

WVDEP Assessment Methodology for Aquatic Life Designated Use in Wadeable Streams and Rivers

May 16, 2016

Introduction – WV DEP has developed rules for determining compliance with the biological component of narrative water quality standards (47CSR2B). The rule describes how the agency will determine attainment of the Aquatic Life Designated Use (AQL) based on benthic macroinvertebrate and fish community data. However, the rule does not include certain specific measures that are expected to change somewhat regularly as more data is collected. At the time the rule was developed, there was insufficient data available to develop Fish IBI's for certain regions, there was insufficient data to develop impairment thresholds for benthic macroinvertebrates collected in winter or those collected from limestone streams. Rather than having to return to the legislature and update these values, they will be defined in this AQL Assessment Methodology document that can be updated as appropriate.

This document describes briefly the data that will be assessed in order to make AQL attainment decisions. It does not include specific details about the individual IBI's (Indices of Biotic Integrity) that are depended on, but rather has links to documents that provide those details. It does include the specific thresholds used for each IBI (Tables 1 and 2) and a description of what those thresholds are based on.

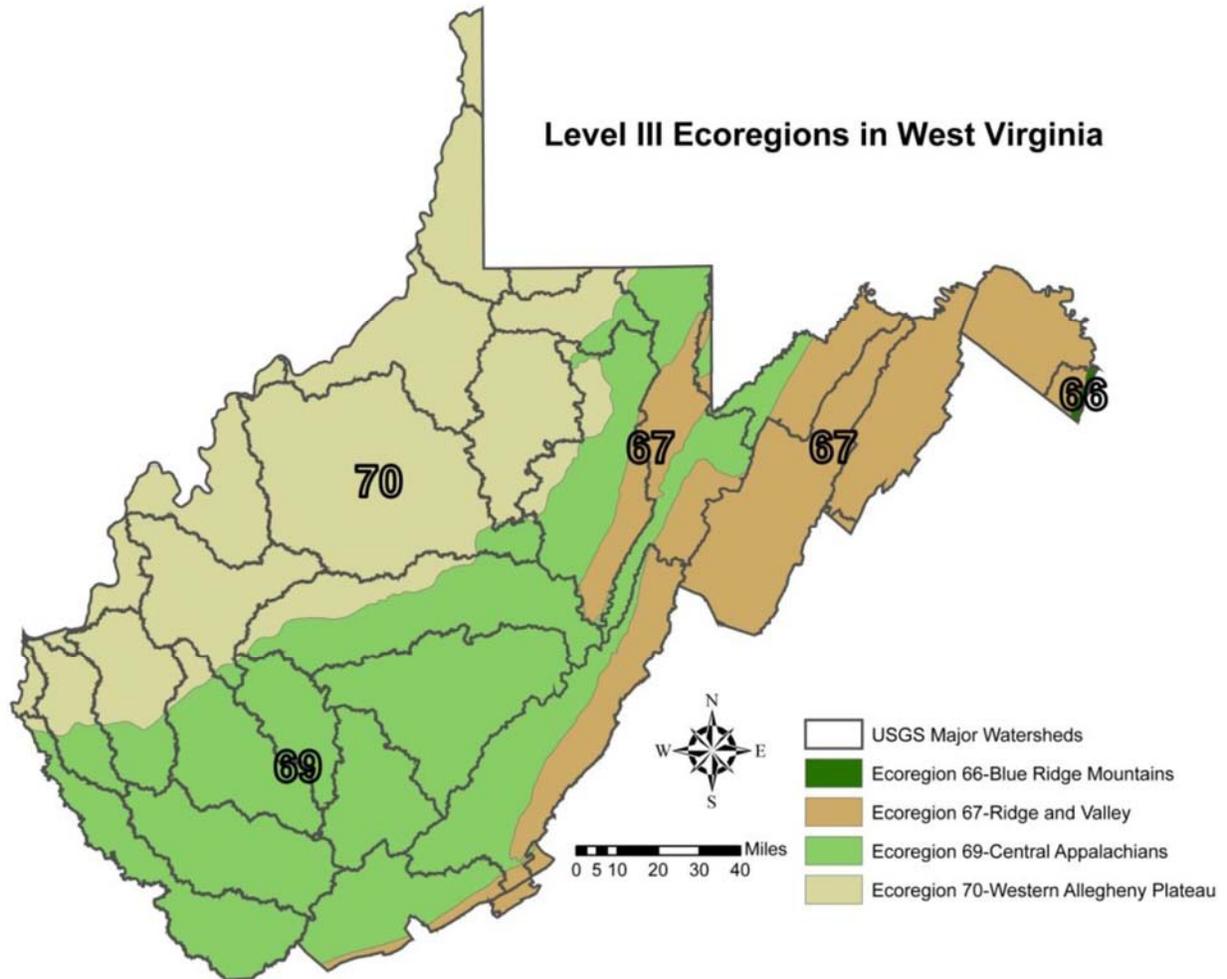
DEP will utilize characteristics of the fish (where applicable) and benthic macroinvertebrate communities to assess the biological integrity of wadeable streams. Assessments will be made using an index of biotic integrity for benthic macroinvertebrates (Benthic IBI) developed for use in West Virginia's wadeable streams that is based on the Genus Level Index of Most Probable Stream Status, but modified to allow the use of family level chironomidae (midges) data and the WV Warmwater Fish IBI (Fish IBI)

From 47CSR2B – Narrative WQS.

Genus Level Benthic IBI - Benthic macroinvertebrates can be assessed in most wadeable streams in the state. WVDEP started identifying benthic macroinvertebrates to genus level in 1998. The Watershed Assessment Section collected approximately 500 samples each year. DEP and EPA worked together, making use of this large amount of data, to develop and test seasonal and regional genus level IBIs for the state. The development of these IBIs, collectively known as GLIMPSS was documented in the report linked to here:

http://www.dep.wv.gov/WWE/watershed/bio_fish/Documents/20110829GLIMPSSFinalWVDEPDOI.pdf. Early drafts of the document were reviewed by benthic macroinvertebrate experts from academia, industry, consultants, and other stakeholders and the report was improved based on comments received. There was some concern expressed that some consultants in the state would have difficulty identifying taxa within the family Chironomidae to genus level. A version of the IBI that collapsed all chironomidae genus data back to the family level (GLIMPSS-CF) was tested and found to perform as well as the version with midges identified to genus level (Appendix G of the above mentioned GLIMPSS document). It was decided that we would use this modified version of GLIMPSS for official AQL assessment purposes. WVDEP will continue to identify midges to genus level in order to aid in the stressor identification process.

In an effort to explain natural variability in macroinvertebrate assemblages, several combinations of seasonal and geographic groupings were evaluated. It was determined that both season and region should be accounted for in the new IBI. Thus, four (4) classification strata were chosen for index development purposes: Mountain Spring (MT Sp), Mountain Summer (MT Su), Plateau Spring (PL Sp), and Plateau Summer (PL Su). The Mountain strata include sites within the Central Appalachian and Ridge and Valley Ecoregions and the Plateau strata include sites within the Western Allegheny Plateau Ecoregion (see map below). The spring sampling period runs March 1st to May 31st and the summer season runs from the first of June thru mid-October. Also, it was determined that benthic macroinvertebrate communities in large streams in the Mountain region naturally vary from smaller streams and should be evaluated separately (Appendix E of GLIMPSS document). Data continues to be collected in order to further calibrate and validate winter GLIMPSS-CF metrics and scoring for both regions.



The GLIMPSS uses ten metrics in the MT Winter/Spring strata, 9 metrics in the MT Summer and PL Summer, and 7 metrics in MT Summer > 60mi² and PL Winter/Spring strata. In total, sixteen metrics were used in the different GLIMPSS strata.

Metrics scores are derived using simple equations that standardize metric values by the Best Standard Values (BSVs) and Worst Standard Values (WSVs) which are based upon the 95th and 5th percentile (ceiling and floor), depending on metric direction, from all sites within the stratum. The table below shows the metrics selected for GLIMPSS by bioregion/season and includes the best and worst standard values (BSV and WSV) used for scoring each metric. Examples of scoring equations can be found in Appendix D of the GLIMPSS document.

Metric	MT Sp & W (n=732)		MT Su (n=1530)		MT SU >60mi ² (n=317)		PL Sp & W (n=692)		PL Su (n=858)	
	Ceiling	Floor	Ceiling	Floor	Ceiling	Floor	Ceiling	Floor	Ceiling	Floor
No. Total Genera			30	8					25	8
No. Intolerant Genera <4	18	1	15	0	10	1	14.5	1		
No. Intolerant Genera <3									7	0
No. EPT Genera					18	5				
No. Ephemeroptera Genera	10	1	9	0			10	1	7	0
No. Plecoptera Genera	8	0	7	0			7	0		
No. Trichoptera Genera	7	1								
No. Clinger Genera	19.5	3.5	18	4	18	7	16.5	3	14	3
No. Scraper Genera	8	0							7	1
No. Shredder Genera			4	0						
HBI (Genus level)	5.87	2.19	5.90	2.80	5.75	4.03	5.94	2.45	5.98	3.84
% Dominant 5 Genera	96.7	55.5	96.7	57.7	92.1	55.1			97.5	64.4
% Ephemeroptera	59.7	0.5								
% mEPT (minus <i>Cheumatopsyche</i>)			86.0	5.2	76.9	13.8	90.8	2.5	67.1	1.3
% Chironomidae					46.1	1.5			69.1	4.0
% Chironomidae+Annelida	75.2	2.8	65.0	2.7			84.6	1.8		

Overall IBI scores are calculated by averaging the individual metric scores. These scores are then converted into a Percent of Reference score or “normalized” to allow comparison of benthic IBI scores across different strata. The scores used to normalize raw IBI scores are equal to the 5th percentile of IBI scores of region/ season appropriate reference sites. Examples are provided in Table D-3 of the GLIMPSS document and the current specific thresholds are listed in Appendix A of this document.

Appropriately collected and processed biological samples that meet quality assurance / quality control and comparability protocols will be used in assessments. These protocols are contained in the Watershed Assessment Section’s Standard Operating Procedures Manual <http://www.dep.wv.gov/WWE/watershed/Pages/WBSOPs.aspx> .

Fish IBI In 2012, WV Legislature passed SB562 which mandated that DEP develop rules to assess the biologic component of our narrative water quality standards. SB562 requires evaluation of the holistic health of the aquatic ecosystem and a determination that the stream:

- (i) Supports a balanced aquatic community that is diverse in species composition;
- (ii) contains appropriate trophic levels of fish, in streams that have flows sufficient to support fish populations; and
- (iii) the aquatic community is composed of benthic invertebrate assemblages sufficient to perform the biological functions necessary to support fish communities within the assessed reach, or, if the assessed reach has insufficient flows to support a fish community, in those downstream reaches where fish are present.

In order to comply with the second criterion, WVDEP contracted with WVU to develop methods to determine “appropriate trophic levels of fish”. It was determined that the most logical way to meet this criteria would be to develop a multi-metric IBI for fish in WV. Additionally, metrics that included some measure of trophic level would be prioritized for inclusion if they met other selection criteria. The process is described in [Fish Based Index of Biotic Integrity for Wadeable Warm Water Streams in WV](#) [\[link\]](#)

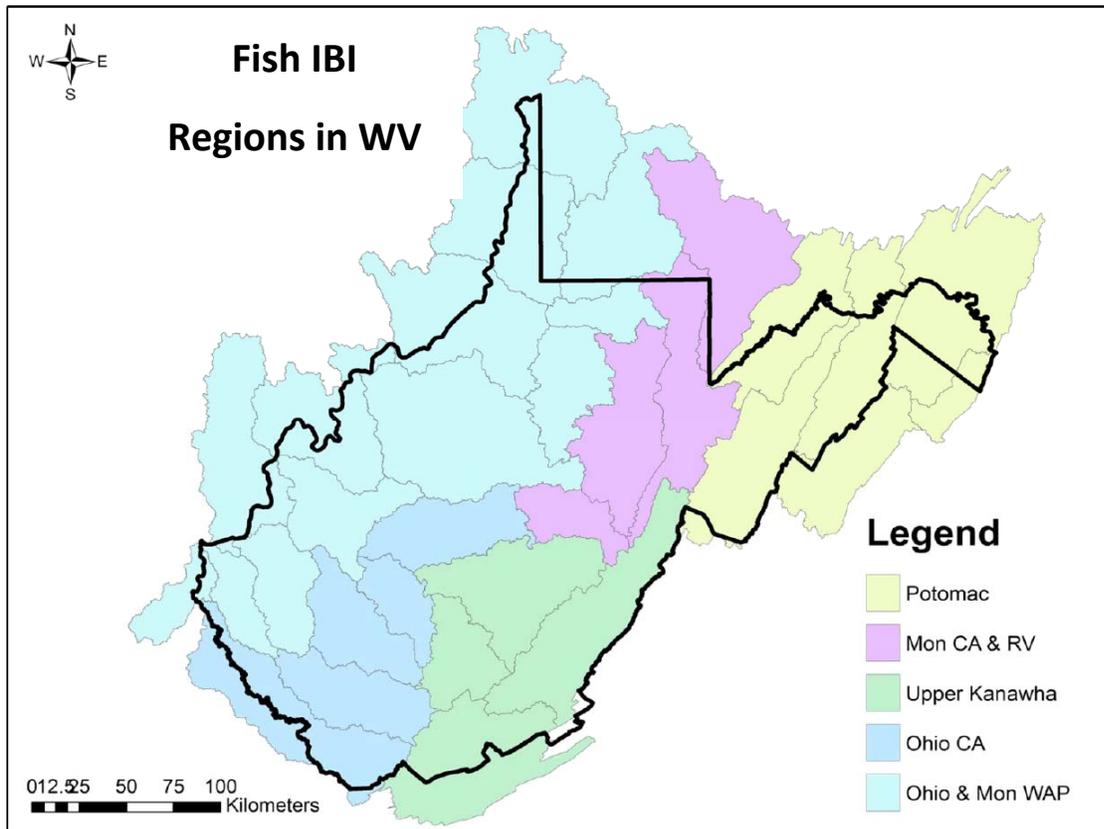
WVU faculty and student researchers assembled all available fish community data, screened it for comparability, and developed a database to house data to be used for IBI development. The focus of their efforts was on wadeable streams with drainage areas between 7 and 400 Km². They analyzed the influence of major drainage basin and ecoregion (Omernik’s Level III) on fish communities and determined that the best classification system would be based on a combination of both. Five distinct regions were identified as best accounting for natural differences in fish communities. See figure below. Due to the low sample size (N=105) and uncertainty of reference condition, the Potomac biomonitoring region was removed from further analysis and IBI development.

Coldwater streams are those that should naturally support fish species typically associated with colder waters. These streams naturally have fewer species and cannot be assessed using the IBIs developed for warmwater streams. Coldwater streams will be assessed based on the IBI scores of the benthic macroinvertebrate community.

Wadeable sites were then classified as least disturbed reference sites, stressed sites, or other. These sites were used to test candidate metrics for use in the final IBI. An initial set of 66 richness and 65 proportional potential fish community metrics, and one trophic

diversity index (Shannon-Weaver Diversity index based on feeding guild), were analyzed for inclusion in regional IBI's.

Larger streams tend to have more diverse fish communities. Each metric was evaluated for its relationship with drainage area (reference sites only). Metrics that had clear relationships with drainage area were then predicted based on the linear model equation and metric values were adjusted accordingly.



Selection of metrics was determined for each region by: 1) range, 2) discrimination between reference and stressed sites, 3) response to stressor gradient, and 4) redundancy. The range of each metric was evaluated based on the 25th percentile of the full distribution of the metric. If the 25th percentile was 0, then the metric was no longer considered for inclusion. Metrics must be able to adequately distinguish reference sites from stressed sites. For discrimination efficiency (i.e. responsiveness), the number of stressed sites that fell below the 25th percentile (for positive metrics) or fell above the 75th percentile (for negative metrics) of the reference distribution were calculated in each biomonitoring region. A minimum discrimination efficiency of 60% was used as an initial screen value. Each metric was then evaluated for their relationship with environmental stressors using Spearman's correlation. Metrics were correlated with % cumulative surface

mining, structure density, total agriculture, development, and total forest along with pH, and specific conductance. Redundancy of metrics was evaluated with Spearman correlation. Any metric which was highly correlated ($>|0.90|$) with another metric was considered for removal from IBI development. This procedure produced a pool of potential metrics that are either correlated with human disturbance, highly discriminate, or both.

A total of 7 metrics were selected for the Mon CA-RV (Table 3.5-1), Ohio CA (Table 3.5-2), and Upper Kanawha (Table 3.5-4) biomonitoring regions. The Ohio and Mon WAP had a total of 8 metrics selected (Table 3.5-3).

As stated earlier, the Potomac Basin did not have enough existing data to develop an IBI at this time. The Fish IBIs for the Upper Kanawha (Kanawha River drainage sites upstream of Kanawha Falls) and the Ohio Drainage / Central Appalachian regions were not finalized at the time DEP filed its legislative rules outlining how DEP will assess the biologic component of our narrative water quality standards. The rule refers to this Assessment Methodology document for specifics regarding applicability and use of regional IBI's. Table 2 in Appendix A lists the IBI scores (and the percentile of reference sites used to determine that score) that are or will be used to calculate Percent of Reference values to use in final AQL assessments.

Final metrics selected for the Mon CA-RV region with metric description and direction.				
Metric	Description	Direction	Ceiling	Floor
P_Benthic2.DEP	Proportion of benthic individuals minus tolerant	Positive	0.683	0
Adj.R_Fish2.DEP	Adjusted species richness minus tolerant	Positive	1.215	0
Adj.R_McC_CGS	Adjusted clean gravel spawner richness	Positive	1.326	0
Adj.P_Fish2.DEP	Adjusted proportion of non-tolerant individuals	Positive	1.537	0
Adj.P_IN	Adjusted proportion of invertivore individuals	Positive	1.506	0
Adj.R_Benthic	Adjusted benthic species richness	Positive	1.370	0
Adj.R_Cyprinid	Adjusted Cyprinidae richness	Positive	1.326	0

Final metrics selected for the Ohio-Mon WAP region with metric description and direction.				
Metric	Description	Direction	Ceiling	Floor
Adj.R_Fish2.DEP	Adjusted non-tolerant species richness	Positive	1.339	0.371
Adj.R_DMS	Adjusted darter-madtom-sculpin richness	Positive	1.158	0.265
Adj.R_Int	Adjusted intolerant species richness	Positive	1.640	0
Adj.P_Tol	Adjusted proportion tolerant individuals	Negative	1.675	0.726
Adj.R_RGS	Adjusted rock-gravel spawner richness	Positive	1.191	0.358
Adj.R_NGL2	Adjusted non-guarding lithophil richness minus tolerant species	Positive	1.454	0
P_OH_CAAN	Aroportion of omnivore-herbivore minus Central Stoneroller	Negative	0.655	0.119
Adj.R_Cyprinid_BNDSEAT	Adjusted Cyprinidae richness minus blacknose dace and Creek Chub	Positive	1.412	0.276

Appendix A – IBI Normalization Basis

Table 1 – Benthic IBI Raw scores used to normalize IBI scores for assessment, based on 5th percentile of season and region appropriate reference sites.

Season/Region	(Benthic IBI Score)
Winter Plateau	65
Spring Plateau	57
Summer Plateau	62
Winter Mountains	64
Spring Mountains	51
Summer Mountains (<60 mi ²)	54
Summer Mountains (>60 mi ²)	51

Table 2 – Fish IBI Scores (and the percentile of reference sites used to determine score) used to normalize IBI scores for assessment.

Region	Region Description	Score	Percentile of Ref Sites
Mon_CARV	Monongahela River Basin sites in the Central Appalachian and Ridge and Valley Ecoregions, plus warmwater sites in the Elk River Watershed that drain into or above Sutton Lake.	56	10th
OhMon_WAP	Ohio and Monongahela River basin sites in the Western Allegheny Plateau Ecoregion	53	25th
Ohio_CA	Ohio River Basin sites in the Central Appalachian Ecoregion	Reserved	
UK	Upper (upstream of Kanawha Falls) Kanawha River Basin sites	Reserved	
Potomac	Potomac River Basin sites	Reserved	