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Refining State Water Quality Monitoring Programs and Aquatic Life Uses: Evaluation of the Minnesota PCA Bioassessment Program

MBI Technical Memorandum 2015-1-1

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January 16, 2015

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Submitted to:

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Foreword

This report is the product of research conducted by the Midwest Biodiversity Institute (MBI), Center for Applied Bioassessment and Biocriteria (CABB) that is focused on State biological assessment programs and their continuing development. As such the conclusions and statements herein are the product of MBI research and that presented in this report may not necessarily reflect the policies or views of the Minnesota Pollution Control Agency (MPCA) past or present. The state program review process developed by U.S. EPA (2013) was used to evaluate technical aspects of the MPCA bioassessment program for rivers and streams using the critical technical elements evaluation process. This follow-up review was done to determine the level of rigor of the current program and to identify progress made by MPCA since 2002 towards attaining Level 4 status in support of the adoption, development, and eventual implementation of tiered aquatic life uses (TALUs) and biocriteria. However, this analysis does not obligate MPCA to adopting such an approach. It may or may not have implications for other parts of Minnesota programs that focus on other beneficial uses.

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EXECUTIVE SUMMARY

U.S. EPA, Region V has been working with state programs to systematically evaluate their biological assessment, monitoring and assessment, and water quality standards programs since 2002. A primary objective is to determine at what level of rigor, as described by U.S. EPA (2013), these programs operate and to determine how each supports water quality management decision-making. The goal is to improve the level of rigor such that each state provides for water body assessments, 303[d] and 305[b] reporting, tiered aquatic life uses (TALU), biological criteria, determining levels of impairment, and associated causes with a TALU based program[1]. This report is focused on the Minnesota Pollution Control Agency (MPCA) biological assessment program. It links to previous efforts to evaluate the MPCA program and aquatic life designated uses in the Minnesota Water Quality Standards (WQS; MBI 2004, 2010). Four critical technical elements evaluations of the MPCA bioassessment program for rivers and streams have been conducted since 2002. A critical technical element is a specific component that pertains to how biological data is collected, interpreted, and used to support biological assessment (U.S. EPA 2013). Recommendations accompanied each of the 2002, 2006, and 2012 reviews and included what was needed in the way of technical changes to elevate the score of each critical element that was below the maximum. Since the 2006 review MPCA has been engaged in a process to make technical improvements, and amass resources and organization to implement a TALU based approach for the assessment and protection of rivers and streams.

The December 2014 critical elements (CE) evaluation was the fourth for the MPCA program since 2002. The 2014 MPCA critical elements evaluation yielded a raw score of 50.5 which at 97.1% of the maximum possible score of 52 represents a Level 4 program (range 49-52). It shows a continuous improvement from the original CE score of 72.1% (Level 2) in 2002, 81.7% (Level 2+) in 2006, and 92.2% (Level 3+) in 2012. These technical improvements were achieved as a direct result of MPCA deciding to pursue the development of numeric biocriteria and TALUs. It also demonstrates that attaining a Level 4 program status and having full TALU program support are *mutually inclusive.* The technical gaps that were identified in the MPCA program in the series of critical elements evaluations spanning nearly 15 years have been successfully addressed such that MPCA now has the technical capacity to support the adoption and implementation of a TALU based approach.

Of the three elements that did not attain the maximum CE score of 4.0, all scored 3.5 and are sufficient to support TALU implementation. However, as the TALU based approach is implemented we expect that at least two elements, Stressor Associations (Element 12) and Professional Review (Element 13) will improve since active efforts to further develop each are underway. Increasing the Spatial Coverage (Element 2) score may also occur as follow-up assessments are conducted to fill gaps in the current spatial coverages as part of the assignment of TALU tiers to individual stream and river reaches.

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[1] The "TALU based approach" includes tiered aquatic life uses (TALU) based on numeric biological criteria and implementation via an adequate monitoring and assessment program that includes biological, chemical, and physical measures, parameters, indicators and a process for stressor identification.

TECHNICAL MEMORANDUM

Evaluation of the Minnesota PCA Bioassessment Program

January 16, 2015

Purpose

U.S. EPA, Region V has been working with state programs to systematically evaluate their biological assessment and water quality monitoring programs to support tiered aquatic life uses (TALUs) and biological criteria since 2002. A primary objective is to determine at what level of rigor, as defined by U.S. EPA (2013), these programs operate and to determine how each supports water quality management decision-making. The overarching goal is to improve the level of rigor such that each state provides for water body assessments, 303[d] and 305[b] reporting, refined aquatic life uses, developing biological criteria, determining degrees of impairment, and associated causes with a TALU based program. This process has been used since 2002 to evaluate the MPCA technical program and to make recommendations for enhancements relative to design, methodology, and execution for credible data for making informed decisions regarding the condition of Minnesota rivers and streams. This included a detailed description of a TALU framework for MPCA to follow in establishing a TALU based approach (MBI 2012).

Attendance

The December 16, 2014 review was the fourth in a 15 year period and it took place at MPCA in St. Paul, MN. Participants included 6 MPCA staff and managers in person and an additional 1 MPCA manager via Live Meeting. The list of participants follows:

Name	Representing	Email
Attending In Person		
Will Bouchard	EAO-WAS-WQS Unit	will.bouchard@state.mn.us
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Basis for Evaluation

U.S. EPA has supported the development of state and tribal bioassessment programs via the production of methods documents, case studies, regional workshops, and evaluations of individual state and tribal programs since 1990. Since 2000, EPA has convened and maintained a developmental and implementation process for incorporating tiered aquatic life uses (TALUs) and numeric biocriteria in state and tribal water quality programs (U.S. EPA 2005). The development and implementation of TALUs is dependent on the rigor, comprehensiveness, and integration of the bioassessment program as an integral component of the monitoring and assessment (M&A) and water quality standards (WQS) programs. The quality and make-up of these programs ultimately determines the quality and accuracy of the outputs of the primary Clean Water Act management programs such as NPDES permitting, TMDLs, nonpoint source management (319), and watershed planning. A TALU based approach plays a key role in determining not only the WQS that are applied in a given management scenario, but also in determining the extent and severity of impaired waters through the application of numeric biocriteria via adequate M&A (Yoder 1998; Yoder and Rankin 1998). Hence the development and implementation of TALUs may alter prior determinations and actions that were based on general uses and less than adequate M&A.

MPCA Bioassessment Program Evaluation

Given the importance that is placed on the MPCA biological assessment program and the intentions to adopt TALU based biological criteria (MPCA 2014), an updated critical elements evaluation was requested by MPCA. The following is a description of the development of the biological program and current status based on the results of the series of critical elements evaluations performed since 2002.

Bioassessment Program Description: Streams and Rivers

Since the early 1990s, MPCA has utilized the Index of Biotic Integrity (IBI) and biocriteria concepts in its stream and river monitoring and assessment program. Narrative language within Minnesota Administrative Rule identifies an IBI calculation as the primary determinant for evaluating impairment of aquatic biota (Chapter 7050.0150, Subp. 6, Impairment of biological community and aquatic habitat). Adoption of the IBIs and biocriteria concepts into rule followed the Minnesota administrative process and were upheld on appeal (Minnesota Pollution Control Agency 1993 a,b,c; 2002a,b,c; U.S. EPA 1995, 2003).

Between 1993 and 2002, MPCA developed fish and macroinvertebrate IBIs for streams in specific ecoregions and major basins of Minnesota, and used them conduct aquatic life use assessments. IBIs were developed for rivers and streams with the Minnesota River Basin (Bailey et al. 1993), the Lake Agassiz Plain Ecoregion of the Red River Basin (Niemela et al. 1999), the St. Croix River Basin (Niemela and Feist 2000; Chirhart 2003), and the Upper Mississippi River Basin (Niemela and Feist 2002; Genet and Chirhart 2004). However, nearly half of Minnesota’s streams and rivers were not covered by these existing IBIs.

Beginning in 2007, MPCA began using a 10-year, rotating watershed approach for comprehensive monitoring and assessment of Minnesota's waters. MPCA has used indices of biological integrity and chemical measures together to assess the integrity of streams since the mid-1990s. However, existing IBIs were insufficient to support the statewide monitoring and assessment effort. For example, no biological assessment tools had been developed for the many miles of streams within the Rainy River and Lake Superior Basins, the Lower Mississippi River Basin, and the Red River Basin outside of the Lake Agassiz Plain Ecoregion. Furthermore, existing IBIs had not been developed concurrently, and varied somewhat in terms of their analytical approaches, classification frameworks, scoring systems, and taxa attributes. To support comprehensive monitoring and assessment of Minnesota's streams, it was necessary to develop new indicators applicable to the entire state of Minnesota, using a consistent, standardized approach.

Development of the most recent F-IBI (MPCA 2013a) and M-IBI (MPCA 2013b) utilized a protocol developed by researchers from the United States Environmental Protection Agency and elsewhere (Whittier et al. 2007). For fish, Minnesota streams and rivers were first partitioned into nine distinct classes, and a unique F-IBI was developed for each. For macroinvertebrates, Minnesota's streams and rivers were first partitioned into nine distinct classes, and a unique M-IBI was developed for each. Within each stream class, biological metrics were sequentially ranked and eliminated by a series of tests, and selected for inclusion in each IBI. Among the most important tests was an evaluation of the ability of each metric to distinguish most-disturbed sites from least-disturbed sites.

Critical Elements Evaluation: Streams and Rivers

The CE process scores 13 elements about the technical aspects of the bioassessment program awarding scores from 1 to 4 (in 0.5 increments), with a 4 being the maximum score possible for an element. The element scores are summed to obtain the CE raw score which is normalized to a percentage score. Four levels of rigor are recognized and are further described in U.S. EPA (2013). The implied goal for any state program is to achieve Level 4 although states can operate a program at a lesser level of rigor. The data we have collected via 24 state program reviews clearly indicates that a Level 4 program is commensurate with having tiered aquatic life uses (TALU) and biocriteria in the state WQS (U.S. EPA 2013). The remaining three levels of bioassessment rigor may be appropriate for some, but not all of the TALU development and water quality management support needs of state programs. Delineating the extent and severity of aquatic life impairments and diagnosing categorical and parameter-specific stressors are the primary tasks for a TALU-based approach to monitoring and assessment that is intended to support multiple water quality management programs. A narrative summary of each critical element is indicated on a CE checklist which also communicates the rationale for each CE score. A second table summarizing recommendations for specific critical elements developmental tasks is also provided to support the development of a continuous improvement process.

MPCA Critical Elements Summary: Rivers and Streams

The December 2014 critical elements (CE) evaluation was the fourth for the MPCA program since 2002. The 2014 MPCA critical elements evaluation yielded a raw score of 50.5 which at

Table 1. Performance of the Minnesota PCA state bioassessment program scored by the critical elements process for lotic ecotypes over a 12 year time frame based on joint scoring with the state during program reviews in 2002 and 2006 and in 2012 as a result of the dedicated TALU developmental process. The 2014 scoring is based on a fourth review conducted December 16, 2014.

Critical Technical Element	2002	2006	2012	2014
1. Index Period	3.5	4.0	4.0	4.0
2. Spatial Coverage	2.5	3.0	3.5	3.5
3. Nat. Classification	2.5	2.5	3.0	4.0
4. Ref. Sites Criteria	3.5	3.5	3.5	4.0
5. Ref. Condition	3.0	3.0	4.0	4.0
6. Taxonomic Resolution	3.0	4.0	4.0	4.0
7. Sample Collection	3.5	4.0	4.0	4.0
8. Sample Processing	4.0	4.0	4.0	4.0
9. Data Management	3.0	4.0	4.0	4.0
10. Ecol. Attributes	3.0	3.0	3.5	4.0
11. Biol. Endpoints	2.0	2.5	3.5	4.0
12. Diagnostic Cap.	2.0	2.0	2.5	3.5
13. Professional Review	2.0	3.0	3.5	3.5
CE Raw Score [52 is max.] **CE % Score** **CE Level**	37.5 **72.1%** **L2**	42.5 **81.7%** **L2+**	47.0 **92.2%** **L3+**	50.5 **97.1%** **L4**

Table 2. A checklist for evaluating the degree of development for each technical element of a bioassessment program and associated comments on the elements for the Minnesota PCA lotic ecosystems bioassessment program. The point scale for each element ranges from lowest to highest resolution. Scores based on a Dec. 2014 evaluation are yellow shaded; green shading is CE score circa 2012 (if different).

Element 1	(Lowest) 1.0	1.5 2.0	2.5 3.0	3.5 4.0 (Highest)	Comments
Index Period [DESIGN]	Collection times are variable throughout the year, and sampling is performed without regard to seasonal influences.	An index period is conceptually recognized, but sampling may take place outside of this period for convenience or to match existing programs; sampling outside of the index is not adjusted for seasonal influences.	A well-documented seasonal index period(s) is calibrated with data for reference conditions, but sampling may take place outside of this period for convenience or to match existing programs; sampling outside of the index is adjusted for seasonal influences. Index periods are selected based on known ecology to minimize natural variability, maximize gear efficiency, and maximize the information gained about the assemblage.	Same as Level 3, but administrative needs and index periods fully reconciled. Scientific basis of temporal sampling influences management decision framework.	MPCA employs a standardized seasonal index period; mid-June – September 30 for fish and August-September for macro-invertebrates; no impetus to operate outside this period for management program support. **Points** **4.0**

Element 2	(Lowest) 1.0	1.5 2.0	2.5 3.0	3.5 4.0 (Highest)	Comments
Spatial Coverage [DESIGN]	An individual site is used for assessment of watershed condition; simple upstream/ downstream and fixed station designs prevail; assessments at local scale.	Multiple sites are used for watershed assessment; spatial coverage only for questions of general status or locally specific problem areas; synoptic (non-random) design at coarse scale (e.g., 8-digit HUC common); spatial extrapolation is based on "rules of thumb"; may be supplemented by simple upstream/downstream assessments.	Spatial network suitable for status assessments; statewide spatial design using rotating basins with single purpose design at coarse scale (e.g., 8 digit HUC); may be supplemented by occasional intensive surveys.	Comprehensive spatial network suitable for reliable watershed assessments in support of multiple water quality management programs at more detailed scale (e.g., 11-14 digit HUC); statewide rotating basin approach or similar scheme to complete statewide monitoring in a specified period of time; multiple spatial designs appropriate for multiple issues.	Rotating basin approach at 8-digit HUC level within which watershed scale assessments (12-14 digit HUC) are performed by sampling at "pour" points and selected watershed scale sites with follow-up surveys to resolve specific issues and stressor i.d. in a second year. Long-term reference sites established at fixed locations. Large rivers are treated as distinct assessment units. Statewide probabilistic network per level II ecoregions. **Points** **3.5**

Table 2. (continued)

Element 3	(Lowest) 1.0	1.5	2.0	2.5	3.0	3.5	4.0 (Highest)	Comments
Natural Variability [DESIGN]	No partitioning of natural variability in aquatic ecosystems. Minimal classification limited to individual watersheds or basins with generalized stratification on a regional basis; does not incorporate differences in stream characteristics such as size, gradient.		Classification recognizes one stratum, usually a geographical or other similar organization such as fishery based cold or warmwater, and is applied statewide; lacks other intra-regional strata such as watershed size, gradient, elevation, temperature, etc.		Classification is based on a combination of landscape features and physical habitat structure (inter-regional); achieves highest level of classification possible by considering all relevant intra-regional strata and subcategories of specific stream types.		Fully partitioned and stratified classification scheme based on a true regional approach that transcends jurisdictional (i.e., State) boundaries to strengthen inter-regional classification and recognizes zoogeographical aspects of assemblages.	Fully partitioned framework is developed for all lotic warmwater and cold water ecotypes and stream/river sizes including head-water, wadeable, and low gradient streams and boatable rivers. **Points** **4.0**

Element 4	(Lowest) 1.0	1.5	2.0	2.5	3.0	3.5	4.0 (Highest)	Comments
Reference Sites Selection [DESIGN]	No criteria, except informal BPJ selection of control sites. May be little documentation and supporting rationale.		Based on "best biology", i.e., BPJ on what the best biology is in the best waterbody; minimal non-biological data used.		Non-biological criteria supported by narrative descriptors only; combine BPJ with narrative description of land use and site characteristics; may use chemical and physical data thresholds as primary filters.		Quantitative descriptors used to support non-biological criteria; characteristics of sites are such that the best biological organization expected to be supported; chemical and physical characteristics of sites used only as secondary and tertiary filters to avoid circularity in other criteria.	Reference site criteria primarily consider abiotic indicators including land use of up-stream catchment, proportion of modified habitats, proximity to point sources, condition of stream channel, immediate land use, condition of upstream riparian corridor, buffer width; chemistry and habitat may be used as secondary filters. **Points** **4.0**

Table 2. (continued)

Element 5	(Lowest) 1.0 1.5	2.0	2.5 3.0	3.5 4.0 (Highest)	Comments
Reference Conditions [DESIGN]	No reference condition; presence and absence of key taxa or best professional judgment rather than established reference conditions may constitute the basis for assessment.	Reference condition based on biology of a 'best' site or waterbody; a site-specific control or paired watershed approach may be used for assessment; regional reference sites lacking.	Reference conditions based on site-specific data, but are used in watershed scale assessments; regional reference sites are conceptually recognized, but are too few in number and/or spatial density to support the derivation of biocriteria.	Applicable regional reference conditions are established within the applicable waterbody ecotypes and aquatic resource classes; consist of multiple sites that either represent reference or are along the BCG in such a manner to allow extrapolation of expected conditions for assessing and monitoring within waterbody ecotype. Re-sampling of reference sites done systematically over a period of years.	Regional reference conditions are defined by a consistent and quantitative process that is applied statewide and within the different strata of lotic ecotypes. **Points** **4.0**

Element 6	(Lowest) 1.0 1.5	2.0	2.5 3.0	3.5 4.0 (Highest)	Comments
Taxa & Taxonomic Resolution [METHODS]	Gross observation of biota; single assemblage only; very low taxonomic resolution (e.g., order/family level for macro-invertebrates.; family for fish by non-biologists).	Single assemblage (usually macroinvertebrates); low taxonomic resolution (e.g., family level) by experienced biologists.	Single assemblage with high taxonomic resolution (e.g., "lowest practical" i.e., genus/species); if multiple assemblages, others are lower resolution or infrequently used.	Two or more assemblages with high taxonomic resolution (e.g., "lowest practical" i.e., genus/species); capacity to use each assemblage concurrently is maintained; practitioners are certified in accordance with available offerings (e.g., NABS, state credible data provisions).	For macroinvertebrates, POET taxa identified to species with remaining taxa identified to genus level including Chironomidae; fish to species; NABS certification required for macroinvertebrate taxonomists (as specified by contract). **Points** **4.0**

Table 2. (continued)

Element 7	(Lowest) 1.0	1.5 2.0	2.5 3.0	3.5 4.0 (Highest)	Comments
Sample Collection [METHODS]	Approach is cursory and relies on operator skill and BPJ, producing highly variable and less comparable results; Training limited to that which is conducted annually for non-biologists who compose the majority of the sampling crew. Documentation of methods more as an overview.	Textbook methods are used rather than in-house development of detail of SOPs to specify methods; a QA/QC document may have been prepared; training consists of short courses (1-2 days) and is provided for new staff and periodically for all staff.	Methods are evaluated and refined (if needed) for State purposes; detailed and well documented; SOPs are updated periodically and supported by in-house testing and development; a formal QA/QC program is in place with field replication taken; rigorous training is for all professional staff, regardless of skill mix to raise skill levels and enhance interaction and consistency.	Same as Level 3, but methods cover multiple assemblages.	Program documentation, QA/QC, and SOPs are in place; field methods are tested and validated; in-house training and orientation for all field staff. **Points** **<u>4.0</u>**

Element 8	(Lowest) 1.0	1.5 2.0	2.5 3.0	3.5 4.0 (Highest)	Comments
Sample Processing [METHODS]	Biological samples are processed in the field using visual guides; sorting and identification are dependent on operator skill and effort.	Organisms are identified and enumerated primarily in the field prohibiting ample QC but done by trained staff; for fish cursory examination of presence and absence only; no in-house development of SOPs.	Laboratory processing of all samples (except for fish); A formal QA/QC program is in place; rigorous training is provided; vouchering of organisms done for ID verification.	Same as Level 3, but is applicable to multiple assemblages; subsampling level tested. Notations made on fish as to diseased, erosion, lesion, tumors.	Program documentation, QA/QC, and SOPs are in place; macroinvertebrates sorted and i.d. by external lab; fish i.d. in field by qualified staff; vouchers retained; DELT anomalies recorded. **Points** **<u>4.0</u>**

Table 2. (continued)

Element 9	(Lowest) 1.0	1.5	2.0	2.5	3.0	3.5	4.0 (Highest)	Comments
Data Management [METHODS]	Sampling event data organized in a series of spreadsheets e.g., (by year, by data-type, etc); QC cursory and mostly for transcription errors.		Separate quasi-databases for physical-chemical and biological data (Excel, Access, dBase, etc) with separate GIS shape files of monitoring stations; data-handling methods manuals available; QC for data entry, value ranges, and site locations.		True relational database containing biological and sampled site info (Oracle, etc); fully documented and implemented data QAPP; structure allows for data export and analysis and biocriteria development; includes dedicated database management.		Relational database of bioassessment data (including indices and biocriteria) with real-time connection to spatial data coverage showing monitored sites in relation to other relevant spatial data layers (population density; impervious surfaces; vegetation coverage, low-flight photos, nutrient concentrations, ecoregion, etc); fully documented and implemented data QAPP; data available from multiple assemblages to enable integrated analysis.	True relational database containing biological, chemical, physical habitat and sampled site information; data available from multiple assemblages to enable integrated analysis; external data access tool allowing public viewing of biological data and associated spatial location coverage. **Points** **4.0**

Element 10	(Lowest) 1.0	1.5	2.0	2.5	3.0	3.5	4.0 (Highest)	Comments
Ecological Attributes [INTERPRETATION]	Linkage to the BCG or adherence to the basic ecological attributes as a foundation is lacking; simple measures of presence/absence.		Only inferences can be made for a few of the comparatively simple ecological attributes, e.g., sensitive/tolerant taxa of a ubiquitous nature; single dimension measures used.		Ecological attributes used as a foundation for bioassessment, but may not be fully developed, or may be lacking. BCG incorporated into conceptual underpinnings.		The ecological attributes of the BCG form the conceptual foundation; level of rigor represents or extends to all underpinnings of the ecological attributes.	A formal BCG process was used for fish and macroinvertebrate assemblages and across all warmwater and cold water lotic ecotypes and bioregions. Bioassessment is fully incorporated into the waterbody assessment process. **Points** **4.0**

Table 2. (continued)

Element 11	(Lowest) 1.0	1.5 / 2.0	2.5 / 3.0	3.5 / 4.0 (Highest)	Comments
Discriminatory Capacity [INTERPRETATION]	Assessment may be based only on presence or absence of targeted or key species; (Some citizen monitoring groups use this level); attainment thresholds not specified; this approach may be sufficient for Coarse problem identification. Coarse method (low signal) and detects only high and low values.	A biological index or endpoint is established for specific water bodies, but is likely not calibrated to waterbody classes or statewide application; index is probably relevant only to a single assemblage; presence/absence based on all taxa; BPJ thresholds based on single dimension attributes. Limited to pass/fail determinations of attainment status that does not reflect incremental measurement along the BCG.	A biological index, or model, has been developed and calibrated for use throughout the State or region for the various classes of a given waterbody type; the index is relevant to a single assemblage; attainment thresholds are based on discriminant model or distribution of candidate reference sites, or some means of quantifying reference condition. Can distinguish 3-4 increments along the BCG; supports narrative evaluations based on multimetric or multivariate analysis that are relevant to the BCG.	Biological index(es), or model(s) for multiple assemblages is (are) developed and calibrated for use throughout the State or region and corresponds to the BCG; integrated assessments using the multiple assemblages are possible, thus improving both the assessment and diagnostic aspects of the process; multiple parameters for evaluation, based on integrated data calibrated to regional reference condition. Able to detect status (integrated signal) on a continuous scale along the BCG; power to detect at least 5-6 categories of condition.	Fish IBI and macroinvertebrate IBI development followed conventional process and latest procedural techniques; initially used to determine status using a single threshold for CWA goal attainment – TALUs being incorporated now; new indices are evaluated for ability to discriminate along BCG, can distinguish 5-6 categories of condition. Impairment decisions now based on TALUs. **Points** **<u>4.0</u>**

Element 12	(Lowest) 1.0	1.5 / 2.0	2.5 / 3.0	3.5 / 4.0 (Highest)	Comments
Stressor Associations [INTERPRETATION]	Diagnostic capability lacking.	Coarse indications of response via assemblage attributes at gross level, i.e., general indicator groups (e.g., EPT taxa); Supporting analysis across spatial and temporal scales limited.	More detailed development of indicator guilds and other aggregations to distinguish and support causal associations; usually involves refined taxonomy (at least genus level); supported by analysis of larger datasets and/or extensive case studies; patterns repeatable across different sources; developed for a single assemblage only.	Response patterns are most fully developed and supported by organized and extensive research and case studies across spatial and temporal scales; results are actively used in biological assessment and in assigning associated causes and sources for program support purposes; involves refined taxonomy; accomplished for two assemblage groups.	Formal development of diagnostic tools is underway; the database is sufficient to support detailed explora-tory analyses; development of biological response signatures is underway. **Points** **<u>3.5</u>**

Table 2. (continued)

Element 13	(Lowest) 1.0 / 1.5	2.0 / 2.5	3.0	3.5 / 4.0 (Highest)	Comments
Professional Review [INTERPRETATION]	Review limited to editorial aspects.	Internal scientific review only, Outside review for objectivity left for higher levels.	Outside review of documentation and reports conducted. However, selection of peer review can be subjective.	Formal process for technical review to include multiple reference and documented system for reconciliation of comments and issues. Process results in methods and reporting improvements. Can include peer-reviewed journal publications.	Review process includes informal review by outside sources; TALU development process is incorporating a formal external stakeholder process and we expect the new indices and BCG will result in peer reviewed publications.
					Points **3.5**

CE Score = 50.5
CE % = 97.1%
Level = Level 4

Level 4: >94.2%
Level 3+: 91.2-94.1%
Level 3: 85.8-91.1%
Level 3-: 82.7-85.7%
Level 2+: 79.6-82.6%
Level 2: 65.4-79.5%
Level 1: <65.3%

97.1% of the maximum possible score of 52 represents a Level 4 program (range 49-52). It shows a continuous improvement from the original CE score of 72.1% (Level 2) in 2002, 81.7% (Level 2+) in 2006, and 92.2% (Level 3+) in 2012. These technical improvements were achieved as a direct result of MPCA deciding to pursue the development of numeric biocriteria and TALUs. It also demonstrates that attaining a Level 4 program status and having full TALU program support are *mutually inclusive.* The technical gaps that were identified in the MPCA program in the series of critical elements evaluations spanning nearly 15 years have been successfully addressed such that MPCA now has the technical capacity to support the adoption and implementation of a TALU based approach.

Of the three elements that did not attain the maximum CE score of 4.0, all scored 3.5 and are sufficient to support TALU implementation. However, as the TALU based approach is implemented we expect that at least two elements, Stressor Associations (Element 12) and Professional Review (Element 13) will improve since active efforts to further develop each are underway. Increasing the Spatial Coverage (Element 2) score may also occur as follow-up assessments are conducted to fill gaps in the current spatial coverages as part of the assignment of TALU tiers to individual stream and river reaches.

TALU Development for Minnesota Rivers and Streams

The MPCA streams and rivers bioassessment program now operates at Level 4. This achievement is the result of a dedicated developmental process that included addressing the technical improvements needed to elevate the CE score, developmental projects to support a WQS rulemaking to include TALUs and biocriteria in the Minnesota WQS, and an implementation framework to direct the implementation and maintenance of a TALU based program. The latter consisted of a TALU development project beginning in 2008 to determine the key steps and attributes of a process for implementing TALU and biocriteria as part of the MPCA water quality regulatory and management programs. The framework and rationale outlined in this framework document (MBI 2012) was based, in part, on the TALU and biocriteria developmental experiences of other TALU states and guidance and methods documents that were produced by U.S. EPA. The process outlined in the TALU framework document (MBI 2012) is a collection of existing "best practices" in the development and implementation of state-based TALU frameworks. In addition, draft language for the Minnesota Water Quality Standards (WQS) was recommended to support a TALU rulemaking process that will take place in 2015.

Numeric biocriteria for Minnesota streams and rivers were developed using a multiple lines of evidence approach which relied most heavily on reference condition and the Biological Condition Gradient (BCG). Both were used in a complimentary manner to set numeric biocriteria. A biocriteria development support document (MPCA 2014) details the approach and how it was used to develop Exceptional, General, and Modified Use biocriteria for each class of Minnesota streams and rivers. Detailed descriptions of the bioassessment and TALU components related to the development of the numeric biocriteria include biological assessment guidance (MPCA 2012a), the stream and river classification scheme (MPCA 2013a,b), a human disturbance score (HDS; MPCA 2013c), and a Biological Condition Gradient (BCG) for Minnesota streams and rivers Gerritsen et al. 2012). This body of work represents the necessary preparation for positioning MPCA to conduct a rulemaking to incorporate TALUs and biocriteria into the Minnesota WQS and follow that with program implementation and maintenance.

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Appendix A: Key Characteristics of TALU Based Programs

A common observation made during nearly 12 years of conducting these types of reviews is that some states have focused exclusively on monitoring designs that support 305[b] reporting and 303[d] listing as a singular output. This contrasts with the states that meet the 305[b]/303[d] objectives, but which also provide day-to-day support for the mainstream CWA management programs such as WQS, NPDES permitting, TMDLs, NPS planning and implementation, 404/401 dredge and fill, compliance/enforcement, and any other program where surface water quality and aquatic life goals are at issue. These latter examples demonstrate that it is possible to do both, i.e., meet the 305[b]/303[d] obligations under the CWA *and* provide "value added" functions for CWA and non-CWA programs alike. Key to achieving the latter is the spatial design of the monitoring networks that are employed. This factor alone can determine whether a state M&A program becomes limited to 305[b]/303[d] or meets the broader goal of full CWA program support which is further buttressed by adherence to a TALU based approach.

The EPA critical technical elements process (U.S. EPA 2013) was used to evaluate the technical capabilities and needs of the MPCA biological assessment program and to identify logical next steps for overall program development. It is a fundamental tenet that attaining full TALU program support and implementation and attaining a Level 4 program status are mutually inclusive. Understanding the characteristics and programmatic capacity of a Level 4 program is therefore important. Appendix Table 1 describes these key program capabilities and outputs that are characteristic of Level 4 programs that in turn provide support to water quality management programs via a TALU based approach. These key program capabilities are:

1. Establish protective guidelines (e.g., refined designated uses) and thresholds (biological criteria) in the WQS to protect existing conditions and support continued improvements; and,
2. Integrate the determination of response (biological) and causal variables (water quality, habitat, etc.) as a matter of routine in producing assessments.

The integration of the monitoring program into the overall WQ program and development of a routine stressor identification process should be an integrated effort within the development of the biological assessment program. This way, as the technical rigor of a program is strengthened, the state can successively use the monitoring and assessment data to address increasingly complex issues. Furthermore, this practice is incorporated as an integral part of the assessment methodology and also accomplishing it in a reasonable time frame. A key attribute of these programs is to provide a cause or causes for all observed biological impairments to not only better support CWA 303[d] listing and Total Maximum Daily Load (TMDL) development, but all aspects of WQS, permitting, and assessment in general. This is an inherent outcome of a well-integrated monitoring and assessment program that routinely provides the right types of paired stressor/response data (U.S EPA 2013).

Appendix Table 1. Key program capabilities and outputs that are characteristic of a Level 4 state program that in turn provides support for a TALU based program.

Key Program Capabilities:

1. Establish protective guidelines (e.g., refined designated uses) and thresholds (biological criteria) in WQS to protect existing conditions and support improvements.
2. Integrate monitoring of response (biological) and causal variables (water quality, habitat, etc.).

Programmatic Output	Explanation
ALUs in WQS are sufficiently detailed to express differences in natural classification strata and levels of protection above CWA minimum thresholds.	Narrative descriptions of ALU classes and attendant numeric biological criteria incorporate elements of natural classification strata and are consistent with underlying distinctions of aquatic ecotypes and levels of restoration and protection including the minimum for CWA goal attainment and attainable levels of protection for higher levels of biological quality. Able to effectively deal with use attainability issues for impairments caused by legacy impacts.
Monitoring and assessment program is designed and conducted to support multiple WQM program objectives and includes multiple biological, chemical, and physical indicators and parameters that are used within defined roles as indicators of response, exposure, and stress.	Monitoring and assessment is integrated into the overall management of surface WQ beyond the determination of general condition or status. Spatial design is sufficient to detect and characterize both chemical and non-chemical pollution gradients at an appropriate scale and to support the assignment of ALUs to individual water bodies. Results are expressed to support multiple program uses including reporting, WQS attainment, and watershed, reach, and site-specific support (i.e., permit effectiveness, investigations, watershed planning, use attainability analysis [UAA] etc.).
Methods and tools are developed for stressor identification and are implemented as part of M&A program. Information is used to support multiple WQM program needs.	Empirical relationships between biological measures and chemical/physical parameters and indicators are well developed, providing a reasonable prediction of biological attainment. Information supports statewide and regional development and refinement of WQ and other criteria as well as moving the findings of biological impairment beyond generic listings (e.g., 4c category) by supporting stressor identification implicit in the M&A process.