	**BRODCR 27R Pasold Farm Preserve**
Coleoptara (beetles)				
Stenelmis spp.	5	2	-	-
Psephenus spp.	4	2	-	-
Promoresi spp.	2	1	3	-
Macronychus spp.	2	1	-	-
Optioservus spp.	4	-	-	1
Diptera (true flies)				
Chironomidae	6	26	26	33
Tipula spp.	4	-	1	-
Hexatoma spp.	2	-	2	1
Prinocera spp.	2	-	2	-
Antocha spp.	3	-	3	3
Prosimulium spp.	2	7	1	13
Ephemeroptera (mayflies)				
Epeorus spp.	0	12	32	34
Maccaffertium spp.	3	3	4	4
Stenacron spp.	4	-	1	-
Ephemerella spp.	1	58	64	34
Drunella spp.	1	25	1	-
Seratella spp.	2	1	-	-
Paraleptophlebia spp.	1	12	4	5
Rithrogena spp.	0	-	2	1
Isonychia spp.	3	3	2	-
Baetis spp.	6	5	1	26
Acentrella spp.	4	-	7	5
Leucrocuta spp.		-	1	-

Benthic Macroinvertebrates of Brodhead Creek from Monroe County's Water Quality Survey in 2021 (continued).				
Oligochaeta (earthworms)	**10**	**2**	**-**	**-**
Plecoptera (stoneflies)				
Agnetina spp.	**1**	**1**	**5**	**3**
Pteronarcys spp.	**0**	**1**	**-**	**-**
Acroneuria	**0**	**2**	**-**	**-**
Paragnetina spp.	**1**	**2**	**-**	**-**
Isoperla spp.	**2**	**8**	**20**	**12**
Allocapnia spp.	**0**	**-**	**-**	**1**
Diploperla spp.	**2**	**-**	**2**	**-**
Tallaperla spp.	**0**	**-**	**1**	**-**
Alloperla spp.	**0**	**-**	**5**	**1**
Hydroperla spp.	**1**	**-**	**1**	**-**
Prostoia spp.	**2**	**1**	**-**	**-**
Clioperla spp.	**2**	**1**	**-**	**-**
Trichoptera (caddisflies)				
Chimarra spp.	**4**	**5**	**-**	**-**
Neophylax spp.	**3**	**4**	**1**	**4**
Ceratopsyche spp.	**5**	**1**	**6**	**2**
Cheumtopsyche spp.	**6**	**6**	**20**	**2**
Rhyacophila spp..	**1**	**6**	**3**	**5**
Psilotreta spp.	**0**	**-**	**3**	**1**
Brachycentrus spp.	**1**	**-**	**-**	**1**
Lepidostoma spp.		**1**	**-**	**1**
Polycentropus spp.	**6**	**-**	**1**	**-**

Total		**206**	**232**	**212**
Drainage Area		**70.6**	**30.1**	**30.1**
Total Taxa Richness		**28**	**24**	**22**
Shannon Diversity Index		**2.54**	**2.43**	**2.37**
EPT Taxa Richness		**18**	**14**	**17**
Hilsenhoff Biotic Index		**2.27**	**2.38**	**2.76**
% Sensitive Individuals		**75.4**	**71.6**	**63.3**
Modified Beck's Index		**29**	**31**	**28**
IBI Small Stream		**88.2**	**81.9**	**79.5**
IBI Large Stream		**96.5**	**91.6**	**91.5**

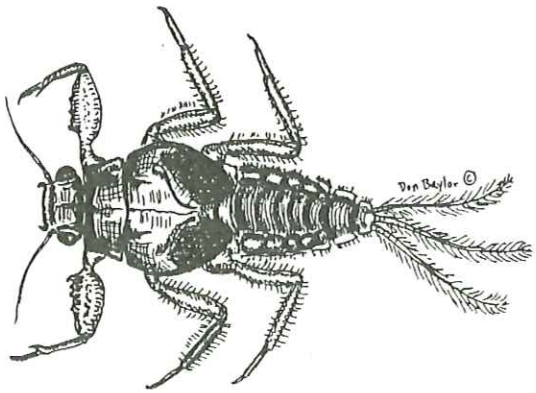
BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK

BELOW PINE MOUNTAIN RUN TRIBUTARY

FOR

THE BRODHEAD WATERSHED ASOCIATION

December 1, 2021



Submitted by:

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BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK
DECEMBER 1, 2021

EXECUTIVE SUMMARY

On December 1, 2021, a station on Brodhead Creek had an excellent benthic macroinvertebrate Index of Biotic Integrity score of 95.7, a score within the range expected in streams qualifying for Exceptional Value status.

BACKGROUND

On December 1, 2021, at the request of the Brodhead Watershed Association, Aquatic Resource Consulting (ARC) biologists Don Baylor sampled benthic macroinvertebrates at a station on Brodhead Creek. The purpose of this study was to evaluate the water quality and to ascertain whether the benthic macroinvertebrate population would meet PA Department of Environmental Protection (DEP) qualifications for Exceptional Value classification. Aquatic macroinvertebrates are preferred indicators of stream water quality because of their limited mobility, one to three year life cycles, and specific sensitivities to pollutants. Clean streams usually support numerous species of invertebrates, theoretically evenly represented numerically. Impairment may be indicated by low taxa richness, shifts in community balance toward dominance of pollution-tolerant forms, or overall scarcity of invertebrates (Plafkin, et al. 1989). In order to assure an accurate assessment, recent work in bio-monitoring stresses the use of several parameters, or metrics, to measure different components of the community structure.

Macroinvertebrate sampling methods followed those recommended by the US Environmental Protection Agency Protocol III (Plafkin, et al., 1989) with the latest modifications adopted by the PA Department of Environmental Protection for riffle/run freestone streams (PA DEP, 2009). At each station, six samples were taken with a D-frame kick net (Wildlife Supply Company #425-D5) of 500u nitex from the best riffle/run areas in a one hundred meter stretch. Samples were taken by placing the net against the substrate and disturbing approximately one square meter above the net by foot for one minute. Organisms and debris were composited for the station in a plastic container and preserved in alcohol for transport to the laboratory. Habitat was evaluated at each station using DEP's Water Quality Network Habitat Assessment forms for streams with riffle/run prevalence. Twelve habitat parameters were ranked on a scale of 1-20 and combined for a total habitat score.

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK

In the laboratory, samples were rinsed in a USGS No. 35 sieve and placed in a white pan marked with a grid to delineate 28 squares measuring two inches on a side. Organisms were then picked from randomly selected grids until 200 organisms +/- 20% were obtained. Organisms were identified to the lowest taxonomic level practicable, enumerated, and assigned a pollution tolerance value (PA DEP, 2009). Metrics for riffle/run freestone streams were calculated for each subsample, including Total Taxa Richness, Ephemeroptera + Plecoptera + Trichoptera Taxa Richness (EPT), Modified Beck's Index, , Hilsenhoff Biotic Index, Shannon Diversity Index, , and Percent Sensitive Individuals. A description and brief rationale for each of the metrics follow:

1. **Total Taxa Richness** – is an index of diversity. The number of taxa (kinds) of invertebrates indicates the health of the benthic community through measurement of the variety of species present. Generally, number of species increases with increased water quality. However, variability in natural habitat (stream order and size, substrate composition, current velocity) also affects this number.

2. **Ephemeroptera, Plecoptera, and Trichoptera Taxa Richness (PTV 1-4)** Mayflies, stoneflies, and caddisflies, collectively referred to as EPT, are generally considered pollution sensitive (Plafkin et al. 1989). Thus, the total number of taxa within the EPT insect groups is used to evaluate community balance. This metric has been modified to include only the EPT taxa with pollution tolerance values of 1-4. Healthy biotic conditions are reflected when these taxa are well represented in the benthic community.

3. **Modified Beck's Index** is a weighted count of taxa with pollution tolerance values of 0, 1, or 2. This metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of pollution sensitive taxa. It is calculated by multiplying by 3 the number of taxa with a pollution tolerance value of 0, multiplying by 2 the number of taxa with a pollution tolerance value of 1, and multiplying by 1 the number of taxa with a pollution tolerance value of 2. The three values are added to yield the Modified Beck's Index score.

4. **Hilsenhoff Biotic Index** – is a direct measure of organic pollution in streams. The biotic index value is the mean tolerance value of all organisms in a sample. Tolerance values range from 0.00 to 10.00; the higher the value, the greater the level of pollution indicated.

Table 1.
Evaluation of water quality using biotic index values (Hilsenhoff, 1987)

BIOTIC INDEX	WATER QUALITY	DEGREE OF ORGANIC POLLUTION
0.00-3.50	Excellent	None Apparent
3.51-4.50	Very Good	Possible Slight
4.51-5.50	Good	Some
5.51-6.50	Fair	Fairly Significant
6.51-7.50	Fairly Poor	Significant
7.51-8.50	Poor	Very Significant
8.51-10.00	Very Poor	Severe

5. **Shannon Diversity Index** measures taxonomic richness and evenness of numbers of individuals across the taxa of a subsample. This metric is expected to decrease in values with increased anthropogenic stress to a stream ecosystem, reflecting loss of pollution-sensitive taxa and predominance of a few pollution-tolerant taxa.

6. **Percent Sensitive Individuals** is the percentage of individuals in the subsample with pollution tolerance values of 0-3. It is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem.

INDEX CALCULATION

An overall index is used to integrate information from these various metrics and standardize them into one score for a subsample. The values for any standardized core metric are set to a maximum value of 1.00, with values closer to zero corresponding to increasing deviation from the expected reference condition and progressively higher values corresponding more closely to the biological reference condition. The adjusted standardized metric values for the six core metrics are averaged and multiplied by 100 to produce an index score ranging from 0-100. This number represents the index of biotic integrity (IBI) score for a sample. The following table shows metric standardization equations and index calculations for the sub-sample from Station 1 on Brodhead Creek.

Table 2.
Metric standardization and Index of Biotic Integrity calculations for the benthic macroinvertebrate sample from Station 1 on Brodhead Creek on December 1, 2021.

Metric	Standardization Equation	Observed Metric Value	Standardized Metric Score	Adjusted Standardized Metric Score Maximum =1.00
Total Taxa Richness	Observed value / 31	29	0.935	0.935
EPT Taxa Richness	Observed Value/ 16	19	1.188	1.000
Modified Beck's Index	Observed value/22	33	1.500	1.000
Hilsenhoff Biotic Index	10-observed value/ (10-3.05)	3.18	0.981	0.981
Shannon Diversity Index	Observed value / 2.86	2.58	0.902	0.902
Percent Sensitive Individuals	Observed value / 66.7	61.14	0.921	0.921
Average of adjusted standardized core metric scores x 100 = IBI score				**95.7**

Sampling Station

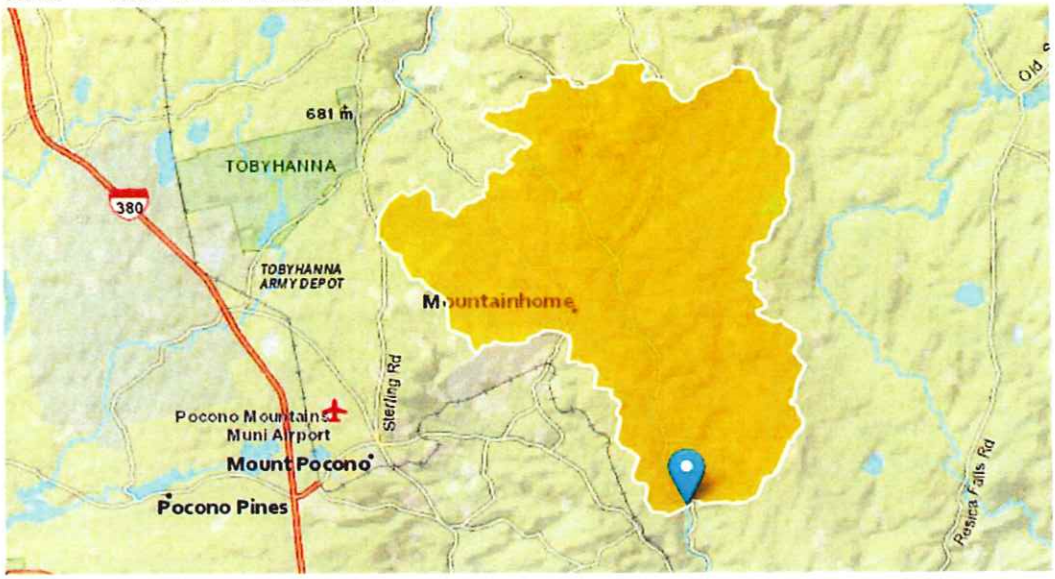
One station was sampled for benthic macroinvertebrates on Brodhead Creek on December 11, 2021. (Figure 1). The location was as follows:

Station 1. – Approximately 100 meters below the confluence of Pine Mountain Run and Brodhead Creek at lat. 41,1024, lon. -75.22146.

Figure 1. Map of station sampled for benthic macroinvertebrates on Brodhead Creek on December 1, 2021.

StreamStats Report

Region ID: PA
Workspace ID: PA20211209155401525000
Clicked Point (Latitude, Longitude): 41.10241, -75.22146
Time: 2021-12-09 10:54:21 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	65.6	square miles

Figure 2. USGS StreamStats report showing drainage area of the Brodhead Creek station sampled for benthic macroinvertebrates on December 1, 2021.

RESULTS AND DISCUSSION

Benthic Macroinvertebrate Communities

Table 3 shows the taxa, numbers, and biotic index pollution tolerance value (PT) for benthic macroinvertebrate samples from Brodhead Creek on December 1, 2021. Table 2 shows metric values and IBI scores for those samples according to DEP's 2012 protocols. For these samples, October-May large stream metrics were applicable as determined by drainage area in USGS StreamStats (Figure 2).

Table 3. Taxa, numbers, and pollution tolerance value (PT) for benthic macroinvertebrate samples from Brodhead Creek on December 1, 2021.

TAXA	STATION 1	PT
Ephemeroptera (mayflies)		
Epeorus spp.	11	0
Maccaffertium spp.	2	3
Ephemerella spp.	12	1
Paraleptophlebia spp.	32	1
Isonychia spp.	3	3
Baetis spp.	14	6
Acentrella spp.	12	4
Trichoptera (caddisflies)		
Rhyacophila spp.	6	1
Brachycentrus spp.	3	1
Psilotreta spp.	2	0
Neophylax. spp.	1	3
Diplectrona spp.	1	0
Ceratopsyche spp.	12	5
Cheumatopsyche spp.	1	6

Table 3. continued		
TAXA	**STATION 1**	**PT**
Plecoptera (stoneflies)		
Acroneuria spp.	**2**	**0**
Agnetina spp.	**1**	**2**
Isogenoides spp.	**1**	**0**
Suwalia/Sweltsa spp.	**1**	**0**
Diploperla spp.	**2**	**2**
Leuctridae	**5**	**0**
Taenionema spp.	**2**	**3**
Oemopteryx spp.	**45**	**3**
Diptera (true flies)		
Chironomidae	**46**	**6**
Hexatoma spp.	**2**	**2**
Antocha spp.	**1**	**3**
Atheryx spp.	**5**	**2**
Ephydridae	**2**	**6**
Coleoptera (beetles)	**5**	**5**
Psephenus spp.	**1**	**4**
Optioservus spp.	**1**	**4**

The benthic macroinvertebrate sample from Brodhead Creek on December 2021 had an excellent IBI score of 95.7 in the range expected in Exceptional Value waters (Table 2). The EPT Index and Beck's Index had adjusted metric scores exceeding the optimal 1.0. The other 5 metrics had adjusted metric scores over 0.9. The Hilsenhoff Biotic Index score was 0.981 indicating a predominance of intolerant individual organisms in the sample. Despite recent floods in the Brodhead drainage, organisms were fairly abundant requiring 11 of the 28 grids picked to obtain 229 organisms. Twenty-two of the 29 taxa were from the intolerant mayfly, caddisfly and stonefly groups. Taxa were well balanced in abundances resulting in a Shannon Diversity adjusted metric score of 0.902. The EPT Taxa Richness and Beck's Index scores over 1.0 reflect an abundance of taxa in the highly intolerant range.

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK

Habitat

Habitat was in the optimal range at the Brodhead Creek station on December 1, 2021 (Table 4).

Table 4. Habitat assessment of the station sampled on Brodhead Creek on December 1, 2021

Parameter	Station 1
1. Instream Cover	17
2. Epifaunal Substrate	20
3. Embeddedness	18
4. Velocity/Depth Regimes	19
5. Channel Alteration	20
6. Sediment Deposition	18
7. Frequency of Riffles	18
8. Channel Flow Status	18
9. Condition of Banks	17
10. Bank Vegetative Protection	19
11. Grazing or Other Disruptive Pressure	20
12. Riparian Vegetative Zone Width	20
TOTAL SCORE	**224**
Score Ranges: Optimal 240-192, Suboptimal 180-132, Marginal 120-72, Poor less than 60.6.0	

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Hilsenhoff, William L. 1987. An improved biotic index of organic stream pollution. Great Lakes Entomologist. 20(1): 31-39.

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APPENDIX D

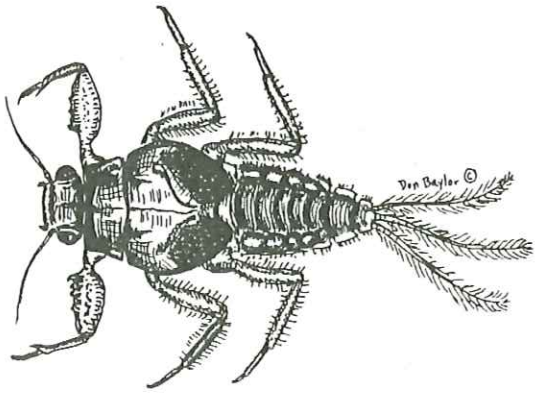
BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK

AT BRODHEAD HUNTING ANDFISHING ASSOCIATION

FOR

THE BRODHEAD WATERSHED ASOCIATION

APRIL 16, 2022



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BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK
APRIL 16, 2022

EXECUTIVE SUMMARY

On April 16, 2022, a station on Brodhead Creek with a drainage area of 46 square miles on property of Brodhead Hunting and Fishing Association had excellent benthic macroinvertebrate Index of Biotic Integrity scores of 95.6 for large stream metrics and 90.0 for small stream metrics. The large stream metrics were most applicable. Macroinvertebrates were very abundant with a strong predominance of intolerant taxa.

BACKGROUND

On April 16, 2022, at the request of the Brodhead Watershed Association, Aquatic Resource Consulting (ARC) biologists Don Baylor sampled benthic macroinvertebrates at a station on Brodhead Creek on the property of Brodhead Hunting and Fishing Association. The purpose of this study was to evaluate the water quality and to ascertain whether the benthic macroinvertebrate population would meet PA Department of Environmental Protection (DEP) qualifications for Exceptional Value classification. Aquatic macroinvertebrates are preferred indicators of stream water quality because of their limited mobility, one to three year life cycles, and specific sensitivities to pollutants. Clean streams usually support numerous species of invertebrates, theoretically evenly represented numerically. Impairment may be indicated by low taxa richness, shifts in community balance toward dominance of pollution-tolerant forms, or overall scarcity of invertebrates (Plafkin, et al. 1989). In order to assure an accurate assessment, recent work in bio-monitoring stresses the use of several parameters, or metrics, to measure different components of the community structure.

Macroinvertebrate sampling methods followed those recommended by the US Environmental Protection Agency Protocol III (Plafkin, et al., 1989) with the latest modifications adopted by the PA Department of Environmental Protection for riffle/run freestone streams (PA DEP, 2009). At each station, six samples were taken with a D-frame kick net (Wildlife Supply Company #425-D5) of 500u nitex from the best riffle/run areas in a one hundred meter stretch. Samples were taken by placing the net against the substrate and disturbing approximately one square meter above the net by foot for one minute. Organisms and debris were composited for the station in a plastic container and preserved in alcohol for transport to the laboratory. Habitat was evaluated at each station using DEP's Water Quality Network Habitat Assessment forms for streams with riffle/run prevalence. Twelve habitat parameters were ranked on a scale of 1-20 and combined for a total habitat score.

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK
APRIL 16, 2022

In the laboratory, samples were rinsed in a USGS No. 35 sieve and placed in a white pan marked with a grid to delineate 28 squares measuring two inches on a side. Organisms were then picked from randomly selected grids until 200 organisms +/- 20% were obtained. Organisms were identified to the lowest taxonomic level practicable, enumerated, and assigned a pollution tolerance value (PA DEP, 2009). Metrics for riffle/run freestone streams were calculated for each subsample, including Total Taxa Richness, Ephemeroptera + Plecoptera + Trichoptera Taxa Richness (EPT), Modified Beck's Index, , Hilsenhoff Biotic Index, Shannon Diversity Index, , and Percent Sensitive Individuals. A description and brief rationale for each of the metrics follow:

1. **Total Taxa Richness** – is an index of diversity. The number of taxa (kinds) of invertebrates indicates the health of the benthic community through measurement of the variety of species present. Generally, number of species increases with increased water quality. However, variability in natural habitat (stream order and size, substrate composition, current velocity) also affects this number.

2. **Ephemeroptera, Plecoptera, and Trichoptera Taxa Richness (PTV 1-4)** Mayflies, stoneflies, and caddisflies, collectively referred to as EPT, are generally considered pollution sensitive (Plafkin et al. 1989). Thus, the total number of taxa within the EPT insect groups is used to evaluate community balance. This metric has been modified to include only the EPT taxa with pollution tolerance values of 1-4. Healthy biotic conditions are reflected when these taxa are well represented in the benthic community.

3. **Modified Beck's Index** is a weighted count of taxa with pollution tolerance values of 0, 1, or 2. This metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of pollution sensitive taxa. It is calculated by multiplying by 3 the number of taxa with a pollution tolerance value of 0, multiplying by 2 the number of taxa with a pollution tolerance value of 1, and multiplying by 1 the number of taxa with a pollution tolerance value of 2. The three values are added to yield the Modified Beck's Index score.

4. **Hilsenhoff Biotic Index** – is a direct measure of organic pollution in streams. The biotic index value is the mean tolerance value of all organisms in a sample. Tolerance values range from 0.00 to 10.00; the higher the value, the greater the level of pollution indicated.

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEKAPRIL 16, 2022

Table 1. Evaluation of water quality using biotic index values (Hilsenhoff, 1987)		
BIOTIC INDEX	**WATER QUALITY**	**DEGREE OF ORGANIC POLLUTION**
0.00-3.50	Excellent	None Apparent
3.51-4.50	Very Good	Possible Slight
4.51-5.50	Good	Some
5.51-6.50	Fair	Fairly Significant
6.51-7.50	Fairly Poor	Significant
7.51-8.50	Poor	Very Significant
8.51-10.00	Very Poor	Severe

5. **Shannon Diversity Index** measures taxonomic richness and evenness of numbers of individuals across the taxa of a subsample. This metric is expected to decrease in values with increased anthropogenic stress to a stream ecosystem, reflecting loss of pollution-sensitive taxa and predominance of a few pollution-tolerant taxa.

6. **Percent Sensitive Individuals** is the percentage of individuals in the subsample with pollution tolerance values of 0-3. It is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem.

INDEX CALCULATION

An overall index is used to integrate information from these various metrics and standardize them into one score for a subsample. The values for any standardized core metric are set to a maximum value of 1.00, with values closer to zero corresponding to increasing deviation from the expected reference condition and progressively higher values corresponding more closely to the biological reference condition. The adjusted standardized metric values for the six core metrics are averaged and multiplied by 100 to produce an index score ranging from 0-100. This number represents the index of biotic integrity (IBI) score for a sample. The following table shows metric standardization equations and index calculations for the sub-sample from Station on Brodhead Creek at Brodhead Hunting and Fishing Association (BH&F) using large stream metrics.

Table 2. Metric standardization and Index of Biotic Integrity calculations for the benthic macroinvertebrate sample from Station BH&F on Brodhead Creek on April 16, 2022.				
Metric	**Standardization Equation - Large Stream**	**Observed Metric Value**	**Standardized Metric Score**	**Adjusted Standardized Metric Score** Maximum =1.00
Total Taxa Richness	Observed value / 31	28	0.903	0.903
EPT Taxa Richness	Observed Value/ 16	17	1.063	1.000
Modified Beck's Index	Observed value/22	34	1.545	1.000
Hilsenhoff Biotic Index	10-observed value/ (10-3.05)	1.91	1.164	1.000
Shannon Diversity Index	Observed value / 2.86	2.39	0.863	0.863
Percent Sensitive Individuals	Observed value / 66.7	78.71	1.180	1.000
Average of adjusted standardized core metric scores x 100 = IBI score				**95.6**

Sampling Station

Sampling Station BH&F, was sampled for benthic macroinvertebrates on Brodhead Creek on property of Brodhead Hunting & Fishing Association on April 16, 2022 (Figures 1 and 3). The station had a drainage area of 46 square miles (Figure 2). The location was as follows:

Station Brodhead Creek BH&F. – Approximately 1,300 meters upstream of the confluence of Stony Run and Brodhead Creek at lat. 41,13646, lon. -75.23845.

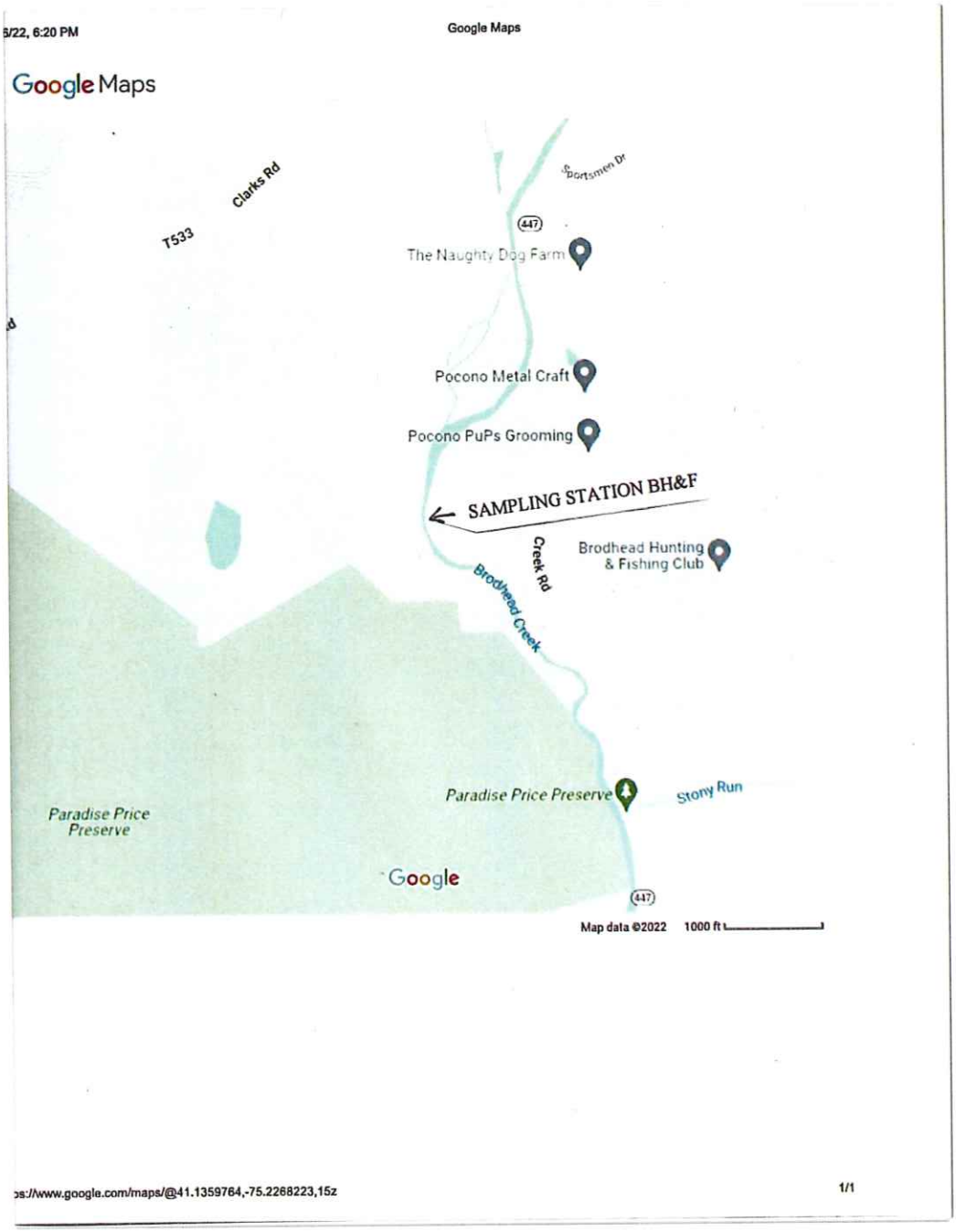


Figure 1. Macroinvertebrate sampling Station BH&F on Brodhead Creek at Brodhead Hunting and Fishing Association.

StreamStats Report

Region ID: PA
Workspace ID: PA20220416222636268000
Clicked Point (Latitude, Longitude): 41.13646, -75.23845
Time: 2022-04-16 18:27:06 -0400

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	46	square miles

Figure 2. USGS StreamStats report showing drainage area of the Brodhead Creek at Station BH&F sampled for benthic macroinvertebrates on April 16, 2022.

Figure 3. Station BH&F on Brodhead Creek sampled for benthic macroinvertebrates on April 16, 2022.

RESULTS AND DISCUSSION

Benthic Macroinvertebrate Communities

Table 3 shows the taxa, numbers, and biotic index pollution tolerance value (PT) for benthic macroinvertebrate samples from Brodhead Creek on April 16, 2022. Table 2 shows metric values and IBI scores for those samples according to DEP's 2012 protocols. For these samples, October-May stream metrics were applicable. The drainage area of 46 square miles is nearest the range (= or > 50 sq. mi.) for large stream metrics, but small stream metrics (= or < 25 sq. mi.) were also calculated as the value was between large and small stream ranges.

Table 3.
Taxa, numbers, and pollution tolerance value (PT) for benthic macroinvertebrate samples from Brodhead Creek Station BH&F on April 16, 2022.

TAXA	STATION 1	PT
Ephemeroptera (mayflies)		
Epeorus spp.	55	0
Ephemerella spp.	71	1
Drunella spp.	13	1
Seratella spp.	5	2
Eurylophella spp.	1	4
Paraleptophlebia spp.	12	1
Isonychia spp.	2	3
Baetis spp.	28	6
Diphetor spp.	1	6
Trichoptera (caddisflies)		
Rhyacophila spp.	5	1
Brachycentrus spp.	3	1
Neophylax. spp.	4	3
Ceratopsyche spp.	3	5
Cheumatopsyche spp.	3	6
Plecoptera (stoneflies)		
Pteronarcys spp.	2	0
Agnetina spp.	1	2
Paragnetina spp.	1	1
Sweltsa spp.	1	0
Diploperla spp.	1	2
Alloperla spp.	1	0
Isoperla spp.	7	2
Diptera (true flies)		
Chironomidae	13	6
Hexatoma spp.	1	2
Blepharicara spp.	4	0
Prosimulium spp.	6	2
Ephydridae	2	6
Coleoptera (beetles)	5	5
Psephenus spp.	2	4
Promoresia spp.	1	2

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK
April 16, 2022

Table 4. Macroinvertebrate community metrics and IBI scores for Brodhead Creek Station BH&F on April 16, 2022.				
Number of Grids Picked of 28	**4**			
METRIC	**LARGE STREAM**			**SMALL STREAM**
	Observed Metric Value	**Standardized Metric Score**	**Adjusted Standardized Metric Score**	**Adjusted Standardized Metric Score**
Total Taxa Richness	28	0.903	0.903	0.848
EPT Taxa Richness (PT 0-4)	17	1.063	1.000	0.895
Beck's Index	34	1.545	1.000	0.895
Hilsenhoff Biotic Index	1.91	1.164	1.000	0.998
Shannon Diversity	2.39	0.863	0.863	0.863
Percent Sensitive Individuals (PT 0-3)	78.71	1.180	1.000	0.931
Index of Biotic Integrity			**95.6**	**90.0**

The benthic macroinvertebrate sample from Brodhead H&F on April 16, 2022 had an excellent IBI score of 95.6 for large stream metrics and 90.0 for small stream metrics (Table 4). With a drainage area of 46 square miles, the large stream metrics were in the range expected in Exceptional Value waters. Macroinvertebrates were very abundant with only 4 of 28 squares picked to obtain 200+ organisms. Using large stream metrics, all metrics excepting Total Taxa Richness and Shannon Diversity scored optimally for Standardized Metric Scores. Shannon Diversity scored less than optimal due to predominance of intolerant mayfly taxa *Epeorus* and *Ephemerella* (Table 3). Species of each of these taxa are spring emergers and were prolific prior to emergence. Because of wide disparity in nymph sizes, it is likely that the genus *Epeorus* was comprised of two species, *E. plurais* and *E. vitrea*. Similarly, the genus *Ephemeralla* was likely comprised of *E. subvaria* and *E. invaria* or *E. dorothea.* Thus, actual species diveristy would be superior to the value obtained. The sample had a predominance of very intolerant taxa and individuals as reflected in the superior scores for Hilsenhoff Biotic Index and Percent Sensitive Individuals. The two metric scores that were less than optimal - Total Taxa Richness and especially Shannon Diversity would likely have been higher without the seasonal proliferation of these few intolerant taxa. It is also probable that if the macroinvertebrates had not been so numerous and more of the sample had been subsampled, more total taxa would have been found.

Habitat

Habitat was in the optimal range at the Brodhead Creek BH&F station on April 16, 2022 (Table 4). There were large pools and shallow riffles in between providing ample cover with a variety of depth regimes and velocities (Figure 3). Very little erosion was evident. Channel flow status was optimal due to recent heavy precipitation. Riparian vegetative zones were intact with a small area of mowed grass within the desired width.

Table 5. Habitat assessment of the station sampled on Brodhead Creek on April 16, 2022

Parameter	Station 1
1. Instream Cover	17
2. Epifaunal Substrate	20
3. Embeddedness	19
4. Velocity/Depth Regimes	20
5. Channel Alteration	20
6. Sediment Deposition	18
7. Frequency of Riffles	18
8. Channel Flow Status	20
9. Condition of Banks	17
10. Bank Vegetative Protection	17
11. Grazing or Other Disruptive Pressure	18
12. Riparian Vegetative Zone Width	18
TOTAL SCORE	**222**

Score Ranges: Optimal 240-192, Suboptimal 180-132, Marginal 120-72, Poor less than 60.6.0

REFERENCES

Hilsenhoff, William L. 1987. An improved biotic index of organic stream pollution. Great Lakes Entomologist. 20(1): 31-39.

Pennsylvania Department of Environmental Protection. 2012. An index of biotic integrity for benthic macroinvertebrate communities in Pennsylvania's wadeable, freestone, riffle-run streams. January 2012.

Pennsylvania Department of Environmental Protection. 2009. 2009 Assessment Methodology. Index of biological integrity for wadeable, freestone streams in Pennsylvania, and Appendix B: Taxa tolerance and trophic classification table. (draft).

Plafkin, J. L. et al. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. EPA/440/4-98/001. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, D.C. 20460.

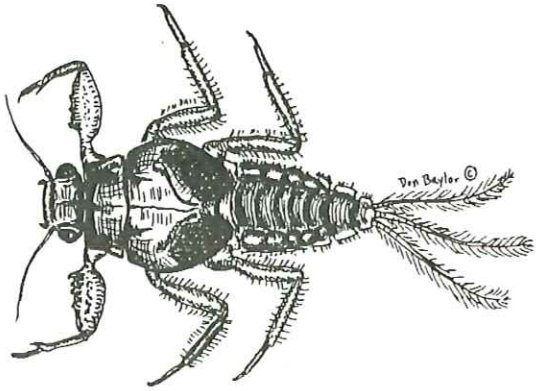
APPENDIX E

BENTHIC MACROINVERTEBRATES OF MIDDLE BRANCH CREEK

FOR

THE BRODHEAD WATERSHED ASOCIATION

APRIL 26, 2022



Submitted by:

Don Baylor

Aquatic Resource Consulting

521 Quail Ridge Lane

Stroudsburg, PA 18360

BENTHIC MACROINVERTEBRATES OF MIDDLE BRANCH CREEK.

APRIL 26, 2022

EXECUTIVE SUMMARY

On April 26, 2022, a station on Middle Branch, tributary to Brodhead Creek was sampled for benthic macroinvertebrates. The sampling station had a drainage area of 5.01 square miles. Using small stream metrics, the station had an excellent benthic macroinvertebrate Index of Biotic Integrity scores of 91.2 The sample had fewer than optimal Total Taxa Richness but a predominance of very intolerant taxa and individuals.

BACKGROUND

On April 26, 2022, at the request of the Brodhead Watershed Association, Aquatic Resource Consulting (ARC) biologists Don Baylor sampled benthic macroinvertebrates at a station on Middle Branch, a headwater tributary to Brodhead Creek at High Acres Park in Barrett Township. The purpose of this study was to evaluate the water quality and to ascertain whether the benthic macroinvertebrate population would meet PA Department of Environmental Protection (DEP) qualifications for Exceptional Value classification. Aquatic macroinvertebrates are preferred indicators of stream water quality because of their limited mobility, one to three year life cycles, and specific sensitivities to pollutants. Clean streams usually support numerous species of invertebrates, theoretically evenly represented numerically. Impairment may be indicated by low taxa richness, shifts in community balance toward dominance of pollution-tolerant forms, or overall scarcity of invertebrates (Plafkin, et al. 1989). In order to assure an accurate assessment, recent work in bio-monitoring stresses the use of several parameters, or metrics, to measure different components of the community structure.

Macroinvertebrate sampling methods followed those recommended by the US Environmental Protection Agency Protocol III (Plafkin, et al., 1989) with the latest modifications adopted by the PA Department of Environmental Protection for riffle/run freestone streams (PA DEP, 2009). At each station, six samples were taken with a D-frame kick net (Wildlife Supply Company #425-D5) of 500u nitex from the best riffle/run areas in a one hundred meter stretch. Samples were taken by placing the net against the substrate and disturbing approximately one square meter above the net by foot for one minute. Organisms and debris were composited for the station in a plastic container and preserved in alcohol for transport to the laboratory. Habitat was evaluated at each station using DEP's Water Quality Network Habitat Assessment forms for streams with riffle/run prevalence. Twelve habitat parameters were ranked on a scale of 1-20 and combined for a total habitat score.

BENTHIC MACROINVERTEBRATES OF MIDDLE BRANCH CREEK.

In the laboratory, samples were rinsed in a USGS No. 35 sieve and placed in a white pan marked with a grid to delineate 28 squares measuring two inches on a side. Organisms were then picked from randomly selected grids until 200 organisms +/- 20% were obtained. Organisms were identified to the lowest taxonomic level practicable, enumerated, and assigned a pollution tolerance value (PA DEP, 2009). Metrics for riffle/run freestone streams were calculated for each subsample, including Total Taxa Richness, Ephemeroptera + Plecoptera + Trichoptera Taxa Richness (EPT), Modified Beck's Index, , Hilsenhoff Biotic Index, Shannon Diversity Index, , and Percent Sensitive Individuals. A description and brief rationale for each of the metrics follow:

1. **Total Taxa Richness** – is an index of diversity. The number of taxa (kinds) of invertebrates indicates the health of the benthic community through measurement of the variety of species present. Generally, number of species increases with increased water quality. However, variability in natural habitat (stream order and size, substrate composition, current velocity) also affects this number.

2. **Ephemeroptera, Plecoptera, and Trichoptera Taxa Richness (PTV 1-4)** Mayflies, stoneflies, and caddisflies, collectively referred to as EPT, are generally considered pollution sensitive (Plafkin et al. 1989). Thus, the total number of taxa within the EPT insect groups is used to evaluate community balance. This metric has been modified to include only the EPT taxa with pollution tolerance values of 1-4. Healthy biotic conditions are reflected when these taxa are well represented in the benthic community.

3. **Modified Beck's Index** is a weighted count of taxa with pollution tolerance values of 0, 1, or 2. This metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of pollution sensitive taxa. It is calculated by multiplying by 3 the number of taxa with a pollution tolerance value of 0, multiplying by 2 the number of taxa with a pollution tolerance value of 1, and multiplying by 1 the number of taxa with a pollution tolerance value of 2. The three values are added to yield the Modified Beck's Index score.

4. **Hilsenhoff Biotic Index** – is a direct measure of organic pollution in streams. The biotic index value is the mean tolerance value of all organisms in a sample. Tolerance values range from 0.00 to 10.00; the higher the value, the greater the level of pollution indicated.

Table 1.
Evaluation of water quality using biotic index values (Hilsenhoff, 1987)

BIOTIC INDEX	WATER QUALITY	DEGREE OF ORGANIC POLLUTION
0.00-3.50	Excellent	None Apparent
3.51-4.50	Very Good	Possible Slight
4.51-5.50	Good	Some
5.51-6.50	Fair	Fairly Significant
6.51-7.50	Fairly Poor	Significant
7.51-8.50	Poor	Very Significant
8.51-10.00	Very Poor	Severe

5. **Shannon Diversity Index** measures taxonomic richness and evenness of numbers of individuals across the taxa of a subsample. This metric is expected to decrease in values with increased anthropogenic stress to a stream ecosystem, reflecting loss of pollution-sensitive taxa and predominance of a few pollution-tolerant taxa.

6. **Percent Sensitive Individuals** is the percentage of individuals in the subsample with pollution tolerance values of 0-3. It is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem.

INDEX CALCULATION

An overall index is used to integrate information from these various metrics and standardize them into one score for a subsample. The values for any standardized core metric are set to a maximum value of 1.00, with values closer to zero corresponding to increasing deviation from the expected reference condition and progressively higher values corresponding more closely to the biological reference condition. The adjusted standardized metric values for the six core metrics are averaged and multiplied by 100 to produce an index score ranging from 0-100. This number represents the index of biotic integrity (IBI) score for a sample. The following table shows metric standardization equations and index calculations for the sub-sample from the station on Middle Branch tributary to Brodhead Creek using small stream metrics.

BENTHIC MACROINVERTEBRATES OF MIDDLE BRANCH CREEK.

Table 2.
Metric standardization and Index of Biotic Integrity calculations for the benthic macroinvertebrate sample from the station on Middle Branch tributary to Brodhead Creek on April 26, 2022.

Metric	Standardization Equation - Large Stream	Observed Metric Value	Standardized Metric Score	Adjusted Standardized Metric Score Maximum =1.00
Total Taxa Richness	Observed value / 33	27	0.818	0.818
EPT Taxa Richness	Observed Value/ 19	18	0.847	0.847
Modified Beck's Index	Observed value/38	44	1.158	1.000
Hilsenhoff Biotic Index	10-observed value/ (10-1.89)	2.06	0.979	0.979
Shannon Diversity Index	Observed value / 2.86	2.45	0.857	0.857
Percent Sensitive Individuals	Observed value / 84.5	73.61	0.897	0.897
Average of adjusted standardized core metric scores x 100 = IBI score				**91.2**

Sampling Station

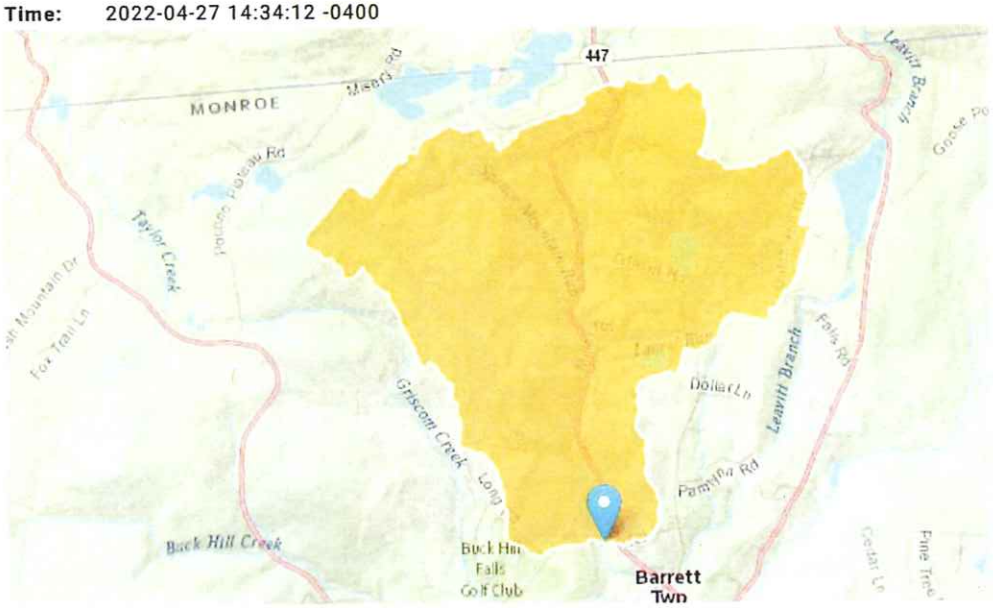
One station was sampled for benthic macroinvertebrates on Middle Branch tributary to Brodhead Creek on April 26, 2022 (Figures 1 and 3). The station had a drainage area of 5.01 square miles (Figure 2). The location was as follows:

Station on Middle Branch at High Acre Park – Approximately 1,067 meters upstream of its confluence with the Leavitt Branch and Buck Hill Creek at lat. 41. 20174, lon. -75.26534.

Figure 1. Macroinvertebrate sampling station on Middle Branch, headwater tributary to Brodhead sampled on April 26,

StreamStats Report

Region ID: PA
Workspace ID: PA20220427183342561000
Clicked Point (Latitude, Longitude): 41.20174, -75.26534
Time: 2022-04-27 14:34:12 -0400



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	5.01	square miles

Figure 2. USGS StreamStats report showing drainage area of Middle Branch Creek Station sampled for benthic macroinvertebrates on April 26, 2022.

BENTHIC MACROINVERTEBRATES OF MIDDLE BRANCH CREEK.
APRIL 26, 2022

Figure 3. Photograph of the station sampled for benthic macroinvertebrates on Middle Branch, April 26, 2022.

BENTHIC MACROINVERTEBRATES OF MIDDLE BRANCH CREEK. APRIL 26, 2022

RESULTS AND DISCUSSION

Benthic Macroinvertebrate Communities

Table 3 shows the taxa, numbers, and biotic index pollution tolerance value (PT) for benthic macroinvertebrate samples from Middle Branch on April 26, 2022. Table 2 shows metric values and IBI scores for those samples according to DEP's 2012 protocols. For these samples, October-May stream metrics were applicable. With the station having a drainage area of only 5.01 square miles, small stream (= or < 25 square miles) metrics were applied.

Table 3.
Taxa, numbers, and pollution tolerance value (PT) for benthic macroinvertebrate samples from Middle Branch headwater tributary to Brodhead Creek April 26, 2022.

TAXA	STATION 1	PT
Ephemeroptera (mayflies)		
Epeorus spp.	59	0
Cinygmula spp.	10	1
Ameletus spp.	7	0
Ephemerella spp.	12	1
Seratella spp.	1	2
Paraleptophlebia spp.	29	1
Baetis spp.	40	6
Diphetor spp.	6	6
Trichoptera (caddisflies)		
Rhyacophila spp.	2	1
Diplectrona spp.	5	0
Parapsyche spp.	1	0
Dolophilodes spp.	3	0

BENTHIC MACROINVERTEBRATES OF MIDDLE BRANCH CREEK.
APRIL 26, 2022

Table 3. continued		
Plecoptera (stoneflies)		
Pteronarcys spp.	**2**	**0**
Agnetina spp.	**1**	**2**
Tallaperla spp.	**1**	**0**
Amphinemura spp.	**1**	**3**
Sweltsa spp.	**2**	**0**
Beloneuria spp.	**1**	**3**
Leuctra spp.	**1**	**0**
Isoperla spp.	**2**	**2**
Diptera (true flies)		
Chironomidae	**8**	**6**
Hexatoma spp.	**7**	**2**
Blepharicara spp.	**1**	**0**
Prosimulium spp.	**8**	**2**
Simulium spp.	**3**	**6**
Antocha spp.	**1**	**3**
Coleoptera (beetles)	**5**	**5**
Promoresia spp.	**2**	**2**

Dispite some disparity in metric scores, the overall Index of Biotic Integrity score for the Middle Branch headwater to Brodhead Creek was 91.2 (Table 2). The benthic macroinvertebrate sample had an abundance of intolerant taxa expected in small, cold headwater streams, including *Ameletus, Cinygmula, Diplectrona, Parapsyche, Pteronarcys*, and *Tallaperla* (Table 3). Of the generally intolerant EPT groups, Ephemeroptera and Plecoptera were represented by numerous taxa. Trichoptera were represented by only 4 taxa, but these were all very intolerant. The optimal Beck's Index score and near optimal Hilsenhoff Biotic Index score reflect the excellent numbers of highly intolerant taxa and individuals in the sample. The less than optimal score for Shannon Diversity was a result of high numbers of *Epeorus* and *Baetis* mayflies, which are spring emergers typically prolific just prior to emergence. *Epeorus spp.* are very intolerant while *Baetis spp*. are moderately tolerant (Table 3).

BENTHIC MACROINVERTEBRATES OF MIDDLE BRANCH CREEK. APRIL 26, 2022

Macroinvertebrates were very abundant in Middle Branch. In the first 4 of 28 grids subsampled, well over the desired 200 plus twenty percent were obtained so that organisms from 4 grids had to be put in another pan and 22 of 28 grids picked to reduce the number. The sample metrics reflected a population of very abundant and intolerant organisms, but with fewer than optimal taxa. The distribution of numbers across taxa resulted in less than optimal Shannon Diversity due to high numbers of two taxa prior to spring emergence.

Habitat

The Middle Branch tributary to Brodhead Creek is a small headwater stream. Middle Branch, Buck Hill Creek, and Leavitt Branch join above Canadensis, PA in Barrett Township to form the beginning of Brodhead Creek. Habitat was in the optimal range (Table 4). It flows through natural habitat with wooded riparian areas near the sampling station.. Riffle habitat for macroinvertebrate sampling was abundant with some deeper pools providing diversity of depth and flow. Nearer the mouth, there are some private residences adjacent to the stream.

Table 4.
Habitat assessment of the station sampled on Brodhead Creek on April 16, 2022

Parameter	Station 1
1. Instream Cover	17
2. Epifaunal Substrate	20
3. Embeddedness	19
4. Velocity/Depth Regimes	18
5. Channel Alteration	19
6. Sediment Deposition	18
7. Frequency of Riffles	18
8. Channel Flow Status	20
9. Condition of Banks	17
10. Bank Vegetative Protection	16
11. Grazing or Other Disruptive Pressure	19
12. Riparian Vegetative Zone Width	18
TOTAL SCORE	**219**
Score Ranges: Optimal 240-192, Suboptimal 180-132, Marginal 120-72, Poor less than 60.6.0	

REFERENCES

Hilsenhoff, William L. 1987. An improved biotic index of organic stream pollution. Great Lakes Entomologist. 20(1): 31-39.

Pennsylvania Department of Environmental Protection. 2012. An index of biotic integrity for benthic macroinvertebrate communities in Pennsylvania's wadeable, freestone, riffle-run streams. January 2012.

Pennsylvania Department of Environmental Protection. 2009. 2009 Assessment Methodology. Index of biological integrity for wadeable, freestone streams in Pennsylvania, and Appendix B: Taxa tolerance and trophic classification table. (draft).

Plafkin, J. L. et al. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. EPA/440/4-98/001. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, D.C. 20460.

APPENDIX F

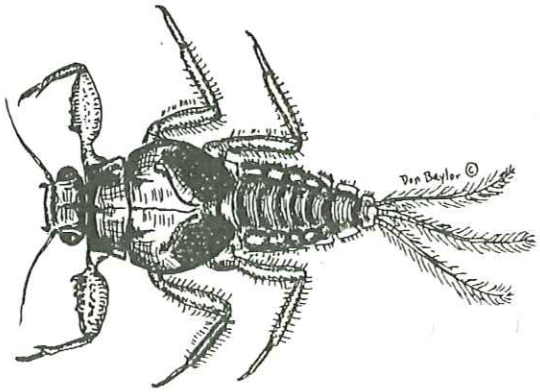
BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK

BELOW POPLAR RUN TRIBUTARY

FOR

THE BRODHEAD WATERSHED ASOCIATION

MAY 10 , 2022



Submitted by:

Don Baylor

Aquatic Resource Consulting

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BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK BELOW POPLAR RUN MAY 10, 2022

EXECUTIVE SUMMARY

On May 10, 2022, a station on Brodhead Creek below Poplar Run was sampled for benthic macroinvertebrates. The sampling station had a drainage area of 61.2 square miles. Using large stream metrics, the station had an excellent benthic macroinvertebrate Index of Biotic Integrity score of 93.8 The sample had optimal metric scores for Total Taxa Richness, EPT Taxa Richness, Beck's Index, and Hilsenhoff biotic Index. Percent Sensitive Individuals scored lower because of a predominance of a moderately tolerant taxon.

BACKGROUND

On May 10, 2022, at the request of the Brodhead Watershed Association, Aquatic Resource Consulting (ARC) biologists Don Baylor sampled benthic macroinvertebrates at a station on Brodhead Creek below the Poplar Run tributary. The purpose of this study was to evaluate the water quality downstream of an area subject to future development and an area zoned industrial. Aquatic macroinvertebrates are preferred indicators of stream water quality because of their limited mobility, one to three year life cycles, and specific sensitivities to pollutants. Clean streams usually support numerous species of invertebrates, theoretically evenly represented numerically. Impairment may be indicated by low taxa richness, shifts in community balance toward dominance of pollution-tolerant forms, or overall scarcity of invertebrates (Plafkin, et al. 1989). In order to assure an accurate assessment, recent work in bio-monitoring stresses the use of several parameters, or metrics, to measure different components of the community structure.

Macroinvertebrate sampling methods followed those recommended by the US Environmental Protection Agency Protocol III (Plafkin, et al., 1989) with the latest modifications adopted by the PA Department of Environmental Protection for riffle/run freestone streams (PA DEP, 2009). At each station, six samples were taken with a D-frame kick net (Wildlife Supply Company #425-D5) of 500u nitex from the best riffle/run areas in a one hundred meter stretch. Samples were taken by placing the net against the substrate and disturbing approximately one square meter above the net by foot for one minute. Organisms and debris were composited for the station in a plastic container and preserved in alcohol for transport to the laboratory. Habitat was evaluated at each station using DEP's Water Quality Network Habitat Assessment forms for streams with riffle/run prevalence. Twelve habitat parameters were ranked on a scale of 1-20 and combined for a total habitat score.

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK BELOW POPLAR RUN MAY 10, 2022

In the laboratory, samples were rinsed in a USGS No. 35 sieve and placed in a white pan marked with a grid to delineate 28 squares measuring two inches on a side. Organisms were then picked from randomly selected grids until 200 organisms +/- 20% were obtained. Organisms were identified to the lowest taxonomic level practicable, enumerated, and assigned a pollution tolerance value (PA DEP, 2009). Metrics for riffle/run freestone streams were calculated for each subsample, including Total Taxa Richness, Ephemeroptera + Plecoptera + Trichoptera Taxa Richness (EPT), Modified Beck's Index, , Hilsenhoff Biotic Index, Shannon Diversity Index, , and Percent Sensitive Individuals. A description and brief rationale for each of the metrics follow:

1. **Total Taxa Richness** – is an index of diversity. The number of taxa (kinds) of invertebrates indicates the health of the benthic community through measurement of the variety of species present. Generally, number of species increases with increased water quality. However, variability in natural habitat (stream order and size, substrate composition, current velocity) also affects this number.

2. **Ephemeroptera, Plecoptera, and Trichoptera Taxa Richness (PTV 1-4)** Mayflies, stoneflies, and caddisflies, collectively referred to as EPT, are generally considered pollution sensitive (Plafkin et al. 1989). Thus, the total number of taxa within the EPT insect groups is used to evaluate community balance. This metric has been modified to include only the EPT taxa with pollution tolerance values of 1-4. Healthy biotic conditions are reflected when these taxa are well represented in the benthic community.

3. **Modified Beck's Index** is a weighted count of taxa with pollution tolerance values of 0, 1, or 2. This metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of pollution sensitive taxa. It is calculated by multiplying by 3 the number of taxa with a pollution tolerance value of 0, multiplying by 2 the number of taxa with a pollution tolerance value of 1, and multiplying by 1 the number of taxa with a pollution tolerance value of 2. The three values are added to yield the Modified Beck's Index score.

4. **Hilsenhoff Biotic Index** – is a direct measure of organic pollution in streams. The biotic index value is the mean tolerance value of all organisms in a sample. Tolerance values range from 0.00 to 10.00; the higher the value, the greater the level of pollution indicated.

Table 1.
Evaluation of water quality using biotic index values (Hilsenhoff, 1987)

BIOTIC INDEX	WATER QUALITY	DEGREE OF ORGANIC POLLUTION
0.00-3.50	Excellent	None Apparent
3.51-4.50	Very Good	Possible Slight
4.51-5.50	Good	Some
5.51-6.50	Fair	Fairly Significant
6.51-7.50	Fairly Poor	Significant
7.51-8.50	Poor	Very Significant
8.51-10.00	Very Poor	Severe

5. **Shannon Diversity Index** measures taxonomic richness and evenness of numbers of individuals across the taxa of a subsample. This metric is expected to decrease in values with increased anthropogenic stress to a stream ecosystem, reflecting loss of pollution-sensitive taxa and predominance of a few pollution-tolerant taxa.

6. **Percent Sensitive Individuals** is the percentage of individuals in the subsample with pollution tolerance values of 0-3. It is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem.

INDEX CALCULATION

An overall index is used to integrate information from these various metrics and standardize them into one score for a subsample. The values for any standardized core metric are set to a maximum value of 1.00, with values closer to zero corresponding to increasing deviation from the expected reference condition and progressively higher values corresponding more closely to the biological reference condition. The adjusted standardized metric values for the six core metrics are averaged and multiplied by 100 to produce an index score ranging from 0-100. This number represents the index of biotic integrity (IBI) score for a sample. The following table shows metric standardization equations and index calculations for the sub-sample from the station on Brodhead Creek below Poplar Run using large stream metrics.

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK BELOW POPLAR RUN MAY 10, 2022

Table 2.
Metric standardization and Index of Biotic Integrity calculations for the benthic macroinvertebrate sample from the station on Brodhead Creek below Poplar Run on may 10, 2022.

Metric	Standardization Equation - Large Stream	Observed Metric Value	Standardized Metric Score	Adjusted Standardized Metric Score Maximum =1.00
Total Taxa Richness	Observed value / 33	35	1.129	1.000
EPT Taxa Richness	Observed Value/ 19	21	1.313	1.000
Modified Beck's Index	Observed value/38	40	1.818	1.000
Hilsenhoff Biotic Index	10-observed value/ (10-1.89)	2.96	1.013	1.000
Shannon Diversity Index	Observed value / 2.86	2.56	0.895	0.895
Percent Sensitive Individuals	Observed value / 84.5	49.0	0.735	0.735
Average of adjusted standardized core metric scores x 100 = IBI score				**93.8**

Sampling Station

One station was sampled for benthic macroinvertebrates on Brodhead Creek on May 10, 2022 (Figure 1). The station had a drainage area of 61.2 square miles (Figure 2). The location was as follows:

Station on Brodhead Creek below Poplar Run (sometimes named Laurel Run) – at lat. 41. 11318, lon. -75.22249.

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK BELOW POPLAR RUN MAY 10, 2022

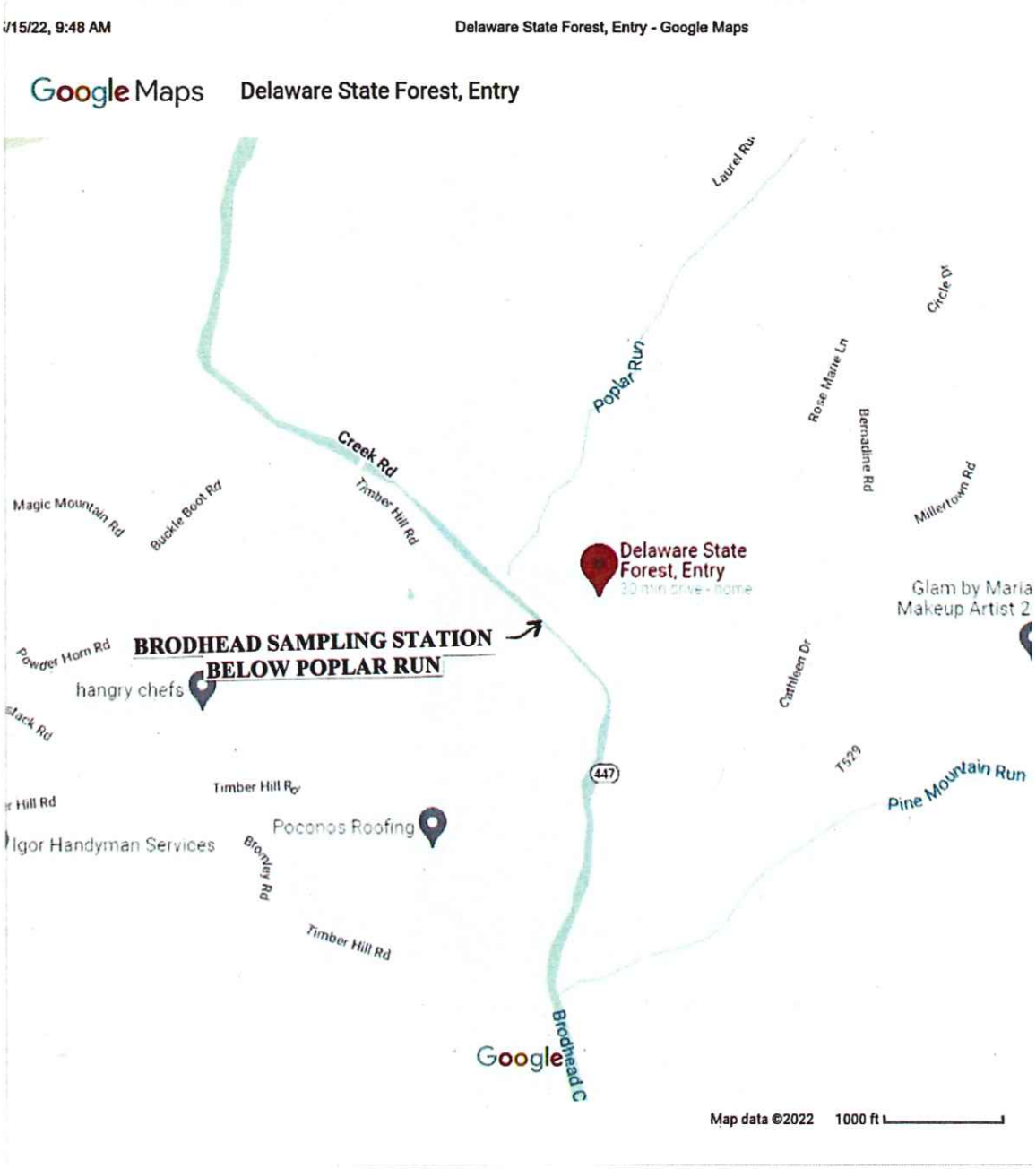
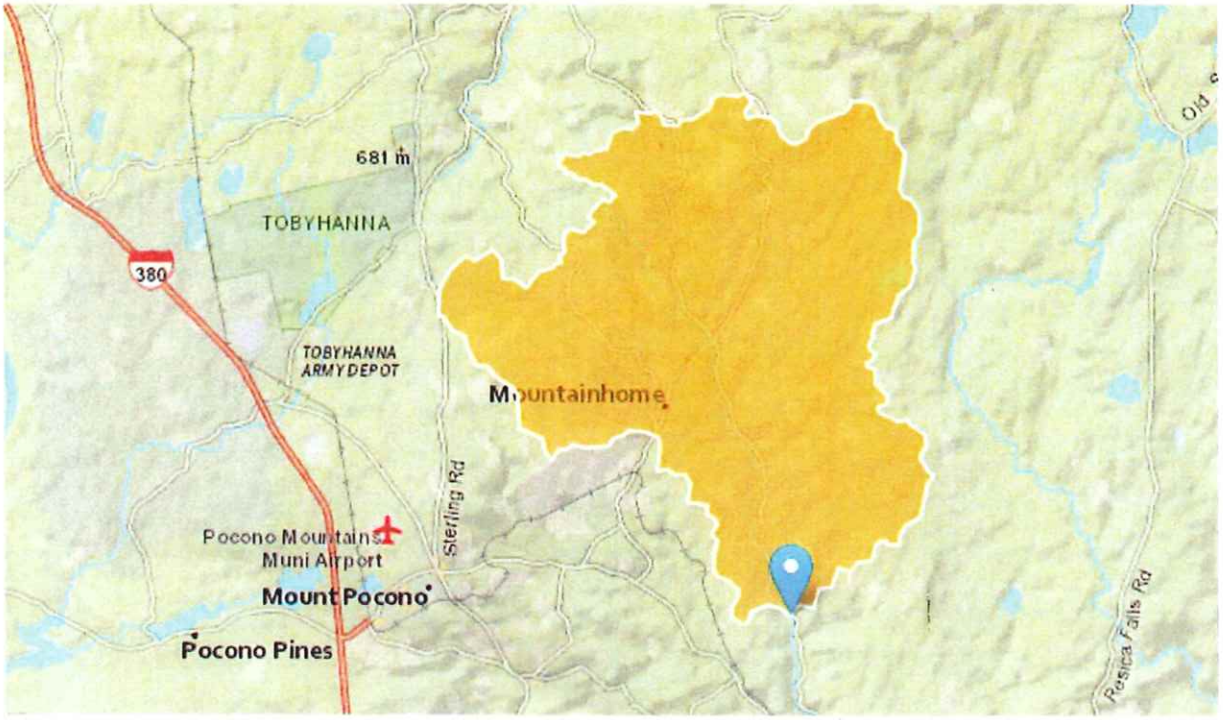


Figure 1. Macroinvertebrate sampling station on Brodhead Crek below Poplar Run on May 10, 2022

StreamStats Report

Region ID: PA
Workspace ID: PA20220512012922491000
Clicked Point (Latitude, Longitude): 41.11318, -75.22249
Time: 2022-05-11 21:29:45 -0400



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	61.2	square miles

Figure 2. USGS StreamStats report showing drainage area (61.2 square Miles) of Brodhead Creek Station sampled for benthic macroinvertebrates on May 10, 2022.

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK BELOW POPLAR RUN MAY 10, 2022

RESULTS AND DISCUSSION

Table 3 shows the taxa, numbers, and biotic index pollution tolerance value (PT) for benthic macroinvertebrate samples from Brodhead Creek on May 10, 2022. Table 2 shows metric values and IBI scores for those samples according to DEP's 2012 protocols. For these samples, October-May stream metrics were applicable. With the station having a drainage area of 61.2 square miles, large stream (= or > 50 square miles) metrics were applied.

Table 3.
Taxa, numbers, and pollution tolerance value (PT) for benthic macroinvertebrate samples from Brodhead Creek below Poplar Run on May 10, 2022

TAXA	STATION 1	PT
Ephemeroptera (mayflies)		
Epeorus spp.	16	0
Ameletus spp.	1	0
Ephemerella spp.	47	1
Drunella spp.	9	1
Seratella spp.	4	2
Baetis spp.	7	6
Diphetor spp.	1	6
Maccaffertium spp.	2	3
Isonychia spp.	2	3
Paraleptophlebia spp.	3	1
Cinygmula spp.	1	1
Acentrella spp.	56	4
Trichoptera (caddisflies)		
Pycnopsyche spp.	1	4
Diplectrona spp.	4	0
Hydropsyche spp.	3	5
Cheumatopsyche spp.	2	6
Brachycentrus spp.	1	1
Helicopsyche spp.	2	3
Lepidostoma spp.	1	1
Agapetus spp.	1	0
Polycentropus spp.	3	6

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK BELOW POPLAR RUN MAY 10, 2022

Table 3. continued		
Plecoptera (stoneflies)		
Pteronarcys spp.	**1**	**0**
Agnetina spp.	**1**	**2**
Leuctridae	**1**	**0**
Arcynopteryx spp.	**1**	**2**
Sweltsa spp.	**4**	**0**
Diptera (true flies)		
Chironomidae	**20**	**6**
Hexatoma spp.	**1**	**2**
Clinocera spp.	**1**	**6**
Prosimulium spp.	**1**	**2**
Simulium spp.	**9**	**6**
Atheryx spp.	**1**	**2**
Coleoptera (beetles)	**5**	**5**
Psephenus spp.	**3**	**4**
Megaloptera (Helgrammites)		
Nigronia spp.	**1**	**2**
Oligochaeta (aquatic earthworms)	**2**	**10**

The benthic macroinvertebrate sample from Brodhead Creek below Poplar Run had an Index of Biotic Integrity score of 93.8. This is in the range of IBI scores expected in Exceptional Value Pennsylvania waters. The sample had outstanding Standardized Metric Scores (greater than 1.000) for Total Taxa Richness, EPT Taxa Richness, Beck's Index, and Hilsenhoff Biotic Index (Table 2). The only less than optimal metric scores were for Shannon Diversity and Percent Sensitive Individuals. These two scores were influenced by a proliferation of one moderately tolerant mayfly taxon *Acentrella* with a pollution tolerance value of 4 (Table 3).. Except for this taxon, numbers in the sample were well balanced with a predominance of intolerant taxa. There were numerous mayfly and caddisfly taxa, mostly intolerant. The predominance of *Acentrella* mayflies is somewhat unusual in exceptional quality spring samples. The next most numerous *Ephemerella* mayflies are more common in spring samples.

BENTHIC MACROINVERTEBRATES OF BRODHEAD CREEK BELOW POPLAR RUN MAY 10, 2022

Habitat

The Brodhead Creek below Poplar Run had optimal habitat (Table 4). Flows were high from recent precipitation. Banks were in good condition and velocity and depth were varied. There was slight embeddednesss with some substrate difficult to overturn. Riparian Zone Width was less than optimal because of the close proximity of Route 447 Paralleling the stream.

Table 4.
Habitat assessment of the station sampled on Brodhead Creek on April 16, 2022

Parameter	Station 1
1. Instream Cover	17
2. Epifaunal Substrate	20
3. Embeddedness	16
4. Velocity/Depth Regimes	18
5. Channel Alteration	19
6. Sediment Deposition	18
7. Frequency of Riffles	18
8. Channel Flow Status	20
9. Condition of Banks	18
10. Bank Vegetative Protection	16
11. Grazing or Other Disruptive Pressure	16
12. Riparian Vegetative Zone Width	13
TOTAL SCORE	**209**
Score Ranges: Optimal 240-192, Suboptimal 180-132, Marginal 120-72, Poor less than 60.6.0	

REFERENCES

Hilsenhoff, William L. 1987. An improved biotic index of organic stream pollution. Great Lakes Entomologist. 20(1): 31-39.

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Plafkin, J. L. et al. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. EPA/440/4-98/001. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, D.C. 20460.

APPENDIX G

ELECTROFISHING SURVEY OF BRODHEAD CREEK

ON THE DEIBLER SECTION OF PARKSIDE ANGLING ASSOCIATION

OCTOBER 9, 2020

Aquatic Resource Consulting

521 Quail Ridge Lane

Stroudsburg, PA 18360

ELECTROFISHING AT PARKSIDE ANGLING ASSOCIATION
OCTOBER 9, 2020

On October 9, 2020, Aquatic Resource Consulting biologists Don Baylor and Chris Hartzler, with assistance from Don Miller and Dave Moore conducted an electrofishing survey at one site on Brodhead Creek on an upper portion of the Deibler stretch of Parkside Angling Association water.

METHODS

The fish communities were sampled using a backpack Smith-Root electrofishing unit with a handheld probe and nets. Electrofishing is a sampling method. It is not possible to capture all fish with this method. A length of unblocked stream was sampled to determine fish assemblage. Wild and stocked trout were weighed and measured and released unharmed. Sufficient trout were collected in one pass to warrant a subsequent pass to estimate total biomass of trout collected. Other fish species were identified and rated as abundant, common, or rare.

Wild trout were distinguished from stocked trout by condition of fins, especially pectoral fins, overall configuration and condition, and coloration. Stocked trout generally have eroded or misshapen pectoral fins. Even stocked trout that have held over from one season to the next generally exhibit some pectoral fin atrophy.

SAMPLING STATIONS

The station sampled began at the tail of the first pool above the Havelick Pool with the large boulder in the middle and progressed upstream for 482 feet around a bend at the head of a pool containing a large fallen tree with a deep scour around the root wad (Figure 1). this stretch was chosen to be representative of a variety of stream features covering some riffles and cover structures such as undercut root masses, fallen trees, and boulders. Larger, deeper pools were avoided because the electrofishing unit can not be used in deep water. Sensors on the bottom of the back pack unit shut the unit off if they become wet. In addition larger pools can not be sampled efficiently as fish can too easily escape and avoid being exposed to the current.

ELECTROFISHING AT PARKSIDE ANGLING ASSOCIATION
OCTOBER 9, 2020

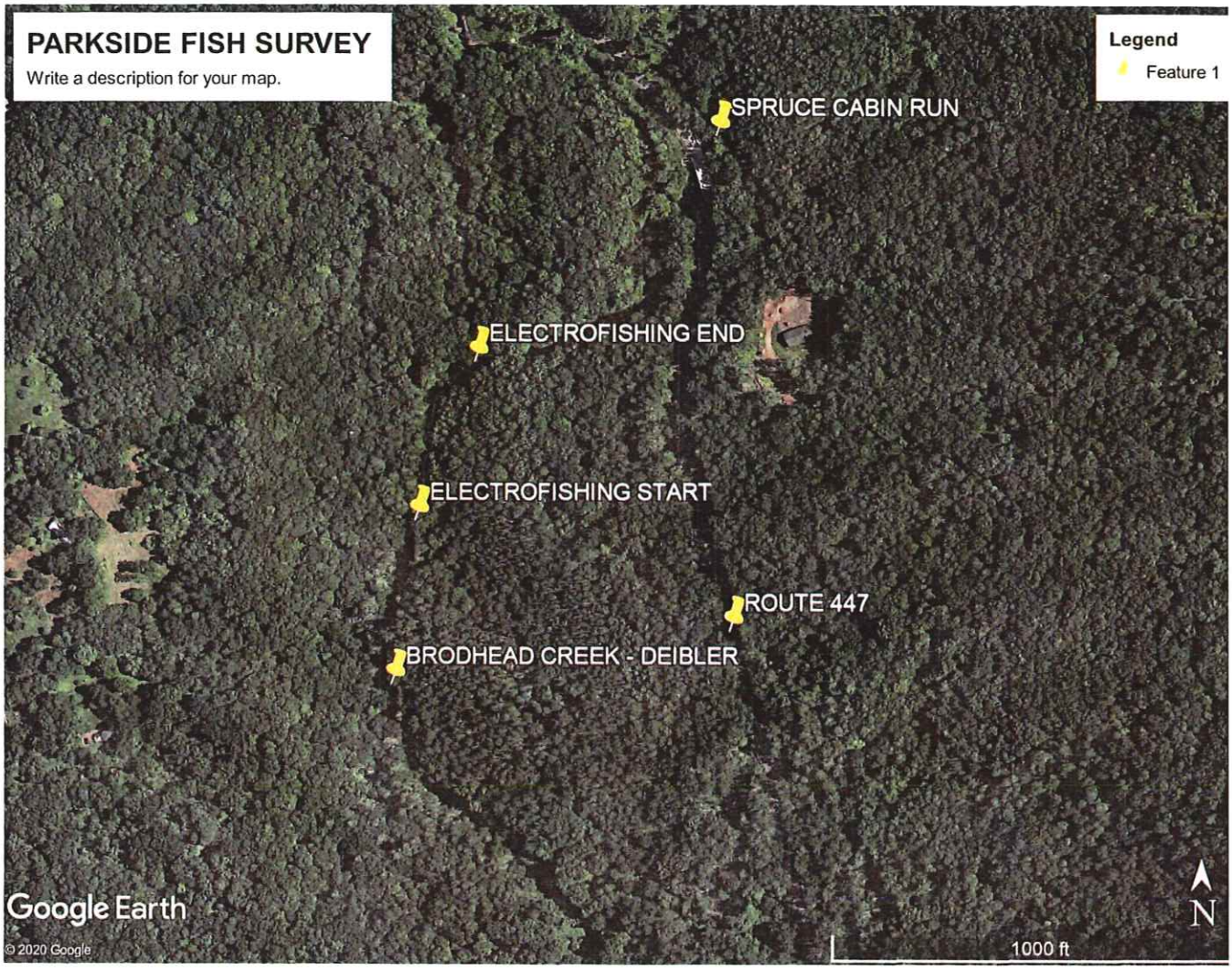

Figure 1. Fish sampling Station on the Deibler section Brodhead Creek at Parkside Angling Association.

ELECTROFISHING AT PARKSIDE ANGLING ASSOCIATION
OCTOBER 9, 2020

GENERAL DISCUSSION

Two electrofishing passes were conducted in a 482 foot section of the Brodhead Creek on the Deibler section of Parkside Angling Association. Time for fish processing and available daylight precluded a third pass. In the two passes,78 trout were collected, anesthetized, weighed and measured. A total of 43 trout were collected on the first pass and 35 on the second. Of the 78 trout captured, 9 were judged to be stocked, of which 6 were browns (*Salmo trutta*) and 3 rainbows (*Oncorhynchus mykiss*). Of the wild trout collected, 3 were young-of-year brook trout (*Salvelinus fontinalis*), and all others were brown trout. Of the wild trout collected, 37 were young-of-year, constituting 47.3 percent of trout collected. The number of young-of-year was evidence of excellent natural reproduction. Larger trout were associated with good cover consisting of depth, undercut root masses, large boulders, and trees fallen in the stream.

Of the trout collected, 20 would be considered by fisheries managers to be catchable-size (>10 inches). Two large brown trout 19.1 and 17.3 inches long were captured. They appeared to be wild and were included as such. Because more trout in two age classes were collected on the second pass than on the first, an estimate of total biomass was not possible. However the biomass of wild trout collected in the two passes was 35.2 Kilograms per hectare (kg/ha) or 32 pounds per acre. With the stocked trout included, the biomass was 43.4 kg/hectare. The Pennsylvania Fish & Boat Commission standard for Class A wild brown trout is 40 kg/ha (35.6 lbs./acre).

It is possible that if it had been feasible to estimate the total wild brown trout biomass, this section of the Brodhead Creek would qualify as Class A Wild Brown Trout Fishery by Pennsylvania Fish & Boat Commission standards. Several age classes were present and young-of-year brown trout were abundant. The abundances and variety of sizes and year classes is representative of a well balanced trout population. The number of larger catchable-size trout suggest that a sufficient population exists to support an excellent sport fishery.

ELECTROFISHING AT PARKSIDE ANGLING ASSOCIATION
OCTOBER 9, 2020

FISH SURVEY DATA

Sampled: length - 480 feet; mean width - 41 feet
Area - 0.45 acres or 0.18 hectares

Trout collected on two consecutive runs

Wild brown trout - 66

wild brook trout - 3 (all young-of-year)

Stocked brown trout - 6

Stocked rainbow trout - 3

Total biomass of wild brown trout collected - 35.2 kg/ha (32.4 lbs/acre)
(not an estimate of total biomass of the stream segment)

Age and length of wild brown trout (from length-frequency distribution)

Age	Average length - mm (in.)	Range - mm (in.)
0+	107 (4.2)	82-121 (3.2-4.8)
1+	188 (7.4)	150-244 (5.9-9.6)
2+	328 (12.9)	292-2360 (11.4-14.2)

Stocked trout length

Brown trout - 351-420 mm (14.8 - 16.5 in.)

Rainbow trout - 340-370 mm (13.4 - 14.6)

Two largest brown trout

485 mm (19.1 in) - 1018 g (2.2 lbs.)

439 mm (17.3 in) - 787 g (1.7 lbs.)

ELECTROFISHING AT PARKSIDE ANGLING ASSOCIATION
OCTOBER 9, 2020

OTHER FISH SPECIES COLECTED

eastern blacknose dace (*Rhinichthys atratulus*) - abundant
Blacknose dace are small to medium-sized minnows with a usually prominent lateral dark band. They typically inhabiting small, cool mountain streams over gravel or boulder substrates. They are usually found in the slower margins and pools

longnose dace (*Rhinichthys cataractae*)- present
Longnose dace are medium-sized minnows generally growing larger than blacknose dace. They lack the dark lateral band of the blacknose dace. They are generally found in small creeks to medium-sized rivers over rocky substrates. Adults inhabit the swifter currents.

white sucker (*Catostomis commersonii*)- present
These are small to medium-sized suckers common and widespread in all Pennsylvania drainages. They occupy a wide range of habitats. In streams they are most common in pools and slower runs.

American eel (*Anguilla rostrata*) - abundant
Eels in Pennsylvania waters are usually the immature phase. When they reach maturity up to 1,000+ mm in length, they migrate to spawn in the Atlantic Ocean in the vicinity of the Sargasso Sea.

tesselated darter (*Etheostoma olmstedi*) - present
Tesselated darters are common in the Delaware drainage. They inhabit small creeks to large rivers usually in slower currents. They range in size up to 70 mm in length.

ELECTROFISHING AT PARKSIDE ANGLING ASSOCIATION
OCTOBER 9, 2020

COMPARISON TO PAST FISH SAMPLING

Two previous electrofishing surveys were conducted in the Havelick area of the Deibler section of Parkside Angling Association . Each involved only one electrofishing pass through a designated length of stream. The section was surveyed by Aquatic Resource Consulting in 1997 and in 2008. Strict comparison is difficult because of varying stream conditions and possible variations in electrofishing effort. However the 2020 survey was completed after a protracted period of low flows and very warm weather. One factor that may have been beneficial to the trout population in 2020 was that it followed a mild winter.

In the 2020 survey of this stream section, a different stream length was surveyed than in 1997 and 2008. Both previous surveys covered 540 feet and the 2020 survey covered 482 feet. The following table shows the data comparison using just the first electrofishing pass for 2020.

Table 1.
Trout survey data from the Deibler section of Parkside Angling Association water on Brodhead Creek in 1997, 2008, and 2020.

YEAR	STREAM LENGTH	WILD BROWN TROUT				STOCKED TROUT
		<5 IN.	5-10 IN.	>10 IN.	TOTAL NUMBER	TOTAL NUMBER
1997	540'	23	9	4	36	1
2008	540'	11	33	9	53	4
2020	482'	19	12	11	42	5
2020 +11%	89% of 540	21	13	12	47	6

The October 2020 survey covered less stream length than the previous surveys in the same area. Nevertheless, the results compare favorably in many areas. Given the percentage of stream covered, young-of-year were more abundant than in 2008 and comparable to 1997. Trout in the 5-10 inch range were more abundant than in1997 but fewer than in 2008. Catchable-size trout over 10 inches and stocked trout were more abundant than in both previous surveys despite representing less stream length.

APPENDIX H

BRODCR27R

Location	170 meters northeast of Pasold Farm Dr. parking area.		
Site #	2020-5	Date	4/29/2020
Stream Name	Brodhead Creek	Time	9:13:00 AM
Township	Barrett	Latitude	41.180941
Habitat Asmt.	208	Longitude	-75.25091

Field Measurements	
Temp C	7.9
pH	7.05
Press inHg	
DO Percent	100.1
DO mg/L	11.88
Cond (uS/cm)	58

Macroinvertebrate Metrics	
Total Taxa	32
Shannon Diversity Index	2.69
EPT Taxa Richness	17
Hilsenhoff Biotic Index	2.92
Intolerant individuals (%)	60.4
Modified Becks Index	31
Index of Biotic Integrity	**97.4**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.44
Aluminum mg/L	<0.160
Calcium mg/L	3.72
Iron mg/L	0.0938
Magnesium mg/L	0.983
Hardness CaCO3	13.3
Chloride mg/L	8.53
pH	6.6
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.138
Alkalinity to pH 4.5 mg CaCO3/L	6.3
Total Dissolved Solids mg/L	96
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

BRODCR22

Location	Sugar Cane Ln. access off of Rt. 191 Bridge upstream of confluence of PARACR08.		
Site #	2020-3	Date	4/30/2020
Stream Name	Brodhead Creek	Time	11:35:00 AM
Township	Stroud	Latitude	41.066523
Habitat Asmt.	205	Longitude	-75.220216

Field Measurements	
Temp C	9.1
pH	7.19
Press inHg	
DO Percent	98.2
DO mg/L	11.31
Cond (uS/cm)	61

Macroinvertebrate Metrics	
Total Taxa	34
Shannon Diversity Index	2.74
EPT Taxa Richness	18
Hilsenhoff Biotic Index	3.24
Intolerant individuals (%)	51.5
Modified Becks Index	36
Index of Biotic Integrity	**95**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.84
Aluminum mg/L	<0.160
Calcium mg/L	4.01
Iron mg/L	<0.0800
Magnesium mg/L	1.07
Hardness CaCO3	14.4
Chloride mg/L	8.47
pH	6.7
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.134
Alkalinity to pH 4.5 mg CaCO3/L	12.6
Total Dissolved Solids mg/L	40
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

BRODCR27

Location	170 meters northeast of Pasold Farm Dr. parking area.		
Site #	2020-4	Date	4/29/2020
Stream Name	Brodhead Creek	Time	9:13:00 AM
Township	Barrett	Latitude	41.180941
Habitat Asmt.	208	Longitude	-75.25091

Field Measurements	
Temp C	7.9
pH	7.05
Press inHg	
DO Percent	100.1
DO mg/L	11.88
Cond (uS/cm)	58

Macroinvertebrate Metrics	
Total Taxa	31
Shannon Diversity Index	2.71
EPT Taxa Richness	17
Hilsenhoff Biotic Index	2.84
Intolerant individuals (%)	59.1
Modified Becks Index	32
Index of Biotic Integrity	**97.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.38
Aluminum mg/L	<0.160
Calcium mg/L	3.71
Iron mg/L	<0.0800
Magnesium mg/L	1
Hardness CaCO3	13.4
Chloride mg/L	8.59
pH	6.5
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.14
Alkalinity to pH 4.5 mg CaCO3/L	8.4
Total Dissolved Solids mg/L	102
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00