

**Michigan Department of Environment, Great Lakes, and Energy  
Water Resources Division  
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**Staff Report**

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**Update of the Great Lakes Watersheds Assessment, Restoration, and Management  
Section Procedure 51  
Macroinvertebrate Scoring and Interpretation**

The Water Resources Division (WRD), Great Lakes Watersheds Assessment, Restoration, and Management Section's Procedure 51 describes qualitative biological and habitat survey protocols for wadeable streams. This report presents the 2024 updated macroinvertebrate multimetric index (MMI) scoring (Tetra Tech, 2023) and recommended thresholds to interpret MMI scores to evaluate the health and function of the biological community.

**General Concept**

The general premise in the interpretation of Procedure 51 macroinvertebrate sampling results is that community scores differing from reference site scores can indicate stream habitat concerns or water quality impacts.

**Stream classification**

Appropriate stream classification ensures that the index calibrated for a stream type gives the most reliable community assessment information. For each site, the stream class will be identified according to specifications in Table 1. The north region includes: (1) Northern Lakes and Forests; and (2) North Central Hardwood Forests ecoregions. The south region includes: (1) Huron/Erie Lake Plains; (2) Eastern Corn Belt Plains; and (3) Southern Michigan/Northern Indiana Drift Plains ecoregions. Stream class can be determined using the Procedure 51 [stream class tool](#). Once a site is sampled using Procedure 51, the stream class is determined and then generally retained for future monitoring events. This prevents a site from switching class based on a small difference in stream width.

Table 1. Stream classes and descriptions in the north and south regions.

North <sup>c</sup>

Stream Width (feet)	< 40% Catchment Water or Wetland Land Cover <sup>a</sup>	40% Catchment Water or Wetland Land Cover <sup>a</sup>
<13	VeryNarrow	VeryNarrow
13-21.27	Narrow	Narrow
>21.27-68.367	MidSizeDry	WideOrMidSizeWet
>68.367	WideOrMidSizeWet	WideOrMidSizeWet

South <sup>d</sup>

Longitude	At or East of -83.72	West of -83.72	West of -83.72
% streamline slope in catchment <sup>b</sup>		< % 0.2976	> % 0.2976
Stream Class	East	WestFlat	WestSteep

a. % of catchment area classified as wetland or water land cover (National Land Cover Data, (United States Geological Survey [USGS], 2014).

- b. % stream slope measured as the slope of flowline based on smoothed elevations (Source: National Hydrography Dataset Plus)
- c. North Ecoregions: Northern Lakes and Forests; North Central Hardwood Forests (Omernick and Bryce, 2010)
- d. South Ecoregions: Eastern Corn Belt Plains, Southern Michigan/Northern Indiana Drift Plains, Huron/Erie Lake Plains (Omernick and Bryce, 2010)

**Metric and Index Calculation**

Metric calculation depends on the list of taxa collected, taxa traits, and calculation descriptions. The taxa traits are identified in Procedure 51 (Appendix I). Each stream class has a specific index that includes a unique set of metrics and scoring formulae (Table 2). Metric scores are first calculated from metric values. Any scores calculated as >100 are reset to 100 and scores calculated to <0 are reset to 0. The calculated and reset scores are averaged across all metrics to arrive at an index score for each site.

Table 2. Metrics, metric categories, and scoring formulas for each stream class. Final index score is an average of all metrics within a stream class (If a metric score is >100, correct to 100; If <0, correct to 0).

<b>Stream Class and Metric</b>	<b>Metric Name (Value = X)</b>	<b>Metric Category</b>	<b>Scoring Formula</b>
VeryNarrow nt_EPT	Number of taxa in Orders Ephemeroptera, Plecoptera, and Trichoptera	Richness	$100*(X - 2.35)/(12.65)$
pt_nonIns	Percent of taxa not of Class Insecta	Richness	$100*(38.89 - X)/(28.18)$
pi_ffg_shred	Percent individuals of Functional Feeding Group - shredder	FFG	$100*(71.15 - X)/(69.82)$
pi_hab_clngr	Percent individuals of Habit - clingers	Habit	$100*(X - 4.27)/(67.89)$
pi_Crus	Percent individuals of Subphylum Crustacea	Composition	$100*(63.71 - X)/(63.71)$
pt_tv_intol	Percent taxa with tolerance value $\leq 3$ - intolerant	Tolerance	$100*(X - 7.51)/(37.73)$

<b>Stream Class and Metric</b>	<b>Metric Name (Value = X)</b>	<b>Metric Category</b>	<b>Scoring Formula</b>
Narrow pt_nonIns	Percent of taxa not of Class Insecta	Richness	$100*(34.39 - X)/(26.25)$
pi_ffg_shred	Percent individuals of Functional Feeding Group - shredder	FFG	$100*(51.34 - X)/(49.46)$
pi_hab_clmbr	Percent individuals of Habit - climbers	Habit	$100*(18.45 - X)/(18.07)$
pi_EPT	Percent individuals of Orders Ephemeroptera, Plecoptera, and Trichoptera	Composition	$100*(X - 14.93)/(57.97)$

pi_tv_toler	Percent individuals with tolerance value $\geq 7$ - tolerant	Tolerance	$100*(18.26 - X)/(18.26)$
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<b>Stream Class and Metric MidSizeDry</b>	<b>Metric Name (Value = X)</b>	<b>Metric Category</b>	<b>Scoring Formula</b>
pt_nonIns	Percent of taxa not of Class Insecta	Richness	$100*(33.33 - X)/(22.62)$
nt_CruMol	Number of taxa of Phylum Mollusca and Subphylum Crustacea	Richness	$100*(8 - X)/(7)$
pi_ffg_pred	Percent individuals of Functional Feeding Group - predator	FFG	$100*(X - 3.21)/(22.51)$
pi_ffg_shred	Percent individuals of Functional Feeding Group - shredder	FFG	$100*(42.23 - X)/(40.87)$
pi_hab_clngr	Percent individuals of Habit - clingers	Habit	$100*(X - 18.39)/(61.18)$
pi_CruMol	Percent individuals of Subphylum Crustacea and Phylum Mollusca	Composition	$100*(51.48 - X)/(50.91)$
nt_tv_toler	Number of taxa with tolerance value $\geq 7$ - tolerant	Tolerance	$100*(5 - X)/(5)$

<b>Stream Class and Metric WideOrMidSizeWet</b>	<b>Metric Name (Value = X)</b>	<b>Metric Category</b>	<b>Scoring Formula</b>
nt_nonIns	Number of taxa not of Class Insecta	Richness	$100*(13 - X)/(9)$
pi_ffg_scrap	Percent individuals of Functional Feeding Group - scraper	FFG	$100*(50.14 - X)/(48.06)$
pi_IsoSnlLch	Percent individuals of Order Isopoda, Class Gastropoda, Subclass Hirudinea	Composition	$100*(38.46 - X)/(38.07)$
pi_nonIns	Percent individuals not of Class Insecta	Composition	$100*(67.29 - X)/(64)$
pi_Pleco	Percent individuals of Order Plecoptera	Composition	$100*(X)/(6.62)$
pt_tv_toler	Percent taxa individuals with tolerance value $\geq 7$ - tolerant	Tolerance	$100*(17.39 - X)/(17.39)$

<b>Stream Class and Metric WestFlat</b>	<b>Metric Name (Value = X)</b>	<b>Metric Category</b>	<b>Scoring Formula</b>
pt_nonIns	Percent of taxa not of Class Insecta	Richness	$100*(43.51 - X)/(25.33)$

pi_ffg_cllct	Percent individuals of Functional Feeding Group - collector-gatherer	FFG	$100*(72.31 - X)/(62.64)$
pi_hab_sprwl	Percent individuals of Habit - sprawlers	Habit	$100*(27.03 - X)/(26.45)$
pi_EPT	Percent individuals of Orders Ephemeroptera, Plecoptera, and Trichoptera	Composition	$100*(X - 0.59)/(60.17)$
pt_tv_intol	Percent taxa individuals with tolerance value $\geq 7$ - tolerant	Tolerance	$100*(X)/(31.06)$
pt_tv_toler	Percent taxa with tolerance value $\leq 3$ - intolerant	Tolerance	$100*(30.04 - X)/(25.71)$

<b>Stream Class and Metric WestSteep</b>	<b>Metric Name (Value = X)</b>	<b>Metric Category</b>	<b>Scoring Formula</b>
nt_Trich	Number of taxa of Order Trichoptera	Richness	$100*(X)/(7)$
pi_EPTnoBH	Percent individuals of Orders Ephemeroptera, Plecoptera and Trichoptera (EPT) and not Families Baetidae or Hydropsychidae	Composition	$100*(X)/(32.58)$
pi_ffg_cllct	Percent individuals of Functional Feeding Group - collector-gatherer	FFG	$100*(77.52 - X)/(72.21)$
pi_hab_clngr	Percent individuals of Habit - clingers	Habit	$100*(X - 1.29)/(69.73)$
pt_tv_toler	Percent taxa individuals with tolerance value $\geq 7$ - tolerant	Tolerance	$100*(30.9 - X)/(30.9)$

<b>Stream Class and Metric East</b>	<b>Metric Name (Value = X)</b>	<b>Metric Category</b>	<b>Scoring Formula</b>
nt_Trich	Number of taxa of Order Trichoptera	Richness	$100*(X)/(7)$
pt_nonIns	Percent of taxa not of Class Insecta	Richness	$100*(50 - X)/(30)$
nt_hab_clngr	Number of taxa of Habit - clingers	Habit	$100*(X - 2)/(10.6)$
pi_IsoSnLch	Percent individuals of Order Isopoda, Class Gastropoda, Subclass Hirudinea	Composition	$100*(48.6 - X)/(47.86)$
pi_tv_intol	Percent individuals with tolerance value $\leq 3$ - intolerant	Tolerance	$100*(X)/(42.08)$

pt_tv_tolер	Percent taxa individuals with tolerance value $\geq 7$ - tolerant	Tolerance	$100 * (31.93 - X) / (26.61)$
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### Interpretation of Macroinvertebrate Community Scores

Previous versions of Procedure 51 scoring and thresholds were developed to classify macroinvertebrate communities into either “excellent,” “acceptable,” or “poor” categories. This update to the Procedure 51 MMI, including new stream classes and taking an updated reference site approach to anchoring community expectations, enables development of protective thresholds that can be used to identify departure from expected conditions. This updated Procedure 51 MMI scoring system determines if a macroinvertebrate community “meets expectations” or does “not meet expectations.” “Not meeting expectations” is an indicator that water quality, stream habitat, or other conditions are impacting the biological community.

With the goal of using macroinvertebrate communities as an indication of stream function and the influence of human impacts, the Procedure 51 MMI uses a minimally-impacted reference site approach to set macroinvertebrate community expectations for each stream class. Within Michigan, two centuries of extensive land use change and resource extraction, along with local and global atmospheric impacts, results in some level of environmental impact at all sites, even minimally-impacted reference sites.

Based on this widespread human influence, a percentile of the reference site scores was used to identify a Procedure 51 score that indicates community deviation from reference condition (Figure 1). There is inherent variability in reference condition and error associated with the process of picking reference sites. Though efforts were made to select meaningful variables while reducing redundancy, Michigan’s reference sites were chosen using a subset of possible catchment- and watershed-scale variables, leaving room for potentially unaccounted for impacts, possibly resulting in sites with some unexpected anthropogenic impacts. Eliminating the lower end of the reference site distribution from the “meeting expectations” range reduces the risk of considering a site to ‘meet expectations’ when it does not. However, the higher the threshold is placed within the range of reference site scores, the more likely a water body could be classified as ‘not meeting expectations’ when it may in fact be “meeting expectations.” Choosing a threshold was a balance between these two types of risk.

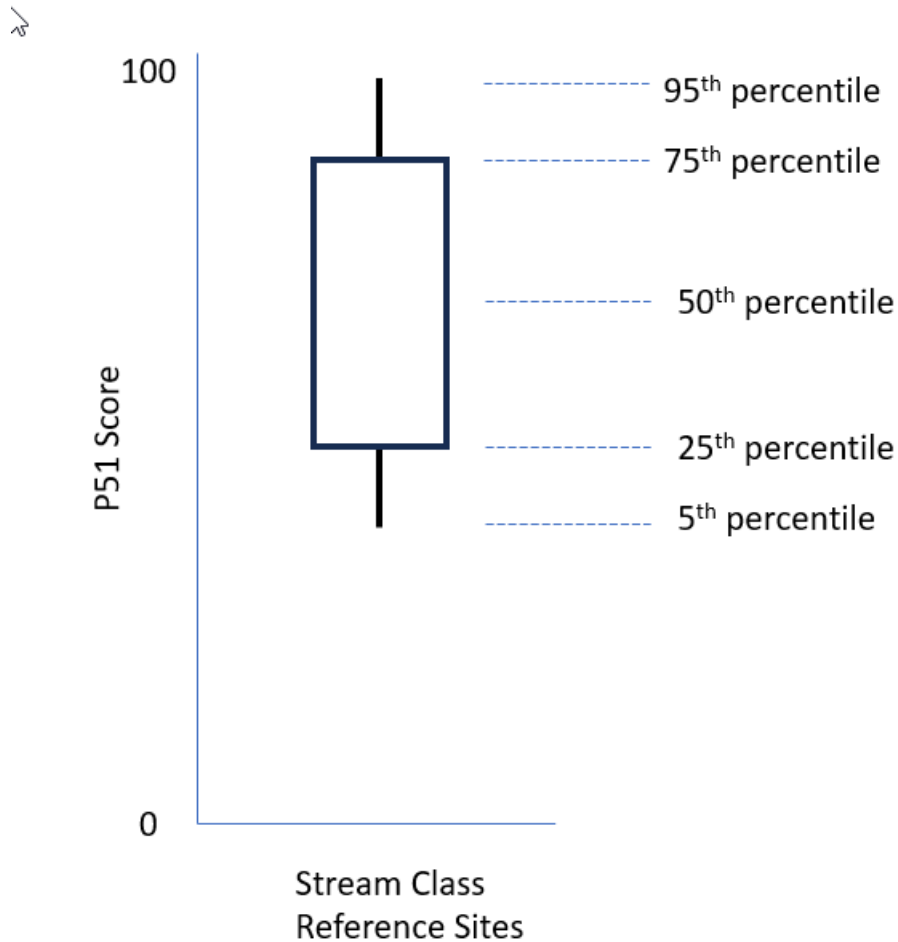


Figure 1. Example box and whisker plot of the range of Procedure 51 macroinvertebrate scores for a single stream class.

To help inform threshold placement for each stream class, prior knowledge of extreme conditions was used (i.e., sites rated poor and excellent using previous versions of Procedure 51) with the intent of continuing to consider sites that used to score excellent to ‘meet expectations’ and that sites that historically scored poor would also ‘not meet expectations’ under the new scoring system. Using this approach resulted in thresholds ranging from the 5th to 15th percentile of reference. Table 3 presents Procedure 51 thresholds and reference site percentile for each stream class.

Table 3. Stream class, stream class description, Procedure 51 threshold scores, and the reference percentile used to select the Procedure 51 threshold score.

Stream Class	Procedure 51 Threshold Score	Reference Percentile
North: VeryNarrow	59	5th
North: Narrow	48	5th
North: MidSizeDry	45	5th
North: WideOrMidSizeWet	45	5th
South: WestFlat	46	10th
South: WestSteep	42	15th
South: East	46	5th

## **Procedure 51 Macroinvertebrate Score Use in Water Quality Standard Assessment**

Procedure 51 macroinvertebrate community scores will be used in Integrated Report assessment of water quality standards in wadeable Michigan streams. Assessment methodology is detailed in the Integrated Report and considers if scores are above or below the threshold score, local conditions, other relevant Procedure 51 scores, and changes in Procedure 51 score.

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