Technical Assistance to Blacklick Creek Watershed Association: Macroinvertebrate Surveys of Blacklick Creek & Two Lick Creek

John W. Wenzel, Conemaugh Valley Conservancy

Carney Run

December 31, 2023

Conemaugh Valley Conservancy
cvconserv@gmail.com 724-391-2191
https://conemaughvalleyconservancy.com/
PO Box 218, Johnstown, PA 15907

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Summary
A survey of 25 sites on streams flowing into Two Lick Creek and Yellow Creek in Indiana County, PA, and headwaters of Blacklick Creek in Cambria County, PA, produced 3539 specimens of macroinvertebrates of 71 genera. Results are used to interpret the health and impairment of the watercourses in anticipation of mitigation efforts largely related to abandonned mine discharges. Many of the headwater streams are of good quality, but the main stems of Two Lick and Yellow Creek become degraded as they flow past impaired tributaries. The headwaters of Blacklick Creek are largely in good shape and healthy ecology should be restored if current efforts to remove mine impacts downstream are successful. Reference to older surveys at certain sites demonstrates that two locations have improved in about 10 years.

Introduction

The most careful assessments of stream ecology include surveys of aquatic macroinvertebrates. Macroinvertebrates are insects, crayfish, worms, and animals without backbones that are large enough to be recognized without high magnification. These aquatic organisms are exposed to all of the conditions of their native stream over long periods and provide a holistic assessment of that environment. Because many of these organisms are known to differ in sensitivity to ecological stress, their presence in the stream is a good indicator of the long-term status of water quality. For example, if a stream gets warm and depleted of oxygen in the summer, or if occasional pulses of acidic water pass down the stream, the insects that cannot tolerate that stress, such as mayflies, will not live in the stream. Their absence will indicate that at some point in the year the stream is impaired even if the water was of good quality on the day the researcher took a sample. By contrast, while physical and chemical tests (temperature, clarity, flow, pH, dissolved oxygen, nitrates, etc.) provide precise information regarding a water sample, these characteristics can fluctuate dramatically over time with flow rates and other factors, giving only a snapshot of environmental conditions at the moment of sampling. As a result, collecting and identifying stream macroinvertebrates is the preferred method of assessing overall ecological health of the watercourse. Macroinvertebrates have been used in this manner for more than a century (Kolkwitz and Marsson, 1909).

Interested parties from Blacklick Creek Watershed Association, Indiana County Conservation District, Western Pennsylvania Conservancy, and Conemaugh Valley Conservancy convened to choose sites for 25 macroinvertebrate surveys and 50 electrofishing surveys. Sites were chosen to with attention to localities that do not have recent survey data, and also to address priorities of the PA Fish and Boat Commission Unassessed Waters Program. The sampling efforts are part of a broad watershed assessment to develop an implementation plan to prioritize mitigation of impacts from abandonned mine discharges or agriculture, and to consider removing streams from the state list of impaired streams if they now attain desired levels of ecological health. The macroinvertebrate surveys reported here were completed by Conemaugh Valley Conservancy, and the fish surveys by Western Pennsylvania Conservancy. The results of the fish survey are available in a separate report by Western Pennsylvania

Conservancy (Western Pennsylvania Conservancy, 2023). The work was supported by a grant to the Consortium for Scientific Assistance to Watersheds (C-SAW) through Conemaugh Valley Conservancy.

The macroinvertebrate survey sites are clustered to address four regions of interest: Two Lick Creek and tributaries in the vicinity of Clymer and upstream; Yellow Creek between the State Park and Homer City; and small tributaries on both the north branch and the south branch of Blacklick Creek. These regions will be discussed in turn. All watercourses are either Chapter 93 designated Cold Water Fisheries or Stocked, except Stewart Run which is High Quality.

Materials and Methods

Under Scientific Collector's Permit #2023-01-0244 to John Wenzel, he and Thad Pajak (Conemaugh Valley Conservancy), Tom Mesoras and Tim Kania (Blacklick Creek Watershed Association) collected specimens according to the "ICE" protocol of Pennsylvania Department of Environmental Protection, 2012 (hereafter PA DEP 2012), briefly summarized as follows. Over a reach of about 100 meters, a person "kicks" one square meter of stream bed by disturbing and dislodging rocks and macroinvertebrates. Another person catches the stream of water from the "kick" in a D-frame aquatic net with a 500-micron mesh size. They do this for one minute. This is repeated five times (six kicks total) at various sites across 100m of stream bed. An effort is made to include a variety of microhabitats such as riffle versus pool, stony bottom versus organic debris. All six collections are pooled as a single sample from the designated site. At each site, temperature and pH were recorded with a handheld meter. Conductance was recorded after the earliest collections for the 20 remaining sites. Collections were made in March and April, 2023. Our methods departed slightly from ICE protocols in that we did not characterize the streams' physical and biological parameters in the field.

In the laboratory, samples were sorted with the goal of attaining about 200 individual macroinvertebrates, or all individuals present if less than 200. ICE protocol focuses on about 200 specimens, but we identified all individuals beyond 200 for certain sites in the hope of documenting rarely collected species. Regardless of statistical protocol, we regard the supernumerary specimens beyond 200 as being an asset to understanding the biology of the stream, and because the total number of specimens is a denominator in statistics discussed below, there should be no systematic bias by including more individual specimens.

Specimens are identified to genus, with about 10% being re-examined by another entomologist as an exercise in Quality Assurance, including at least a few specimens of every genus. This step was executed by Andrea Kautz, an entomologist at Carnegie Museum of Natural History who is highly experienced in aquatic insect identification (Kautz et al. 2022). When errors were found, in addition to correcting the exact specimen identification from genus A (incorrect) to genus B (correct), all other specimens identified to genus A were re-examined to correct any similar errors. Ms. Kautz also identified all the fly larvae, flies being her primary expertise, in which she is certified.

Tallying numbers of individuals in specific genera provides the data for calculating several different indeces that characterize different features, and these are summarized by the final Index of Biotic Integrity (IBI, see PA DEP 2012) which is used to indicate overall stream ecological health, with high values being good and low values being poor. For small streams collected between November and May, IBI of 50 or above is required to characterize the stream as attaining desirable ecological health. A final check against the raw data is performed to guard against known circumstances in which the IBI may not reflect stream health accurately.

Results

Twenty-five sites were sampled from March 20, 2023, to April 27, 2023. From these sites, 3539 specimens of macroinvertebrates of 71 genera were recovered, plus incidental bycatch of 10 fish and two salamanders. Of the macroinvertebrates, 3,011 specimens of 53 genera were deposited in the Frost Entomological Museum at Pennsylvania State University. Conemaugh Valley Conservancy retained some specimens for a synoptic collection, and others were donated to the University of Florida Entomology and Nematology teaching collection.

Localities sampled.
Along Two Lick Creek (Figure 1), from north to south, sites were at Starford, Wandin, Diamondville, above Brown's Run, Buck Run itself above mouth (Figure 2), at Clymer, and below Sample Run (Figure 3). Four sites were sampled along Dixon Run, from north to south being at Pear Road, at Dixonville, at Road 24, and at the mouth just above the confluence with Two Lick at Clymer. The tributary of Penn Run was sampled both headwaters and near the mouth, which opens on Two Lick just above the reservoir.

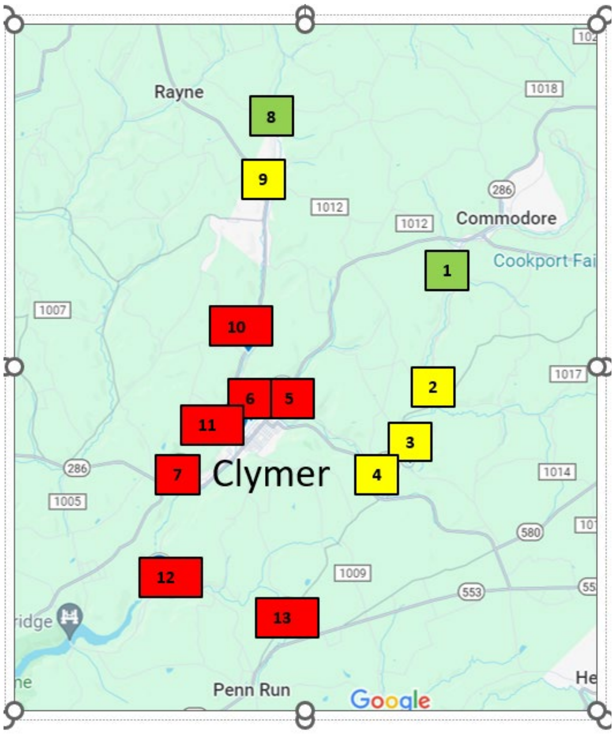


Figure 1. Sites near Clymer. 1: Two Lick at Starford; 2: Two Lick at Wandin; 3: Two Lick at Diamondville; 4: Two Lick above Brown's Run; 5: Buck Run, mouth above Two Lick; 6: Two Lick at Clymer; 7: Two Lick below Sample Run; 8: Dixon Run at Pear Road; 9:Dixon Run at Dixonville; 10; Dixon Run at Road 24; 11: Dixon Run mouth above Two Lick; 12: Penn Run above mouth; 13: Penn Run headwaters. Red box means site is in poor condition by final assessment (IBI<50, *see below*), *yellow means site is in moderate condition,* (50 < IBI < 70)*, green means site is in good condition* (IBI > 70).

Figure 2. Thad Pajak, Buck Run upstream from mouth. Stream is fast flowing over rocks with good hemlock canopy at this point, but impaired.

Figure 3. Two Lick Creek just downstream from Sample Run. Basin is wide and mostly open to the sky. Flow from Sample Run and staining on rocks is visible on left side, deeper water that appears unaffected by Sample Run on right side, but Two Lick Creek is impaired at this location.

Yellow Creek was sampled at Route 954 , at Tide, and at Homer City above the confluence with Two Lick (Figure 4). The stream looks good at Rt. 954 (Figure 5, 6) but just under the quality threshold (Figure 4).

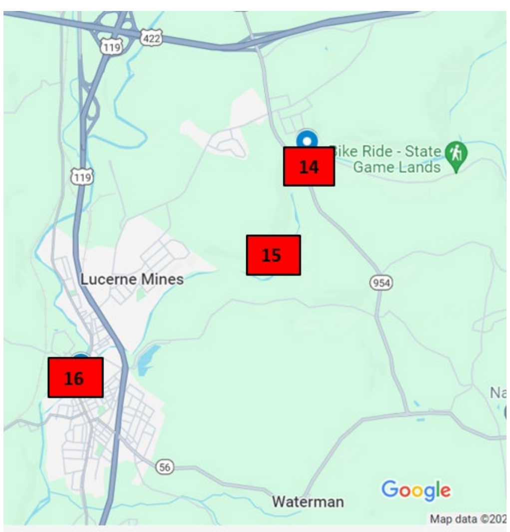


Figure 4. Sampling locations along Yellow Creek. 14: Yellow Creek at Rt. 954; 15: Yellow Creek at Tide; 16: Yellow Creek at Floodway Park, Homer City. Red box means site is in poor condition by final assessment (IBI<50, *see below*).

Figure 5. Yellow Creek at Route 954, looking upstream to upper right. Stream is fast flowing over rocks, but wide and open to the sky. Stream is just below the quality threshold with IBI = 48.5 at this site, and is a popular location for stocked trout fishing.

Figure 6. Large predatory hellgramite (Corydalus) recovered from Yellow Creek at Route 954. These predators are fun to see and popular as bait, but they are only of middling senstivity to water quality.

The north branch of Blacklick Creek was sampled at tributaries in the vicinity of Belsano: Elk Creek, Little Elk Creek, and Unnamed Tributary 44554 at Iverson Road (Figures 7, 8). The north branch itself was sampled just below the Red Mill discharge (Figure 9), and tributaries feeding into Blacklick near this location were Carney Run, Downey Run (Figure 10), and Walker Run.

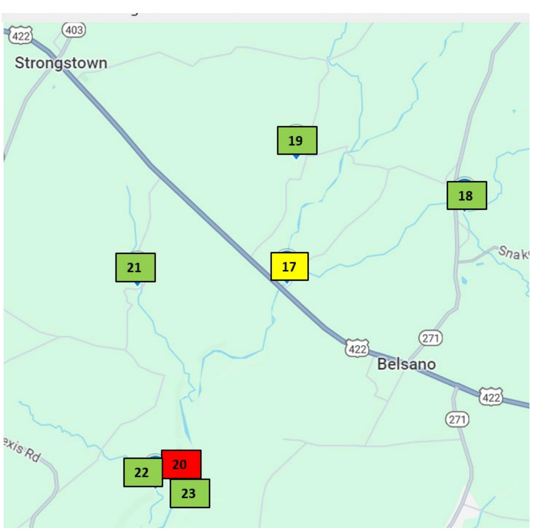


Figure 7. Sampling locations for North Branch Blacklick Creek at Red Mill and tributaries nearby Belsano. 17: Elk Creek; 18: Little Elk Creek; 19: Unnamed Tributary 44554 at Iverson Road; 20: North Branch Blacklick just below the Red Mill discharge; 21: Carney Run; 22: Downey Run; 23: Walker Run. Red box means site is in poor condition by final assessment (IBI < 50, *see below), yellow means site is in moderate condition by final assessment* (50 < IBI < 70), *green means site is in good condition* (IBI > 70).

Figure 8. Tim Kania and Tom Mesoras at UNT 44554 near Iverson Road. The stream is fast flowing over rocks under a good canopy of hemlocks.

Figure 9. Red Mill discharge crossing Sportsmans Club to join North Branch Blacklick Creek after failure of treatment system on site. Typically, red stains are from iron deposits and white from aluminum. The stream below this discharge is surprisingly alive, perhaps due to ample input from nearby tributaries.

Figure 10. Downey Run, one of the best streams in the survey, joins North Branch Blacklick just downstream from the Red Mill discharge. Above the flood plain, the stream tumbles down a rocky hill with strong riffle and pool structure and substantial shade from hemlocks.

Headwaters of the South Branch Blacklick Creek were sampled above Nanty Glo (Figure 11) at an Unnamed Tributary of Williams Run near Revloc (Figure 12), and Stewart Run at Route 22. These sites relate to State Game Lands 79 and indicate a best case scenario for the north branch above the town of Nanty Glo.

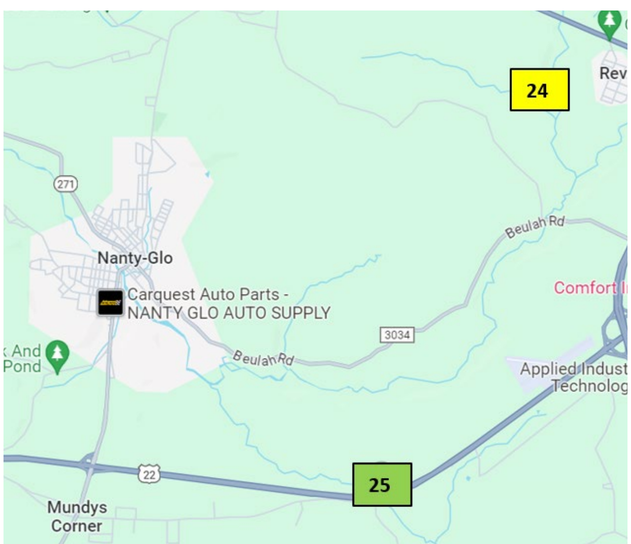


Figure 11. Sampling locations for South Branch Blacklick Creek upstream from Nanty Glo. 24: Unnamed Tributary of Williams Run near Revloc; 25: Stewart Run at Route 22. Yellow Box means site is in moderate condition by final assessment (50 < IBI < 75, see below)*, green means site is in good condition* (IBI > 70).

Figure 12. Unnamed Tributary of Williams Run near Revloc. Coming out of Game Lands 79, this stream is fast flowing over rocks and well shaded by hemlocks. Williams Run in turn enters a different section of GL 79, and joins with Stewart Run just before exiting the game lands again, upstream from Nanty Glo.

Biodiversity Measures.
Raw data of identifications were analysed through the ordinary protocols of the PA DEP 2012 to generate six common measures for each of the 25 locations. These six measures were combined by a standardization procedure described by PA DEP 2012, and compiled into a standard Index of Biotic Integrity. Analyses of each location are attached in Appendix A. Table 1 lists all sites with lat/lon location, physical parameters measured in the field, and other data that contribute to the final IBI score (Table 1.) The richest site was Stewart Run (IBI=93.9, 312 individuals collected, 36 genera) and the poorest were Dixon Run at Road 24 (four insects) and Two Lick at Homer City (three insects).

Discussion.

Watershed analysis
The main stem of Two Lick Creek at Starford, the furthest upstream we sampled, is in fairly good shape (245 individual macroinvertebrates collected, 27 genera , IBI=71.7). It becomes somewhat less healthy by Wandin although still exceeding threshold (157 individuals, 27 genera, IBI=65.2) and somewhat further degraded at Diamondville above the discharge there (159 individuals, 25 genera, IBI=57.9). Two Lick Creek regains health by the time it is above Brown's Run (267 individuals, 31 genera, IBI=65.7). This is encouraging. After some distance, Two Lick Creek takes in Buck Run, which is greatly impaired, although the habitat of the creek near the mouth just above the railroad looks good (Fig 2, 31 individuals, 9 genera, IBI=33.9). In Clymer, Two Lick shows clear impairment (22 individuals, 7 genera, IBI=31.1). Downstream from the town of Clymer, Two Lick takes in Dixon Run (see below) and Sample Run, at which point it is very degraded (below Sample Run: 61 individuals, 10 genera, IBI=23.9 , Fig 3).

Table 1. Summary statistics for all sites. Values are reported for site number, location, date collected, latitude, longitude, temperature oC, pH, conductivity, number of individual specimens recovered, number of genera recovered, IBI for the site. For sites that were sampled previously, the old IBI is reported followed by the year of the survey. Site number corresponds to the numerals on the maps of Figures 1, 4, 7, and 11.

Site #	location	Date	Lat	Lon	Temp C	pH	Conduct.	Indiv.	Genera	2023 IBI	Old IBI	Old Year
1	Starford	27-Mar-23	40.6977	-78.9583	7.6	8.06		245	27	71.7		
2	Wandin	27-Mar-23	40.6747	-78.9622	7.4	7.71		157	27	65.2		
3	Diamondville	27-Mar-23	40.6577	-78.9752	7.5	7.68		159	25	57.9		
4	Two Lick above Brown Run	27-Mar-23	40.6578	-78.9751	8	7.7		267	31	65.7		
5	Buck Run mth	7-Apr-23	40.673	-79.0029	7	7.47	350	31	9	33.9		
6	Clymer, Two Lick above Dixon	7-Apr-23	40.6716	-79.0121	8.1	7.92	277	22	7	31.1		
7	Two Lick at Sample Run	12-Apr-23	40.6575	-79.0298	11.3	4.84	515	61	10	23.9	17.3	2008
8	Dixon Run Pear Rd	30-Mar-23	40.7286	-79.0041	8.2	8.05		239	25	72.8		
9	Dixonville	30-Mar-23	40.7164	-79.0064	5.9	7.62	313	313	22	60.5		
10	Dixon Run Rd 24	30-Mar-23	40.6855	-79.0118	5	7.27		4	4	24.6		
11	Mouth Dixon Rn Clymer	7-Apr-23	40.6683	-79.014	7.8	7.58	440	15	10	34.9	26.3	2010
12	Penn Rn mouth	12-Apr-23	40.6375	-79.0354	12.5	7.2	368	15	8	31.6		
13	Penn Rn headwaters	12-Apr-23	40.6286	-79.0016	15.5	8	225	172	13	25.1		
14	Yellow Cr at Rt 954	14-Apr-23	40.5698	-79.1268	14	7.74	167	228	20	48.5	48.3	2010
15	Yellow Cr at Tide	14-Apr-23	40.557	-79.132	16.8	7.43	252	86	17	41.6		
16	Yellow Cr Homer City	14-Apr-23	40.544	-79.1613	19	7.15	310	3	3	34.7		
17	Elk Cr	20-Mar-23	40.5281	-78.8887	1.8	7.31		104	18	56.4	32.3	2010
18	Little Elk Cr	20-Mar-23	40.5361	-78.8627	0.7	8.02	340	240	25	88.3		
19	UNT 44554 Iverson Rd	20-Mar-23	40.5394	-78.887	1.4	7.46	52	190	20	75.7		
20	Red Mill	27-Apr-23	40.5057	-78.9044	9.8	7.34	346	39	10	45.9	48.9	2015
21	Carney Run	27-Apr-23	40.5278	-78.9105	9.7	7.64	134	180	21	75.2	78	2014
22	Downey Run	27-Apr-23	40.5053	-78.9079	11	7.64	89	246	26	76.7		
23	Walker Rn	27-Apr-23	40.5041	-78.9042	7.5	8	66	120	24	78.9		
24	UNT of Williams Run	23-Apr-23	40.4883	-78.776	7.6	7.74	116	146	16	69	67.8*	2008
25	Stewart Run	23-Apr-23	40.4463	-78.7986	8.7	7.87	184	312	36	93.9		

* 2008 UNT Williams, 79% (Leuctra+Amphinemoura), therefore acidified

Having regained health at Brown's Run, Two Lick loses its status through the next tributaries and the town of Clymer.

Dixon Run presents an interesting challenge. The headwaters are healthy, but passing through historical and current degradations leave the mouth of Dixon Run badly degraded as it enters Two Lick Creek. The most northern site, at Pear Road, was in good shape (239 individuals, 25 genera, IBI=72.8). Even in the Dixonville site, where we sampled in the middle of town with no vegetation or tree cover, the statistics remain acceptable (313 individuals, 22 genera, IBI=60.5). Note that half of the body count for individuals is prosimuliid blackflies, which will inflate the Hilsenhoff index and hence IBI (Appendix A). These are sensitive (PTV=2), but their great number is deceiving because their colonies can be very numerous, unlike most other sensitive insects. Moving south to Road 24 we find one of the worst sites in the survey, only four insects (4 genera, IBI=24.6). This location has on one side a railroad track and coal tipple, with a highway on the other side. The stream remains badly impaired all the way to the mouth (15 individuals, 10 general, IBI=34.9) where it deposits into Two Lick Creek. Dixon Run's headwaters are healthy, and if the lower reaches are improved, then it will be a positive addition to Two Lick Creek.

Further downstream, Two Lick takes in Penn Run for which neither the stream near the mouth (15 individuals, 8 genera, IBI=31.6) nor the headwaters (172 individuals, 13 genera, IBI=25.1) are beneficial. Following this input is Two Lick Reservoir. At the same time as it is an asset to water availability, a reservoir is genereally a detriment to water quality relative to a clean stream.

Yellow Creek below the State Park issues from the large lake in the park. Lake water generally is not considered high quality compared to flowing streams, and there are a number of old mine features in the watershed below the lake. The creek passes beside a coal handling site just upstream from Route 954, where Yellow Creek is a popular spot for fishermen seeking stocked trout (Fig 5). The stream appears to be full of life (228 individuals, 20 genera, Fig 6), nonetheless, it should be considered on the cusp between impaired and marginal attainment (IBI=48.5). Water quality continues to decline as Yellow Creek passes below the bony pile at Tide (86 individuals, 17 genera, IBI=41.6), and by the time it is in Homer City below Lucerne mines, it is the most sterile location in this entire survey program (three insects recovered at Floodway Park).

In contrast to the disappointing results of the Two Lick and Yellow Creek surveys, those of the head waters of the north branch of Blacklick Creek in Cambria County in the vicinity of Belsano were encouraging (Figure 7). Even the weakest among them attains threshold, Elk Creek (104 individuals, 18 genera, IBI=56.4). Scoring highly are Little Elk (240 individuals, 25 genera, IBI=88.3) and Unnamed Tributary 44554 at Iverson Road (190 individuals, 20 genera, IBI=75.7, Figure 8) and Carney Run (180 individuals, 21 genera, IBI=75.2, Fig 10). Downstream from these locations, the main stem of the north branch of Blacklick Creek was sampled below the discharge at Red Mill (Figure 9) where it is impaired (39 individuals, 10 genera, IBI=45.9), but nonetheless surprisingly resilient given the severity of the discharge. This may be because the flow of the stream keeps the AMD on one bank and the other seems to be largely unaffected. Just downstream from the discharge the main stem is joined by two tributaries that are in good condition, Walker Run (120 individuals, 24 genera, IBI=78.9) and Downey Run (246 individuals, 26 genera, IBI=76.7, Fig 10). Taken as a whole, these data mean that if the degradation of the stream at Red Mill is mitigated by drawing down the mine pool and removing the AMD to the soon-to-be inaugurated treatment plant at Wehrum, the healthy tributaries feeding into the north branch should rather rapidly restore the watercourse to good condition.

We sampled two tributaries of South Branch Blacklick Creek (Figure 11). In the north is an Unnamed Tributary that comes out of State Gamelands 79 south of Revloc, joins Williams Run (Fig 12), and thence the south branch of Blacklick Creek. We also sampled Stewart Run, which passes under Route 22 near Mundy's Corner and into State Gamelands 79, where it joins South Branch Blacklick Creek. The unnamed tributary is in good shape (146 individuals, 16 genera, IBI=69.0) while Stewart Run is the best stream in the entire survey (312 individuals, 36 genera, IBI=93.9).

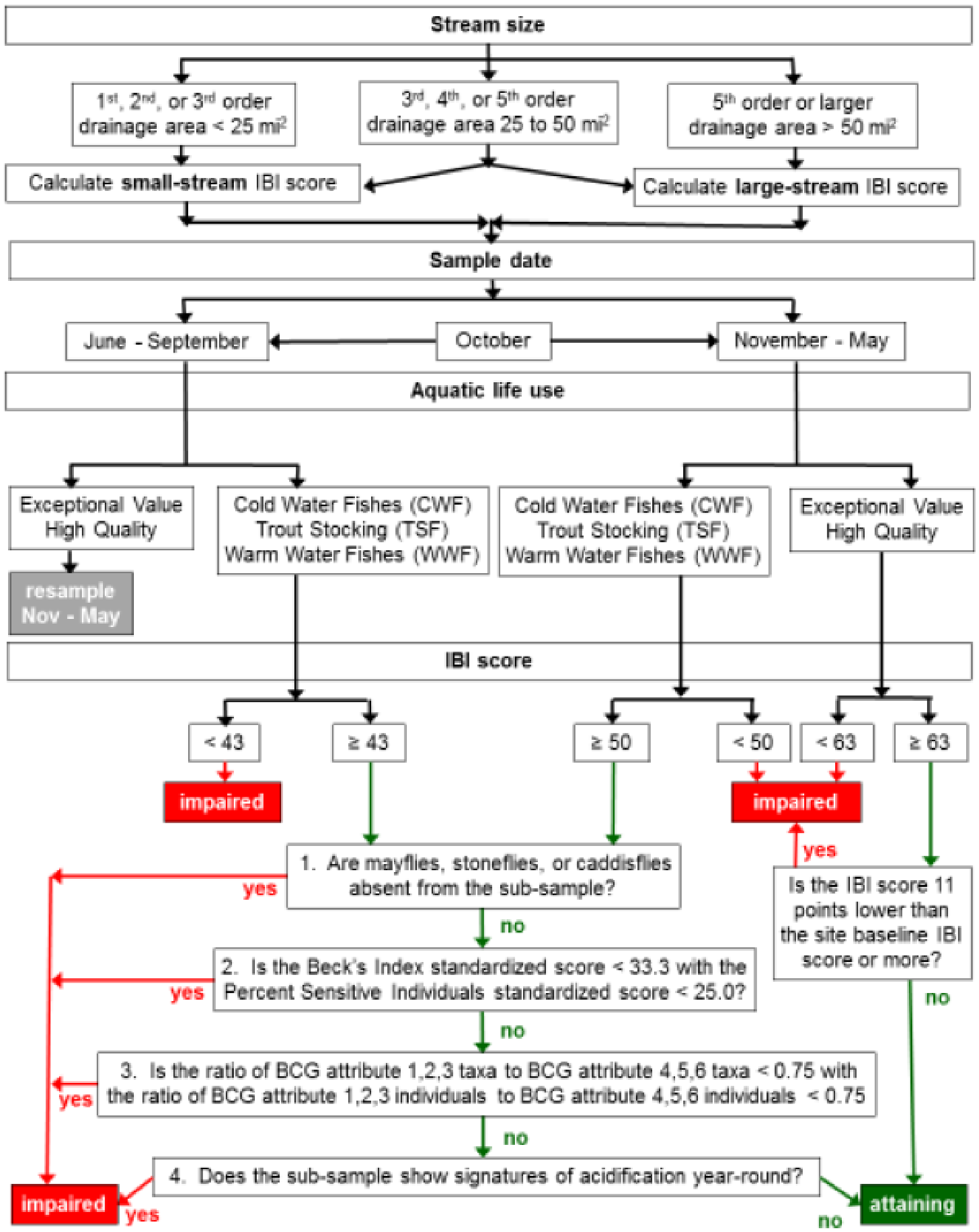
Stream Classification

Indeces are artificial constructs developed for convenience. Whenever possible, they should be examined with one eye on the primary data that went into them, which is why we have reported the number of individual insects and the number of genera in the sample in Table 1. The primary data are the actual values from nature and are the ultimate source of all conclusions that follow. For example, there is little point to tyring to make sense of index values for badly impaired sites, such as Dixon Run at Road 24 (four individual insects recovered) or Yellow Creek at Homer City (three insects). Also, one should take caution not to place too much emphasis on IBI values that may be inflated by local colonies of insects that live densely, such as at Dixonville with prosimuliid black flies (above).

Classification of stream health based on IBI relies on a decision tree protocol that checks final statistics for known distortions that may occur in specific circumstances. Figure 13 reproduces the decision tree from the PA DEP 2012. After calculating IBI, four additional Quality Assurance questions must be answered for final classification of streams (Figure 13, bottom). Using these protocols, streams are classified as impaired (IBI<50), and "attaining" (IBI>50). "Attaining" streams are arbitrarily divided here into those with 50<IBI<70 (moderate quality) and those of IBI>70 (good quality). Color coding of this classification scheme permits rapid visual assessment of the relative water quality across a watershed in Figures 1, 4, 7, and 11.

Seven of our sample locations were visited in years past, and the primary data for earlier surveys is available at https://www.depgis.state.pa.us/macroviewer/index.html, and reproduced in Appendix A. Several of the streams show little change from earlier IBI values regarding general categorization of poor, marginal, and good (Table 1). Ranking very poorly in 2023 (IBI = 24.4), Two Lick below Sample Run was also very poor in 2008 (IBI = 17.3) Slightly improved since 2010, the mouth of Dixon Run at Clymer is nonetheless still poor (IBI = 34.9 in 2023, versus IBI = 26.3 in 2010). Yellow Creek at Rt 954 was marginal in this study (IBI = 48.5) and was marginal in 2010 (IBI = 48.3). The same applies to South Branch Blacklick Creek at Red Mill (IBI = 45.9 in 2023, IBI = 48.9 in 2015). Consistency is more satisifying for Carney Run because it has proven to be a healthy stream twice (IBI = 75.2 in 2023, IBI = 78.0 in 2014). Two streams demonstrate meaningful rebound to healthier conditions. Most clearly, Elk Creek improved to acceptable (IBI = 56.4) whereas it had previously been poor with IBI = 39.3. Less obvious, but also favorable, Unnamed Tributary of Williams Run near Revloc scored IBI = 69.0 in 2023. In 2008, the stream violated quality assurance question #4 in the decision tree (Figure 13) by having excessive numbers of Leuctra and Amphinemura stoneflies, constituting 79% of all individuals, and only a single mayfly (Eurylophella), indicating acidification of the stream. No such violation obtains for the 2023 data, indeed about a third of the individuals were highly sensitive Epeorus mayflies, so the good IBI value can be taken at face value.

Figure 13. Decision tree for characterizing streams using IBI values. From PA DEP 2012. Our data are from small streams sampled in March and April. The Unnamed Tributary of Williams Run in 2008 violated the Quality Assurance question #4 by showing an excessive number of low-pH tolerant stoneflies and near complete absence of sensitive mayflies.



Conclusions

In the case of Two Lick Creek, degradation of water quality is evident as sampling progressed downstream. Several sites appear to be severly impaired, including Buck Run, Sample Run, lower Dixon Run, Penn Run, and Yellow Creek at Homer City. While stocking trout for fishermen may permit recreation along certain reaches, the depauperate macroinvertebrate community makes it unlikely that wild breeding populations of game fish can survive without additional mitigation efforts. Tributaries in the headwaters of Blacklick Creek are largely in good shape, with both Elk Creek and Unnamed Tributary of Williams Run evidently showing improvement since earlier surveys. The soon-to-be-completed active treatment facility at Wehrum may rescue Blacklick Creek from AMD entering at Red Mill, Vintondale, and Wehrum, in which case the main stem should improve quickly via colonization of macroinvertebrates from tributaries. Data from this survey should be useful in measuring recovery in future years.

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APPENDIX A

Individual site records and callculations for IBI. The pages that follow are in the order of Table 1, with old surveys following the 2023 survey of the same site. Demonstrations of Beck's and Hilsenhoff indeces are provided in Appendix B, taken from PA DEP 2012. IBI is the average of the adjusted standardized values for all six indeces: taxa richness; Ephemeroptera, Plecoptera, and Trichoptera richness with PTV of 0 to 4; Beck's index; Hilsenhoff index; Shannon diversity; and Percent sensitive individuals with PTV 0 to 3.

Location Genus Pollution Tolerance Value # of Individuals

Calculations for Shannon

# of genera

# of EPT genera PTV 0-4

% individuals PTV 0-3

IBI

Two Lick Starford	PTV	N=245	n/245	lnE	E*F
Diplectrona	0	1	0.00408	-5.50126	-0.02245
Leuctra	0	2	0.00816	-4.80811	-0.03925
Suwallia	0	2	0.00816	-4.80811	-0.03925
Wormaldia	0	1	0.00408	-5.50126	-0.02245
Ephemerella	1	1	0.00408	-5.50126	-0.02245
Nemoura	1	3	0.01224	-4.40265	-0.05391
Rhyacophila	1	15	0.06122	-2.79321	-0.17101
Serratella	2	1	0.00408	-5.50126	-0.02245
Ephemera	2	1	0.00408	-5.50126	-0.02245
Hexatoma	2	6	0.02449	-3.7095	-0.09084
Prosimulium	2	42	0.17143	-1.76359	-0.30233
Amphinemura	3	1	0.00408	-5.50126	-0.02245
Antocha	3	3	0.01224	-4.40265	-0.05391
Dannella	3	1	0.00408	-5.50126	-0.02245
Isonychia	3	1	0.00408	-5.50126	-0.02245
Maccaffertium	3	19	0.07755	-2.55682	-0.19828
Neophylax	3	1	0.00408	-5.50126	-0.02245
Arigomphus	4	2	0.00816	-4.80811	-0.03925
Optioservus	4	10	0.04082	-3.19867	-0.13056
Stenacron	4	7	0.02857	-3.55535	-0.10158
Tipula	4	9	0.03673	-3.30403	-0.12137
Hydropsyche	5	25	0.10204	-2.28238	-0.2329
Baetis	4	44	0.17959	-1.71707	-0.30837
Cheumatopsyche	6	10	0.04082	-3.19867	-0.13056
Chironomidae	6	34	0.13878	-1.9749	-0.27407
Procambarus	6	2	0.00816	-4.80811	-0.03925
Oligochete	10	1	0.00408	-5.50126	-0.02245
					-2.551

Metric		Standard	Standardi:	Adjusted
Taxa richne	27	33	81.8182	81.82
EPT richness	15	19	78.9474	78.95
Beck's index	22	38	57.8947	57.89
Hilsenhoff bi	4.02	1.89	73.7361	73.77
Shannon div	2.55	2.86	89.1608	89.16
% sensitive (I	41.22	84.5	48.7811	48.78
		IBI=		71.7283

Beck (3*4)+(2*3)+(1*4)=22

Hilsenhoff	PTV	N	PTV*N
	0	4	0
	1	19	19
	2	50	100
	3	26	78
	4	28	112
	5	25	125
	6	90	540
	7	0	0
	8	0	0
	9	0	0
	10	1	10
		Sum	984
		984/245=4.016	

Shannon diversity Beck's Calculation Hilsenhoff calculation

Two Lick Starford

	PTV	N=245	n/245	lnE	E*F
Diplectrona	0	1	0.004082	-5.50126	-0.02245
Leuctra	0	2	0.008163	-4.80811	-0.03925
Suwallia	0	2	0.008163	-4.80811	-0.03925
Wormaldia	0	1	0.004082	-5.50126	-0.02245
Ephemerella	1	1	0.004082	-5.50126	-0.02245
Nemoura	1	3	0.012245	-4.40265	-0.05391
Rhyacophila	1	15	0.061224	-2.79321	-0.17101
Serratella	2	1	0.004082	-5.50126	-0.02245
Ephemera	2	1	0.004082	-5.50126	-0.02245
Hexatoma	2	6	0.02449	-3.7095	-0.09084
Prosimulium	2	42	0.171429	-1.76359	-0.30233
Amphinemura	3	1	0.004082	-5.50126	-0.02245
Antocha	3	3	0.012245	-4.40265	-0.05391
Dannella	3	1	0.004082	-5.50126	-0.02245
Isonychia	3	1	0.004082	-5.50126	-0.02245
Maccaffertium	3	19	0.077551	-2.55682	-0.19828
Neophylax	3	1	0.004082	-5.50126	-0.02245
Arigomphus	4	2	0.008163	-4.80811	-0.03925
Optioservus	4	10	0.040816	-3.19867	-0.13056
Stenacron	4	7	0.028571	-3.55535	-0.10158
Tipula	4	9	0.036735	-3.30403	-0.12137
Hydropsyche	5	25	0.102041	-2.28238	-0.2329
Baetis	4	44	0.179592	-1.71707	-0.30837
Cheumatopsyche	6	10	0.040816	-3.19867	-0.13056
Chironomidae	6	34	0.138776	-1.9749	-0.27407

Metric		Standard	Standardiz	Adjusted
Taxa richn	27	33	81.81818	81.82
EPT richne	15	19	78.94737	78.95
Beck's inde	22	38	57.89474	57.89
Hilsenhoff	4.02	1.89	73.73613	73.77
Shannon d	2.55	2.86	89.16084	89.16
% sensitive	41.22	84.5	48.78107	48.78
		IBI=		71.72833

Beck (3*4)+(2*3)+(1*4)=22

Hilsenhoff	PTV	N	PTV*N
	0	4	0
	1	19	19
	2	50	100
	3	26	78
	4	28	112
	5	25	125
	6	90	540
	7	0	0
	8	0	0
	9	0	0
	10	1	10
		Sum	984

984/245=4.016

Procambarus	6	2		0.008163	-4.80811	-0.03925
Oligochete	10	1		0.004082	-5.50126	-0.02245
						-2.551

Two Lick South Branch

	PTV Wandin	N=157	n/157	lnE	E*F	
Leuctra	0	1	0.006369	-5.05625	-0.03221	
Suwallia	0	6	0.037975	-3.27084	-0.12421	
Rhyacophila	1	3	0.018987	-3.96398	-0.07527	
Serratella	2	2	0.012658	-4.36945	-0.05531	
Boyeria	2	1	0.006329	-5.0626	-0.03204	
Hexatoma	2	3	0.018987	-3.96398	-0.07527	
Nigronia	2	1	0.006329	-5.0626	-0.03204	
Prosimulium	2	6	0.037975	-3.27084	-0.12421	
Amphinemura	3	1	0.006329	-5.0626	-0.03204	
Antocha	3	1	0.006329	-5.0626	-0.03204	
Maccaffertium	3	33	0.208861	-1.56609	-0.32709	
Chimarra	4	1	0.006329	-5.0626	-0.03204	
Eurylophella	4	5	0.031646	-3.45316	-0.10928	
Optioservus	4	5	0.031646	-3.45316	-0.10928	
Pycnopsyche	4	8	0.050633	-2.98315	-0.15105	
Stenacron	4	3	0.018987	-3.96398	-0.07527	
Tipula	4	4	0.025316	-3.6763	-0.09307	
Hydropsyche	5	8	0.050633	-2.98315	-0.15105	
Baetis	4	24	0.151899	-1.88454	-0.28626	
Polycentropus	6	3	0.018987	-3.96398	-0.07527	
Cheumatopsyche	6	10	0.063291	-2.76001	-0.17468	
Probezzia	6	1	0.006329	-5.0626	-0.03204	
Chironomidae	6	24	0.151899	-1.88454	-0.28626	
Procambarus	6	3	0.018987	-3.96398	-0.07527	= -2.592

Metric		Standard	Standardiz	Adjusted
Taxa richn	24	33	72.72727	72.7
EPT richne	15	19	78.94737	78.95
Beck's inde	13	38	34.21053	34.21
Hilsenhoff	4.25	1.89	70.90012	70.9
Shannon d	2.59	2.86	90.55944	90.56
% sensitive	36.94	84.5	43.71598	43.72
		IBI=		65.17333

Beck (3*2)+(2*1)+(1*5)=13

Hilsenhoff	PTV	N	PTV*N
	0	7	0
	1	3	3
	2	13	26
	3	35	105
	4	26	104
	5	8	40
	6	65	390
	7	0	0
	8	0	0
	9	0	0
	10	0	0
		Sum	668

668/157=4.254

	PTV					
Two Lick Diamondville						
		N=159	n/159	lnE	E*F	
Ameletus	0	1	0.006289	-5.0689	-0.03188	
Suwallia	0	1	0.006289	-5.0689	-0.03188	
Hexatoma	2	3	0.018868	-3.97029	-0.07491	
Nigronia	2	2	0.012579	-4.37576	-0.05504	
Prosimulium	2	4	0.025157	-3.68261	-0.09264	
Antocha	3	6	0.037736	-3.27714	-0.12367	
Apatania	3	3	0.018868	-3.97029	-0.07491	
Dannella	3	2	0.012579	-4.37576	-0.05504	
Isonychia	3	2	0.012579	-4.37576	-0.05504	
Maccaffertium	3	29	0.18239	-1.70161	-0.31036	
Neophylax	3	3	0.018868	-3.97029	-0.07491	
Arigomphus	4	1	0.006289	-5.0689	-0.03188	
Optioservus	4	7	0.044025	-3.12299	-0.13749	
Pycnopsyche	4	23	0.144654	-1.93341	-0.27968	
Stenacron	4	1	0.006289	-5.0689	-0.03188	
Stenonema	4	1	0.006289	-5.0689	-0.03188	
Tipula	4	1	0.006289	-5.0689	-0.03188	
Helichus	5	2	0.012579	-4.37576	-0.05504	
Hydropsychidae	5	7	0.044025	-3.12299	-0.13749	
Stenelmis	5	3	0.018868	-3.97029	-0.07491	
Baetis	6	2	0.012579	-4.37576	-0.05504	
Sialis	6	1	0.006289	-5.0689	-0.03188	
Cheumatopsyche	6	5	0.031447	-3.45947	-0.10879	
Chironomidae	6	47	0.295597	-1.21876	-0.36026	
Procambarus	6	2	0.012579	-4.37576	-0.05504	= -2.4

Metric		Standard	Standardiz	Adjusted
Taxa richn	25	33	75.75758	75.76
EPT richne	10	19	52.63158	52.63
Beck's inde	9	38	23.68421	23.68
Hilsenhoff	4.35	1.89	69.66708	69.67
Shannon d	2.4	2.86	83.91608	83.91
% sensitive	35.22	84.5	41.68047	41.68
		IBI=		57.88833

Beck (3*2)+(2*0)+(1*3)=9

Hilsenhoff	PTV	N	PTV*N
	0	2	0
	1	0	0
	2	9	18
	3	45	135
	4	34	136
	5	12	60
	6	57	342
	7	0	0
	8	0	0
	9	0	0
	10		0
		Sum	691
		691/159=4.345	

Two Lick above Brown	PTV Rn	N=267	n/267	lnE	E*F
Epeorus	0	2	0.007491	-4.8941	-0.03666
Soyedina	0	2	0.007491	-4.8941	-0.03666
Suwallia	0	2	0.007491	-4.8941	-0.03666
Nemoura	1	1	0.003745	-5.58725	-0.02093
Paraleptophlebia	1	8	0.029963	-3.50781	-0.1051
Atherix	2	2	0.007491	-4.8941	-0.03666
Ephemera	2	2	0.007491	-4.8941	-0.03666
Hexatoma	2	5	0.018727	-3.97781	-0.07449
Nigronia	2	2	0.007491	-4.8941	-0.03666
Prosimulium	2	10	0.037453	-3.28466	-0.12302
Antocha	3	5	0.018727	-3.97781	-0.07449
Dannella	3	2	0.007491	-4.8941	-0.03666
Maccaffertium	3	57	0.213483	-1.5442	-0.32966
Neophylax	3	4	0.014981	-4.20095	-0.06294
Arigomphus	4	1	0.003745	-5.58725	-0.02093
Chimarra	4	1	0.003745	-5.58725	-0.02093
Eurylophella	4	3	0.011236	-4.48864	-0.05043
Optioservus	4	4	0.014981	-4.20095	-0.06294
Pycnopsyche	4	2	0.007491	-4.8941	-0.03666
Tipula	4	4	0.014981	-4.20095	-0.06294
Dolichopodidae	4	1	0.003745	-5.58725	-0.02093
Ectopria	5	1	0.003745	-5.58725	-0.02093
Hydropsyche	5	10	0.037453	-3.28466	-0.12302
Baetis	4	9	0.033708	-3.39002	-0.11427
Sialis	6	1	0.003745	-5.58725	-0.02093

Metric		Standard	Standardiz	Adjusted
Taxa richn	31	33	93.93939	93.94
EPT richne	12	19	63.15789	63.16
Beck's inde	18	38	47.36842	47.37
Hilsenhoff	4.59	1.89	66.70777	67.57
Shannon d	2.17	2.86	75.87413	75.87
% sensitive	38.95	84.5	46.09467	46.09
		IBI=		65.66667

Beck (3*3)+(2*2)+(1*5)=18

Hilsenhoff	PTV	N	PTV*N
	0	6	0
	1	9	9
	2	21	42
	3	68	204
	4	16	64
	5	11	55
	6	125	750
	7	0	0
	8	4	32
	9	0	0
	10	7	70
		Sum	1226

1226/267=4.591

Chironomidae	6	113	0.423221	-0.85986	-0.36391
Tabanidae	6	1	0.003745	-5.58725	-0.02093
Procambarus	6	1	0.003745	-5.58725	-0.02093
Prosobranchia	8?	1	0.003745	-5.58725	-0.02093
Physidae	8	3	0.011236	-4.48864	-0.05043
Oligochete	10	7	0.026217	-3.64134	-0.09547
					-2.174

Buck Run mth

	PTV	N=31	n/31	lnE	E*F
Rhyacophila	1	1	0.032258	-3.43399	-0.11077
Diploperla	2	1	0.032258	-3.43399	-0.11077
Isoperla	2	1	0.032258	-3.43399	-0.11077
Pycnopsyche	4	4	0.129032	-2.04769	-0.26422
Tipula	4	12	0.387097	-0.94908	-0.36739
Hydropsyche	5	6	0.193548	-1.64223	-0.31785
Baetis	6	1	0.032258	-3.43399	-0.11077
Chironomidae	6	4	0.129032	-2.04769	-0.26422
Procambarus	6	1	0.032258	-3.43399	-0.11077
					-1.767

Metric		Standard	Standardiz	Adjusted
Taxa richn	9	33	27.27273	27.27
EPT richne	4	19	21.05263	21.05
Beck's inde	4	38	10.52632	10.52
Hilsenhoff	4.225	1.89	71.20838	71.21
Shannon d	1.767	2.86	61.78322	61.78
% sensitive	9.68	84.5	11.45562	11.46
		IBI=		33.88167

Beck (3*0)+(2*1)+(1*2)=4

Hilsenhoff	PTV	N	PTV*N
	0	0	0
	1	1	1
	2	2	4
	3	0	0
	4	15	60
	5	6	30
	6	6	36
	7	0	0
	8	0	0
	9	0	0
	10	0	0
		Sum	131

131/31=4.225

PTV

Two Lick Clymer aboveDIxon Rn

	PTV	N=22	n/22	lnE	E*F
Atherix	2	1	0.045455	-3.09104	-0.1405
Maccaffertium	3	6	0.272727	-1.29928	-0.35435
Hydropsyche	5	7	0.318182	-1.14513	-0.36436
Polycentropus	6	1	0.045455	-3.09104	-0.1405
Chironomidae	6	5	0.227273	-1.4816	-0.33673
Procambarus	6	1	0.045455	-3.09104	-0.1405
Oligochete	10	1	0.045455	-3.09104	-0.1405
					-1.617

Metric		Standard	Standardiz	Adjusted
Taxa richn	7	33	21.21212	21.21
EPT richne	1	19	5.263158	5.26
Beck's inde	1	38	2.631579	2.63
Hilsenhoff	4.86	1.89	63.37855	63.37
Shannon d	1.62	2.86	56.64336	56.64
% sensitive	31.81	84.5	37.64497	37.64
		IBI=		31.125

Beck (3*0)+(2*0)+(1*1)=1

Hilsenhoff	PTV	N	PTV*N
	0	0	0
	1	0	0
	2	1	2
	3	6	18
	4	0	0
	5	7	35
	6	7	42
	7	0	0
	8	0	0
	9	0	0
	10	1	10
	Sum		107

107/22=4.863

Two Lick Sample Run

	PTV	N=61	n/61	lnE	E*F
Maccaffertium	3	3	0.04918	-3.01226	-0.14814
Baetis	4	1	0.016393	-4.11087	-0.06739
Optioservus	4	2	0.032787	-3.41773	-0.11206
Hydropsyche	5	11	0.180328	-1.71298	-0.3089
Stenelmis	5	1	0.016393	-4.11087	-0.06739
Sialis	6	1	0.016393	-4.11087	-0.06739
Cheumatopsyche	6	3	0.04918	-3.01226	-0.14814
Chironomidae	6	37	0.606557	-0.49996	-0.30325
Hemerodromia	6	1	0.016393	-4.11087	-0.06739
Procambarus	6	1	0.016393	-4.11087	-0.06739
					-1.357

Metric		Standard	Standardiz	Adjusted
Taxa richn	10	33	30.30303	30.3
EPT richne	1	19	5.263158	5.26
Beck's inde	0	38	0	0
Hilsenhoff	5.56	1.89	54.74723	54.75
Shannon d	1.36	2.86	47.55245	47.55
% sensitive	4.92	84.5	5.822485	5.82
		IBI=		23.94667

Beck (3*0)+(2*0)+(1*0)=0

Hilsenhoff PTV	N	PTV*N
0	0	0
1	0	0
2	0	0
3	3	9
4	3	12
5	12	60
6	43	258
7	0	0
8	0	0
9	0	0
10	0	0
Sum		339

339/61= 5.56

2008 Two Lick Sample	PTV	N=220	n/220	lnE	E*F
Acentrella - 2	4	2	0.009091	-4.70048	-0.04273
Plauditus - 3	4	3	0.013636	-4.29502	-0.05857
Hydropsyche - 4	5	4	0.018182	-4.00733	-0.07286
Cheumatopsyche - 1	5	1	0.004545	-5.39363	-0.02452
Baetis - 1	6	1	0.004545	-5.39363	-0.02452
Hemerodromia - 2	6	2	0.009091	-4.70048	-0.04273
Chironomidae - 201	6	201	0.913636	-0.09032	-0.08252
Ceratopsyche - 4	6	4	0.018182	-4.00733	-0.07286
Clitellata – 2	10	2	0.009091	-4.70048	-0.04273
					-0.464

Metric		Standard	Standardiz	Adjusted
Taxa richn	9	33	27.27273	27.3
EPT richne	2	19	10.52632	10.53
Beck's inde	0	38	0	0
Hilsenhoff	5.97	1.89	49.69174	49.69
Shannon d	0.464	2.86	16.22378	16.2
% sensitive	0	84.5	0	0
		IBI=		17.28667

Beck (3*0)+(2*0)+(1*0)=0

Hilsenhoff	PTV	N	PTV*N
	0	0	0
	1	0	0
	2	0	0
	3	0	0
	4	5	20
	5	5	25
	6	208	1248
	7	0	0
	8	0	0
	9	0	0
	10	2	20
		Sum	1313
		1313/220= 5.97	

Dixon Run Pear Rd

	PTV	N=239	n/239	lnE	E*F	
Alloperla	0	2	0.008368	-4.78332	-0.04003	
Ameletus	0	1	0.004184	-5.47646	-0.02291	
Suwallia	0	2	0.008368	-4.78332	-0.04003	
Rhyacophila	1	1	0.004184	-5.47646	-0.02291	
Serratella	2	2	0.008368	-4.78332	-0.04003	
Ephemera	2	1	0.004184	-5.47646	-0.02291	
Hexatoma	2	1	0.004184	-5.47646	-0.02291	
Isoperla	2	4	0.016736	-4.09017	-0.06845	
Prosimulium	2	115	0.481172	-0.73153	-0.35199	
Amphinemura	3	1	0.004184	-5.47646	-0.02291	
Dicranota	3	1	0.004184	-5.47646	-0.02291	
Maccaffertium	3	22	0.09205	-2.38542	-0.21958	
Chimarra	4	1	0.004184	-5.47646	-0.02291	
Pycnopsyche	4	12	0.050209	-2.99156	-0.1502	
Stenacron	4	1	0.004184	-5.47646	-0.02291	
Stenonema	4	8	0.033473	-3.39702	-0.11371	
Tipula	4	3	0.012552	-4.37785	-0.05495	
Hydropsyche	5	14	0.058577	-2.83741	-0.16621	
Ptilostomis	5	1	0.004184	-5.47646	-0.02291	
Baetis	6	19	0.079498	-2.53202	-0.20129	
Chironomidae	6	20	0.083682	-2.48073	-0.20759	
Procambarus	6	3	0.012552	-4.37785	-0.05495	
Caenis	7	1	0.004184	-5.47646	-0.02291	
Prosobranchia	8?	2	0.008368	-4.78332	-0.04003	
Physidae	8	1	0.004184	-5.47646	-0.02291	= -2.001

Metric		Standard	Standardiz	Adjusted
Taxa richn	25	33	75.75758	75.75
EPT richne	13	19	68.42105	68.42
Beck's inde	16	38	42.10526	42.12
Hilsenhoff	3.25	1.89	83.23058	83.23
Shannon d	2	2.86	69.93007	69.93
% sensitive	82	84.5	97.04142	97.04
		IBI=		72.74833

Beck (3*3)+(2*1)+(1*5)=16

Hilsenhoff	PTV	N	PTV*N
	0	5	0
	1	1	1
	2	123	246
	3	24	72
	4	25	100
	5	15	75
	6	42	252
	7	1	7
	8	3	24
	9	0	0
	10	0	0
		Sum	777

777/239=3.251

Dixon Run Dixonville

	PTV	N=313	n/313	lnE	E*F
Suwallia	0	4	0.01278	-4.35991	-0.05572
Ephemerella	1	1	0.003195	-5.7462	-0.01836
Paraleptophlebia	1	2	0.00639	-5.05306	-0.03229
Ephemera	2	1	0.003195	-5.7462	-0.01836
Isoperla	2	4	0.01278	-4.35991	-0.05572
Prosimulium	2	158	0.504792	-0.68361	-0.34508
Maccaffertium	3	4	0.01278	-4.35991	-0.05572
Chimarra	4	7	0.022364	-3.80029	-0.08499
Eurylophella	4	4	0.01278	-4.35991	-0.05572
Pycnopsyche	4	2	0.00639	-5.05306	-0.03229
Stenacron	4	2	0.00639	-5.05306	-0.03229
Tipula	4	2	0.00639	-5.05306	-0.03229
Hydropsyche	5	28	0.089457	-2.414	-0.21595
Ptilostomis	5	1	0.003195	-5.7462	-0.01836
Stenelmis	5	2	0.00639	-5.05306	-0.03229
Hydrophilidae	5	1	0.003195	-5.7462	-0.01836
Baetis	6	15	0.047923	-3.03815	-0.1456
Cheumatopsyche	6	1	0.003195	-5.7462	-0.01836
Probezzia	6	17	0.054313	-2.91299	-0.15821
Chironomidae	6	47	0.15016	-1.89606	-0.28471
Simulium	6	3	0.009585	-4.64759	-0.04455
Procambarus	6	7	0.022364	-3.80029	-0.08499
					-1.84

Metric		Standard	Standardiz	Adjusted
Taxa richn	22	33	66.66667	66.67
EPT richne	10	19	52.63158	52.63
Beck's inde	8	38	21.05263	21.05
Hilsenhoff	3.54	1.89	79.65475	79.64
Shannon d	1.84	2.86	64.33566	64.3
% sensitive	66.66	84.5	78.88757	78.89
		IBI=		60.53

Beck (3*1)+(2*2)+(1*3)=8

Hilsenhoff	PTV	N	PTV*N
	0	4	0
	1	3	3
	2	163	326
	3	4	12
	4	17	68
	5	32	160
	6	90	540
	7	0	0
	8	0	0
	9	0	0
	10	0	0
		Sum	1109

1109/313=3.543

Dixon Run Rd24

	PTV	N=4	n/4	lnE	E*F
Ephemera	2	1	0.25	-1.38629	-0.34657
Probezzia	6	1	0.25	-1.38629	-0.34657
Chironomidae	6	1	0.25	-1.38629	-0.34657
Oligochete	10	1	0.25	-1.38629	-0.34657
					-1.386

Metric		Standard	Standardiz	Adjusted
Taxa richn	4	33	12.12121	12.12
EPT richne	1	19	5.263158	5.26
Beck's inde	1	38	2.631579	2.63
Hilsenhoff	6	1.89	49.32182	49.32
Shannon d	1.39	2.86	48.6014	48.6
% sensitive	25	84.5	29.5858	29.59
		IBI=		24.58667

Beck (3*0)+(2*0)+(1*1)=1

Hilsenhoff	PTV	N	PTV*N
	0	0	0
	1	0	0
	2	1	2
	3	0	0
	4	0	0
	5	0	0
	6	2	12
	7	0	0
	8	0	0
	9	0	0
	10	1	10
		Sum	24

24/4=6

Dixon Run Mouth Clymer

	PTV	N=15	n/15	lnE	E*F
Epeorus	0	1	0.066667	-2.70805	-0.18054
Atherix	2	1	0.066667	-2.70805	-0.18054
Prosimulium	2	1	0.066667	-2.70805	-0.18054
Dannella	3	2	0.133333	-2.0149	-0.26865
Dicranota	3	1	0.066667	-2.70805	-0.18054
Maccaffertium	3	4	0.266667	-1.32176	-0.35247
Stenacron	4	2	0.133333	-2.0149	-0.26865
Tipula	4	1	0.066667	-2.70805	-0.18054
Probezzia	6	1	0.066667	-2.70805	-0.18054
Chironomidae	6	1	0.066667	-2.70805	-0.18054
					-2.15

Metric		Standard	Standardiz	Adjusted
Taxa richn	10	33	30.30303	27.27
EPT richne	4	19	21.05263	26.31
Beck's inde	5	38	13.15789	10.52
Hilsenhoff	3.27	1.89	82.98397	72.01
Shannon d	2.15	2.86	75.17483	61.78
% sensitive	66.66	84.5	78.88757	11.46
		IBI=		34.89167

Beck (3*1)+(2*0)+(1*2)=5

Hilsenhoff	PTV	N	PTV*N
	0	1	0
	1	0	0
	2	2	4
	3	7	21
	4	3	12
	5	0	0
	6	2	12
	7	0	0
	8	0	0
	9	0	0
	10	0	0
		Sum	49

49/15=3.266

2008 Dixon Run Mouth	PTV	N=141	n/141	lnE	E*F
Paracapnia - 10	1	10	0.070922	-2.64617	-0.18767
Taeniopteryx - 2	2	2	0.014184	-4.25561	-0.06036
Antocha – 1	3	1	0.007092	-4.94876	-0.0351
Optioservus - 1	4	1	0.007092	-4.94876	-0.0351
Tipula - 12	4	12	0.085106	-2.46385	-0.20969
Hydropsyche - 4	5	4	0.028369	-3.56247	-0.10106
Diphetor - 1	6	1	0.007092	-4.94876	-0.0351
Chironomidae - 102	6	102	0.723404	-0.32379	-0.23423
Bezzia - 2	6	2	0.014184	-4.25561	-0.06036
Hemerodromia - 2	6	2	0.014184	-4.25561	-0.06036
Cheumatopsyche - 1	6	1	0.007092	-4.94876	-0.0351
Lymnaeidae - 1	7	1	0.007092	-4.94876	-0.0351
Acariformes - 1	7	1	0.007092	-4.94876	-0.0351
Clitellata - 1	10	1	0.007092	-4.94876	-0.0351
					-1.159

Metric		Standard	Standardiz	Adjusted
Taxa richn	14	33	42.42424	42.4
EPT richne	2	19	10.52632	10.5
Beck's inde	3	38	7.894737	7.9
Hilsenhoff	5.43	1.89	56.35018	56.4
Shannon d	1.16	2.86	40.55944	40.4
% sensitive	0.09	84.5	0.106509	0.1
		IBI=		26.28333

Beck (3*0)+(2*1)+(1*2)=3

Hilsenhoff	PTV	N	PTV*N
	0	0	0
	1	10	10
	2	2	4
	3	1	3
	4	13	52
	5	5	25
	6	109	654
	7	1	7
	8	0	0
	9	0	0
	10	1	10
		Sum	765

765/141=5.425

	PTV				
Penn Run mouth					
		N=15	n/15	lnE	E*F
Epeorus	0	1	0.066667	-2.70805	-0.18054
Isoperla	2	2	0.133333	-2.0149	-0.26865
Tipula	4	2	0.133333	-2.0149	-0.26865
Hydropsyche	5	5	0.333333	-1.09861	-0.3662
Polycentropus	6	1	0.066667	-2.70805	-0.18054
Sialis	6	1	0.066667	-2.70805	-0.18054
Chironomidae	6	2	0.133333	-2.0149	-0.26865
Gerris	9	1	0.066667	-2.70805	-0.18054
					-1.894

Metric		Standard	Standardiz	Adjusted
Taxa richn	8	33	24.24242	24.24
EPT richne	2	19	10.52632	10.52
Beck's inde	4	38	10.52632	10.52
Hilsenhoff	3.86	1.89	75.709	75.71
Shannon d	1.89	2.86	66.08392	66.08
% sensitive	2	84.5	2.366864	2.36
		IBI=		31.57167

Beck (3*1)+(2*0)+(1*1)=4

Hilsenhoff PTV	N	PTV*N
0	1	0
1	0	0
2	2	4
3	0	0
4	2	8
5	5	25
6	2	12
7	0	0
8	0	0
9	1	9
10	0	0
	Sum	58

58/15= 3.86

Penn Run Headwtr

	PTV	N=172	n/172	lnE	E*F
Diplectrona	0	1	0.005814	-5.14749	-0.02993
Atherix	2	1	0.005814	-5.14749	-0.02993
Amphinemura	3	5	0.02907	-3.53806	-0.10285
Antocha	3	1	0.005814	-5.14749	-0.02993
Chimarra	4	6	0.034884	-3.35574	-0.11706
Stenacron	4	1	0.005814	-5.14749	-0.02993
Tipula	4	1	0.005814	-5.14749	-0.02993
Baetis	6	1	0.005814	-5.14749	-0.02993
Cheumatopsyche	6	1	0.005814	-5.14749	-0.02993
Chironomidae	6	151	0.877907	-0.13021	-0.11432
Hemerodromia	6	1	0.005814	-5.14749	-0.02993
Procambarus	6	1	0.005814	-5.14749	-0.02993
Oligochete	10	1	0.005814	-5.14749	-0.02993
					-0.6335

Metric		Standard	Standardiz	Adjusted
Taxa richn	13	33	39.39394	39.39
EPT richne	4	19	21.05263	21.05
Beck's inde	4	38	10.52632	10.52
Hilsenhoff	5.77	1.89	52.15783	52.16
Shannon d	0.63	2.86	22.02797	22.03
% sensitive	4.65	84.5	5.502959	5.5
		IBI=		25.10833

Beck (3*1)+(2*0)+(1*1)=4

Hilsenhoff PTV	N	PTV*N
0	1	0
1	0	0
2	1	2
3	6	18
4	8	32
5	0	0
6	155	930
7	0	0
8	0	0
9	0	0
10	1	10
Sum		992

992/172= 5.767

Yellow Cr Rt 954

	PTV	N=228	n/228	lnE	E*F
Isoperla	2	1	0.004386	-5.42935	-0.02381
Prosimulium	2	64	0.280702	-1.27046	-0.35662
Antocha	3	1	0.004386	-5.42935	-0.02381
Isonychia	3	15	0.065789	-2.7213	-0.17903
Maccaffertium	3	31	0.135965	-1.99536	-0.2713
Corydalus	4	1	0.004386	-5.42935	-0.02381
Chimarra	4	10	0.04386	-3.12676	-0.13714
Eurylophella	4	2	0.008772	-4.7362	-0.04155
Optioservus	4	1	0.004386	-5.42935	-0.02381
Pycnopsyche	4	3	0.013158	-4.33073	-0.05698
Stenacron	4	1	0.004386	-5.42935	-0.02381
Stenonema	4	1	0.004386	-5.42935	-0.02381
Hydropsyche	5	6	0.026316	-3.63759	-0.09573
Baetis	6	2	0.008772	-4.7362	-0.04155
Polycentropus	6	1	0.004386	-5.42935	-0.02381
Cheumatopsyche	6	15	0.065789	-2.7213	-0.17903
Chironomidae	6	51	0.223684	-1.49752	-0.33497
Hemerodromia	6	1	0.004386	-5.42935	-0.02381
Simulium	6	20	0.087719	-2.43361	-0.21347
Procambarus	6	1	0.004386	-5.42935	-0.02381
					-2.121

Metric		Standard	Standardiz	Adjusted
Taxa richn	20	33	60.60606	60.61
EPT richne	8	19	42.10526	42.11
Beck's inde	2	38	5.263158	5.26
Hilsenhoff	4.05	1.89	73.36621	73.37
Shannon d	2.12	2.86	74.12587	74.13
% sensitive	49.12	84.5	58.13018	35.78
		IBI=		48.54333

Beck (3*0)+(2*0)+(1*2)=2

Hilsenhoff PTV	N	PTV*N
0	0	0
1	0	0
2	65	130
3	47	141
4	19	76
5	6	30
6	91	546
7	0	0
8	0	0
9	0	0
10	0	0
	Sum	923

923/228= 4.048

2010 Yellow Cr @ Rt 954	PTV	N=228	n/228	lnE	E*F
Acroneuria - 1	0	1	0.004386	-5.42935	-0.02381
Taeniopteryx - 23	2	23	0.100877	-2.29385	-0.2314
Nigronia - 2	2	2	0.008772	-4.7362	-0.04155
Isonychia - 15	3	15	0.065789	-2.7213	-0.17903
Antocha - 14	3	14	0.061404	-2.79029	-0.17133
Maccaffertium - 11	4	11	0.048246	-3.03145	-0.14625
Plauditus - 1	4	1	0.004386	-5.42935	-0.02381
Stenacron - 1	4	1	`	#VALUE!	#VALUE!
Optioservus - 1	4	1	0.004386	-5.42935	-0.02381
Psephenus - 1	4	1	0.004386	-5.42935	-0.02381
Corydalus - 1	4	1	0.004386	-5.42935	-0.02381
Chimarra - 42	4	42	0.184211	-1.69168	-0.31162
Hydropsyche - 30	5	30	0.131579	-2.02815	-0.26686
Baetis - 1	6	1	0.004386	-5.42935	-0.02381
Chironomidae - 18	6	18	0.078947	-2.53897	-0.20045
Hemerodromia - 2	6	2	0.008772	-4.7362	-0.04155
Simulium - 2	6	2	0.008772	-4.7362	-0.04155
Cheumatopsyche - 36	6	36	0.157895	-1.84583	-0.29145
Planorbidae - 2	6	2	0.008772	-4.7362	-0.04155
Amphipoda - 3	6	3	0.013158	-4.33073	-0.05698
Hydroptila - 1	6	1	0.004386	-5.42935	-0.02381
Acariformes - 10	7	10	0.04386	-3.12676	-0.13714
Nematoda – 3	9	3	0.013158	-4.33073	-0.05698
Clitellata - 7	10	7	0.030702	-3.48344	-0.10695
					-2.513

Metric		Standard	Standardiz	Adjusted
Taxa richn	24	33	72.72727	72.7
EPT richne	6	19	31.57895	31.58
Beck's inde	5	38	13.15789	13.16
Hilsenhoff	4.79	1.89	64.24168	64.24
Shannon d	2.51	2.86	87.76224	87.76
% sensitive	17.1	84.5	20.23669	20.24
		IBI=		48.28

Beck (3*1)+(2*0)+(1*2)=5

Hilsenhoff	PTV	N	PTV*N
	0	1	0
	1	0	0
	2	25	50
	3	29	87
	4	58	232
	5	30	150
	6	65	390
	7	10	70
	8	0	0
	9	3	27
	10	7	70
		Sum	1076

1076/228=4.719

Yellow Cr Tide

	PTV	N=86	n/86	lnE	E*F
Sweltsa	0	1	0.011628	-4.45435	-0.05179
Prosimulium	2	3	0.034884	-3.35574	-0.11706
Antocha	3	16	0.186047	-1.68176	-0.31289
Isonychia	3	5	0.05814	-2.84491	-0.1654
Strophopteryx	3	1	0.011628	-4.45435	-0.05179
Eurylophella	4	1	0.011628	-4.45435	-0.05179
Optioservus	4	1	0.011628	-4.45435	-0.05179
Pycnopsyche	4	1	0.011628	-4.45435	-0.05179
Stenacron	4	1	0.011628	-4.45435	-0.05179
Hydropsyche	5	15	0.174419	-1.7463	-0.30459
Polycentropus	6	1	0.011628	-4.45435	-0.05179
Sialis	6	1	0.011628	-4.45435	-0.05179
Cheumatopsyche	6	8	0.093023	-2.37491	-0.22092
Chironomidae	6	28	0.325581	-1.12214	-0.36535
Hemerodromia	6	1	0.011628	-4.45435	-0.05179
Simulium	6	1	0.011628	-4.45435	-0.05179
Oligochete	10	1	0.011628	-4.45435	-0.05179
					-2.056

Metric		Standard	Standardiz	Adjusted
Taxa richn	17	33	51.51515	51.51
EPT richne	3	19	15.78947	15.79
Beck's inde	4	38	10.52632	10.52
Hilsenhoff	4.8	1.89	64.11837	64.12
Shannon d	2.06	2.86	72.02797	72.03
% sensitive	30.23	84.5	35.77515	35.78
		IBI=		41.625

Beck (3*1)+(2*0)+(1*1)=4

Hilsenhoff PTV	N	PTV*N
0	1	0
1	0	0
2	3	6
3	22	66
4	4	16
5	15	75
6	40	240
7	0	0
8	0	0
9	0	0
10	1	10
Sum		413

413/86= 4.80

	PTV					
Yellow Cr Homer City						
		N=3	n/3	lnE	E*F	
Amphinemura	3	1	0.333333	-1.09861	-0.3662	
Chironomidae	6	1	0.333333	-1.09861	-0.3662	
Empididae	6	1	0.333333	-1.09861	-0.3662	
					-1.098	

	Metric		Standard	Standardiz	Adjusted
	Taxa richn	3	33	9.090909	9.09
	EPT richne	1	19	5.263158	5.26
	Beck's inde	1	38	2.631579	2.63
	Hilsenhoff	4	1.89	73.98274	73.98
	Shannon d	1.1	2.86	38.46154	38.46
	% sensitive	66.66	84.5	78.88757	78.89
			IBI=		34.71833
Beck	(3*0)+(2*0)+(1*1)=1				

Hilsenhoff PTV		N	PTV*N
	0	1	0
	1	0	0
	2	0	0
	3	0	0
	4	0	0
	5	0	0
	6	2	12
	7	0	0
	8	0	0
	9	0	0
	10	0	0
		Sum	12
		12/3= 4	

Elk Creek Mouth

	PTV	N=104	n/104	lnE	E*F
Acroneuria	0	4	0.038462	-3.2581	-0.12531
Ameletus	0	2	0.019231	-3.95124	-0.07599
Leuctra	0	1	0.009615	-4.64439	-0.04466
Soyedina	0	1	0.009615	-4.64439	-0.04466
Wormaldia	0	7	0.067308	-2.69848	-0.18163
Ephemerella	1	1	0.009615	-4.64439	-0.04466
Nemoura	1	1	0.009615	-4.64439	-0.04466
Isonychia	3	5	0.048077	-3.03495	-0.14591
Oemopteryx	3	4	0.038462	-3.2581	-0.12531
Strophopteryx	3	2	0.019231	-3.95124	-0.07599
Chimarra	4	15	0.144231	-1.93634	-0.27928
Tipula	4	2	0.019231	-3.95124	-0.07599
Tipulidae	4	1	0.009615	-4.64439	-0.04466
Hydropsyche	5	1	0.009615	-4.64439	-0.04466
Baetis	4	1	0.009615	-4.64439	-0.04466
Polycentropus	6	3	0.028846	-3.54578	-0.10228
Cheumatopsyche	6	7	0.067308	-2.69848	-0.18163
Chironomidae	6	46	0.442308	-0.81575	-0.36081
					-2.042

Metric		Standard	Standardiz	Adjusted
Taxa richn	18	33	54.54545	54.54
EPT richne	11	19	57.89474	57.89
Beck's inde	22	38	57.89474	57.89
Hilsenhoff	4.77	1.89	64.48829	64.73
Shannon d	2.04	2.86	71.32867	71.33
% sensitive	26.92	84.5	31.85799	31.86
		IBI=		56.37333

Beck	(3*5)+(2*2)+(1*3)=22

Hilsenhoff	PTV	N	PTV*N
	0	15	0
	1	2	2
	2	21	42
	3	11	33
	4	18	72
	5	1	5
	6	57	342
	7	0	0
	8	0	0
	9	0	0
	10	0	0
		Sum	496

	496/104=4.769

2010 Elk Cr	PTV	N=33		n/33	lnE	E*F
Leuctra - 1	0	1		0.030303	-3.49651	-0.10595
Isonychia - 1	3	1		0.030303	-3.49651	-0.10595
Antocha - 5	3	5		0.151515	-1.88707	-0.28592
Ceratopsyche - 7	5	7		0.212121	-1.5506	-0.32891
Sialis - 1	6	1		0.030303	-3.49651	-0.10595
Chironomidae - 9	6	9		0.272727	-1.29928	-0.35435
Cheumatopsyche	6	9		0.272727	-1.29928	-0.35435
						-1.641

	Metric		Standard	Standardiz	Adjusted
	Taxa richn	7	33	21.21212	21.2
	EPT richne	12	19	63.15789	63.2
	Beck's inde	3	38	7.894737	7.9
	Hilsenhoff	5.06	1.89	60.91245	60.9
	Shannon d	1.64	2.86	57.34266	57.3
	% sensitive	21.21	84.5	25.10059	25.1
			IBI=		39.26667
Beck	(3*1)+(2*0)+(1*0)=3				
	Hilsenhoff	PTV	N	PTV*N	
		0	1	0	
		1	0	0	
		2	0	0	
		3	6	18	
		4	0	0	
		5	7	35	
		6	19	114	
		7	0	0	
		8	0	0	
		9	0	0	
		10	0	0	
			Sum	167	
			167/33=5.06		

Little Elk Cr

	PTV	N=240	n/240	lnE	E*F	
Ameletus	0	1	0.004167	-5.48064	-0.02284	
Diplectrona	0	11	0.045833	-3.08274	-0.14129	
Dolophilodes	0	2	0.008333	-4.78749	-0.0399	
Epeorus	0	39	0.1625	-1.81708	-0.29528	
Goera	0	1	0.004167	-5.48064	-0.02284	
Leuctra	0	6	0.025	-3.68888	-0.09222	
Soyedina	0	1	0.004167	-5.48064	-0.02284	
Wormaldia	0	1	0.004167	-5.48064	-0.02284	
Ephemerella	1	1	0.004167	-5.48064	-0.02284	
Nemoura	1	1	0.004167	-5.48064	-0.02284	
Paraleptophlebia	1	10	0.041667	-3.17805	-0.13242	
Rhyacophila	1	12	0.05	-2.99573	-0.14979	
Nigronia	2	1	0.004167	-5.48064	-0.02284	
Prosimulium	2	114	0.475	-0.74444	-0.35361	
Dannella	3	1	0.004167	-5.48064	-0.02284	
Maccaffertium	3	7	0.029167	-3.53473	-0.1031	
Neophylax	3	2	0.008333	-4.78749	-0.0399	
Eurylophella	4	1	0.004167	-5.48064	-0.02284	
Pycnopsyche	4	1	0.004167	-5.48064	-0.02284	
Stenacron	4	3	0.0125	-4.38203	-0.05478	
Tipula	4	5	0.020833	-3.8712	-0.08065	
Hydropsyche	5	2	0.008333	-4.78749	-0.0399	
Baetis	4	3	0.0125	-4.38203	-0.05478	
Sialis	6	1	0.004167	-5.48064	-0.02284	
Chironomidae	6	13	0.054167	-2.91569	-0.15793	1.986

Metric		Standard	Standardiz	Adjusted
Taxa richn	25	33	75.75758	75.75
EPT richne	18	19	94.73684	94.74
Beck's inde	34	38	89.47368	89.47
Hilsenhoff	1.82	1.89	100.8631	100
Shannon d	1.99	2.86	69.58042	69.58
% sensitive	87.91	84.5	104.0355	100
		IBI=		88.25667

Beck (3*8)+(2*4)+(1*2)=34

Hilsenhoff	PTV	N	PTV*N
	0	62	0
	1	24	24
	2	115	230
	3	10	30
	4	10	40
	5	2	10
	6	17	102
	7	0	0
	8	0	0
	9	0	0
	10	0	0
		Sum	436
		436/240=1.816	

UNT 44554 Iverson Rd

	PTV	N=190	n/190	lnE	E*F
Acroneuria	0	1	0.005263	-5.24702	-0.02762
Alloperla	0	1	0.005263	-5.24702	-0.02762
Ameletus	0	3	0.015789	-4.14841	-0.0655
Dolophilodes	0	1	0.005263	-5.24702	-0.02762
Epeorus	0	26	0.136842	-1.98893	-0.27217
Leuctra	0	11	0.057895	-2.84913	-0.16495
Wormaldia	0	8	0.042105	-3.16758	-0.13337
Rhyacophila	1	5	0.026316	-3.63759	-0.09573
Boyeria	2	1	0.005263	-5.24702	-0.02762
Diura	2	4	0.021053	-3.86073	-0.08128
Nigronia	2	1	0.005263	-5.24702	-0.02762
Prosimulium	2	72	0.378947	-0.97036	-0.36771
Maccaffertium	3	10	0.052632	-2.94444	-0.15497
Neophylax	3	1	0.005263	-5.24702	-0.02762
Pycnopsyche	4	2	0.010526	-4.55388	-0.04794
Tipula	4	2	0.010526	-4.55388	-0.04794
Polycentropus	6	2	0.010526	-4.55388	-0.04794
Cheumatopsyche	6	18	0.094737	-2.35665	-0.22326
Probezzia	6	1	0.005263	-5.24702	-0.02762
Chironomidae	6	20	0.105263	-2.25129	-0.23698
					-2.133

Metric		Standard	Standardiz	Adjusted
Taxa richn	20	33	60.60606	60.6
EPT richne	12	19	63.15789	63.16
Beck's inde	27	38	71.05263	71.05
Hilsenhoff	2.34	1.89	94.45129	94.45
Shannon d	2.13	2.86	74.47552	74.47
% sensitive	76.32	84.5	90.31953	90.32
		IBI=		75.675

Beck (3*7)+(2*1)+(1*4)=27

Hilsenhoff	PTV	N	PTV*N
	0	51	0
	1	5	5
	2	78	156
	3	11	33
	4	4	16
	5	0	0
	6	39	234
	7	0	0
	8	0	0
	9	0	0
	10	0	0
		Sum	444

444/190=2.336

NB Blacklick Red Mill

	PTV	N=39	n/39	lnE	E*F
Acroneuria	0	1	0.025641	-3.66356	-0.09394
Alloperla	0	2	0.051282	-2.97041	-0.15233
Rhyacophila	1	2	0.051282	-2.97041	-0.15233
Nigronia	2	1	0.025641	-3.66356	-0.09394
Prosimulium	2	13	0.333333	-1.09861	-0.3662
Chimarra	4	1	0.025641	-3.66356	-0.09394
Hydropsyche	5	6	0.153846	-1.8718	-0.28797
Chironomidae	6	11	0.282051	-1.26567	-0.35698
Pedicia	6	1	0.025641	-3.66356	-0.09394
Oligochete	10	1	0.025641	-3.66356	-0.09394
					-1.785

Metric		Standard	Standardiz	Adjusted
Taxa richn	10	33	30.30303	30.3
EPT richne	4	19	21.05263	21.05
Beck's inde	10	38	26.31579	26.32
Hilsenhoff	3.74	1.89	77.18866	77.19
Shannon d	1.79	2.86	62.58741	62.59
% sensitive	48.72	84.5	57.6568	57.66
		IBI=		45.85167

Beck (3*2)+(2*1)+(1*2)=10

Hilsenhoff PTV	N	PTV*N
0	3	0
1	2	2
2	14	28
3	0	0
4	1	4
5	6	30
6	12	72
7	0	0
8	0	0
9	0	0
10	1	10
Sum		146

146/39= 3.74

2015 Red Mill	PTV	N=78	n/78	lnE	E*F
Leuctra - 2	0	2	0.025641	-3.66356	-0.09394
Nigronia - 1	2	1	0.012821	-4.35671	-0.05586
Antocha - 3	3	3	0.038462	-3.2581	-0.12531
Maccaffertium - 7	3	7	0.089744	-2.4108	-0.21635
Isonychia - 2	3	2	0.025641	-3.66356	-0.09394
Taenionema - 1	3	1	0.012821	-4.35671	-0.05586
Chimarra - 2	4	2	0.025641	-3.66356	-0.09394
Baetisca - 1	4	1	0.012821	-4.35671	-0.05586
Optioservus - 5	4	5	0.064103	-2.74727	-0.17611
Hydropsyche - 12	5	12	0.153846	-1.8718	-0.28797
Baetis - 4	6	4	0.051282	-2.97041	-0.15233
Simulium - 1	6	1	0.012821	-4.35671	-0.05586
Chironomidae - 30	6	30	0.384615	-0.95551	-0.3675
Ceratopogon - 2	6	2	0.025641	-3.66356	-0.09394
Caenis – 2	7	2	0.025641	-3.66356	-0.09394
Cambaridae - 3	10	3	0.038462	-3.2581	-0.12531
					-2.44

	Metric		Standard	Standardiz	Adjusted
	Taxa richn	16	33	48.48485	48.5
	EPT richne	11	19	57.89474	57.89
	Beck's inde	4	38	10.52632	10.53
	Hilsenhoff	4.76	1.89	64.61159	66.61
	Shannon d	2.44	2.86	85.31469	85.31
	% sensitive	20.5	84.5	24.26036	24.3
			IBI=		48.85667
Beck	(3*1)+(2*0)+(1*1)=4				

Hilsenhoff	PTV	N	PTV*N
	0	2	0
	1	0	0
	2	2	4
	3	13	39
	4	8	32
	5	12	60
	6	37	222
	7	2	14
	8	0	0
	9	0	0
	10	0	0
		Sum	371
		371/78= 4.756	

Carney Run

	PTV	N=180	n/180	lnE	E*F
Acroneuria	0	2	0.011111	-4.49981	-0.05
Ameletus	0	3	0.016667	-4.09434	-0.06824
Dolophilodes	0	4	0.022222	-3.80666	-0.08459
Epeorus	0	10	0.055556	-2.89037	-0.16058
Leuctra	0	2	0.011111	-4.49981	-0.05
Soyedina	0	1	0.005556	-5.19296	-0.02885
Rhyacophila	1	17	0.094444	-2.35974	-0.22286
Atherix	2	1	0.005556	-5.19296	-0.02885
Isoperla	2	1	0.005556	-5.19296	-0.02885
Prosimulium	2	37	0.205556	-1.58204	-0.3252
Amphinemura	3	1	0.005556	-5.19296	-0.02885
Maccaffertium	3	3	0.016667	-4.09434	-0.06824
Baetis	6	4	0.022222	-3.80666	-0.08459
Optioservus	4	1	0.005556	-5.19296	-0.02885
Pycnopsyche	4	1	0.005556	-5.19296	-0.02885
Stenonema	4	2	0.011111	-4.49981	-0.05
Tipula	4	4	0.022222	-3.80666	-0.08459
Hydropsyche	5	12	0.066667	-2.70805	-0.18054
Baetis	6	4	0.022222	-3.80666	-0.08459
Polycentropus	6	1	0.005556	-5.19296	-0.02885
Cheumatopsyche	6	20	0.111111	-2.19722	-0.24414
Chironomidae	6	50	0.277778	-1.28093	-0.35581
Procambarus	6	2	0.011111	-4.49981	-0.05
Oligochete	10	1	0.005556	-5.19296	-0.02885
					-2.31

Metric		Standard	Standardiz	Adjusted
Taxa richness	23	33	69.69697	69.70
EPT richness (PTV 0-4)	12	19	63.15789	63.16
Beck's index	23	38	60.52632	60.53
Hilsenhoff biotic index	3.73	1.89	77.31196	77.31
Shannon diversity	2.31	2.86	80.76923	80.77
% sensitive (PTV 0-3)	45.56	84.5	53.91716	100.00
			IBI=	75.24

Beck (3*6)+(2*1)+(1*3)=23

Hilsenhoff	PTV	N	PTV*N
	0	22	0
	1	17	17
	2	39	78
	3	4	12
	4	8	32
	5	12	60
	6	77	462
	7	0	0
	8	0	0
	9	0	0
	10	1	10
		Sum	671

671/180=3.727

2014 Carney Run	PTV	N=222	n/222	lnE	E*F
Acroneuria - 2	0	2	0.009009	-4.70953	-0.04243
Epeorus - 11	0	11	0.04955	-3.00478	-0.14889
Leuctra - 35	0	35	0.157658	-1.84733	-0.29125
Haploperla - 20	0	20	0.09009	-2.40695	-0.21684
Diplectrona - 15	0	15	0.067568	-2.69463	-0.18207
Ephemerella - 6	1	6	0.027027	-3.61092	-0.09759
Paraleptophlebia -	1	1	0.004505	-5.40268	-0.02434
Rhyacophila - 1	1	1	0.004505	-5.40268	-0.02434
Cinygmula – 5	1	5	0.022523	-3.79324	-0.08543
Hexatoma - 2	2	2	0.009009	-4.70953	-0.04243
Lype - 1	2	1	0.004505	-5.40268	-0.02434
Isoperla - 1	2	1	0.004505	-5.40268	-0.02434
Prosimulium - 1	2	1	0.004505	-5.40268	-0.02434
Maccaffertium - 2	3	2	0.009009	-4.70953	-0.04243
Antocha - 4	3	4	0.018018	-4.01638	-0.07237
Dicranota - 2	3	2	0.009009	-4.70953	-0.04243
Amphinemura - 3	3	3	0.013514	-4.30407	-0.05816
Stenacron - 2	4	2	0.009009	-4.70953	-0.04243
Lanthus - 2	5	2	0.009009	-4.70953	-0.04243
Ectopria - 2	5	2	0.009009	-4.70953	-0.04243
Oulimnius - 43	5	43	0.193694	-1.64148	-0.31794
Polycentropus - 5	6	5	0.022523	-3.79324	-0.08543
Cheumatopsyche -	6	1	0.004505	-5.40268	-0.02434
Chironomidae - 35	6	35	0.157658	-1.84733	-0.29125
Habrophlebiodes -	6	5	0.022523	-3.79324	-0.08543
Baetis - 1	6	1	0.004505	-5.40268	-0.02434
Diphetor - 2	6	2	0.009009	-4.70953	-0.04243
Hemerodromia - 5	6	5	0.022523	-3.79324	-0.08543
Ceratopogonidae -	6	1	0.004505	-5.40268	-0.02434
Chrysops - 1	7	1	0.004505	-5.40268	-0.02434
Chelifera - 5	7	5	0.022523	-3.79324	-0.08543
					-2.661

Metric		Standard	Standardiz	Adjusted
Taxa richn	31	33	93.93939	93.9
EPT richne	14	19	73.68421	73.68
% sensitive	41.44	84.5	49.04142	49.04
Beck's inde	27	38	71.05263	71.1
Hilsenhoff	2.98	1.89	86.5598	86.66
Shannon d	2.66	2.86	93.00699	93
		IBI=		77.89667

Beck (3*5)+(2*4)+(1*4)=27

Hilsenhoff	PTV	N	PTV*N		4
	0	83	0		
	1	13	13		
	2	5	10		
	3	11	33		
	4	2	8		
	5	45	225		
	6	55	330		
	7	6	42		
	8	0	0		
	9	0	0		
	10	0	0		
		Sum	661		
		661/222=2.977			

Downey Run

	PTV	N=246	n/246	lnE	E*F	
Acroneuria	0	4	0.01626	-4.11904	-0.06698	
Alloperla	0	1	0.004065	-5.50533	-0.02238	
Diplectrona	0	1	0.004065	-5.50533	-0.02238	
Dolophilodes	0	11	0.044715	-3.10744	-0.13895	
Epeorus	0	68	0.276423	-1.28582	-0.35543	
Haploperla	0	3	0.012195	-4.40672	-0.05374	
Leuctra	0	4	0.01626	-4.11904	-0.06698	
Suwallia	0	11	0.044715	-3.10744	-0.13895	
Wormaldia	0	6	0.02439	-3.71357	-0.09057	
Hexatoma	2	1	0.004065	-5.50533	-0.02238	
Isoperla	2	4	0.01626	-4.11904	-0.06698	
Prosimulium	2	6	0.02439	-3.71357	-0.09057	
Beloneuria	3	6	0.02439	-3.71357	-0.09057	
Dicranota	3	1	0.004065	-5.50533	-0.02238	
Chimarra	4	8	0.03252	-3.42589	-0.11141	
Pycnopsyche	4	2	0.00813	-4.81218	-0.03912	
Stenacron	4	1	0.004065	-5.50533	-0.02238	
Stenonema	4	2	0.00813	-4.81218	-0.03912	
Tipula	4	7	0.028455	-3.55942	-0.10128	
Polycentropus	6	2	0.00813	-4.81218	-0.03912	
Cheumatopsyche	6	41	0.166667	-1.79176	-0.29863	
Baetis	6	26	0.105691	-2.24723	-0.23751	
Probezzia	6	2	0.00813	-4.81218	-0.03912	
Chironomidae	6	18	0.073171	-2.61496	-0.19134	
Procambarus	6	3	0.012195	-4.40672	-0.05374	
Oligochete	10	7	0.028455	-3.55942	-0.10128	-2.52

Metric		Standard	Standardiz	Adjusted
Taxa richness	26	33	78.78788	78.79
EPT richness (PTV 0-4)	15	19	78.94737	78.95
Beck's index	29	38	76.31579	76.32
Hilsenhoff biotic index	3.028	1.89	85.96794	85.97.33
Shannon diversity	2.52	2.86	88.11189	88.11
% sensitive (PTV 0-3)	51.62	84.5	61.08876	61.09
			IBI=	76.65

Beck (3*9)+(2*0)+(1*2)=29

Hilsenhoff	PTV	N	PTV*N
	0	109	0
	1	0	0
	2	11	22
	3	7	21
	4	20	80
	5	0	0
	6	92	552
	7	0	0
	8	0	0
	9	0	0
	10	7	70

745/246 = 3.028

Walker Run	PTV	N=120	n/120	lnE	E*F
Acroneuria	0	2	0.016667	-4.09434	-0.06824
Alloperla	0	4	0.033333	-3.4012	-0.11337
Diplectrona	0	4	0.033333	-3.4012	-0.11337
Epeorus	0	9	0.075	-2.59027	-0.19427
Haploperla	0	2	0.016667	-4.09434	-0.06824
Leuctra	0	14	0.116667	-2.14843	-0.25065
Suwallia	0	3	0.025	-3.68888	-0.09222
Wormaldia	0	9	0.075	-2.59027	-0.19427
Rhyacophila	1	2	0.016667	-4.09434	-0.06824
Hexatoma	2	1	0.008333	-4.78749	-0.0399
Isoperla	2	4	0.033333	-3.4012	-0.11337
Prosimulium	2	1	0.008333	-4.78749	-0.0399
Tallaperla	2	1	0.008333	-4.78749	-0.0399
Beloneuria	3	4	0.033333	-3.4012	-0.11337
Amphinemura	3	10	0.083333	-2.48491	-0.20708
Dicranota	3	1	0.008333	-4.78749	-0.0399
Pycnopsyche	4	6	0.05	-2.99573	-0.14979
Hydropsyche	5	1	0.008333	-4.78749	-0.0399
Polycentropus	6	2	0.016667	-4.09434	-0.06824
Probezzia	6	2	0.016667	-4.09434	-0.06824
Chironomidae	6	34	0.283333	-1.26113	-0.35732
Tabanidae	6	2	0.016667	-4.09434	-0.06824
Procambarus	6	1	0.008333	-4.78749	-0.0399
Oligochete	10	1	0.008333	-4.78749	-0.0399
					-2.588

Metric		Standard	Standardiz	Adjusted
Taxa richness	24	33	72.72727	72.73
EPT richness (PTV 0-4)	14	19	73.68421	73.68
Beck's index	30	38	78.94737	78.94
Hilsenhoff biotic index	2.883	1.89	87.75586	87.76
Shannon diversity	2.59	2.86	90.55944	90.56
% sensitive (PTV 0-3)	59.17	84.5	70.02367	70.02
		IBI=		78.94833

Beck (3*8)+(2*1)+(1*4)=30

Hilsenhoff	PTV	N	PTV*N
	0	47	0
	1	2	2
	2	7	14
	3	15	45
	4	6	24
	5	1	5
	6	41	246
	7	0	0
	8	0	0
	9	0	0
	10	1	10
		Sum	346
		346/120= 2.883	

UNT Williams Run Revloc

	PTV	N=146	n/146	lnE	E*F
Acroneuria	0	1	0.006849	-4.98361	-0.03413
Dolophilodes	0	3	0.020548	-3.88499	-0.07983
Epeorus	0	47	0.321918	-1.13346	-0.36488
Leuctra	0	7	0.047945	-3.0377	-0.14564
Wormaldia	0	2	0.013699	-4.29046	-0.05877
Ephemerella	1	2	0.013699	-4.29046	-0.05877
Rhyacophila	1	20	0.136986	-1.98787	-0.27231
Isoperla	2	6	0.041096	-3.19185	-0.13117
Prosimulium	2	23	0.157534	-1.84811	-0.29114
Tallaperla	2	1	0.006849	-4.98361	-0.03413
Maccaffertium	3	3	0.020548	-3.88499	-0.07983
Hydropsyche	5	3	0.020548	-3.88499	-0.07983
Baetis	6	19	0.130137	-2.03917	-0.26537
Polycentropus	6	2	0.013699	-4.29046	-0.05877
Chironomidae	6	6	0.041096	-3.19185	-0.13117
Pedicia	6	1	0.006849	-4.98361	-0.03413
					-2.11

Metric		Standard	Standardiz	Adjusted
Taxa richn	16	33	48.48485	48.48
EPT richne	9	19	47.36842	47.37
Beck's inde	22	38	57.89474	57.89
Hilsenhoff	2.4	1.89	93.71147	93.71
Shannon d	2.1	2.86	73.42657	73.42
% sensitive	78.77	84.5	93.21893	93.22
		IBI=		69.015

Beck (3*5)+(2*2)+(1*3)=22

Hilsenhoff PTV	N	PTV*N
0	60	0
1	22	22
2	30	60
3	3	9
4	0	0
5	3	15
6	28	168
7	0	0
8	0	0
9	0	0
10	0	0
Sum		274

274/146= 2.4041

UNT williams 2008	PTV	N=219	n/219	lnE	E*F
Diplectrona - 6	0	6	0.027397	-3.59731	-0.09856
Acroneuria - 1	0	1	0.004566	-5.38907	-0.02461
Haploperla - 1	0	1	0.004566	-5.38907	-0.02461
Sweltsa - 2	0	2	0.009132	-4.69592	-0.04289
Leuctra - 151	0	151	0.689498	-0.37179	-0.25635
Rhyacophila - 2	1	2	0.009132	-4.69592	-0.04289
Lepidostoma - 1	1	1	0.004566	-5.38907	-0.02461
Hexatoma - 1	2	1	0.004566	-5.38907	-0.02461
Prosimulium - 1	2	1	0.004566	-5.38907	-0.02461
Maccaffertium - 1	3	1	0.004566	-5.38907	-0.02461
Amphinemura - 22	3	22	0.100457	-2.29803	-0.23085
Dicranota - 2	3	2	0.009132	-4.69592	-0.04289
Eurylophella - 1	4	1	0.004566	-5.38907	-0.02461
Optioservus - 2	4	2	0.009132	-4.69592	-0.04289
Pycnopsyche - 1	4	1	0.004566	-5.38907	-0.02461
Chironomidae - 21	6	21	0.09589	-2.34455	-0.22482
Cambaridae - 2	10	2	0.009132	-4.69592	-0.04289
Lepidoptera – 1	10	1	0.004566	-5.38907	-0.02461
					-1.2465

Metric		Standard	Standardiz	Adjusted
Taxa richn	18	33	54.54545	57.6
EPT richne	11	19	57.89474	57.9
Beck's inde	18	38	47.36842	47.4
Hilsenhoff	1.47	1.89	105.1788	100
Shannon d	1.25	2.86	43.70629	43.7
% sensitive	86.76	84.5	102.6746	100
		IBI=		67.76667

Beck	(3*4)+(2*2)+(1*2)=18	**FAIL - Leuctra+ Amphinemura = 79%**

Hilsenhoff	PTV	N	PTV*N
	0	160	0
	1	3	3
	2	2	4
	3	25	75
	4	4	16
	5	0	0
	6	21	126
	7	0	0
	8	0	0
	9	0	0
	10	10	100
		Sum	324
		324/219=1.47	

Stewart Run

	PTV	N=312	n/312	lnE	E*F
Acroneuria	0	1	0.003205	-5.743	-0.01841
Alloperla	0	5	0.016026	-4.13357	-0.06624
Ameletus	0	1	0.003205	-5.743	-0.01841
Dolophilodes	0	14	0.044872	-3.10395	-0.13928
Epeorus	0	33	0.105769	-2.2465	-0.23761
Haploperla	0	2	0.00641	-5.04986	-0.03237
Leuctra	0	2	0.00641	-5.04986	-0.03237
Pteronarcys	0	7	0.022436	-3.79709	-0.08519
Suwallia	0	1	0.003205	-5.743	-0.01841
Wormaldia	0	1	0.003205	-5.743	-0.01841
Ephemerella	1	38	0.121795	-2.10542	-0.25643
Nemoura	1	5	0.016026	-4.13357	-0.06624
Paraleptophlebia	1	8	0.025641	-3.66356	-0.09394
Rhyacophila	1	11	0.035256	-3.34511	-0.11794
Serratella	2	8	0.025641	-3.66356	-0.09394
Hexatoma	2	24	0.076923	-2.56495	-0.1973
Isoperla	2	12	0.038462	-3.2581	-0.12531
Prosimulium	2	1	0.003205	-5.743	-0.01841
Tallaperla	2	2	0.00641	-5.04986	-0.03237
Beloneuria	3	4	0.012821	-4.35671	-0.05586
Amphinemura	3	1	0.003205	-5.743	-0.01841
Antocha	3	2	0.00641	-5.04986	-0.03237
Dicranota	3	4	0.012821	-4.35671	-0.05586
Maccaffertium	3	12	0.038462	-3.2581	-0.12531
Optioservus	4	7	0.022436	-3.79709	-0.08519
Tipula	4	1	0.003205	-5.743	-0.01841
Ectopria	5	1	0.003205	-5.743	-0.01841

Metric		Stanc	Standardized	Adjusted
Taxa richness	33	33	100	100
EPT richness (PTV 0-4)	20	19	105.2631579	100
Beck's index	43	38	113.1578947	100
Hilsenhoff biotic index	2.8	1.9	88.77928483	88.78
Shannon diversity	2.83	2.9	98.95104895	98.95
% sensitive (PTV 0-3)	63.8	85	75.47928994	75.48
			IBI=	93.86833

Beck (3*10)+(2*4)+(1*5)=43

Hilsenhoff	PTV	N	PTV*N
	0	105	0
	1	62	62
	2	47	94
	3	23	69
	4	8	32
	5	6	30
	6	98	588
	7		0
	8		0
	9		0
	10		

875/312 = 2.80

Hydropsyche	5	5	0.016026	-4.13357	-0.06624
Baetis	6	54	0.173077	-1.75402	-0.30358
Cheumatopsyche	6	32	0.102564	-2.27727	-0.23357
Probezzia	6	1	0.003205	-5.743	-0.01841
Chironomidae	6	10	0.032051	-3.44042	-0.11027
Simulium	6	1	0.003205	-5.743	-0.01841
					-2.82885

APPENDIX B

Calculation of Beck's index and Hilsenhoff's index. Demonstrations from PA DEP 2012.

Beck's index relies on counting sensitive genera. Genera with PTV of 0 are given weight 3, those with PTV 1 are given weight 2, and those with PTV 2 are given weight 1. All other genera are ignored in this calculation. For Beck, higher numbers are better, as with most other indeces.

Hilsenhoff's index counts all individuals and weighs them all according to their respective PTV. All individuals with PTV 0 are weighted zero, those with PTV of 1 are weighted one, and so forth. Unlike other indeces used in this study, lower values are better in Hilsenhoff. In the standardization process that precedes the calculation of the IBI, Hilsenhoff is subtracted from 10, inverting the polarity of the index: Hilsenhoff of 3 becomes 7 (10-3=7), and Hilsenhoff of 6 becomes 4 (10-6=4). By this method, *higher* values are now better, and values become more comparable to those of other indeces prior to calculating the average for all, which is IBI.

Beck's Index (version 3)

Driftwood Branch Sinnemahoning creek

$= 3(n_{taxaHILS0}) + 2(n_{taxaHILS1}) + 1(n_{taxaHILS2})$

where $n_{taxaHILSi}$ = the number of taxa in a sub-sample with a pollution tolerance value (PTV) of i

There are **3 taxa** in this sub-sample with PTV = 0.

Epeorus **Acroneuria** **Glossosoma**

There are **6 taxa** in this sub-sample with PTV = 1.

Leucrocuta **Ephemerella** **Paraleptophlebia**
Paragnetina **Rhyacophila** **Lepidostoma**

There are **4 taxa** in this sub-sample with PTV = 2.

Serratella **Taeniopteryx** **Nigronia**
Atherix

Beck's Index (version 3) = 3(3) + 2(6) + 1(4)
Beck's Index (version 3) = 9 + 12 + 4
Beck's Index (version 3) **= 25**

Taxa Name	Number of Individuals	Pollution Tolerance Value
Isonychia	15	3
Epeorus	**10**	**0**
Leucrocuta	**13**	**1**
Maccaffertium	18	3
Ephemerella	**3**	**1**
Eurylophella	3	4
Serratella	**8**	**2**
Paraleptophlebia	**5**	**1**
Stylogomphus	1	4
Taeniopteryx	**13**	**2**
Taenionema	37	3
Allocapnia	1	3
Neoperla	4	3
Paragnetina	**2**	**1**
Acroneuria	**2**	**0**
Nigronia	**1**	**2**
Chimarra	3	4
Polycentropus	2	6
Ceratopsyche	3	5
Cheumatopsyche	1	6
Rhyacophila	**1**	**1**
Glossosoma	**2**	**0**
Lepidostoma	**2**	**1**
Apatania	5	3
Neophylax	1	3
Oligochaeta	2	10
Psephenus	5	4
Optioservus	20	4
Atherix	**2**	**2**
Antocha	1	3
Chironomidae	6	6

Hilsenhoff Biotic Index

Driftwood Branch Sinnemahoning Creek

$$= \sum_{i=0}^{10} [(i * n_{indvPTVi})] / N$$

where $n_{indvPTVi}$ = the number of individuals in a sub-sample with pollution tolerance value (PTV) of i and N = the total number of individuals in a sub-sample

There are 14 individuals with PTV = 0
There are 26 individuals with PTV = 1
There are 24 individuals with PTV = 2
There are 82 individuals with PTV = 3
There are 32 individuals with PTV = 4
There are 3 individuals with PTV = 5
There are 9 individuals with PTV = 6
There are 0 individuals with PTV = 7, 8, or 9
There are 2 individuals with PTV = 10.

There are a total of 192 individuals in the sub-sample.

Hilsenhoff Biotic Index =
[(0 * 14) + (1 * 26) + (2 * 24) +
(3 * 82) + (4 * 32) + (5 * 3) +
(6 * 9) + (7 * 0) + (8 * 0) +
(9 * 0) + (10 * 2)] / 192

Hilsenhoff Biotic Index = 2.80

Taxa Name	Number of Individuals	Pollution Tolerance Value
Isonychia	15	3
Epeorus	10	0
Leucrocuta	13	1
Maccaffertium	18	3
Ephemerella	3	1
Eurylophella	3	4
Serratella	8	2
Paraleptophlebia	5	1
Stylogomphus	1	4
Taeniopteryx	13	2
Taenionema	37	3
Allocapnia	1	3
Neoperla	4	3
Paragnetina	2	1
Acroneuria	2	0
Nigronia	1	2
Chimarra	3	4
Polycentropus	2	6
Ceratopsyche	3	5
Cheumatopsyche	1	6
Rhyacophila	1	1
Glossosoma	2	0
Lepidostoma	2	1
Apatania	5	3
Neophylax	1	3
Oligochaeta	2	10
Psephenus	5	4
Optioservus	20	4
Atherix	2	2
Antocha	1	3
Chironomidae	6	6