

# **Appendix A:**

## Benthic Macroinvertebrates

## **BENTHIC MACROINVERTEBRATES**

Aquatic macroinvertebrates are animals that are large enough to be seen by the unaided eye and live at least part of their life cycles within or upon available substrates in a body of water or water transport system. These include insects such as mayflies, annelids, mollusks, flatworms, roundworms, and crustaceans. The samples collected allow for a detailed analysis of the aquatic community. A brief explanation of these factors is offered to enable the reader to understand the importance of measuring the relative stability of the aquatic community.

The sampling technique is a standard kick sample format using a 500 micron mesh size, 1 meter x 1 meter seine net. Normally one sample (one square meter of substrate) is taken from a riffle in the stream and one sample (one square meter of substrate) is taken from a run. The entire sample is taken to the Monroe County Conservation District office where it is subsampled. A minimum subsample of 100 organisms is desired for a valid analysis.

The following are the metrics used for the macroinvertebrate analysis. Metrics are the various counts, indexes, and ratios computed from the results of the subsamples as described above. Different metrics convey different types of information about the macroinvertebrate community. For example, taxa richness is an index of diversity and the Hilsenhoff Biotic Index measures pollution tolerance. By using a set of metrics that measures multiple aspects of the macroinvertebrate community, a complete picture of a community can be attained.

Total Individuals is the actual number of macroinvertebrates collected.

Total Taxa (Species richness) is a measure of the variety of taxa (total number of species) present. This generally increases with increasing water quality or habitat. In some situations, organic enrichment may also result in an increase in the number of taxa.

Percent Contribution of Dominant Taxa gives an indication of the balance in the community. A community dominated by relatively few species would indicate environmental stress. An even distribution of all taxa (preferably sensitive species) is more desirable.

Percent Noninsects gives an indication of the balance in the community. Noninsects are generally tolerant species. A community dominated by noninsects would be an indication of environmental stress. An even distribution of all taxa (preferably sensitive species) is more desirable.

Modified Hilsenhoff Biotic Index (HBI) is a ranking based on pollution tolerance to organic sources values. These values range from 0-10, increasing as water quality decreases. The Biotic Index is an average of tolerance values for all individuals collected from a site.

The following demonstrates the range for Biotic Index:

|           |             |
|-----------|-------------|
| 0.00-3.75 | Excellent   |
| 3.76-4.25 | Very Good   |
| 4.26-5.00 | Good        |
| 5.01-5.75 | Fair        |
| 5.76-6.50 | Fairly Poor |
| 6.51-7.25 | Poor        |
| 7.26-10.0 | Very Poor   |

EPT Index is a measure of the total number of distinct taxa within the orders of Ephemeroptera, Plecoptera and Trichoptera. This summarizes the taxa richness within the insect orders that are generally sensitive to pollution. The EPT Index generally increases with increasing water quality.

Percent Intolerant Taxa gives an indication of the balance in the community. Intolerant organisms are usually not found associated with organic contaminants and are generally intolerant of even moderate reductions in dissolved oxygen. Intolerant organisms are indicators of clean water only.

The Ratio of Shredders to the Total Number of Insects uses the relative abundance of shredders as an indication of the dominant food or energy source in a small watershed. Shredders are insects that shred coarse particulate detritus for feeding. Shredders represent a distinct functional feeding group that is found predominantly in watersheds less than 10 square miles in size where the primary energy source in the stream is derived from leaf litter and similar detritus entering the watercourse. Shredders should become less abundant as the stream width increases and the canopy cover opens and photosynthesis becomes the primary energy source in the stream.

### **Scoring Schemes**

Scoring schemes have been completed for the entire County. The EPA conducted the majority of the statistical analysis needed to determine the metrics that are used for the Pocono Plateau and Low Pocono subcoregions. The metrics were selected because of their accuracy in detecting impairment. The County completed the work for the remaining subcoregions in the County, but without the help of the EPA this work would have been much more difficult.

A simple process was used to develop the reference conditions for the different stream classes. Within each stream class, minimally impaired reference sites were sampled. Descriptive statistics for each metric were calculated from a group of similar candidate reference sites. Only the candidate reference sites with optimal habitat and intact benthic macroinvertebrate communities were included in the reference condition. Test sites, or sites thought to be impaired, were not used in the development of reference conditions. Thresholds for optimal, slightly to moderately impaired and severely impaired categories were developed for each metric. The data from each metric was compiled and ranked. If a metric increases with impact (HBI for example), the 75<sup>th</sup> percentile of the reference condition is used as the threshold for the optimal category. The remaining range between that value and the maximum value obtainable for that metric was halved to provide two more ranges for scoring the slightly to moderately impaired and severely impaired categories. If the metric value decreases with impact (taxa richness for example), the 25<sup>th</sup> percentile of the reference condition is used as the threshold for the optimal category. The remaining range between that value and the minimum value was halved to

provide two more ranges for scoring the slightly to moderately impaired and severely impaired categories. For some metrics, this may result in somewhat insensitive scoring. For percent noninsects, for example, the maximum possible is 100%. However, 25% was the maximum encountered in the severely impacted sites for the Pocono Plateau / Glide Pool subcoregion. The scoring was adjusted to reflect the values of that metric generally encountered in impacted streams for this subcoregion, in order to make the scoring for that metric more sensitive.

All candidate reference sites were scored using the scoring scheme for that stream classification. These scores were then ranked. The lower 25<sup>th</sup> percentile was used to define the lower range of the optimal category. The remaining range between that value and the minimum possible optimal score was bisected to define two more ranges for the slightly to moderately impaired and severely impaired categories for the total scores.

The County identified all organisms collected to the family level and all the calculations were performed using family level identifications. The family level of identification was chosen to make data sharing both easier and faster. Identification of macroinvertebrates to the family is easier to perform and yields results that are suitable for our purposes. Another reason for choosing this level of identification was the interest of local watershed groups in performing macroinvertebrate sampling. For these groups genus level identification would be too difficult and time consuming. In order for the County to accept their data, however, the identifier would have to pass a quality assurance program established by the County.

The following are tables for the scoring schemes.

**Pocono Plateau, Riffle / Run < 10 square miles**

Samples from Keiper Run, Beaver Creek, Cross Keys Run, Frame Cabin Run and Tripup Run were used to develop the reference condition.

**Resulting scoring scheme for the reference condition  
for the Pocono Plateau, Riffle / Run < 10 square miles**

| Score Assigned<br>→→→→ | 5<br>(Optimal) | 3<br>(slightly to<br>moderately<br>impaired) | 1<br>(Severely<br>impaired) |
|------------------------|----------------|--|-----------------------------|
| Metric                 |                |  |                             |
| Total Taxa             | > = 15         | 14 - 8                                       | 7 - 0                       |
| EPT Taxa               | > = 8          | 7 - 4  | 3 - 0                       |
| HBI                    | < = 5.4        | 5.5 - 7.7                                    | 7.8 - 10                    |
| % Intolerant Taxa      | > = 35.3       | 35.2 - 17.7                                  | 17.6 - 0                    |
| % Noninsect            | < = 2.0        | 2.1 - 25.0                                   | 25.1 - 100                  |
| Shredders / Total      | > = 0.02       | 0.019 - 0.01                                 | 0.009 - 0                   |

The reference sites were all scored using this scoring scheme. The lower 25th percentile of the reference site scores represents the lower threshold for the "optimal" category. The 25th percentile of the reference scores is 26. The range 25 - 16 will be the slightly to moderately impaired category, and any site with a total score of less than 16 will be considered severely impaired.

**Pocono Plateau, Riffle / Run > 10 square miles**

Samples collected from Tunkhannock Creek and Tobyhanna Creek were used to develop a reference condition for the larger streams on the plateau. Descriptive statistics for the metrics at these two sites were calculated and the resulting scoring scheme was developed as described previously. The scoring scheme for the larger streams is shown in the following table.

**Resulting scoring scheme for the reference condition  
for the Pocono Plateau, Riffle / Run > 10 square miles**

| Score Assigned<br>→→→→ | 5<br>(Optimal) | 3<br>(slightly to<br>moderately<br>impaired) | 1<br>(Severely<br>impaired) |
|------------------------|----------------|--|-----------------------------|
| Metric                 |                |  |                             |
| Total Taxa             | > = 15         | 14 - 8                                       | 7 - 0                       |
| EPT Taxa               | > = 8          | 7 - 4  | 3 - 0                       |
| HBI                    | < = 5.7        | 5.8 - 7.9                                    | 8.0 - 10                    |
| % Intolerant Taxa      | > = 39.3       | 39.2 - 19.7                                  | 19.6 - 0                    |
| % Noninsect            | < = 3.6        | 3.7 - 25.0                                   | 25.1 - 100                  |
| Shredders / Total      | > = 0.003      | 0.0029 - 0.0015                              | 0.0014 - 0                  |

The reference sites were all scored using this scoring scheme. The 25<sup>th</sup> percentile of the reference scores is 26. The range 25 - 16 will be the slightly to moderately impaired category, and any site with a total score of less than 16 will be considered severely impaired.

## **Pocono Plateau, Glide / Pool**

Samples collected from Tunkhannock Creek were used to develop a reference condition for the glide pool streams found in the Long Pond area. Descriptive statistics for the metrics at these sites were calculated and the resulting scoring scheme was developed as described previously. The scoring scheme for the glide pool streams is shown in the following table.

### **Resulting scoring scheme for the reference condition for the Pocono Plateau, Glide / Pool**

| Score Assigned<br>→→→→ | 5<br>(Optimal) | 3<br>(slightly to<br>moderately<br>impaired) | 1<br>(Severely<br>impaired) |
|------------------------|----------------|--|-----------------------------|
| Metric                 |                |  |                             |
| Total Taxa             | $\geq 15$      | 14 - 8                                       | 7 - 0                       |
| EPT Taxa               | $\geq 6$       | 5 - 3  | 2 - 0                       |
| HBI                    | $\leq 5.5$     | 5.6 - 7.8                                    | 7.9 - 10                    |
| % Intolerant Taxa      | $\geq 26.7$    | 26.6 - 13.4                                  | 13.3 - 0                    |
| % Noninsect            | 0              | $>0 - 25.0$                                  | 25.1                        |
| Shredders / Total      | $\geq 0.01$    | 0.009 - 0.005                                | 0.0049 - 0                  |

The reference sites were all scored using this scoring scheme. The lower 25th percentile of the reference site scores represents the lower threshold for the "optimal" category. The 25th percentile of the reference scores is 28. The range 27 - 17 will be the slightly to moderately impaired category, and any site with a total score of less than 17 will be considered severely impaired.

**Low Pocono, Riffle / Run < 10 square miles**

Samples from Spruce Cabin Run and Buck Hill, Rattlesnake, Mill, Poplar Run, Devils Hole, Fall, Poplar and Swiftwater Creeks were used in developing a scoring scheme for this region. Descriptive statistics for the metrics at these sites were calculated, and the resulting scoring scheme was developed as described earlier. The main difference between the metrics from the Pocono Plateau and Low Pocono subcoregions is the inclusion of the percent dominant family for the Low Pocono.

**Resulting scoring scheme for the reference condition  
for the Low Pocono, Riffle / Run < 10 square miles**

| Score Assigned<br>→→→→ | 5<br>(Optimal) | 3<br>(slightly to<br>moderately<br>impaired) | 1<br>(Severely<br>impaired) |
|------------------------|----------------|--|-----------------------------|
| Metric                 |                |  |                             |
| Total Taxa             | > = 16         | 15 - 8                                       | 7 - 0                       |
| EPT Taxa               | > = 11         | 10 - 6                                       | 5 - 0                       |
| HBI                    | < = 4.5        | 4.6 - 7.3                                    | 7.4 - 10                    |
| % Dominant Family      | < = 42.6       | 42.7 - 71.3                                  | 71.4 - 100                  |
| % Intolerant Taxa      | > = 55.6       | 55.5 - 27.8                                  | 27.7 - 0                    |
| % Noninsect            | < = 0          | 0 - 25.0                                     | 25.1 - 100                  |
| Shredders / Total      | > = 0.11       | 0.10 - 0.06                                  | 0.05 - 0                    |

The reference sites were all scored using this scoring scheme. The 25th percentile of the reference sites scores is 31. The range 30 - 19 will be the slightly to moderately impaired category, and any site with a total score less than 19 will be considered severely impaired.

**Low Pocono, Riffle / Run > 10 square miles**

Samples collected from the Bushkill, McMichael, Brodhead, Paradise, and Pocono Creeks were calculated and the resulting scoring scheme was developed.

**Resulting scoring scheme for the reference condition  
for the Low Pocono, Riffle / Run > 10 square miles**

| Score Assigned<br>→→→→ | 5<br>(Optimal) | 3<br>(slightly to<br>moderately<br>impaired) | 1<br>(Severely<br>impaired) |
|------------------------|----------------|--|-----------------------------|
| Metric                 |                |  |                             |
| Total Taxa             | > = 17         | 16 - 9                                       | 8 - 0                       |
| EPT Taxa               | > = 10         | 9 - 5  | 4 - 0                       |
| HBI                    | < = 5.6        | 5.7 - 7.8                                    | 7.9 - 10                    |
| % Dominant Family      | < = 46.3       | 46.4 - 73.2                                  | 73.3 - 100                  |
| % Intolerant Taxa      | > = 35.7       | 35.6 - 17.9                                  | 17.8 - 0                    |
| % Noninsect            | < = 9.6        | 9.7 - 25.0                                   | 25.1 - 100                  |
| Shredders / Total      | > = 0.03       | 0.029 - 0.015                                | 0.014 - 0                   |

The reference sites were all scored using this scoring scheme. The 25th percentile of the reference scores is 29. The range 28 - 18 will be the slightly to moderately impaired category, and any site with a total score of less than 18 will be considered severely impaired.

**Northern Shale Valleys and Slopes, Riffle / Run < 10 square miles**

Samples collected from the Princess, Ross Common, and Cherry Creeks were calculated and the resulting scoring scheme was developed. This scoring scheme follows the work that has been completed for the Low Pocono subcoregions in that it also includes the percent dominant family metric.

**Resulting scoring scheme for the reference condition  
for the Northern Shale Valleys and Slopes, Riffle / Run < 10 square miles**

| Score Assigned<br>→→→→ | 5<br>(Optimal) | 3<br>(slightly to<br>moderately<br>impaired) | 1<br>(Severely<br>impaired) |
|------------------------|----------------|--|-----------------------------|
| Metric                 |                |  |                             |
| Total Taxa             | > = 18         | 17 - 9                                       | 8 - 0                       |
| EPT Taxa               | > = 9          | 8 - 4  | 3 - 0                       |
| HBI                    | < = 5.0        | 5.1 - 7.5                                    | 7.6 - 10                    |
| % Dominant Family      | < = 34.9       | 35.0 - 71.4                                  | 71.5 - 100                  |
| % Intolerant Taxa      | > = 26.1       | 26.2 - 13.0                                  | 12.9 - 0                    |
| % Noninsect            | < = 5.6        | 5.7 - 25.0                                   | 25.1 - 100                  |
| Shredders / Total      | > = 0.14       | 0.139 - 0.070                                | 0.069 - 0                   |

The reference sites were all scored using this scoring scheme. The 25<sup>th</sup> percentile of the reference scores is 31. The range 30 - 18 will be the slightly to moderately impaired category, and any site with a total score of less than 18 will be considered severely impaired. It should be noted that only six sites were used in creating this scoring scheme. It will be adjusted after further studies have provided more data.

**Northern Shale Valleys and Slopes, Riffle / Run > 10 square miles**

Samples collected from the McMichael, Pohopoco, Aquashicola, Cherry, and Buckwha Creeks were calculated and the resulting scoring scheme was developed.

**Resulting scoring scheme for the reference condition  
for the Northern Shale Valleys and Slopes, Riffle / Run > 10 square miles**

| Score Assigned<br>→→→→ | 5<br>(Optimal) | 3<br>(slightly to<br>moderately<br>impaired) | 1<br>(Severely<br>impaired) |
|------------------------|----------------|--|-----------------------------|
| Metric                 |                |  |                             |
| Total Taxa             | > = 19         | 18 - 10                                      | 9 - 0                       |
| EPT Taxa               | > = 11         | 10 - 6                                       | 5 - 0                       |
| HBI                    | < = 5.1        | 5.2 - 7.6                                    | 7.7 - 10                    |
| % Dominant Family      | < = 42.6       | 42.7 - 71.4                                  | 71.5 - 100                  |
| % Intolerant Taxa      | > = 28.6       | 28.5 - 14.3                                  | 14.2 - 0                    |
| % Noninsect            | < = 3.9        | 4.0 - 25.0                                   | 25.1 - 100                  |
| Shredders / Total      | > = 0.02       | 0.019 - 0.009                                | 0.008 - 0                   |

The reference sites were all scored using this scoring scheme. The 25th percentile of the reference scores is 31. The range 30 - 18 will be the slightly to moderately impaired category, and any site with a total score of less than 18 will be considered severely impaired.

## **Northern Sandstone Ridges, Riffle / Run**

Samples collected from the Poplar, Caledonia and Ross Common Creeks were calculated and the resulting scoring scheme was developed.

### **Resulting scoring scheme for the reference condition for the Northern Sandstone Ridges, Riffle / Run**

| Score Assigned<br>→→→→ | 5<br>(Optimal) | 3<br>(slightly to<br>moderately<br>impaired) | 1<br>(Severely<br>impaired) |
|------------------------|----------------|--|-----------------------------|
| Metric                 |                |  |                             |
| Total Taxa             | $\geq 16$      | 15 - 8                                       | 7 - 0                       |
| EPT Taxa               | $\geq 10$      | 9 - 5  | 4 - 0                       |
| HBI                    | $\leq 3.9$     | 4.0 - 7.0                                    | 7.1 - 10                    |
| % Dominant Family      | $\leq 24.1$    | 24.2 - 62.1                                  | 62.2 - 100                  |
| % Intolerant Taxa      | $\geq 37.5$    | 37.4 - 18.8                                  | 18.7 - 0                    |
| % Noninsect            | $\leq 2.2$     | 2.3 - 51.2                                   | 51.3 - 100                  |
| Shredders / Total      | $\geq 0.09$    | 0.089 - 0.045                                | 0.044 - 0                   |

The reference sites were all scored using this scoring scheme. The 25th percentile of the reference scores is 33. The range 32 - 17 will be the slightly to moderately impaired category, and any site with a total score of less than 16 will be considered severely impaired.

## MACROINVERTEBRATE SUMMARY

The following tables show results for the Pocono Plateau, Low Pocono and Northern Shale Valleys and Slopes streams using the EPA/County scoring schemes.

### Scores for samples for the Pocono Plateau, Riffle / Run < 10 square miles

| Stream Name | Sample Number | Type of Site | Score | Condition         |
|-------------|---------------|--------------|-------|-------------------|
| Red Run     | REDRU03       | Monitor      | 22    | Slightly Impaired |
| Hawkey Run  | HAWKRU02      | Monitor      | 14    | Severely Impaired |

The range 30 - 26 is considered optimal. The range 25 - 16 is the slightly to moderately impaired category, and any site with a total score of less than 16 is considered severely impaired.

### Scores for samples for the Pocono Plateau, Riffle / Run > 10 square miles

| Stream Name       | Sample Number | Type of Site | Score | Condition           |
|-------------------|---------------|--------------|-------|---------------------|
| Tobyhanna Creek   | TOBYCR01      | Reference    | 22    | Slightly Impaired   |
| Tunkhannock Creek | TUNKCR03      | Reference    | 28    | Optimal             |
| Trout Creek       | TROUCR03      | Monitor      | 18    | Moderately Impaired |
| Tobyhanna Creek   | TOBYCR14      | Monitor      | 24    | Slightly Impaired   |
| Lehigh River      | LEHIRI01      | New          | 28    | Optimal             |
| Lehigh River      | LEHIRI02      | New          | 26    | Optimal             |

The range 30 - 26 is considered optimal. The range 25 - 16 is the slightly to moderately impaired category, and any site with a total score of less than 16 is considered severely impaired.

### Scores for samples for the Pocono Plateau, Glide Pool

| Stream Name       | Sample Number | Type of Site | Score | Condition         |
|-------------------|---------------|--------------|-------|-------------------|
| Tunkhannock Creek | TUNKCR06      | Reference    | 24    | Slightly Impaired |

The range 30 - 29 is considered optimal. The range 28 - 17 is the slightly to moderately impaired category, and any site with a total score of less than 17 is considered severely impaired.

**Scores for samples for the Low Pocono,  
Riffle / Run < 10 square miles**

| Stream Name                    | Sample Number | Type of Site | Score | Condition           |
|--------------------------------|---------------|--------------|-------|---------------------|
| Butz Run                       | BUTZRU01      | Monitor      | 23    | Moderately Impaired |
| Cranberry Creek (Paradise Twp) | CRCRPA01      | Monitor      | 27    | Slightly Impaired   |
| Paradise Creek                 | PARACR04      | Monitor      | 31    | Optimal             |
| Devils Hole Creek              | DEHOCR04      | Monitor      | 31    | Optimal             |
| Cranberry Creek (Stroud Twp)   | CRANCR01      | New          | 19    | Moderately Impaired |
| Forest Hills Run               | FOHIRU01      | Monitor      | 25    | Slightly Impaired   |
| Forest Hills Run               | FOHIRU06      | Monitor      | 19    | Moderately Impaired |
| Forest Hills Run               | FOHIRU09      | Monitor      | 15    | Severely Impaired   |
| Indian Run                     | INDIRU01      | Monitor      | 29    | Slightly Impaired   |
| Swiftwater Creek               | SWIFCR06      | Monitor      | 23    | Moderately Impaired |
| Swiftwater Creek               | SWIFCR02      | Monitor      | 17    | Moderately Impaired |
| Swiftwater Creek               | SWIFCR07      | Monitor      | 27    | Slightly Impaired   |
| Swiftwater Creek               | SWIFCR05      | Monitor      | 25    | Slightly Impaired   |
| Cranberry Creek (Barrett Twp)  | CRCRPA03      | Monitor      | 27    | Slightly Impaired   |
| Dry Sawmill Run                | DRSARU01      | Monitor      | 25    | Slightly Impaired   |
| Pocono Creek                   | POCOCR20      | Monitor      | 27    | Slightly Impaired   |
| Pocono Creek                   | POCOCR16      | Monitor      | 27    | Slightly Impaired   |
| Pocono Creek                   | POCOCR17      | Monitor      | 19    | Moderately Impaired |
| Scotrun Creek                  | SCOTCR04-(A)  | Monitor      | 17    | Moderately Impaired |
| Scotrun Creek                  | SCOTCR04-(B)  | Duplicate    | 23    | Moderately Impaired |
| Swiftwater Creek               | SWIFCR03      | Monitor      | 25    | Slightly Impaired   |
| Jonas Creek                    | JONASCR01     | New          | 29    | Slightly Impaired   |

The range 35 - 31 is considered optimal. The range 30 - 16 is the slightly to moderately impaired category, and any site with a total score of less than 16 is considered severely impaired.

**Scores for samples for the Low Pocono,  
Riffle / Run > 10 square miles**

| Stream Name    | Sample Number | Type of Site        | Score | Condition           |
|----------------|---------------|---------------------|-------|---------------------|
| Paradise Creek | PARACR03-(A)  | Monitor             | 27    | Slightly Impaired   |
| Paradise Creek | PARACR03-(B)  | Duplicate           | 25    | Slightly Impaired   |
| Paradise Creek | PARACR01      | Monitor             | 25    | Moderately Impaired |
| Pocono Creek   | POCOCR15      | Monitor             | 31    | Optimal             |
| Pocono Creek   | POCOCR19      | Monitor             | 31    | Optimal             |
| Brodhead Creek | BRODCR01      | Reference           | 35    | Optimal             |
| Brodhead Creek | BRODCR12      | Monitor             | 31    | Optimal             |
| Bushkill Creek | BUSHCR07      | Monitor / Reference | 29    | Optimal             |
| Pohopoco Creek | POHOOCR06     | Monitor             | 31    | Optimal             |

The range 35 - 29 is considered optimal. The range 28 - 14 is the slightly to moderately impaired category, and any site with a total score of less than 14 is considered severely impaired.

**Scores for samples for the Northern Shale Valleys and Slopes,  
Riffle / Run < 10 square miles**

| Stream Name       | Sample Number | Type of Site | Score | Condition           |
|-------------------|---------------|--------------|-------|---------------------|
| Buckwha Creek     | BUCKCR01      | Monitor      | 31    | Optimal             |
| Aquashicola Creek | AQUACR09      | Monitor      | 33    | Optimal             |
| Aquashicola Creek | AQUACR10      | Monitor      | 33    | Optimal             |
| Sambo Creek       | SAMBCR10      | Monitor      | 17    | Severely Impaired   |
| Weir Creek        | WEIRCR02      | New          | 21    | Moderately Impaired |

The range 35 - 31 is considered optimal. The range 30 - 18 is the slightly to moderately impaired category, and any site with a total score of less than 18 is considered severely impaired.

**Scores for samples for the Northern Shale Valleys and Slopes,  
Riffle / Run > 10 square miles**

| Stream Name      | Sample Number | Type of Site        | Score | Condition           |
|------------------|---------------|---------------------|-------|---------------------|
| Pocono Creek     | POCOCR18      | Monitor             | 25    | Slightly Impaired   |
| Pocono Creek     | POCOCR22      | Monitor             | 31    | Optimal             |
| Pocono Creek     | POCOCR14      | Monitor / Reference | 25    | Slightly Impaired   |
| McMichaels Creek | MCMICR21      | Monitor / Reference | 25    | Slightly Impaired   |
| Marshalls Creek  | MARSCR08      | Monitor             | 25    | Slightly Impaired   |
| Marshalls Creek  | MARSCR09      | Monitor             | 25    | Slightly Impaired   |
| McMichael Creek  | MCMICR30      | Monitor             | 21    | Moderately Impaired |
| McMichael Creek  | MCMICR28      | Monitor             | 21    | Moderately Impaired |
| Brodhead Creek   | BRODCR15      | New                 | 29    | Slightly Impaired   |
| Cherry Creek     | CHERCR11      | Monitor             | 31    | Optimal             |
| Brodhead Creek   | BRODCR13      | Monitor             | 15    | Severely Impaired   |
| Brodhead Creek   | BRODCR14      | New                 | 31    | Optimal             |
| Pohopoco Creek   | POHOOCR08     | New                 | 31    | Optimal             |

The range 35 - 31 is considered optimal. The range 30 - 18 is the slightly to moderately impaired category, and any site with a total score of less than 18 is considered severely impaired.

The following tables compare trending results of the EPA/County scoring schemes for repeat sites (1996 through 2006).

| Site # | Site ID  | Site Name                  | 2006  | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 | 1999 | 1998 | 1997 | 1996 |
|--------|----------|----------------------------|-------|------|------|------|------|------|------|------|------|------|------|
| 1      | PARACR03 | Paradise Creek             | 27/25 | 35   | 33   | 31   |      |      |      |      |      |      |      |
| 2      | BUTZRU01 | Butz Run                   | 23    | 23   | 29   | 23   |      |      |      |      |      |      |      |
| 3      | CRCRPA01 | Cranberry Creek (Paradise) | 27    | 29   | 29   |      |      |      |      |      |      |      |      |
| 4      | DEHOCR04 | Devils Hole Creek          | 31    | 33   | 31   | 31   |      |      |      |      |      |      |      |
| 5      | PARACR04 | Paradise Creek             | 31    | 33   | 33   | 31   |      |      |      |      |      |      |      |
| 6      | INDIRU01 | Indian Run                 | 29    | 33   |      | 31   |      |      |      |      |      |      |      |
| 7      | FOHIRU01 | Forest Hills Run           | 25    | 29   | 29   | 25   |      |      |      |      |      |      |      |
| 8      | SWIFCR06 | Swiftwater Creek           | 23    | 25   | 21   | 23   |      |      |      |      |      |      |      |
| 9      | SWIFCR02 | Swiftwater Creek           | 17    | 27   | 25   | 27   |      |      |      |      |      |      |      |
| 10     | PARACR01 | Paradise Creek             | 25    | 33   | 29   | 29   |      |      |      |      |      |      |      |
| 11     | FOHIRU09 | Forest Hills Run           | 15    | 21   | 15   | 17   |      |      |      |      |      |      |      |
| 12     | FOHIRU06 | Forest Hills Run           | 19    |      |      |      |      |      |      |      |      |      |      |
| 13     | LEHIRI01 | Lehigh River               | 28    |      |      |      |      |      |      |      |      |      |      |
| 14     | LEHIRI02 | Lehigh River               | 26    |      |      |      |      |      |      |      |      |      |      |
| 15     | TOBYCR01 | Tobyhanna Creek            | 22    | 28   | 22   | 26   | 26   | 22   | 24   | 20   | 14   | 18   |      |
| 16     | SWIFCR07 | Swiftwater Creek           | 27    | 29   | 29   | 25   | 29   | 33   |      |      |      |      |      |
| 17     | SWIFCR05 | Swiftwater Creek           | 25    | 33   | 33   | 23   | 25   | 29   | 27   | 25   | 29   | 21   | 25   |
| 18     | SWIFCR03 | Swiftwater Creek           | 25    | 27   | 29   | 29   | 25   | 29   | 29   | 17   | 27   | 19   | 27   |
| 19     | CRCRPA03 | Cranberry Creek (Barrett)  | 27    |      | 21   | 23   |      |      |      |      |      |      |      |
| 20     | DRSARU01 | Dry Sawmill Run            | 25    | 19   | 21   | 27   | 31   | 21   | 23   |      |      | 29   |      |
| 21     | POCOCR20 | Pocono Creek               | 27    | 35   | 27   | 23   | 29   | 27   |      |      |      |      |      |
| 22     | POCOCR16 | Pocono Creek               | 27    | 27   | 27   | 25   | 31   | 23   | 29   | 29   |      |      |      |
| 23     | POCOCR17 | Pocono Creek               | 19    | 31   | 21   | 23   | 33   | 29   | 33   |      |      |      |      |
| 24     | POCOCR19 | Pocono Creek               | 31    | 31   | 31   | 27   | 35   | 33   |      |      |      |      |      |
| 25     | SCOTCR04 | Scotrun Creek              | 17/23 | 23   | 27   | 27   | 31   | 29   |      |      |      |      |      |
| 26     | POCOCR15 | Pocono Creek               | 31    | 33   | 35   | 29   | 31   | 35   | 31   | 27   |      |      |      |
| 27     | POCOCR18 | Pocono Creek               | 25    | 28   | 33   | 33   | 31   | 31   | 27   |      |      |      |      |
| 28     | POCOCR22 | Pocono Creek               | 31    | 35   | 33   |      |      |      |      |      |      |      |      |
| 29     | POCOCR14 | Pocono Creek               | 25    | 29   | 23   | 27   | 29   | 25   | 21   | 29   |      |      |      |

| Site # | Site ID   | Site Name                | 2006 | 2005  | 2004 | 2003  | 2002 | 2001 | 2000 | 1999 | 1998 | 1997 | 1996 |
|--------|-----------|--------------------------|------|-------|------|-------|------|------|------|------|------|------|------|
| 30     | MCMICR21  | McMichael Creek          | 25   | 23    | 25   | 25    | 31   | 33   | 25   | 29   | 27   | 25   | 31   |
| 31     | REDRU03   | Red Run                  | 22   | 22    | 24   | 22    | 24   |      |      |      |      |      |      |
| 32     | HAWKRU02  | Hawkey Run               | 14   |       |      |       |      |      |      |      |      |      |      |
| 33     | TROUCR03  | Trout Creek              | 18   |       |      |       |      |      |      |      |      |      |      |
| 34     | TOBYCR14  | Tobyhanna Creek          | 24   | 26    |      |       |      |      |      |      |      |      |      |
| 35     | TUNKCR03  | Tunkhannock Creek        | 28   | 28    | 28   | 28    | 30   | 28   | 26   | 26   | 28   | 30   | 30   |
| 36     | JONASCR01 | Jonas Creek              | 29   |       |      |       |      |      |      |      |      |      |      |
| 37     | POHOGR08  | Pohopoco Creek           | 31   |       |      |       |      |      |      |      |      |      |      |
| 38     | WEIRCR02  | Weir Creek               | 21   |       |      |       |      |      |      |      |      |      |      |
| 39     | POHOGR06  | Pohopoco Creek           | 31   | 31    | 33   | 35    | 33   | 31   | 33   | 33   | 33   | 31   | 33   |
| 40     | BUCKCR01  | Buckwha Creek            | 31   | 31    |      |       |      |      |      |      |      |      |      |
| 41     | AQUACR09  | Aquashicola Creek        | 33   | 35    | 29   | 27    | 29   | 33   | 31   | 33   | 29   | 35   | 35   |
| 42     | AQUACR10  | Aquashicola Creek        | 33   | 33    | 33   |       |      |      |      |      |      |      |      |
| 43     | MARSCR08  | Marshalls Creek          | 25   | 33    | 27   | 23    | 23   | 27   | 25   | 19   | 27   | 19   | 23   |
| 44     | MARSCR09  | Marshalls Creek          | 25   | 25/25 | 25   | 23    | 31   | 29   | 25   | 31   | 25   | 21   | 25   |
| 45     | SAMBCR10  | Sambo Creek              | 17   | 25    | 31   |       |      |      |      |      |      |      |      |
| 46     | BRODCR14  | Brodhead Creek           | 31   |       |      |       |      |      |      |      |      |      |      |
| 47     | BRODCR15  | Brodhead Creek           | 29   |       |      |       |      |      |      |      |      |      |      |
| 48     | CRANCR01  | Cranberry Creek (Stroud) | 19   |       |      |       |      |      |      |      |      |      |      |
| 49     | MCMICR28  | McMichael Creek          | 21   | 25    | 21   | 23    |      |      |      |      |      |      |      |
| 50     | BRODCR01  | Brodhead Creek           | 35   | 33    | 35   | 35/31 | 35   | 35   | 33   | 35   | 35   | 33   | 35   |
| 51     | BRODCR12  | Brodhead Creek           | 31   | 33    | 29   | 29    | 29   | 29   | 29   | 29   | 29   | 27   | 29   |
| 52     | BUSHCR07  | Bushkill Creek           | 29   | 31    | 27   | 29    | 29   | 31   | 27   | 29   | 27   | 33   | 29   |
| 53     | BRODCR13  | Brodhead Creek           | 15   | 19    |      | 23/25 | 29   | 27   | 21   | 29   | 27   | 27   | 11   |
| 54     | CHERCR11  | Cherry Creek             | 31   |       | 29   | 33    | 31   | 29   | 33   | 27   | 29   |      |      |
| 55     | MCMICR30  | McMichael Creek          | 21   | 21    | 27   |       |      |      |      |      |      |      |      |
| 56     | TUNKCR06  | Tunkhannock Creek        | 24   | 24    | 22   | 24    | 20   | 28   | 24   | 20   | 18   | 18   |      |

**Debris Sample Analysis - 2006**

|                            |          |               |          |              |          |               |
|----------------------------|----------|---------------|----------|--------------|----------|---------------|
| SITE #                     | 10       | 10            | 20       | 20           | 30       | 30            |
| SITE ID                    | PARACR01 | PARACR01 - DS | DRSARU01 | DRSARU01- DS | MCMICR21 | MCMICR21 - DS |
| Number of Organisms        | 335      | 379           | 147      | 165          | 293      | 335           |
| Number of Taxa             | 16       | 17            | 17       | 17           | 14       | 14            |
| HBI                        | 5.68     | 5.77          | 5.59     | 5.56         | 5.34     | 5.49          |
| EPT Index                  | 9        | 9             | 11       | 11           | 9        | 9             |
| % Contrib. of Dom. Taxa    | 44.2     | 47.2          | 46.9     | 44.2         | 32.8     | 38.2          |
| % Intolerant Taxa (0-2 TV) | 25.0     | 23.5          | 35.3     | 35.3         | 28.6     | 28.6          |
| % Non-insects              | 0.00     | 0.26          | 0.00     | 0.00         | 0.68     | 0.60          |
| Shredders/Total            | 0.006    | 0.005         | 0.007    | 0.006        | 0.000    | 0.000         |
|                            |          |               |          |              |          |               |
| SITE #                     | 40       | 40            | 50       | 50           |          |               |
| SITE ID                    | BUCKCR01 | BUCKCR01-DS   | BRODCR01 | BRODCR01-DS  |          |               |
| Number of Organisms        | 231      | 276           | 234      | 260          |          |               |
| Number of Taxa             | 15       | 16            | 23       | 25           |          |               |
| HBI                        | 4.68     | 4.79          | 4.44     | 4.62         |          |               |
| EPT Index                  | 11       | 11            | 15       | 16           |          |               |
| % Contrib. of Dom. Taxa    | 32.0     | 33.7          | 32.9     | 36.9         |          |               |
| % Intolerant Taxa (0-2 TV) | 46.7     | 43.8          | 39.1     | 40.0         |          |               |
| % Non-insects              | 0.00     | 0.00          | 0.43     | 0.38         |          |               |
| Shredders/Total            | 0.009    | 0.007         | 0.085    | 0.077        |          |               |

The Debris Sample (DS) column shows the composite of the original count + the debris sample count

PARACR01 (Paradise Creek) was the first debris sample site. In the composite sample, PARACR01 - DS, 11.60% of the total number of organisms were found in the debris analysis. The debris sample for this site was comprised predominantly of chironomidae (47%).

The second composite sample was DRSARU01 (Dry Sawmill Run) - DS, 10.9% of the organisms were found in the debris sample. Two taxa dominated the debris sample for this site, chironomidae (44.2%) and baetidae (27.8%).

MCMICR21 (McMichael Creek) was the third site tested to include a debris sample analysis. The debris sample comprised approximately 12.5% of the composite sample at this site. Two taxa dominated the debris sample for this site, chironomidae (38.2%) and hydropsychidae (16.7%).

BUCKCR01 (Buckwha Creek) was the fourth site tested to include a debris sample analysis. The debris sample comprised approximately 16.3% of the composite sample at this site. The dominant taxon for this site was heptageniidae (23.6%).

The final site chosen for a debris sample was BRODCR01 (Brodhead Creek). At this site, the debris sample comprised 10% of the composite sample. The debris sample for this site was composed predominantly of chironomidae (36.9%).

The method of debris sample analysis involved the naked eye and a 2x magnification lens. Due to the size of these creatures the debris samples were found primarily because of the use of the magnifying lens.

The method of sorting of debris samples involved (naked eye and a 2x magnification lens), due to the size of these creatures the debris sample analysis were found primarily because of the use of the magnifying lens.

In future studies work will continue to refine this method of quality assurance and control.