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Framework and Implementation Recommendations for Tiered Aquatic Life Uses: Minnesota Rivers and Streams

A Report to:
Minnesota Pollution Control Agency

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CLEAN WATER LAND & LEGACY AMENDMENT

Foreword

The Minnesota Pollution Control Agency (MPCA) has embarked on a detailed developmental effort to determine how the concept of TALU can be applied to Minnesota rivers and streams. This effort is the result of work that began in the early 1990s to develop a robust biological monitoring and assessment program in Minnesota. In the last 20 years Minnesota has developed many of the tools and program capabilities needed to implement a TALU framework. When this process is completed MPCA will be one of a handful of states in the U.S capable of supporting a TALU framework.

The MPCA commissioned this project 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 report is based on the TALU and biocriteria developmental experiences of other states and guidance and methods documents that have been produced by U.S. EPA. The process outlined by this report is a collection of existing "best practices" in the development and implementation of a state-based TALU framework. In addition, draft language for the Minnesota Water Quality Standards (WQS) is recommended and will support the rulemaking that will be proposed for adoption in 2014.

This report was completed in fulfillment of Task 3 of the MBI TALU work plan (Appendix A). It contains recommendations by MBI to MPCA based on the best scientific evidence and "best practices" that are currently available. It is advisory in terms of how MPCA might choose to implement the recommendations herein. The recommendations are the result of a participatory process by which MBI was involved in every step of the TALU and biocriteria development with MPCA staff and management. The underpinnings and conceptual tenets of a TALU-based approach have been carefully explained to MPCA management and staff via internal stakeholder engagement. In addition, external stakeholders have been informed at the same level of detail via various meetings and workshops at MPCA headquarters and regional offices.

The report is organized into major sections and subsections as follows:

1. Section 1.0 describes the Minnesota TALU initiative and origins.
2. Section 2.0 provides a detailed description of the TALU framework and its components.
3. Section 3.0 outlines the recommendations for a framework for developing and applying TALUs and biocriteria in the Minnesota WQS.
4. Section 4.0 describes recommendations and examples about how TALUs should be implemented in Minnesota.
5. Section 5.0 describes the likely effects that a TALU approach will have on major Minnesota PCA management programs.

This report reflects the detailed needs within MPCA and how a TALU-based approach might change the current Minnesota WQS and how that in turn might affect current MPCA water quality management programs. As such this report is advisory in nature and implementation of all or parts of the recommendations in this report are solely at the discretion of MPCA who will decide based on internal and external stakeholder consultation. Regulatory adoption of a TALU framework and affiliated standards and criteria will undergo the normal public rule making processes as outlined in the Minnesota Administrative Procedures Act.

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Glossary of Terms

Ambient Monitoring — Sampling and evaluation of receiving waters not necessarily associated with episodic perturbations.

Antidegradation Policy — The part of state water quality standards that protects existing uses, prevents degradation of high quality water bodies unless certain determinations are made, and which protects the quality of outstanding national resource waters. (Currently nondegredation in MN)

Aquatic Assemblage — An association of interacting populations of organisms in a given water body, for example, the fish assemblage or the benthic macroinvertebrate assemblage.

Aquatic Community — An association of interacting assemblages in a given water body, the biotic component of an ecosystem.

Aquatic Life Use (ALU) — A beneficial use designation in which the water body provides suitable habitat for survival and reproduction of desirable fish, shellfish, and other aquatic organisms; classifications specified in State water quality standards relating to the level of protection afforded to the resident biological community by the custodial State agency.

Attainment Status — The state of condition of a water body as measured by chemical, physical, and biological indicators. Full attainment is the point at which measured indicators signify that a water quality standard has been met and it signifies that the designated use is both attained and protected. Non-attainment is when the designated use is not attained based on one or more of these indicators being below the required condition or state for that measure or parameter.

Attribute — A measurable part or process of a biological system.

Beneficial Uses — Desirable uses that acceptable water quality should support. Examples are drinking water supply, primary contact recreation (such as swimming), and aquatic life support.

Benthic Macroinvertebrates — Animals without backbones, living in or on the substrates, of a size large enough to be seen by the unaided eye, and which can be retained by a U.S. Standard No. 30 sieve (0.595 mm openings). Also referred to as benthos, infauna, or macrobenthos.

Best Management Practice (BMP) An engineered structure or management activity, or combination of these that eliminates or reduces an adverse environmental effect of a pollutant, pollution, or stressor effect.

Biological Assessment An evaluation of the biological condition of a water body using surveys of the structure and function of a community of resident biota; also known as bioassessment. It also includes the interdisciplinary process of determining condition and relating that condition to chemical, physical, and biological factors that are measured along with the biological sampling.

Biological Criteria (Biocriteria) Scientific meaning: quantified values representing the biological condition of a water body as measured by structure and function of the aquatic communities typically at reference condition; also known as biocriteria.

Regulatory meaning: narrative descriptions or numerical values of the structure and function of aquatic communities in a water body necessary to protect a designated aquatic life use, implemented in, or through state water quality standards.

Biological Condition Gradient (BCG) A scientific model that describes the biological responses within an aquatic ecosystem to the increasing effects of stressors.

Biological Diversity Refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different taxa and their relative frequencies. For biological diversity, these taxa are organized at many levels, ranging from complete ecosystems to the biochemical structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species, and genes; also known as biodiversity.

Biological Indicator An organism, species, assemblage, or community characteristic of a particular habitat or indicative of a

	particular set of environmental conditions; also known as a bioindicator.
Biological Integrity	The ability of an aquatic ecosystem to support and maintain a balanced, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a region (after Karr and Dudley 1981).
Biological Monitoring	The use of a biological entity (taxon, species, assemblage) as a detector and its response as a measure of response to determine environmental conditions. Ambient biological surveys and toxicity tests are common biological monitoring methods; also known as biomonitoring.
Biological Survey	The collection, processing, and analysis of a representative portion of the resident aquatic community to determine its structural and/or functional characteristics and hence its condition using standardized methods.
Bioregion	Any geographical region characterized by a distinctive flora and/or fauna.
Clean Water Act (CWA)	An act passed by the U.S. Congress to control water pollution (formally referred to as the Federal Water Pollution Control Act of 1972). Public Law 92-500, as amended. 33 U.S.C. 1251 et seq.; referred to herein as the Act.
CWA Section 303(d)	This section of the Act requires States, territories, and authorized Tribes to develop lists of impaired waters for which applicable water quality standards are not being met, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop TMDLs for these waters. States, territories, and authorized Tribes are to submit their list of waters on April 1 in every even-numbered year.
CWA Section 305(b)	Biennial reporting required by the Act to describe the quality of the Nation's surface waters, to serve as an evaluation of progress made in maintaining and restoring

	water quality, and describe the extent of remaining problems.
Criteria	A limit on a particular pollutant or condition of a water body presumed to support or protect the designated use or uses of a water body. Criteria may be narrative or numeric and are commonly expressed as a chemical concentration, a physical parameter, or a biological assemblage endpoint.
DELT Anomalies	The percentage of Deformities, Erosions (e.g., fins, barbels), Lesions and Tumors on fish assemblages (DELT). An important fish assemblage attribute that is a commonly employed metric in fish IBIs.
Designated Uses	Those uses specified in state water quality standards for each water body or segment whether or not they are being attained.
Disturbance	Any activity of natural or human causes that alters the natural state of the environment and its attributes and which can occur at or across many spatial and temporal scales.
Ecological integrity	The summation of chemical, physical, and biological integrity capable of supporting and maintaining a balanced, integrated adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats in the region.
Ecoregion	A relatively homogeneous geographical area defined by a similarity of climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables; ecoregions are portioned at increasing levels of spatial detail from level I to level IV.
Existing Uses	Those uses actually attained in a water body on or after November 28, 1975, whether or not they are included in the state water quality standards (November 28, 1975 is the date on which U.S. EPA promulgated its first water quality standards regulation in 40CFR Part 131). Existing uses must be maintained and cannot be removed.

Functional Organization The summation of processes required for normal performance of a biological system (may be applied to any level of biological organization).

Index of Biotic Integrity (IBI) An integrative expression of site condition across multiple metrics comprised of attributes of a biological assemblage. It refers to the index developed by Karr (1981) and explained by Karr et al. (1986). It has been used to express the condition of fish, macroinvertebrate, algal, and terrestrial assemblages throughout the U.S. and in each of five major continents.

Metric A calculated term or enumeration representing an attribute of a biological assemblage, usually a structural aspect, that changes in a predictable manner with an increased effect of human disturbance.

Monitoring and Assessment The entire process of collecting data from the aquatic environment using standardized methods and protocols, managing that data, analyzing that data to make assessments in support of multiple program objectives, and disseminating the assessments to stakeholders and the public.

Multimetric Index An index that combines assemblage attributes, or metrics, into a single index value. Each metric is tested and calibrated to a scale and transformed into a unitless score prior to being aggregated into a multimetric index. Both the index and metrics are useful in assessing and diagnosing ecological condition.

Narrative Biocriteria Written statements describing the narrative attributes of the structure and function of aquatic communities in a water body necessary to protect a designated aquatic life use.

Natural Condition This includes the multiplicity of factors that determine the physical, chemical, or biological conditions that would exist in a water body in the absence of measurable impacts from human activity or influence.

Numeric Biocriteria Specific quantitative and numeric measures of the structure and function of aquatic communities in a water body necessary to protect a designated aquatic life use.

Reference Condition

The condition that approximates natural, unimpacted to best attainable conditions (biological, chemical, physical, etc.) for a water body. Reference condition is best determined by collecting measurements at a number of sites in a similar water body class or region under minimally or least disturbed conditions (by human activity), if they exist. Since undisturbed or minimally disturbed conditions may be difficult or impossible to find in some states, least disturbed conditions, combined with historical information, models or other methods may be used to approximate reference condition as long as the departure from natural or ideal is comprehended. Reference condition is used as a benchmark to establish numeric biocriteria and can be further described as follows:

Minimally Disturbed Condition (MDC) – This term describes the condition of the biota in the absence of significant human disturbance and it is the best approximation of biological integrity.

Historical Condition (HC) - The condition of the biota at some point in its history. It may be a more accurate estimator of true reference condition (i.e., biological integrity) if the historical point chosen is before the effect of any adverse human disturbance. However, more than one historical reference point is possible (e.g., pre-industrial, pre-Columbian).

Least Disturbed Condition (LDC) – Least disturbed condition is found in conjunction with the best available physical, chemical, and biological habitat conditions given today's state of the landscape.

Best Attainable Condition (BAC) – This is the expected condition of least disturbed sites under the implementation of BMPs for a sufficient period of time. This is a condition that results from the convergence of management goals, best available technologies, and a public commitment to achieving environmental goals (e.g., as established by WQS) under prevailing uses of the landscape. BAC may be equivalent to either to either MDC

	or LDC depending on the prevailing level of human disturbance in a region.
Reference Site	A site selected to represent an approximation of reference condition and by comparison to other sites being assessed. For the purpose of assessing the ecological condition of other sites, a reference site is a specific locality on a water body that is minimally or least disturbed and is representative of the expected ecological condition of other localities on the same water body or nearby water bodies.
Regional Reference Condition	A description of the chemical, physical, or biological condition based on an aggregation of data from reference sites that are representative of a water body type in an ecoregion, subregion, bioregion, or major drainage unit.
Stressors	Physical, chemical, and biological factors that can adversely affect aquatic organisms. The effect of stressors is apparent in the biological responses.
Use Attainability Analysis (UAA)	A structured scientific assessment of the physical, chemical, biological or economic factors affecting attainment of the uses of water bodies.
Use Classes	A broad capture of a designated use for general purposes such as recreation, water supply, and aquatic life.
Use Subclasses	A subcategorization of use classes into discrete and meaningful descriptions. For aquatic life this would include a hierarchy of warmwater and cold water uses and additional stratification provided by different levels of warmwater uses and further stratification by water body types.
TALU-Based Approach	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.
Tiered Aquatic Life Uses (TALUs)	<u>As defined</u>: The structure of designated aquatic life uses that incorporates a hierarchy of use subclasses and

	stratification by natural divisions that pertain to geographical and water body class strata. TALUs are based on representative ecological attributes and these should be reflected in the narrative description of each TALU tier and be embodied in the measurements that extend to expressions of that narrative through numeric biocriteria and by extension to chemical and physical indictors and criteria. As used: TALUs are assigned to water bodies based on the protection and restoration of ecological potential. This means that the assignment of a TALU tier to a specific water body is done with regard to reasonable restoration or protection expectations and attainability. Hence knowledge of the current condition of a water body and an accompanying and adequate assessment of stressors affecting that water body are needed to make these assignments.
Total Maximum Daily Load (TMDL)	The maximum amount of a pollutant that a body of water can receive while still meeting water quality standards. Alternatively, a TMDL is an allocation of a water pollutant deemed acceptable to attain the designated use assigned to the receiving water.
Water Quality Standards (WQS)	A law or regulation that consists of the designated use or uses of a water body, the narrative or numerical water quality criteria (including biocriteria) that are necessary to protect the use or uses of that particular water body, and an antidegradation policy.
Water Quality Management	A collection of management programs relevant to a water resource protection that includes problem identification, the need for and placement of best management practices, pollution abatement actions, and measuring the effectiveness of management actions.

List of Acronyms

ALU	Aquatic Life Use
BCG	Biological Condition Gradient
BMPs	**Best Management Practices**
CFR	Code of Federal Regulations
CWA	Clean Water Act
EPT	Ephemeroptera, Plecoptera, Trichoptera
FIBI	Fish Index of Biotic Integrity
IBI	Index of Biotic Integrity
M&A	Monitoring and Assessment
MIBI	Macroinvertebrate Index of Biotic Integrity
MPCA	Minnesota Pollution Control Agency
MSHA	Minnesota Stream Habitat Assessment
NPDES	National Pollutant Discharge Elimination System
QHEI	Qualitative Habitat Evaluation Index
TALU	Tiered Aquatic Life Use
TMDL	Total Maximum Daily Load
UAA	Use Attainability Analysis
WLA	Waste Load Allocation
WQS	Water Quality Standards
WWTP	Wastewater Treatment Plant

Executive Summary

Background

Stream biology integrates watershed water quality conditions because biological communities integrate multiple stressors which occur at both local and watershed-level scales. Fish and macroinvertebrates communities have different ecological requirements, so they respond to different stressors thereby providing a more comprehensive measure aquatic life condition. Minnesota's water quality standards (WQS) are designed to protect aquatic life and apply to most waters of the state. However, the current WQS are not sufficient to protect or manage the wide diversity of aquatic resources in Minnesota and are in need of an update to improve water quality management outcomes.

Water Quality Standards

The objective of the Clean Water Act is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." As part of this objective, Minnesota protects all Class 2 waters for aquatic life. For example, cold water streams (Class 2A) are protected to "permit the propagation and maintenance of a healthy community of cold water sport or commercial fish and associated aquatic life and their habitats". To achieve protection of aquatic life designated uses, conditions are set using chemical, physical, and biological criteria, which are sometimes also referred to as standards. All three types of criteria are used, with chemical criteria historically the most prevalent. For example in cold water streams, these waters need to meet a minimum condition of 7.0 mg/L of dissolved oxygen to protect for fish growth and survival. Although historically less common, biological criteria or "biocriteria" have become more widespread because they have the advantage of directly measuring attainment of the aquatic life use. Because the designated use determines the criteria that are applied, it is imperative that the correct use is applied to a water body; otherwise management efforts could be less effective. The development and implementation of numeric biocriteria create the opportunity to improve WQS by refining uses for Minnesota's rivers and streams.

Overview of Tiered Aquatic Life Uses (TALU)

Tiered aquatic life uses or "TALU" are a water quality standard structure that is based on the biological potential of appropriately classified water bodies. The TALU framework recognizes that the ecological potential of a water body can legitimately vary in accordance with the natural features of aquatic ecosystems. This supports defining classes and subclasses of water bodies in accordance with their ecological attributes within a structure of designated aquatic life uses. In addition, TALUs for streams and rivers further refines Minnesota's WQS which recognizes that there are differences in the potential for restoration and protection among all waters. TALU achieves these goals by providing additional protection to high quality waters and setting more appropriate biological and chemical goals for waters impacted by historical impacts (for example channelized streams). TALUs are an outgrowth of the cumulative knowledge about aquatic ecosystems that have become central to aquatic ecological assessment and represent an integration of WQS and monitoring and assessment. Adoption within a TALU framework will provide a more direct assessment of the biological condition of

Minnesota's rivers and streams and will result in better environmental outcomes. This revision will only impact Minnesota's aquatic life uses (Classes 2 and 7) for streams and rivers.

Tiered Designated Uses and Criteria

As noted earlier, the existing WQS for protecting aquatic life uses are a statewide, one-size-fits-all approach. A In contrast, TALU is a framework of refined designated aquatic life uses and biological and chemical criteria that are linked to the condition of similar water bodies that are managed appropriately. This is achieved through *representative ecological attributes* that are reflected in the narrative description of each TALU tier and are protected by numeric biocriteria and by the associated chemical and physical indictors and criteria. TALUs are assigned to water bodies based on the protection and restoration of *ecological potential*. This means that the assignment of a TALU tier to a specific water body is done with regard to reasonable restoration or protection expectations and their attainability. Knowledge of the current condition of a water body and adequate assessment of stressors affecting that water body are needed to make these assignments. Conversely TALU does not provide a basis for *"user preferences"* (i.e., accommodations for effluent conveyance, drainage conveyance, land use practices, prior existing conditions). TALUs are based first on ecological attributes and potentials, not on the activities that affect a water body. They also do not serve as a rationale for the *a priori* relaxation of pollution controls or impairment determinations. Finally, a TALU framework does not provide an "easy exit" from an *impaired waters* listing. While TALU may provide more than one "choice" for WQS that determine TMDL listings and requirements, a rigorous and objective process of assessment is required (i.e., a TALU structured use attainability analysis [UAA]) to determine if the original basis for a TMDL needs to be reconsidered or revised. As a result, TALUs could affect existing pollution control or water quality management requirements that may not have been adequately considered in the development of existing requirements.

TALU Implementation Recommendations for Minnesota

It is recommended that Minnesota Pollution Control Agency (MPCA) adopt the framework of detailed narratives measured by numeric biological criteria as described in this report. The framework consists of a set of designated use subcategories within a framework of warmwater and cold water ecotypes. Added to this is the stratification provided by the stream classification structure for fish and macroinvertebrate assemblages and with numeric expectations being calibrated to water body class specific goals.

TALU Use Tier	Description
Exceptional	High quality waters
General	Good quality waters – Equivalent to Minnesota's current aquatic life use goal
Modified	Waters with modified habitat – Examples include channelized streams
Limited	Waters with limited habitat – Examples include ephemeral channelized streams and concrete revetments

The proposed framework has a number of implications for Minnesota's WQS and to programs associated with water quality management. As part of the development of a TALU framework, the MPCA has been working to develop new and improved tools and engaging with internal and external stakeholders to determine how TALU will be implemented in WQS programs. The goal is to develop the tools that will be employed to effectively and efficiently manage refined stream uses and will fit with existing programs. Some of the major implications of the TALU framework are as follows:

- **Exceptional Use Waters:** The designation of these high quality waters is based on the demonstration that the water body meets exceptional biological goals. These waters will need to be protected or restored using more stringent biological goals and for some pollutants, more stringent chemical standards.
- **Modified Use Waters:** These water bodies will be designated by demonstration that general use goals are not met and a UAA determines that the biology is limited by habitat that has been modified in a legal manner (e.g., legal under ditch law). To protect this use tier less restrictive biological criteria and some chemical criteria would be applied.
- **Limited Use Waters:** Limited use waters will be designated by demonstration that modified use goals are not met and a UAA determines that the biology is severely limited by habitat that has been modified in a legal manner (e.g., legal under ditch law). Many of these water bodies will be ephemeral. To protect limited Use waters they will need to meet chemical criteria that could be equivalent to the current Class 7 standard.
- **Monitoring and assessment:** The current intensive watershed management approach is sufficient to support a TALU framework, however the selection of monitoring stations and the number of stations could be increased to better address use designations and other water quality management activities (e.g., permitting).
- **Documentation of changes over time:** As part of a TALU monitoring and assessment program, incremental changes in water quality can be documented. This allows entities working to improve water quality to document and show progress toward a goal.
- **Stressor Identification and UAA Tools:** When the biology is determined to not be attaining the General Use, the MPCA will need to have the tools and knowledge to determine in a timely manner if a lower use is appropriate (i.e, UAA) and if the water body does not attain the designated use, what stressors are resulting in nonattainment. TALU incorporates the concept of pollution into assessments of condition and provides an opportunity to address the key stressors that are the most determinant of biological condition. In doing so, TALU allows assessment and water quality management efforts to focus on the correct problems
- **Data Management:** To support a TALU framework new database and GIS tools are needed to document designated uses, criteria, assessments, and other water quality management actions in these waters. This will need to include a transparent system that allows stakeholders to review and participate in decisions made in these waters.
- **How TALU Can Affect Major MPCA Water Quality Management Programs**: The data collected to support a TALU framework also provides information that can be integral for development of total maximum daily loads (TMDLs), watershed planning, Pollutant Discharge Elimination System (NPDES) permitting, and any other program that has the protection of designated aquatic life uses as a goal.

Adoption of TALU in Minnesota is planned for 2014. Through the adoption of a TALU framework for Minnesota streams, refined designated uses and their associated criteria will result in improved management of these systems by producing better more appropriate assessments of goals and by providing support to associated water quality management programs.

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1. Introduction & Project Description

The Minnesota Pollution Control Agency (MPCA) is seeking to develop a framework for the development and adoption of tiered aquatic life uses (TALUs) for Minnesota rivers and streams. Specifically the MPCA requested that MBI assist with the following tasks:

1) Leading discussions regarding the regulatory and technical applications of biological standards and a TALU framework to internal and external stakeholder groups;

2) Identifying the implications of the proposed changes to each stakeholder's program activities and interests;

3) Developing an implementation plan for internal stakeholders that will suggest options to modify their programmatic activities in response to the new biological standards and TALU framework; and,

4) Providing technical assistance on biological criteria and TALU, including review and recommendations related to index of biotic integrity (IBI) development, the Biological Condition Gradient (BCG), habitat indicators of beneficial uses, impairment thresholds, and the other criteria used to designate an aquatic life use that are legally and scientifically defensible, environmentally effective, understandable by stakeholders, and amenable to implementation by a public agency.

In brief, the MPCA requested assistance for developing a framework for TALU and biological criteria for Minnesota rivers and streams. This entails the detailed description of designated use tiers (i.e., the narrative description of each), how biological criteria are derived for each tier, and how such a system of tiered uses and biocriteria can be implemented via monitoring and assessment to support all relevant water quality management programs. The full details of the work plan appear in Appendix A.

1.1 Project Accomplishments to Date

The MPCA TALU project was initiated by contract on February 18, 2008. Since that time several work plan tasks have been either fully or partially executed. These are summarized by work plan task as follows:

Task 1 – Internal and External Stakeholder Meetings
Between June and September 2008 a series of presentations about the basic fundamentals of a TALU-based approach[1] and the potential implications for changes to the Minnesota WQS were made to MPCA management and staff. These were intended to educate and inform MPCA about the basic principles of a TALU approach and to seek input from managers and staff about the potential impacts of TALU.

At about the same time a general presentation was made to invited external stakeholders. More detailed and focused stakeholder meetings were held in January 2009 at five regional MPCA locations across the state. This was followed up by a more detailed and focused series of meetings and presentations organized by major management programs and interests (e.g., municipalities, industries, stormwater interests, agricultural interests, state agencies, etc.). The feedback gained from these events was used to adjust and modify both the TALU work plan and the technical approach to developing the various tools and criteria that comprise a TALU approach.

Task 2 – Exploratory Data Analyses and Indicator Development
The work plan includes a series of technical development tasks to provide the tools and products that are seen as being essential for TALU development and implementation in Minnesota. These included five specific technical tasks:

Task 2a consisted of a detailed review of the MPCA biological indices and assessment criteria. This led to the revision of the statewide indices and their replacement with a set of fish and macroinvertebrate IBIs that were based on a natural classification scheme developed by MPCA staff. These indices are the basis of the numeric biocriteria that are an essential component of TALU-based biocriteria.

Task 2b consisted of a review of the current structure of designated aquatic life uses and how these might be changed by a transition to tiered uses. The results of that process are documented in this implementation plan and reflect the detailed narratives of the new TALU-based TALUs.

Task 2c consisted of the detailed development of a calibrated Biological Condition Gradient (BCG). This was accomplished under the leadership of Jeroen Gerritsen and included technical sessions with MPCA staff that resulted in the development of BCG levels for each fish and macroinvertebrate stream and river class. The principal product of this effort were detailed rules for the use of a fuzzy set model that is a key implementation mechanism for determining the BCG membership of a sample. This process produced a draft report that details these technical developments (Gerritsen et al. 2009).

[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.

Task 2d examined the comparability of boat electrofishing data collected by the MPCA and the MDNR. Each agency utilizes different sampling approaches and protocols. This task determined how comparable are the results, particularly in terms of using the MDNR data to determine attainment of the TALU-based biocriteria. This project was executed in 2010 and included a final report (Mueller et al. 2010).

Task 2e involved the development of detailed relationships between the MPCA fish and macroinvertebrate IBIs and metrics with the Minnesota Stream Habitat Assessment (MSHA) and its component attributes. This was accomplished by analyzing the extant MPCA statewide database and is needed to conduct the use attainability analyses (UAA) that are inherent to the implementation of a TALU-based approach. That project is nearing completion and is currently documented in a draft report by MBI (Rankin and Yoder 2011).

These are the principal technical products that are currently completed or near completion. Additional technical tasks are ongoing and include Tasks 4 and 5 that are detailed in a newly revised work plan (Appendix A).

2. Rationale for Tiered Aquatic Life Uses

Designated aquatic life uses are State or Tribal descriptions of the biological goals for their water bodies. Ideally, use designations are assigned to a water body based on the *potential* aquatic assemblage that can realistically be sustained given the regional reference condition and the level of protection afforded by the applicable criteria. The TALU framework recognizes that the ecological potential of a water body or can legitimately vary in accordance with the natural features of aquatic ecosystems. As such this supports defining classes and subclasses of water bodies in accordance with their ecological attributes and within a structure of designated aquatic life uses. U.S. EPA's current thinking (U.S. EPA 2005, 2011) is that a TALU framework can accomplish the following:

- accommodate and account for observable differences in expected biological condition in water bodies in different ecological regions;
- provide an objective means of describing the biological potential for a specific classes or subclasses of water bodies;
- recognize and accommodate observable differences in biological restoration potential among waters with different types and levels of legacy and background stressors;
- reflect an understanding of the relationship between stressors and biological community response (i.e., the BCG/human disturbance gradient [HDG] intersection);
- guide the selection of environmental indicators for monitoring and assessment and make fuller use of available biological data as an incremental measure of condition; and,
- better articulate a stressor-response model that maximizes the likelihood of success of water quality based management actions (WQS, assessment, 303[d] listings/Total Maximum Daily Load (TMDL), National Pollution Discharge Elimination System (NPDES) permits, nonpoint source assessment, stormwater management, etc.).

TALUs are an outgrowth of the cumulative knowledge about aquatic ecosystems that have become central to aquatic ecological assessment and are consistent with 30+ years of empirical observation. These include:

- surface waters and the biological assemblages they support are predictably and consistently different across the continent (stratification of ecotypes, classification along natural gradients, ecological regions concept);
- within the same ecological regions, different water body types (e.g., headwater streams, wadeable streams, small rivers, large rivers, lakes, reservoirs, wetlands, etc.) support predictably different compositional properties of key aquatic assemblages (water body classification);
- within a given class or subclass of water bodies, observed biological condition in a specific water body is a function of the level of stress (mostly of anthropogenic origin) to which the water body has been subjected (U.S. EPA's Biological Condition Gradient; Davies and Jackson 2006);

- similar stressors at similar intensities produce predictable and consistent biological responses in waters within a water body ecotype, and those responses can be detected and quantified along the BCG and also in terms of deviations from expected conditions (i.e., reference condition);
- water bodies exposed to higher levels of stress will exhibit biological performance that increasingly departs from the applicable reference condition than do waters exposed to lesser levels of stress (congruence of the BCG and the HDG; U.S. EPA 2005, Davies and Jackson 2006), and,
- the routine and systematic application of adequate monitoring and assessment (Yoder 1998) will generate sufficient data such that empirical relationships between biological condition and response and stressor/exposure variables can be produced and used to diagnose causes and set more detailed and stratified management criteria and goals; key to success in this function is the capacity to incrementally measure biological condition along the BCG (Yoder et al. 2008).

In essence TALUs represent a distinct refinement of the traditional application of general and fishery-based uses that are commonplace in state WQS and status-based monitoring and assessment. TALU brings about an integration of WQS and monitoring and assessment that generally does not exist under a general uses framework.

2.1 Defining TALUs

TALUs conjure up varied expectations among diverse stakeholder groups. This is likely because they represent both a change in the general operation of state water quality management programs and stand to alter certain decisions that were made on the basis of single-dimension uses and criteria. Hence it is important to clarify here what TALUs are and what they are not.

2.1.1 What TALUs Are

TALUs are a framework of refined designated uses and narrative and numeric biological criteria that are linked to the BCG. In brief, TALUs are:

- A reflection of the whole ecosystem. TALUs are based on *representative ecological attributes* and these should be reflected in the narrative description of each TALU tier and be embodied in the measurements that extend to expressions of that narrative through numeric biocriteria and by extension to chemical and physical indictors and criteria.
- Assigned to water bodies based on the protection and restoration of *ecological potential*. This means that the assignment of a TALU tier to a specific water body is done with regard to reasonable restoration or protection expectations and attainabilities. Hence knowledge of the current condition of a water body and an accompanying and adequate assessment of stressors affecting that water body are needed to make these assignments.

An acceptable TALU program will incorporate these properties into the narratives of the designated aquatic life use tiers, how the numeric biological criteria are derived, and how specific TALUs are assigned to specific water bodies.

2.1.2 What TALUs Are Not

While the incorporation of TALUs into a state's WQS may represent a modification in how water quality goals are visualized and how prior decisions were made, they *are not* intended to provide for, accommodate, or accomplish any of the following:

- TALUs do not provide a basis for *"user preferences"* (i.e., accommodations for effluent conveyance, drainage conveyance, land use practices, prior existing conditions, etc.) – TALUs are based on ecological attributes and potentials, not on the activities that affect a water body;
- TALUs do not serve as a rationale for the *a priori* relaxation of pollution controls – TALUs may affect existing pollution control or water quality management requirements making them more or less stringent depending on site-specific circumstances that may not have been adequately considered in the development of existing requirements; and,
- TALUs do not provide an "easy exit" from an *impaired waters* listing – while TALUs may now provide more than one "choice" for WQS that in turn determine TMDL requirements, a rigorous and objective process of assessment is required (i.e., a TALU structured use attainability analysis) to determine if the original basis for a TMDL needs to be reconsidered or revised.

This does not mean that TALUs might not play a role in resolving issues that include some of the above that have gone unresolved under a framework of general uses. Relative to how some decisions were made under such a system, some new decisions may be viewed as being more or less stringent. The more accurate view of such changes is that because these decisions are now based on a more rigorous and systematic assessment process and the closer approximation of true potential, that such represents neither an "upgrade" or "downgrade", but rather a more accurate reflection of verified potential and site-specific circumstances.

2.2 *Clean Water Act Goals – The "Drivers"*

A critical objective of the 1972 Clean Water Act (CWA) is to . . . "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (CWA sec 101[a][2]). In the scientific literature, an aquatic ecosystem that possesses chemical, physical, and biological integrity is described as being capable of "supporting and maintaining a balanced, integrated, adaptive community of organisms having a composition and diversity comparable to that of the natural habitats of the region" (Frey 1977). Over the intervening years, our understanding of how to define and measure the integrity of aquatic systems has been better developed. The term integrity has been further refined in the literature to mean . . . "a balanced, integrated, adaptive system having a full range of ecosystem elements (genes, species, assemblages) and processes (mutation, demographics, biotic interactions, nutrient and energy dynamics, metapopulation dynamics) expected in areas with no or minimal human influence" (Karr 2000). The aquatic biota residing in a water body are the result of complex and interrelated chemical, physical, and biological processes that act over time and on multiple scales (e.g., instream, riparian, landscape; Karr et al. l986; Yoder l995). By directly measuring the condition of the aquatic biota, we are able to more accurately define the aquatic community that is the "product" of these factors.

2.2.1 Water Quality Standards Overview

Section 101[a][2] of the CWA establishes broad national goals and objectives such as the chemical, physical, and biological integrity provision. Other sections of the CWA establish the programs and authorities for implementation of those goals and objectives. Section 303[c] sets up the basis of the current WQS program. WQS are parts of State (or, in certain instances, federal) law that define the water quality goals of a water body, or parts of a water body, by designating the use or uses of the water body and by setting criteria necessary to protect those uses. The standards also include an antidegradation policy consistent with 40 CFR Part 131.12.

In recognition of the uncertainties regarding the attainment of biological integrity, the CWA also established an interim goal for the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water as a guiding principle for the development of WQS. The interim protection and propagation goal for aquatic life has been interpreted by U.S. EPA to include the protection of the full complement of aquatic organisms residing in or migrating through a water body. The protection afforded by WQS includes a representative aquatic community (e.g., fish, benthic macroinvertebrates, algae, etc.), not just the protection of commercially important or special status (e.g., rare, threatened, endangered) species.

> "The fact that sport or commercial fish are not present does not mean that the water may not be supporting an aquatic life protection function. An existing aquatic community composed entirely of invertebrates and plants, such as may be found in a pristine tributary alpine stream, should be protected whether or not such a stream supports a fishery. Even though the shorthand expression 'fishable/swimmable' is often used, the actual objective of the Act is to restore the chemical, physical and biological integrity of our Nation's waters (Section 101[a][2]). The term 'aquatic life' would more accurately reflect the protection of the aquatic community that was intended in Section 101[a][2] of the Act." (Appendix G, EPA-823-B-94-005)

The representative assemblage of aquatic organisms residing in, or migrating through, a water body will vary depending on the water body type and other factors that are considered in the development and derivation of TALUs. For example, fish, benthic macroinvertebrates, and increasingly periphyton, are common aquatic assemblages that are typically measured by States and Tribes when assessing the condition of their streams and rivers. In headwater streams and many wetlands, amphibians are an important component of the biotic assemblages for this water body ecotype and functionally replace fish when they are absent or cannot be used as a reliable indicator assemblage. Hence the concept is clearly to protect the whole ecosystem and its representative attributes.

2.2.2 U.S. EPA "TALU Methods" Development

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 when they released national program guidance (U.S. EPA 1990). This was followed by a series of workshops, pilot program documents, and limited technical assistance to the states. In 2000, EPA convened an intensive developmental and implementation process for incorporating TALUs and numeric biocriteria in state and tribal water quality programs. This included a steering committee comprised of EPA staff, States, and active researchers and a working group comprised of EPA program and research staff, state managers, and leading academic researchers. This process culminated in the release of the document entitled *Use of Biological Information to Better define Designated Aquatic Life Uses in State and Tribal Water Quality Standards: Tiered Aquatic Life Uses (August 2005).* This document provides examples of practical and scientifically sound approaches to using biological information to tier designated aquatic life uses. As such U.S. EPA believes that the use of biological information can help improve water quality protection and encourages States and Tribes to incorporate biological information into their decision making processes.

The successful development and implementation of TALUs is directly dependent on the rigor, comprehensiveness, and integration of the bioassessment program as a component of the broader 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 water quality management programs such as NPDES permitting, TMDLs, nonpoint source management (319 program), and watershed planning. A TALU-based approach plays a key role in determining not only the WQS that are applied to 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 and Barbour 2009). 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.

2.2.3 State TALU Program Development

In addition to the U.S. EPA supported framework and tool documentation, selected states have implemented TALU-based programs. Ohio and Maine have the most tenured and mature programs and each has been described in detail in U.S. EPA (2005) and each state has posted their TALU documentation and program products on their respective websites[2].

EPA has supported a state program review process which has been conducted at least once with 22 different states and several tribes. An essential component of this review is determining a state's status in terms of meeting needs for developing and implementing a TALU-based approach to monitoring and assessment and WQS. A hypothetical timeline that describes the sequence of steps including the development of a baseline bioassessment program, initial support for management programs, development of biocriteria, increasingly

[2] Ohio EPA: http://www.epa.ohio.gov/dsw/bioassess/ohstrat.aspx;
Maine DEP: http://www.maine.gov/dep/water/monitoring/biomonitoring/index.html.

sophisticated support for all relevant water quality management programs, and long-term maintenance of a TALU-based program. The ultimate goal is use of biological information to more precisely define aquatic life uses and the development of numeric biological criteria (Figure 2-1). The essential first step is for a state to determine where their program is along this timeline. MPCA used this process to determine that rigor of their program in 2005 and what tasks were yet to be accomplished to reach the above stated goals. The next step is for the state to undergo a critical technical elements review (Yoder and Barbour 2009) that determines the technical level of rigor of the bioassessment program. This process helped MPCA produce a detailed work plan for the eventual development and adoption of numeric biocriteria and TALUs in their WQS, supported by a Level 4 program by 2013 (Table 5-1). This constitutes a working example of how states can use the results of the overall program review and critical technical elements process to develop a "blueprint" for making orderly improvements and attaining full TALU status.

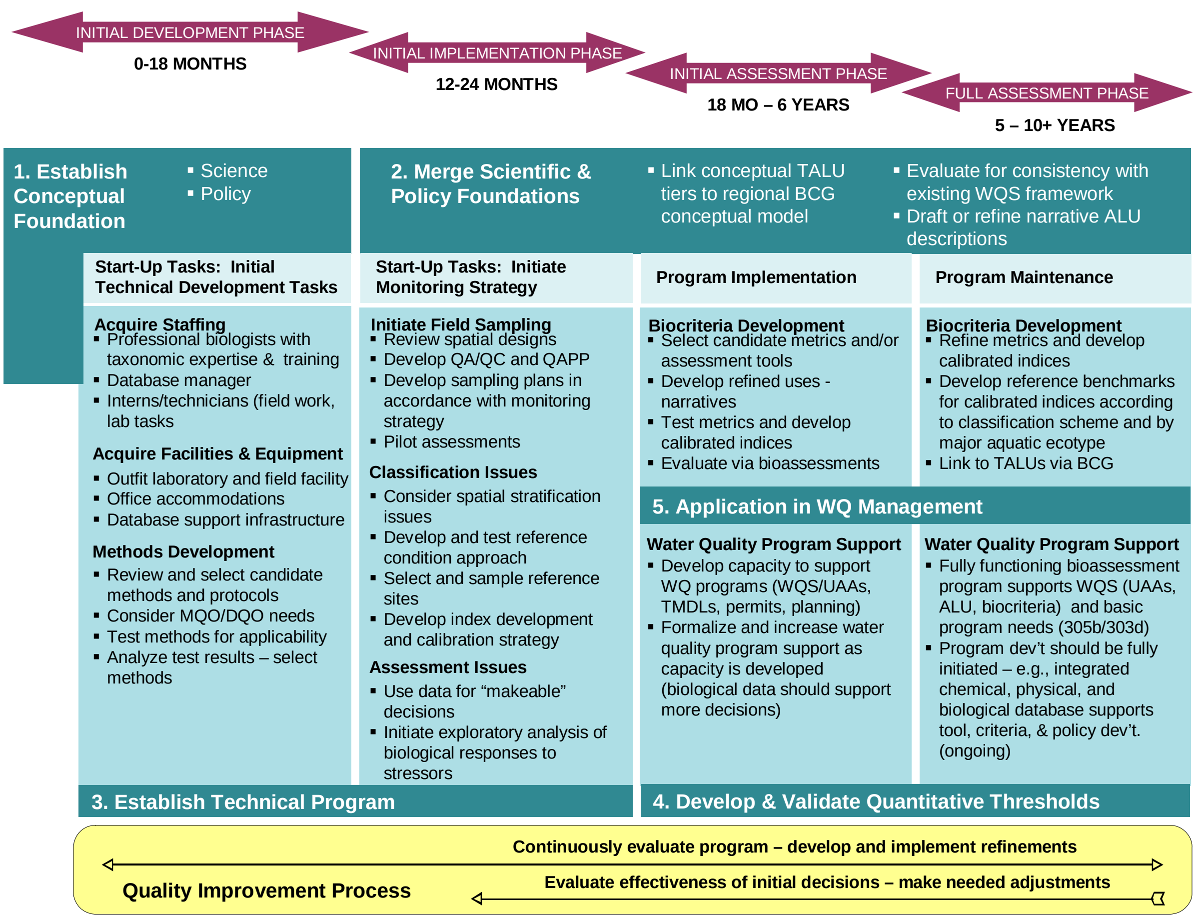


Figure 2-1. Timeline for full TALU program development and implementation intended to be used by States/Tribes to determine current program status with respect to the development and implementation goals of the TALU approach (from U.S. EPA 2005).

The results of the 22 state reviews indicate that 12 States function at a technical rigor consistent with a Level 2 program. Of the remaining States, two are consistent with a Level 4 program, and nine are at Level 3; no program is currently at Level 1. There were no strong geographic or jurisdictional patterns evident in the results. The relationship of the level of rigor to whether a state has or is capable of developing TALUs and numeric biocriteria is depicted in Table 2-1. Of the 22 states that have been part of the program evaluation process, two have fully developed TALUs and biocriteria in their WQS (each has a level 4 programs). One level 3+ program has TALUs in their WQS, but has not fully completed the process. Of the five other states that have TALU development programs in place (with the eventual adoption in their WQS as a goal) two are level 3+ and three are level 3. Only two of the remaining level 3 programs have no TALU developments underway at present. Of the remaining states that have no TALU development activities, all are level 2 programs.

Table 2-1. Status of state adoption and/or development of tiered aquatic life uses and numeric biological criteria in their water quality standards with respect to the latest level of rigor as determined by the critical technical elements process.

Level of Rigor [# states]	TALU in WQS	TALU in Development	None
L4 [2]	2		
L3+ [3]	1	2	
L3 [5]		3	2
L2 [12]			12
Total [22]	2	6	14

2.3 State Water Quality Standards

Although the CWA gives the U.S. EPA an important role in determining appropriate minimum levels of protection and providing national oversight, it also gives considerable flexibility and discretion to States and Tribes to design their own programs and establish levels of protection beyond a minimally acceptable program. Section 303 directs States and authorized Tribes to adopt WQS to protect public health and welfare, enhance the quality of water, and serve the purposes of the CWA. "Serve the purposes of the Act" (as defined in Sections 101[a][2], and 303[c] of the CWA) means that WQS should:

- include provisions for restoring and maintaining chemical, physical, and biological integrity of State and Tribal waters;
- provide, wherever attainable, water quality for the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water (i.e., "fishable/swimmable"); and,
- consider the use and value of State and Tribal waters for public water supplies, propagation of fish and wildlife, recreation, agricultural and industrial purposes, and navigation.

State WQS provide an important foundation for water quality-based management programs. With the public participating in their adoption (see 40 CFR 131.20), such standards serve the dual purposes of establishing the water quality goals for specific water bodies and serving as the regulatory basis for the establishment of water quality-based management strategies beyond the technology-based levels of treatment required by Sections 301 and 306 of the CWA.

WQS are an integral part of state water quality management programs under the CWA. Designated or beneficial uses are intended to describe the existing and potential "uses" of a water body and as such establish and articulate the goals for a water body. The attendant chemical, physical, and biological criteria are intended to provide the measurable properties of the designated use and can be used to measure existing quality and to develop requirements for managing activities that impact the quality of that water body. Criteria have predominantly been written in chemical concentration terms, but also have included physical properties and narrative statements of desired conditions. In 1990 U.S. EPA issued national guidance for the development and adoption of biological criteria recommending that states adopt narrative biocriteria by 1993 and numerical biological criteria by 1996 (U.S. EPA 1990). As such biological criteria represent a significant advancement over a purely chemical approach to WQS by incorporating a more complete and reliable measure of designated use attainment status (Rankin 2003; Yoder 1995) and incorporating monitoring and assessment as an integral part of the overall process of defining and setting designated aquatic life uses.

2.3.1 Designated Uses

It is in designating uses that States and Tribes establish the environmental goals for their water resources and then measure attainment of these goals. In designating uses, a State or Tribe weighs the environmental, social, and economic consequences of its decisions. The regulation allows the State or Tribe, with public participation, some flexibility in weighing these considerations and adjusting these goals over time. However, reaching a conclusion about the uses that appropriately reflect the current and potential future uses for a water body, determining the attainability of those goals, and appropriately evaluating the consequences of a designation can be a difficult and controversial task. A principal function of designated uses in WQS is to communicate the desired state of surface waters to water quality managers, the regulated community, and the interested public. An effective designated use system is one that translates readily into indicators (e.g., numeric water quality criteria, biological indices) that respond in predictable ways to stress and can be evaluated using data collected from the water body. Experience with implementation of various State designated use systems suggests that, regardless of the system employed, States that use biological data as part of their assessment program apply some type of refined, or tiered, aquatic life use approach to guide interpretation of their biological data. Some states have either made this explicit by adopting the tiers directly into their WQS as designated uses or implicit by using tiers in their monitoring and assessment protocols. Although the benefits of more specificity may apply to any of the designated uses described in CWA section 303, it may be most relevant for aquatic life uses.

A water body's designated use(s) are those uses specified in WQS, whether or not they are being attained (40 CFR 131.3[f]). The "use" of a water body is the most fundamental description of its role in the aquatic and human environments. All of the water quality protections established by the CWA emanate from the water body's designated use. As designated uses are critical in determining the water quality criteria that apply to a given water body, determining the appropriate designated use is of paramount importance in establishing criteria that are appropriately protective of that designated use. Section 131.10 of the regulation describes the State's responsibilities for designating and protecting uses. The regulation requires or allows for:

- that States and Tribes specify the water uses to be achieved and protected;
- protection of downstream uses;
- establishing sub-categories and seasonal uses;
- the definition of criteria for determining attainability;
- the consideration of six factors of which at least one must be satisfied to justify the removal of a designated use that is not an existing use;
- the maintenance of existing uses;
- the upgrading of uses that are presently being attained but which are not designated; and,
- the establishment of conditions and requirements for conducting use attainability analyses (UAAs).

In addition, the regulations effectively establish a "rebuttable presumption" that uses consistent with the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water are attainable and should apply to all water bodies, unless it has been demonstrated that such uses are not attainable via an acceptable UAA process. The classification of the waters of a State must also take into consideration the use and value of the water body for public water supply, protection and propagation of fish, shellfish, and wildlife, recreation in and on the water, and agricultural, industrial, and other purposes, including navigation.

Changes to the designated use(s) of a specific water body are subject to U.S. EPA review and approval (40 CFR 131.21). The regulations allow States to subcategorize or refine the aquatic life use designations for a water body and set the appropriate criteria to reflect the varying needs of such subcategories of uses (see 40 CFR 131.10[c]). While this has generally been described as differentiating such broad concepts as cold water and warm water fisheries, the implications are such that it can extend to more detailed distinctions provided the mechanisms are consistent and sufficiently predictable. As such this is what a TALU framework offers in the way of refining designated uses.

2.3.2 Aquatic Life Uses

Aquatic life uses are a significant component of state WQS. They are intended to provide for the restoration and protection of aquatic life in all surface water bodies as has already been described. Designated aquatic life uses are the most broadly applicable of all designated uses and the application of the criteria usually result in the most stringent requirements for water quality management. While criteria for other uses may have lower concentrations, aquatic life are generally applied at critical low flows which translates to lower discharge loading allowances. This is especially true of water quality based limitations for NPDES permits under steady-state assumptions of receiving water dilution and effluent flows. The management requirements for the most widely applicable chemical/physical parameters such as dissolved oxygen (D.O.), ammonia-N, temperature, and common heavy metals are generally dictated by aquatic life protection endpoints. Exceptions to this are bioaccumulative parameters such as mercury and PCBs which are usually dictated by human and wildlife health effects. Nevertheless, virtually all water quality management issues will involve requirements for the protection of aquatic life. More recently criteria based directly on attributes of the aquatic biota have been developed. Termed biological criteria these are based on sampling of aquatic assemblages and employ numeric indices that are anchored in regional reference conditions and developed and calibrated to provide a linear measure of ecological quality across the entirety of the stressor gradients that impact aquatic systems. Where they have been developed and used in a systematic monitoring and assessment program the result is a more comprehensive approach to water quality management and more accurate and comprehensive criteria including previously deemphasized components such as habitat, flow, and more importantly their interactions with chemical/physical attributes.

2.3.3 Tiered Aquatic Life Uses (TALUs)

It has been long established that aquatic communities can vary significantly from water body to water body hence it makes equivalent sense that the goals set for each can likewise vary – that is one of the major tenets of the TALU framework. A major challenge in assigning designated use tiers is distinguishing the natural variability that is a function of aquatic ecotype (e.g., cold water vs. warmwater, headwater vs. large river, high gradient vs. low gradient wetland dependent streams) and geographic location (e.g., ecoregions) from the variability that results from exposure to stressors. By accounting for natural variability in aquatic systems via stratification of similar attributes and expectations, biologically-based TALUs account for a major source of uncertainty and error in otherwise one-size-fits-all water quality management efforts. TALU is an enhancement of the rote replication of CWA section 303 uses in that it is a more refined framework that expresses designated uses in very specific terms and includes subclassifications that also exact different levels of protection. TALU includes subcategories based on aquatic assemblage types, including descriptions of the core assemblage attributes that are representative of each subcategory (e.g., cold water and warmwater fisheries).

States and Tribes have adopted varying levels of TALUs in their programs. These range from what is effectively informal policy application via monitoring and assessment to narrative biocriteria to the full adoption of TALUs and numeric biocriteria. Most are presently developing the technical program in an effort to further tighten the linkage between their narrative use statements and numeric biological criteria (U.S. EPA 2002). Thus far three States (Maine, Ohio, and Vermont) have either sufficiently developed both their technical program and WQS rule language to qualify as “TALU States”. While their approaches for tiering aquatic life uses may differ in detail and bioassessment methods, their TALU frameworks share the following core elements:

- Biological information is the basis for the use designations.
- Numeric biological indicators or biocriteria are developed for each use.
- Development of tiers is based on data from comprehensive, robust monitoring program.

The insights and experiences from States and Tribes that have adopted TALUs and numeric biocriteria in their WQS, as well as from those currently developing biological assessment and criteria programs, reveal the values of TALUs implemented in State and Tribal WQS (Table 2-2).

2.3.4 TALU Options for States

A TALU approach describes ecologically-based subcategories of water body types, such as A, B, C or descriptive titles such as Warmwater Habitat, Exceptional Warmwater Habitat, Modified Warmwater Habitat, etc. Furthermore, subclassifications within each subcategory that pertain to regionally specific (i.e., ecoregions, subregions, bioregions) or other attributes (i.e., stream size, gradient, temperature) are assigned as each is apparent in the development and application process. Also, to the extent that there are other waterways that may share the same characteristics, an approach that describes categories and subcategories of use classifications in sufficient detail allows similar waterways to be consistently and predictably classified, thereby eliminating the need or risk of having to continually develop "new use classification categories" via a site specific UAA process. This is a more workable and clearer approach to establishing a multi-tiered use classification system under state water quality regulations. As we have learned via the state program evaluation process (e.g., including the critical technical elements evaluation; Yoder and Barbour 2009) most state aquatic life use designations are either too vague, too broad, or rely too much on site-specific assumptions rather than the above described classification and subclassification scheme. Furthermore, by integrating the task of determining the appropriate classification of specific water bodies with a routine spatial monitoring and assessment program the task of vetting the appropriateness of a use designation is resolved ahead of its use in water quality management (e.g., NPDES permits, TMDLs). One problem with most conventional UAAs at present is that they are initiated by the realization that the use designation may be inappropriate as revealed by the application of a TMDL or permit, which places an inappropriate burden on the WQS program and not enough on the M&A program to resolve these issues ahead of their application in WQ management.

Based on past and current practice among states that use biological data at some level to make assessment decisions, there are four options that are available (Figure 2-2). These include:

1. Applying biological data as described in methods or guidance manuals for making general decisions about water body status, mostly for 305b/303d purposes, and under a "one-size-fits-all" general or fishery based use designation framework;

2. Applying biological data under a specific policy adopted by the state for the use of such data to make decisions;

3. Adoption of a narrative biocriterion in the WQS that consists of qualitative goal statements for biological condition and a translator mechanism adopted as policy for applying biological data to make decisions; and,

Table 2-2. The value added features of a TALU-based framework in a state water quality management context with references to applicable EPA regulations (after U.S. EPA 2005, Table 1-2).

Value-added Attribute	Explanation	Supporting WQS Regulation
Set more appropriate designated ALUs	Define ALUs in a more precise way that is nether under-protective of existing high quality resources nor overprotective for waters that have been extensively or irretrievably altered.	40 CFR 131.10 40 CFR 131.12 (protect high quality waters) 40 CFR 130.23 (Support attainment decisions and diagnose causes)
Strengthen the linkage between designated ALUs and how attainment is assessed	TALUs help to clarify and refine water quality goal statements so numeric biological, chemical, and physical criteria can be adopted to protect the use.	40 CFR 131.10 40 CFR 131.12 (protect high quality waters) 40 CFR 130.23 (Support attainment decisions and diagnose causes)
Enhance public understanding and participation in setting water quality goals	TALUs provide a common frame of reference for generic yardstick to more clearly recognize common ground and differences in desired environmental goals of various stakeholders as designated uses are adopted.	40 CFR 131.20[a][b]

4. Adoption of TALUs that represent detailed narrative goal statements for biological tiers that are directly relevant to the Biological Condition Gradient and as measured by numeric biological endpoints that serve as quantitative measures of attainment of each tier; the narrative language should specify how the numeric endpoints are derived in terms of resource stratification and reference thresholds and how they are to be measured; the numeric endpoints are adopted as biocriteria in the WQS.

Options 1 and 2 seem to be the "easiest" to implement, but they lack a firm regulatory foundation and may be seen as being "optional" for decision-making. Option 3 provides for a direct link to the WQS, but it lacks the specificity needed for applying TALUs and for supporting certain regulatory decisions - it can also encumber a "rule by reference" label. Option 4 may be the more "difficult" and time consuming to develop and implement, but it provides the strongest and most compelling legal foundation.

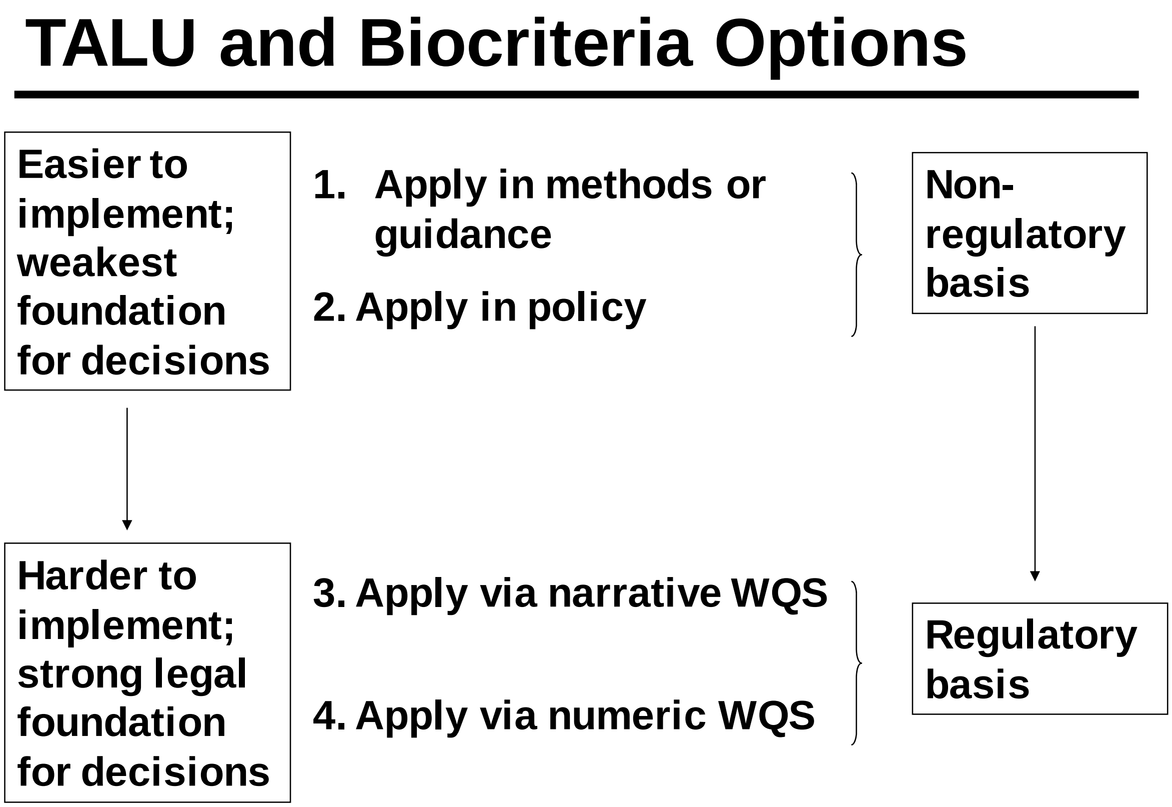


Figure 2-2. Options presently available to states and tribes for developing and implementing biological criteria and tiered aquatic life uses. The numbers correspond to the discussion of each in the text.

2.3.5 Narrative and Numeric Biocriteria

Elements of a narrative biocriterion generally include the following:

- Waters of the State shall be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities.
- Without detrimental changes in the resident biological communities *means no loss of ecological integrity when compared to natural conditions at an appropriate reference site or region.*
- Ecological integrity *means the summation of chemical, physical, and biological integrity capable of supporting and maintaining a balanced, integrated adaptive community of*

organisms having a species composition, diversity, and functional organization comparable to that of natural habitats in the region.

Narrative biocriteria necessarily contain general language (e.g., without detrimental change) that cannot be precisely measured, thus a numeric translator is required and is usually implemented via a policy statement and/or methods guidance. While the above narrative contains the appropriate ecological intent and language, it lacks the quantitative aspects of what EPA expects for a TALU.

Numeric biological criteria require additional defining language in the designated use narrative that pertains to stratification between different types of streams and rivers (e.g., headwaters, small streams, large rivers, great rivers, etc.), ecotype specificity (cold and warmwater, low or moderate gradient, etc.) biogeographical regions, and the level of protection afforded by tiered uses as illustrated by the following example from the Ohio WQS (Warmwater Habitat use tier):

> "Warmwater" – these are waters capable of supporting and maintaining a balanced, integrated, adaptive community of warmwater aquatic organisms having a species composition, diversity, and functional organization comparable to the twenty-fifth percentile of the identified reference sites within each of the following ecoregions: the interior plateau ecoregion, the Erie/Ontario lake plains ecoregion, the western Allegheny plateau ecoregion and the eastern corn belt plains ecoregion. For the Huron/Erie lake plains ecoregion, the comparable species composition, diversity and functional organization are based on the ninetieth percentile of all sites within the ecoregion. For all ecoregions, the attributes of species composition, diversity, and functional organization will be measured using the index of biotic integrity, the modified index of well-being, and the invertebrate community index as defined in "Biological Criteria for the Protection of Aquatic Life: Volume II, Users Manual for Biological Field Assessment of Ohio Surface Waters," as cited in paragraph (B) of rule 3745-1-03 of the Administrative Code. In addition to those water body segments designated in rules 3745-1-08 to 3745-1-32 of the Administrative Code, all upground storage reservoirs are designated warmwater habitats. Attainment of this use designation (except for upground storage reservoirs) is based on the criteria in Table 7-14 of this rule. A temporary variance to the criteria associated with this use designation may be granted as described in paragraph (F) of rule 3745-1-01 of the Administrative Code.

This represents a fully developed TALU narrative that accomplishes the following:

- it defines the overall goal of the TALU tier;
- it identifies and quantifies the reference benchmarks that correspond to this TALU tier;
- it explicitly states a linkage to the accepted methodologies;
- it explains the relationships with other non-aquatic life uses and any exceptions;
- it states any variance provisions; and,

- it references the quantitative numeric biological criteria and these are further stratified by water body ecotype and ecological region.

When combined with a systematic and routine re-sampling of regional reference sites it sets the stage for potential future revisions based on any cues from empirically measured reference condition. In this case the regional reference sites are re-sampled once every ten years.

2.3.6 Biocriteria Application Language in WQS

Biocriteria are a relatively new concept in WQS and they serve primarily as a direct measure of aquatic life use attainment status hence their application in water quality management needs to be defined. This will also clarify their relationship with other chemical, physical, and narrative water quality criteria. We recommend that this be accomplished by appropriately modifying the already detailed application language in the Minnesota WQS (7050.0150). Such language indicates the most commonly occurring options that are available to the state (i.e., the Director, Board, Commissioner, etc.) when biocriteria indicate attainment and non-attainment of aquatic life uses. This also presumes that the state is operating a bioassessment program that is consistent with at least an upper Level 3 and preferably Level 4 under the U.S. EPA *Critical Technical Elements of a Bioassessment Program* (Barbour and Yoder 2008; Yoder and Barbour 2009) and is implemented following the principles of Adequate Monitoring and Assessment (Yoder 1998). Less rigorous programs will simply not be equipped to reliably produce the assessment outcomes and implement the management options that are detailed by the following guidelines. The biocriteria implementation language should explicitly emulate the following and also include detailed options for various management responses:

1) **Define what role the biological criteria will play in the WQS**: This includes stating the extent of their "presumptive applicability", i.e., the biological criteria provide a direct measure of the attainment of the specified designated aquatic life use tiers (i.e., in lieu of a former reliance on chemical/physical surrogates).

2) **State the data requirements**: This includes how the determination of aquatic life use attainment status and the accompanying stressor identification processes are executed. Options include:

    - Frequency, magnitude, and duration provisions – while biocriteria inherently transcend these existing issues that are common to chemical/physical surrogate indicators, a clear statement about what comprises an exceedence is needed;
    - For multiple assemblage assessments (at least two assemblages comprise a level 4 program) mixed findings by each assemblage will need to be addressed;
    - Tier-specific provisions, i.e., higher than CWA minimum use tiers will require a showing of attainment by both assemblages.

3) **State the options for a finding of full attainment**: This includes stating the relationship of biological criteria to other water quality criteria including chemical-specific, narrative, and whole effluent toxicity criteria and endpoints. Management response options include:

- Designating biocriteria as the preferred arbiter of aquatic life use attainment.
- Detailing options for chemical/physical and whole effluent criteria when these are exceeded to include alternate management responses consistent with the biocriteria attainment, revising reasonable potential assumptions within a WLA or TMDL, conducting a site-specific criteria modification, or developing a UAA.

4) **State the options for a finding of non-attainment**: This includes any situation, in which the biocriteria indicate non-attainment, including when the biocriteria are the only indication of non-attainment. Management response options can include:

- A UAA will be conducted to determine the attainability of the designated use tier that is currently assigned to the water body(ies) in question; this will be especially important in previously unassessed, inadequately assessed, and/or default use designated waters.
- The appropriate use will be established prior to new or additional regulatory or management actions.
- When the appropriate use tier is established, the cause(s) of any biocriteria non-attainment *will be* determined based on an *adequate* assessment of the river or stream segment subject to the application of the WQS and subsequent management actions (i.e., NPDES permit, TMDL, 401 certification, stormwater permitting, etc.); designating biocriteria impairments with unknown causes should be extremely rare in this process.
- This is not a justification to supersede other management policies such as anti-backsliding.

Furthermore, language about how a finding of biocriteria non-attainment will affect the consideration of additional regulatory controls on permitted point sources is usually requested to clarify the relationship to a previously issued NPDES permit. Additional permit requirements are based on the following assessment and will generally not be imposed unless:

- The point source is reasonably shown to be a contributing cause to the biocriteria non-attainment; this can include the showing of non-attainment triggering a review of prior reasonable potential determinations or other WLA assumptions.
- The application of alternate treatment/control technologies can reasonably be expected to restore the impaired status.
- Due consideration has been given to the technological and economic feasibility of alternate treatment/control technology required to attain the limitations imposed by this process.

The above comprise the principles by which TALU narratives, numeric biological criteria, and specific application language can be written in the Minnesota WQS. However, given that the Minnesota WQS already include a structure of aquatic life uses, narrative biological criteria, and language for the application of chemical, physical, and biological monitoring data in making use assessments, that existing structure will need to be considered in adapting the new TALUs and numeric biocriteria within that existing framework.

3. A TALU Framework for Minnesota

An important objective of this project is to describe a detailed framework of TALUs and biological criteria for Minnesota rivers and streams. Furthermore, it is implied that such a framework should be consistent with current and emerging U.S. EPA guidance (e.g., U.S. EPA 2005), published methods (e.g., Davis and Simon 1995), and the precedents established by other states that are developing (e.g., Illinois, Vermont, Florida, California), or that already have adopted tiered uses and biocriteria in their WQS (e.g., Ohio, Maine). U.S. EPA, Region V initiated a process in 2002 by which the status of the monitoring and assessment, bioassessment, and WQS programs of the six state's (including Minnesota) would be assessed and in relation to their capacity to support TALU development and implementation. This was initially detailed in a 2004 status report (MBI 2004) and in two major workshops and follow-up visits to each state including Minnesota.

3.1. Minnesota WQS

The primary objective of the CWA is the restoration and maintenance of the chemical, physical and biological integrity of the Nation's waters. States are responsible for adopting and revising WQS and must consider their use and value in protecting public water supplies, propagation of fish and wildlife, recreation, agriculture, industrial and navigation purposes. Minnesota adopted a beneficial use framework that includes uses for drinking water, aquatic life and recreation, industry, agriculture and wildlife, aesthetic enjoyment and navigation, limited resource value waters and other uses. Implicit in the CWA and the federal regulations was the presumption that the aquatic life use should be considered attainable unless proven otherwise through the completion of a use-attainability analysis. Thus, in Minnesota, all waters are considered fishable and swimmable with the exception of waters designated as limited resource value waters (Class 7), which are protected for secondary body contact only.

The Minnesota WQS are codified in the Minnesota Administrative Rules at Chapter 7050, Waters of the State. Parts 7050.0130 to 7050.0227 apply to all waters of the state, both surface and underground. This includes a classification system of beneficial uses applicable to waters of the state, narrative and numeric WQS that protect specific beneficial uses, antidegradation provisions, and other provisions to protect the physical, chemical, and biological integrity of waters of the state. Parts 7050.0400 to 7050.0470 classify all surface waters within or bordering Minnesota and designate the beneficial uses for which these waters are protected. This applies to point source and nonpoint source discharges and to the physical alterations of wetlands. Other water quality rules of general or specific application that include any more stringent WQSs or prohibitions are preserved.

The WQS exist in part for Minnesota to meet the goals of the Federal CWA. With respect to the protection of aquatic life, the Minnesota WQS comprise what we refer to as a "general use" framework in which the designated use consists of a generalized statement of intent and the accompanying criteria are comprised of a list of chemical and physical parameters. The beneficial uses are codified at Chapter 7050.0140 and include the protection of aquatic life, recreation, water supply, and fish consumption and they are specified across seven distinct classes as follows:

> ***Subpart 1. Introduction.*** *Based on considerations of best usage and the need for water quality protection in the interest of the public, and in conformance with the requirements of Minnesota Statutes, section 115.44, the waters of the state are grouped into one or more of the classes in subparts 2 to 8. The classifications are listed in parts 7050.0400 to 7050.0470. The classifications should not be construed to be in order of priority, nor considered to be exclusive or prohibitory of other beneficial uses.*
>
> ***Subpart 2. Class 1 waters, domestic consumption.***
> *Domestic consumption includes all waters of the state that are or may be used as a source of supply for drinking, culinary or food processing use, or other domestic purposes and for which quality control is or may be necessary to protect the public health, safety, or welfare.*
>
> ***Subpart 3. Class 2 waters, aquatic life and recreation.***
> *Aquatic life and recreation includes all waters of the state that support or may support fish, other aquatic life, bathing, boating, or other recreational purposes and for which quality control is or may be necessary to protect aquatic or terrestrial life or their habitats or the public health, safety, or welfare.*
>
> ***Subpart 4. Class 3 waters, industrial consumption.***
> *Industrial consumption includes all waters of the state that are or may be used as a source of supply for industrial process or cooling water, or any other industrial or commercial purposes, and for which quality control is or may be necessary to protect the public health, safety, or welfare.*
>
> ***Subpart 5. Class 4 waters, agriculture and wildlife.***
> *Agriculture and wildlife includes all waters of the state that are or may be used for any agricultural purposes, including stock watering and irrigation, or by waterfowl or other wildlife and for which quality control is or may be necessary to protect terrestrial life and its habitat or the public health, safety, or welfare.*
>
> ***Subpart 6. Class 5 waters, aesthetic enjoyment and navigation.***
> *Aesthetic enjoyment and navigation includes all waters of the state that are or may be used for any form of water transportation or navigation or fire prevention and for which quality control is or may be necessary to protect the public health, safety, or welfare.*
>
> ***Subpart 7. Class 6 waters, other uses and protection of border waters.***
> *Other uses includes all waters of the state that serve or may serve the uses in subparts 2 to 6 or any other beneficial uses not listed in this part, including without limitation any such uses in this or any other state, province, or nation of any waters flowing through or originating in this state, and for which quality control is or may be necessary for the declared purposes in this part, to conform with the requirements of the legally constituted state or national agencies having jurisdiction over such waters, or for any other considerations the agency*

may deem proper.

Subpart 8. Class 7 waters, limited resource value waters.
Limited resource value waters include surface waters of the state that have been subject to a use attainability analysis and have been found to have limited value as a water resource. Water quantities in these waters are intermittent or less than one cubic foot per second at the $7Q_{10}$ flow as defined in part 7050.0130, subpart 3. These waters shall be protected so as to allow secondary body contact use, to preserve the groundwater for use as a potable water supply, and to protect aesthetic qualities of the water. It is the intent of the agency that very few waters be classified as limited resource value waters. The use attainability analysis must take into consideration those factors listed in Minnesota Statutes, section 115.44, subdivisions 2 and 3. The agency, in cooperation and agreement with the Department of Natural Resources with respect to determination of fisheries values and potential, shall use this information to determine the extent to which the waters of the state demonstrate that:

A. *The existing and potential faunal and floral communities are severely limited by natural conditions as exhibited by poor water quality characteristics, lack of habitat, or lack of water;*

B. *The quality of the resource has been significantly altered by human activity and the effect is essentially irreversible; or*

C. *There are limited recreational opportunities, such as fishing, swimming, wading, or boating, in and on the water resource.*

The conditions in items A and C or B and C must be established by the use attainability analysis before the waters can be classified as limited resource value waters.

This framework and implementation plan will deal primarily with subparts 3 and 8 (Class 2 and 7) in terms of how a TALU-based approach will be structured by the Minnesota WQS. The current Minnesota WQS include specific classes for aquatic life and primarily for distinctions between warmwater and cold water aquatic life in subpart 3. These are currently defined at 7050.0222 “Specific WQS for Class 2 waters of the state; aquatic life and recreation” as follows:

Subpart 2. Class 2A; Aquatic Life Cold water Habitat *The quality of Class 2A surface waters shall be such as to permit the propagation and maintenance of a healthy community of cold water sport or commercial fish and associated aquatic life, and their habitats (see definitions in subp. 2b). These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. This class of surface waters is also protected as a source of drinking water.*

Subpart 4. Class 2B; Aquatic Life Warmwater Habitat. *The quality of Class 2B surface waters shall be such as to permit the propagation and maintenance of a healthy community* *of cool or warm water sport or commercial fish and associated aquatic life, and their habitats (see definitions in subp. 4b). These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. The applicable standards are given below.*

Proposed new tiered uses will replace these "general" uses and follow the rationale described in Sections 3.1.1. and 3.1.2 as follows. In addition, we recommend that Class 7 be eliminated and replaced by the new tiered uses. Existing Class 7 waters will be evaluated the same as current 2A and 2B waters via the UAA process described in Section 4.

3.1.1 The Need for a Minnesota TALU Framework

Over the past 30+ years the Minnesota WQS have been modified to reflect more recent scientific understanding of certain criteria in order to better protect both human health and aquatic life. However the current aquatic life use framework has not reflected the most recent advances in our understanding of the CWA aquatic life goals and how to achieve them. MPCA has initiated a long term project to develop and implement a TALU-based approach to WQS and monitoring and assessment. Minnesota is working to revise its WQS (MN Rule Chapter 7050) to incorporate a TALU framework for rivers and streams in the state. The TALU framework represents a significant revision to the WQSs of the state's aquatic life use classification. The TALU framework builds upon existing WQSs with a goal of improving how water resources are monitored and managed. Additionally, these changes advance the ability to identify "stressors" and develop effective mechanisms to improve and maintain the condition of waters in the state of Minnesota.

The CWA requires states to assign beneficial uses to water bodies and to develop WQS to protect those uses. Most surface waters in Minnesota are protected for aquatic life and recreation, which means they must be "fishable and swimmable". There are two primary sub-classes of streams protected for aquatic life including a cold water stream class (2A) and a warmwater stream class (2B). While the current system of beneficial uses and WQS has served Minnesota well, advances in the fields of biological assessment and stream ecology have led to the recognition that all waters are not the same and that there exists a diversity of the water body types. For example, within rivers and streams, factors like water body size, geographic location, hydrology, water temperature, and stream gradient influence chemical, physical and biological composition. The inherent differences in water bodies combined with a rigid and inflexible set of standards and beneficial uses have led to chemical and biological goals that are often under protective of the highest-quality resources and overprotection of some water bodies that for various reasons will likely never achieve certain chemical and biological standards. In short, MPCA now recognizes that proper management of our water bodies requires a more considered and comprehensive approach, one in which the goals are tailored to specific water body types and uses. In response to these challenges, MPCA is proposing to modify the beneficial use framework for aquatic life. The new TALU framework would allow for better goal-setting processes through the application of a framework that recognizes tiers, or levels of aquatic life-use based on a stream's type and potential. For example, under a tiered system of aquatic life uses, our highest-quality rivers and streams might belong to an "exceptional use" subclass, with water chemistry and biological standards designed to protect the higher use. Additionally, under a TALU framework, uses could be designed to more appropriately reflect the potential of channelized streams and ditches. The fundamental goal of TALU is to set biological and chemical goals that are protective, yet attainable following U.S. EPA guidelines for conducting use attainability analyses (UAA). The TALU framework fully complies with CWA requirements which allow for the establishment of subcategories of the major uses, as long as existing uses are protected. At the same time, it allows MPCA to utilize the latest scientific knowledge to develop appropriate standards and uses and meet the increasingly complex challenges of protecting our water resources.

Traditionally, aquatic life has been protected primarily through the application of water chemistry based standards. For example, the Minnesota standard for dissolved oxygen in all non-cold water streams is 5 parts per million (ppm). These chemically-based standards have been, and will remain, an important aspect of our protection measures. However, the addition of biological monitoring and biological standards will complement and enhance the chemical standards by:

- Providing a direct way to monitor, assess, and ultimately to protect aquatic life.
- Providing a mechanism to identify water quality problems that chemical measurements might miss or underestimate.
- Improving our ability to accurately identify the wide diversity of stressors that impact Minnesota's water resources.

Even if Minnesota recognized aquatic life as a stand-alone use designation, it would not completely satisfy the interim goal of the CWA for states to support healthy, self-sustaining populations of fish, shellfish and other aquatic life in surface waters. While it has been recognized for some time that there is natural variability within aquatic assemblages in Minnesota streams, the current WQS do not adequately reflect the detail of those differences. These include differences in habitat types (i.e., stream size, substrates, flow regime, thermal regime, etc.) and patterns of geological and geographical attributes across the state. MPCA engaged in a process to incorporate this in the development of revised biological indices (i.e., the partitioning accomplished by stream and river classes) as a necessary first step towards adopting a TALU framework in the Minnesota WQS. Furthermore, present assessments of aquatic life use attainment are based on a simple pass/fail framework, even though the stratification accomplished by the biological index refinements is an advancement over applying a uniform statewide IBI. Within the water bodies that are considered to be fully attaining the current set of general aquatic life uses, some have inherently better water quality and biodiversity than others. As such a one-size-fits-all aquatic life use framework is unable to distinguish an adequate level of protection for these higher quality waters. Conversely, it could also result in waters that are of an inherent or irretrievably lower quality being listed as impaired because of unrealistic expectations. This can result in water quality management resources being devoted to issues with a minimal or no environmental return on investment.

Once a TALU framework for Minnesota is developed and implemented a "one-size-fits-all" approach may still be applicable for some numeric chemical criteria such as xenobiotic and bioaccumulative substances. However, simply keeping streams and rivers free from these compounds does not necessarily provide a measure as to whether or not existing high quality waters are being adequately protected. A preoccupation with keeping waters free from toxics also fails to acknowledge that some waters are simply not going to provide for high or even moderate quality aquatic assemblages due to natural conditions or legacy impacts that are irreversible. As a result of the aforementioned limitations, Minnesota's WQS framework is in need of refinement to enhance the designation of appropriate aquatic life uses and the assessment of the attainment of those uses.

3.1.2 Minnesota TALU Framework

The Minnesota TALU framework is built upon a scientific model called the biological condition gradient (BCG; Davies and Jackson 2006). This model describes how biological communities change with increasing levels of stress. The BCG is based on the concept that water bodies receiving higher levels of stress have biological communities with lower condition compared to water bodies receiving lower levels of stress (Figure 3-1). The BCG provides a common framework to interpret changes in biological condition regardless of geography or water resource type. It permits a more accurate determination and classification of Minnesota's aquatic resources which improves the ability to make well-informed decisions on aquatic life designations. Another advantage of the BCG is that it provides a means to communicate existing and potential uses to the public. The development of a set of BCGs specific to each of the aquatic resource classes was accomplished (Gerritsen et al. 2009) by MPCA biologists with assistance from MBI and Tetratech. The development of warmwater BCG models involved input from biological experts familiar with biological communities in Minnesota from the MPCA and Minnesota DNR. BCG models were developed for fish and macroinvertebrates for each of the 7 warmwater stream classes. A cold water BCG is currently in development via a U.S. EPA funded regional project and involved experts from Minnesota, Wisconsin, Michigan, and several tribes located in those states. In Minnesota this included 2 classes each for fish and macroinvertebrates. Model development for each class involved reviewing biological community data from monitoring sites and then assigning that community to a BCG level. A sufficient number of samples were assessed to develop a model which can duplicate the panel's BCG level assignments. Using the BCG and reference condition stream stations permits the MPCA to develop biological criteria that are protective, consistent, and attainable across the State (MPCA 2012a). The adoption of a TALU framework for Minnesota achieves several goals:

Biological Standards. Numeric water quality criteria that are codified in the Minnesota WQS are currently based on chemical and physical criteria such as dissolved oxygen, temperature, and pH. These criteria do not directly measure the health or condition of biological communities which include fishes, insects, mussels, aquatic plants and algae. Although chemical and physical measures can tell us a lot about water quality, these criteria are essentially surrogates for a direct measure of the biological community. This can be problematic due to the large number and diversity of the stressors that impact biological communities which include chemicals, reduced oxygen, sedimentation, increased temperature, and habitat degradation (Figure 3-2). As a result, the monitoring of chemical and physical parameters for all potential stressors can become too cumbersome to be practical. Rather than measuring the wide variety of stressors, biological communities can be monitored as they are a direct measure of the response of the biota to a wide range of physical and chemical stressors. In other words, their condition is a reflection of all the impacts of multiple stressors over time. A major goal of the CWA and Minnesota's WQS is to protect the fish, invertebrates, and other aquatic organisms in Minnesota's waters. Therefore, it is sensible that we use a direct measurement of these communities to monitor their condition. Furthermore, if water resources are not suitable to support healthy aquatic communities, they may not be suitable for a variety of human activities such as fishing and swimming.

Natural Variability. One of the strengths of the TALU approach is its ability to address the natural variation in water resources across Minnesota. Minnesota's diverse water resources mean that "one-size-fits-all" standards lead to errors in assessment and management. In other words, we need to have different expectations for different water resources. For example, streams along the North Shore are very different from streams in southern Minnesota and we would expect that the biological communities in those streams under natural conditions to be different. The TALU framework takes into account these natural differences and requires that comparisons be made between streams with similar expectations.

The BCG and Reference Condition. The biological monitoring program in Minnesota relies on BCG models and the "reference condition" approach to set expectations for water bodies. The BCG is a conceptual model of aggregated biological knowledge used to describe changes in biological communities along a gradient of increasing stress. The BCG provides a common "yardstick" of biological condition that is rooted in the natural condition. As a result, the BCG can be used to develop of biocriteria that are consistent across regions and stream types in Minnesota. This is particularly important for a state such as Minnesota where the range of existing quality is regionally distinct and extreme (i.e., near pristine to highly degraded). The reference condition approach identifies waterbodies that are least stressed and uses them to establish the "reference condition." Once this reference condition has been established, then waterbodies with unknown condition can be compared to this baseline. If the condition of the waterbody is lower than that of the reference condition, it would be considered impacted or stressed. The use of a reference condition relies on the development of accurate expectations for least stressed sites. Using the BCG and reference condition approach biological criteria were developed to protect Minnesota's aquatic life goals (MPCA 2012a).

High Quality Water Resources. A shortcoming of the current water quality framework is that high quality resources are often under protected. At present there is a framework to protect the degradation of high quality waters called antidegradation, but there are still elements of Minnesota's antidegradation provisions in rule that can allow considerable degradation of these waters without violating the CWA. TALU establishes a higher tier of use to protect these high quality waters. Once a water body has been established as meeting the requirements of a high quality water resource, the resource needs to be protected to maintain that status. The concept of protecting the "existing" use of a water body is one of the most important tenets of the CWA.

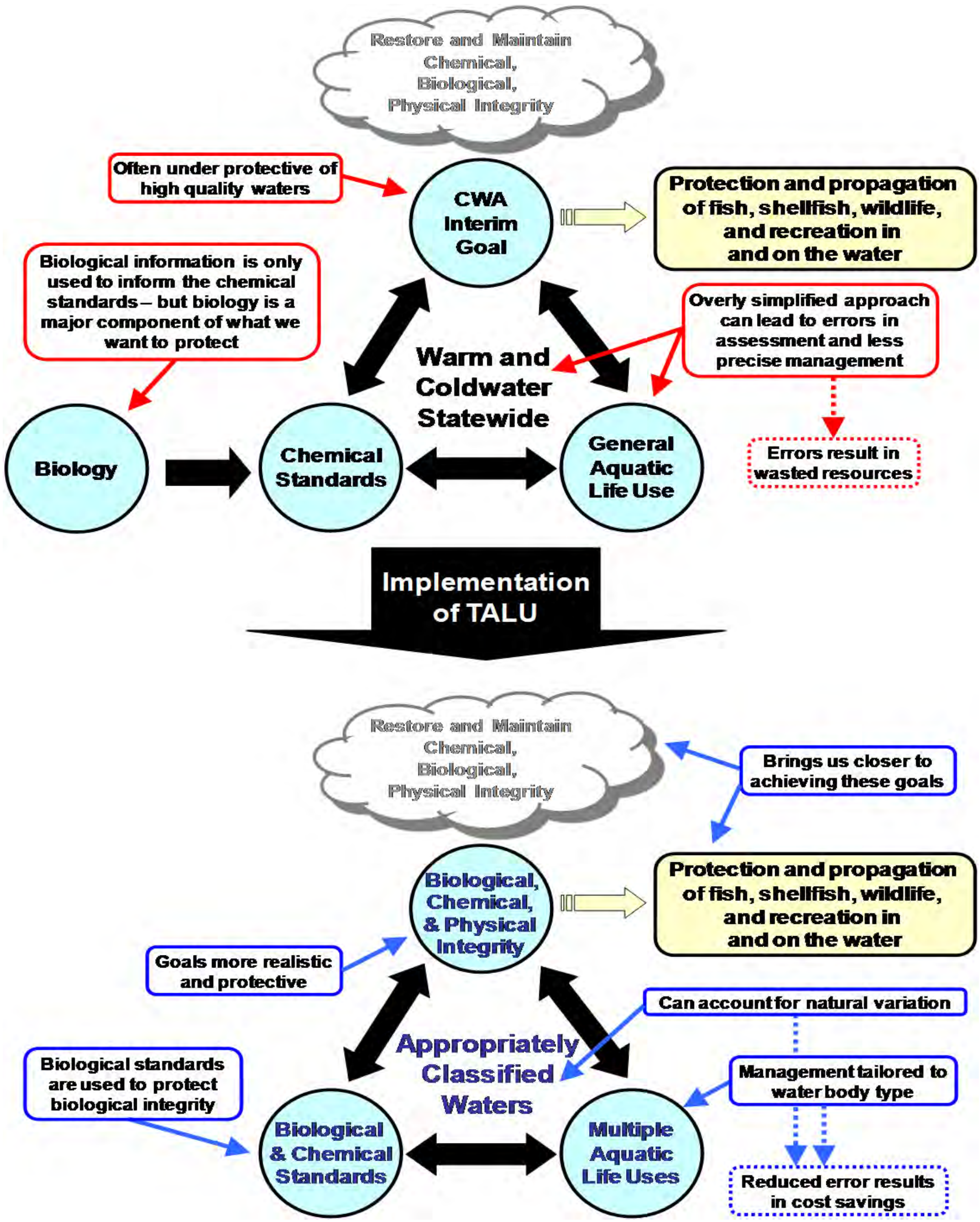


Figure 3-2. The characterization of CWA goals, Minnesota aquatic life uses, and new biological standards before and after implementation of a TALU framework.

Modified or Limited Water Resources. There are water resources in this State that will not in the near future meet the CWA interim goals due to historical or legacy impacts. These legacy impacts include streams under drainage maintenance or other irreversible hydromodification that preclude attainment of goals. For example, channelized streams and ditches would be included under this category. TALU provides a mechanism to monitor and set realistic expectations for waters that are unlikely to meet goals due to legacy impacts. The expectations are fully protective of the existing uses for each water body and recognize their historical and current site specific context. This element of TALU allows for the establishment of realistic expectations for water bodies that have multiple and well established uses.

Some other goals/benefits of TALU adoption include:

- Monitoring of incremental improvements in water quality. This allows entities working to improve water quality to document and show progress toward a goal.
- TALU helps guide development and modification of WQS to produce improved standards.
- TALU merges the design and practice of monitoring and assessment with the development and implementation of WQS.

Achieving these goals through the TALU framework will bring Minnesota closer to the protection and maintenance of the biological, chemical, and physical integrity of water resources in the state.

3.2 A Revised Aquatic Life Use Framework for Minnesota

We propose here the following conceptual structure of designated aquatic life uses as either a modification or outright replacement for the current General Use standards framework as it applies to aquatic life. This would also seem to eventually necessitate the clarification of the other non-aquatic life use subcategories that are currently bundled together under General Use standard, but that is not a purpose of this plan. However, it will be an MPCA decision about how the new TALU-based WQS will be structured within chapter 7050.

There are several factors that we considered in recommending a revised structure for designated aquatic life uses in Minnesota. The current framework of the biological assessment approach including the development and use of multimetric indices and their derivation and calibration based on “minimally disturbed” to “least impacted” regional reference condition makes a tiered structure the most attractive option. As such this framework consists of distinct descriptions of categorical use subcategories or “tiers” of expected condition and potential quality. This also includes distinct “warmwater” and “cold water” assemblage baselines for Minnesota rivers and streams that will be directly included in the TALU framework. The major aquatic life use subcategories proposed herein are described as follows:

Exceptional - These are waters that exhibit the highest quality of “exceptional” assemblages (as measured by assemblage attributes and indices) on a Minnesota Biological Condition Gradient (BCG) basis; narrative descriptors such as “exceptional” can be used as the distinguishing descriptors in the designated use narrative, but other descriptive terms are possible. These communities have minimal changes in structure of the biotic assemblage and in ecosystem function which is the ultimate goal of the CWA. It functions as a preservation use, which means it is intended for waters that already exhibit or have the realistic potential to attain an exceptional quality as measured by the biological criteria.

General – These are waters that harbor "typically good" assemblages of freshwater organisms (as measured by assemblage attributes and indices) and that reflect the lower range of the central tendency of "least impacted" regional reference condition. In the language of the BCG, they are communities that can be characterized as possessing "*overall balanced distribution of all expected major groups; ecosystem functions largely maintained through redundant attributes*". As such this use represents the minimum CWA goal attainment threshold and it serves as the principal restoration use for management programs. It also serves as the "triggering threshold" for when a UAA is required to determine the attainability of this designated use tier for specific river or stream segments.

Modified – These are waters that have been extensively altered and currently exhibit legacy physical modifications that pre-date the November 28, 1975 existing use date in the Federal Water Quality regulations (40CFR Part 131). These waters have been determined to be in non-attainment of the General use biological criteria and have been determined to be incapable of attaining those criteria via a UAA. The biological criteria for the Modified use are established based on a separate population of "modified reference sites" that exhibit these types of modifications with little presence of other types of stressors. Possible subcategories include channelization for flood control and agricultural drainage and impoundments created by run-of-river low head dams. Separate reference populations are needed to derive the numeric biocriteria for each subcategory.

Limited - These are waters that have been substantially altered and currently exhibit severe and essentially irretrievable legacy modifications that pre-date the November 28, 1975 existing use date in the Federal Water Quality regulations (40CFR Part 131). These waters have been determined to be in non-attainment of the Modified biological criteria and have been determined to be incapable of attaining those criteria via a UAA. The biological criteria for the Limited Resource use are established at the "poor" level of biological performance in keeping with preventing nuisance conditions. As such the biocriteria for this use are not based on a distinct set of "limited reference" sites. Possible subcategories include small drainageway maintenance for flood control and severe restrictions of the channel for different purposes (e.g., via concrete revetments).

The preceding describes the general circumstances under which one of the four categorical tiers would apply. However, the narrative language for each use will need to include more detailed and descriptive language to include the following:

1) A definitive statement about the overall goal of the use tier. An example is using the definition of biological integrity (Frey 1977; Karr and Dudley 1981) as follows:

“. . . these are waters capable of supporting and maintaining a balanced, integrated, adaptive community of warmwater aquatic organisms that are comparable to . . .”

2) A description of the geographic applicability of the use tier (or subclass) – an example for Minnesota would be the fish and macroinvertebrate stream and river classes.
3) A clear statement about how attainment of each use tier is to be measured, at least by reference to numeric endpoints in rule.
4) A reference to the method(s) documentation that must be followed to generate the data from which the biological data is processed and attainment can be determined. This could also include any certifications or credible data qualifications.
5) Any exceptions to the applicability of the use tier, i.e., that the use does not apply to non-aquatic life uses and their criteria, variance provisions, etc.

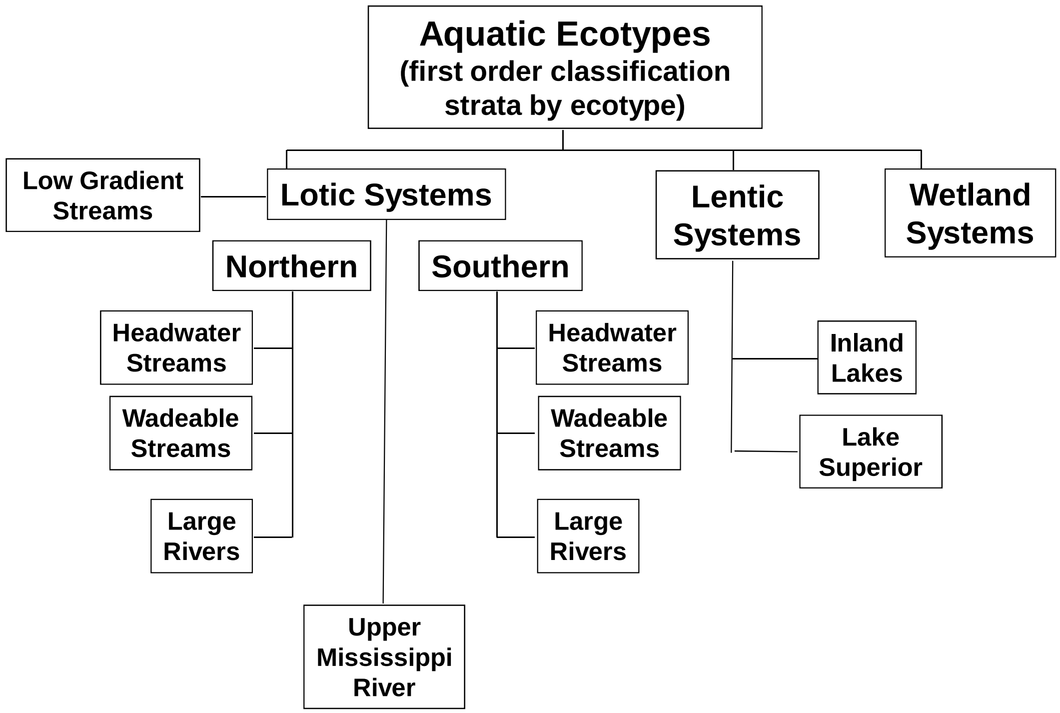
The specific narrative language and accompanying numeric biological criteria for each use tier within the warmwater and cold water subclasses is developed next and serve as the narratives for the new tiered designated uses for adoption in chapter 7050. There will be cold water and warmwater distinctions for at least the exceptional and general subcategories. The modified and limited resource use subcategories will be applicable to warmwater streams and rivers exclusively.

Figures 3-3 through 3-5 depict the organizational hierarchy of the new aquatic life use structure including the overall distinction of aquatic ecotypes (Figure 3-2), the distinctions between warmwater (Figure 3-3) and cold water (Figure 3-4), and the use tiers and subcategories within each (Figures 3-3 and 3-4). This is the organization that we expect based on the developmental work accomplished by MPCA. However, modifications to the ecotype classifications and refinements to the TALU tiers (the tier specific subcategories in particular) are possible in the future as they are recognized based on the feedback provided by consistent TALU program implementation.

3.2.1 Proposed Tiered Uses and Numeric Biocriteria for Minnesota

Based on the preceding guidelines, four overall aquatic life use tiers are recommended for Minnesota that includes numeric biocriteria for fish and macroinvertebrates and within each of the nine natural classes for rivers and streams for each assemblage. We feel that the already developed bioassessment methods and indices for Minnesota (MPCA 2012b) are sufficiently rigorous for supporting the implementation of numeric biocriteria. Our purpose herein is to describe a framework and structure for tiered uses with linkages to the current bioassessment methodologies used by MPCA.

The four general “tiers” described in Section 3.2 are recommended at this time while also recognizing the possibility that further refinements or subclasses may become apparent as the TALU framework is implemented by MPCA. At present Minnesota has what might be



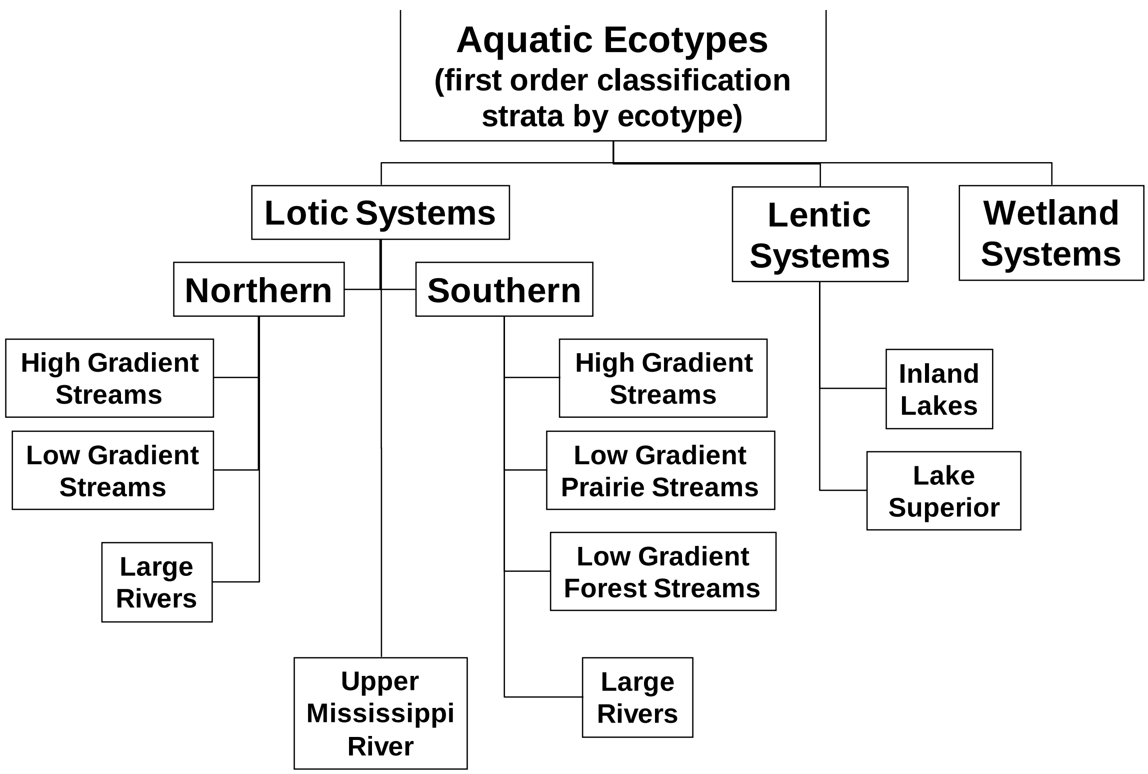


Figure 3-3. First order classification of aquatic ecotypes for fish (upper) and macroinvertebrates (lower) showing the classification strata for the lotic ecotype in Minnesota. Classification strata are possible for lentic and wetland systems, but are not the subject of this project. Upper Mississippi River is below Twin Cities Lock and Dam #1.

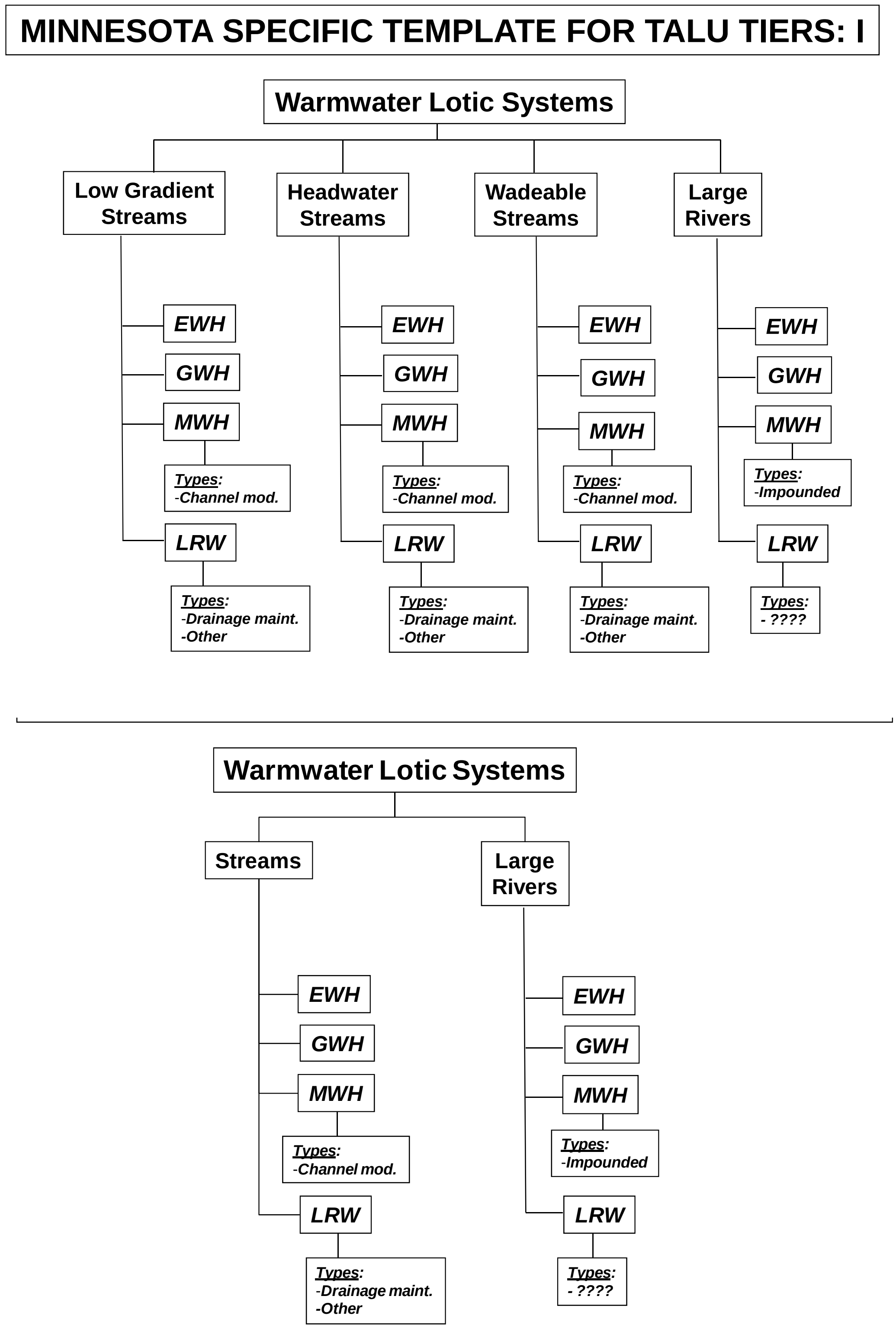


Figure 3-4. Tiered aquatic life uses for fish (upper) and macroinvertebrates (lower) for the warmwater lotic ecotype classifications to which it is expected to apply. Distinct fish and macroinvertebrate IBIs and BCG rules apply to each lotic classification. Numeric biocriteria are derived for each tier (EWH = Exceptional Warmwater Habitat; GWH = General Warmwater Habitat; MWH = Modified Warmwater Habitat; LRW = Limited Resource Water) and by disturbance type for MWH and LRW.

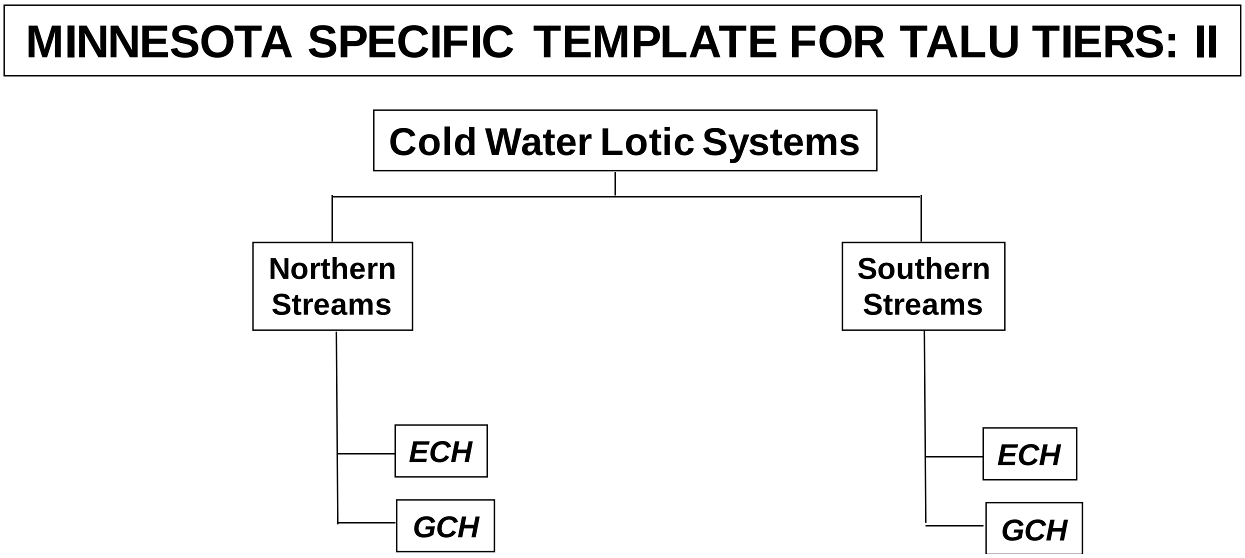


Figure 3-5. Tiered aquatic life uses for the cold water lotic ecotype classifications to which it is expected to apply. Distinct fish and macroinvertebrate IBIs and BCG rules apply to each lotic classification and numeric biocriteria are derived for each tier (ECH = Exceptional Cold water Habitat; GCH = General Cold water Habitat).

considered as "non-regulatory" biological criteria (see Figure 2-1) that are largely applied via methodological guidance detailed in their 305[b] reporting and 303[d] listing process (MPCA 2011). Adopting the TALU framework described herein will result in a firmer regulatory basis via the tiered uses and numeric biocriteria.

3.2.2 Designated Use Narratives Applicable to Minnesota Rivers and Streams

The recommended designated use narratives are composed here to reflect the previously described provisions in Sections 3.1 and 3.2 about what each use tier narrative should include and to reflect the biological methods and indices/models upon which the numeric biocriteria and their application will take place. The following is the recommended 7050 rule language for the warmwater use subclass as follows:

> *"Exceptional Warmwater" – these are waters capable of supporting and maintaining an exceptional and unusual balanced, integrated, adaptive community of warmwater aquatic organisms having a species composition, diversity, and functional organization comparable to the 75th percentile of Biological Condition Gradient Level 3 as specified in Calibration of the Biological Condition Gradient for Streams of Minnesota (Gerritsen et al. 2009). For all stream and river classes, the attributes of species composition, diversity, and functional organization will be measured using the fish-based Index of Biotic Integrity as defined in "Manual for Calculating Fish Index of Biotic Integrity Scores for Streams and Rivers in Minnesota" and the macroinvertebrate Index of Biotic Integrity as defined in "Manual for Calculating Macroinvertebrate Index of Biotic Integrity Scores for Streams and Rivers in Minnesota" as cited in [reference to analytical methods part of 7050 goes here]. Attainment of this use designation is*

based on the criteria in [refers to table of biocriteria values in 7050.0222].

“General Warmwater” – these are waters capable of supporting and maintaining a balanced, integrated, adaptive community of warmwater aquatic organisms having a species composition, diversity, and functional organization comparable to the median of Biological Condition Gradient Level 4 as specified in Calibration of the Biological Condition Gradient for Streams of Minnesota (Gerritsen et al. 2009). For all stream and river classes, the attributes of species composition, diversity, and functional organization will be measured using the fish-based Index of Biotic Integrity as defined in “Manual for Calculating Fish Index of Biotic Integrity Scores for Streams and Rivers in Minnesota” and the macroinvertebrate Index of Biotic Integrity as defined in “Manual for Calculating Macroinvertebrate Index of Biotic Integrity Scores for Streams and Rivers in Minnesota” as cited in [reference to analytical methods part of 7050 goes here]. Attainment of this use designation is based on the criteria in [refers to table of IBI biocriteria values in 7050.0222] except in instances where biological data is not readily available.

“Modified Warmwater” – these are waters that have been the subject of a use attainability analysis and have been found to be incapable of supporting and maintaining a balanced, integrated, adaptive community of warmwater organisms due to irretrievable modifications of the physical habitat. Such modifications are of a long-lasting duration (i.e., twenty years or longer) and may include the following examples: extensive stream channel modification activities permitted under sections 401 and 404 of the act or [Minnesota Statutes Chapter 103E], and extensive permanent impoundment of free flowing water bodies. [any other precluding categorical activities added here] Numeric biocriteria are derived from a distinct population of “impacted reference” sites reflecting only the categorical impacts implied in this definition (MPCA 2012a). For all stream and river classes, the attributes of species composition, diversity, and functional organization will be measured using the fish-based Index of Biotic Integrity as defined in “Manual for Calculating Fish Index of Biotic Integrity Scores for Streams and Rivers in Minnesota” and the macroinvertebrate Index of Biotic Integrity as defined in “Manual for Calculating Macroinvertebrate Index of Biotic Integrity Scores for Streams and Rivers in Minnesota” as cited in [reference to analytical methods part of 7050 goes here]. Attainment of this use designation is based on the criteria in [refers to table of IBI biocriteria values in 7050.0222] and by the categorical subclasses based on the modification type.

"Limited Resource Water" - these are waters that have been the subject of a use attainability analysis and have been found to lack the potential for any resemblance of any other aquatic life subclass. The use attainability analysis must demonstrate that the extant fauna is substantially degraded and that the potential for recovery of the fauna to the level characteristic of any other aquatic life habitat is realistically precluded.

While a hierarchy of four tiers of aquatic life uses is recommended here, the specific language included above can be modified to accommodate the specific needs of the Minnesota WQS (i.e., other rule references, exclusions, variances, etc.) or it can be accounted for in the MPCA implementation language described in Section 3.5.

3.3 Numerical Biological Criteria for Minnesota Rivers and Streams

The just described designated use narratives are the essential first part of a TALU. The numerical biological criteria are the essential second part and they are derived in accordance with the stated conditions of the narrative. As such the thresholds that are described in the narrative are the numerical biocriteria as derived from the class-specific BCG models and the regional reference datasets that are used to derive and calibrate the biological indices. The rigor of these datasets is an important linchpin in this process and is evaluated as part of the Critical Elements process (Yoder and Barbour 2009). At this point we recommend utilizing the newly developed set of calibrated biological indices and the classification scheme employed for each as the basis of the numeric biocriteria. The narratives are written such that future changes can be accommodated without making any changes to the designated use narratives themselves.

Key to the derivation of numeric biocriteria is the reference threshold for each biological index that is selected for each aquatic life use tier. The biocriteria applicable to the highest TALU tiers are intended to correspond to the upper levels of the BCG, i.e., levels 1, 2, and 3. The upper tiers that represent level 1 and upper level 2 conditions can also be used to develop more refined antidegradation tiers.

3.3.1 Regional Reference Condition

The most recent available guidance on reference condition can be found in Stoddard et al. (2006). This paper describes a framework for organizing reference condition and recognizing that there are differences between minimally disturbed and least impacted reference conditions. The concept of a reference condition is used to describe the standard or benchmark against which current condition is compared. However the phrase itself can have many meanings and different contexts. Stoddard et al. (2006) stated the need for reference condition to refer to the “naturalness” of the aquatic biota in terms of its structure and function. As such this anchors reference condition in the upper levels of the Biological Condition Gradient (BCG). To organize and standardize the use of reference condition Stoddard et al. (2006) defined the following hierarchy of reference condition:

- **Minimally Disturbed Condition (MDC)** – This term describes the condition of the biota in the absence of significant human disturbance and it is the best approximation of biological integrity. It is acknowledged that finding actual sampling sites that are truly undisturbed by the global influence of human activities is probably not possible. This would be especially true of the agricultural, urbanized, and industrialized Midwestern U.S. of which Minnesota is a part. MDC also recognizes that some natural variability in biological indicators will always occur and needs to be recognized when empirically describing this condition.

- **Historical Condition (HC)** – This term describes the condition of the biota at some point in their history. It may be an accurate estimator of true reference condition (i.e., biological integrity) if the historical point chosen is before the start of any human disturbance. However, many of the historical reference points are possible (e.g., pre-industrial, pre-Columbian). A recent example of developing and accessing historical conditions was described by Armitage and Rankin (2009) for the Wabash River basin of Indiana and by Rankin and Yoder (2010) for the Upper Mississippi River.

- **Least Disturbed Condition (LDC)** – Least disturbed condition is found in conjunction with the best available physical, chemical, and biological habitat conditions given today's state of the landscape. It is ideally described by evaluating at data collected at sites selected according to a set of explicit criteria defining what is ''best'' or least disturbed by human activities. The resulting least disturbed biological conditions will vary from region to region and/or water body type and class and are developed iteratively with the goal of establishing the least amount of human disturbance based primarily on stressors that can be delineated by geographic information system data, proximity to obvious sources of impact (e.g., large point sources), and other evidence of disturbance at a site. As such this represents an evaluation and ranking of the "cultural setting" represented by candidate reference sites. The first attempts at selecting reference sites were largely based on qualitative measures (e.g., Yoder and Rankin 1995a), but more recently they have included more quantitative measures of landscape disturbance (U.S. EPA 2006). Because the condition of the overall environment may change through time as restoration and/or degradation proceeds, this condition may change through time. Hence the expectation that a level 4 bioassessment program will provide for the regular re-sampling of reference condition (e.g., once every 10 years). This enables the tracking of any changes in reference condition to include a recalibration of the biological indices, the biological criteria, or both on a predictable basis (Yoder and Rankin 1995a). The CWA and federal regulations preclude any lowering of the numeric biocriteria once they are established in the WQS.

- **Best Attainable Condition (BAC)** – This is the expected condition of least disturbed sites under the implementation of best management practices (BMPs) for a sufficient period of time. This is a condition that results from the convergence of management goals, best available technologies, and a public commitment to achieving environmental goals (e.g., as established by WQS) under prevailing uses of the landscape. BAC may be equivalent to either to either MDC or LDC depending on the prevailing level of human disturbance in a region. It is not invariable because the above factors can vary over time. In some cases where historical disturbance has been extensive and widespread it may not satisfy the minimum CWA goals for aquatic life, hence alternate approaches to setting biological criteria may be needed.

The span of reference conditions represented by the just described hierarchy is illustrated as it relates to the Biological Condition Gradient (BCG) in Figure 3-6 (modified from Stoddard et al. 2006). In a region where the majority if not all of the reference sites truly represent minimally disturbed conditions the reference sites would score in levels 1 and 2 of the BCG along the axis

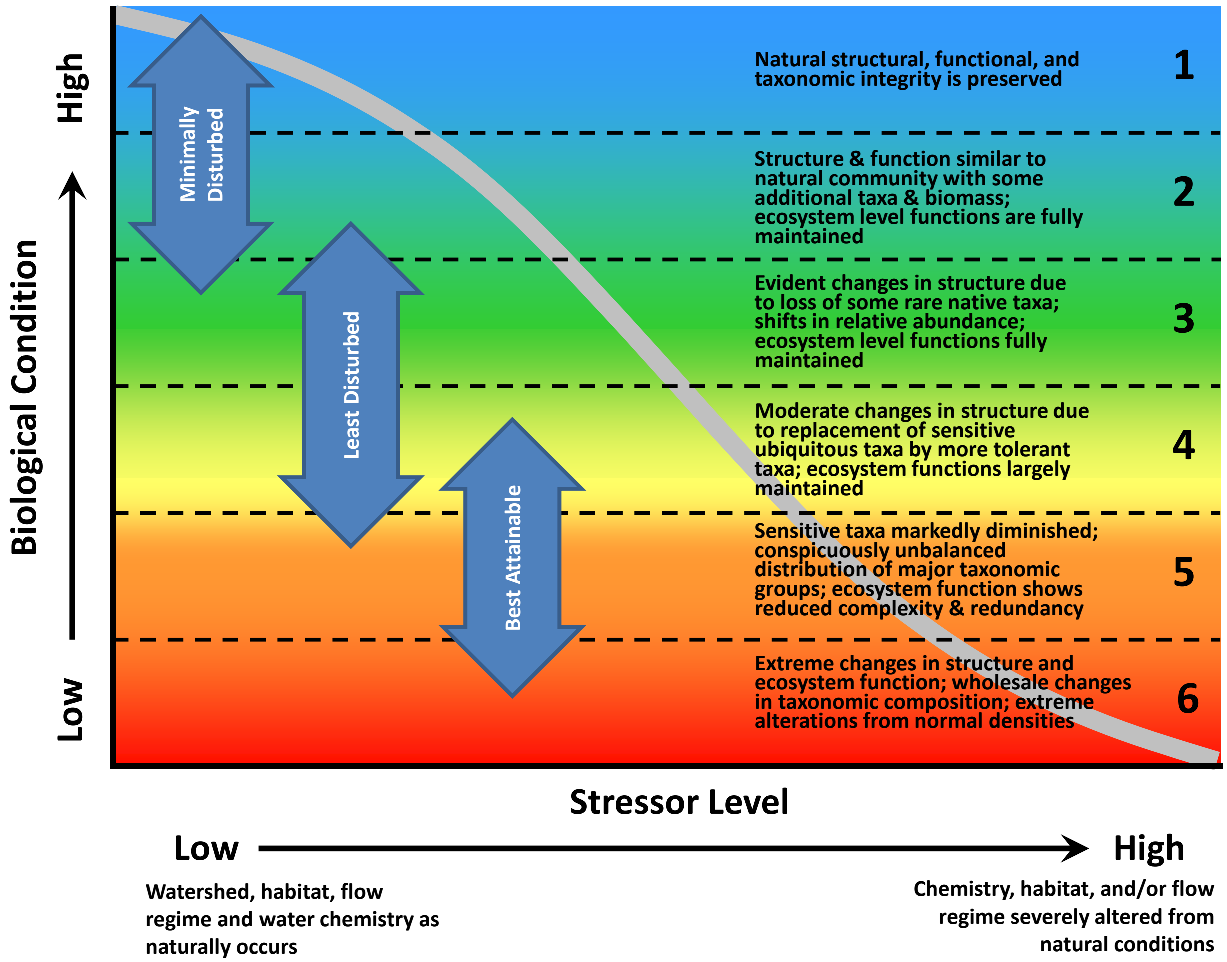


Figure 3-6. The distribution of minimally disturbed, least disturbed, and best attainable reference condition along the axis of biological condition against the level of stress. Minimally disturbed, least disturbed, and best attainable are shown as they relate to their position in the Biological Condition Gradient (BCG; Davies and Jackson 2006). Adapted from Stoddard et al. (2006).

of the biological index. In a region with fewer minimally disturbed reference sites and an increasing number of least impacted reference sites, the range along the biological index axis would extend into levels 3 and 4 of the BCG. In regions that have no minimally disturbed sites and a majority of least disturbed and best attainable sites, the range along the biological index axis would extend into tier 4 and perhaps even tier 5 of the BCG. Under no circumstances should least impacted reference sites occupy tier 5 and extend into tier 6. This would illustrate a lack of any redeeming reference condition and an alternate approach would be needed to derive numerical biocriteria consistent with CWA goals. Modified and limited reference sites would be expected to represent tier 5 and even into to tier 6, almost by definition, because neither attains the minimum CWA goal. Referring specifically to this standardized framework of reference condition and clearly indicating which practical definition of reference condition is being used to set biocriteria will make biological criteria and the assessments upon which they are based more comparable between the classification regions.

3.3.2 Minnesota Reference Condition

Another important aspect of this framework is that a better understanding of the quality of the applicable regional reference condition will better standardize how numeric biological criteria are established. The relative quality of the regional reference condition is a key variable in determining at what percentile of the reference distribution (i.e., the threshold) of a biological index that represents the minimally acceptable biocriterion for CWA purposes. The actual distribution of empirically measured reference condition also influences how many upper level tiers might be needed and where those biocriteria are set. An example is displayed in Figure 3-7 that depicts the reference site scores for the Minnesota stream and river classification strata. These are the fish and macroinvertebrate IBI scores at minimally to least disturbed reference sites for each fish and macroinvertebrate class. The IBIs were derived and calibrated for each classification strata and the numerical biocriteria derived by the BCG tiers. This framework ensures that the resultant numeric biocriteria are consistent with the goals of the CWA and hence are protective of their designated uses and hedge against unintentional bias that may be introduced by including too many potentially marginal reference sites. The Southern streams and headwaters FIBI GWH biocriterion for fish is above the median reference value (Figure 3-7) and it is doubtful that few if any of those sites represent least impacted reference conditions since the effects of hydromodification and agricultural land use are so extensive and BMPs have not been validated in terms of CWA goal attainment. As such basing the biocriteria thresholds on the median of the BCG tier 4 protects against having the biocriteria determined by what is in this class "best attainable" conditions. In contrast the Northern rivers and streams reflect a preponderance of minimally disturbed conditions as reflected by the position of those FIBI thresholds (Figure 3-7).

3.3.3 Derivation of Numeric Biocriteria for Minnesota Rivers and Streams

An example of how the numeric biological criteria will be structured for Minnesota rivers and streams appears in Table 3-1 and is based on thresholds that correspond to "reference" conditions reflective of Human Disturbance Score (HDS) scores of >61 for headwaters and streams and >45 for large rivers for the General uses. Based on our prior discussion of reference condition this equates to the "bottom" of a least impacted reference condition. Within the Exceptional use an upper tier exceptional biocriterion is being proposed for the Northern Rivers class. The decision about which percentile to select is based on our estimate of the extent of either how "minimally disturbed" of "least impacted" is the prevailing reference condition, with more conservative percentiles (as noted above) being used when that population is comprised predominantly of least impacted and best attainable conditions. In northern classes the 10^{th} percentile of reference sites was used and in southern and statewide classes the 25^{th} percentile was used. Comparison with the BCG indicated that these thresholds most closely matched the median of BCG 4 so this threshold was used to set the General Use (GU) biocriteria values.

For exceptional uses the 75^{th} percentile of IBI scores for reference sites was chosen to be in keeping with the narrative attributes of this tier. This threshold most closely corresponded to the 75^{th} percentile of BCG level 3 and it was used to set biological criteria for the Exceptional Use (EU). Modified Use (MU) criteria were developed by identifying modified "reference" sites

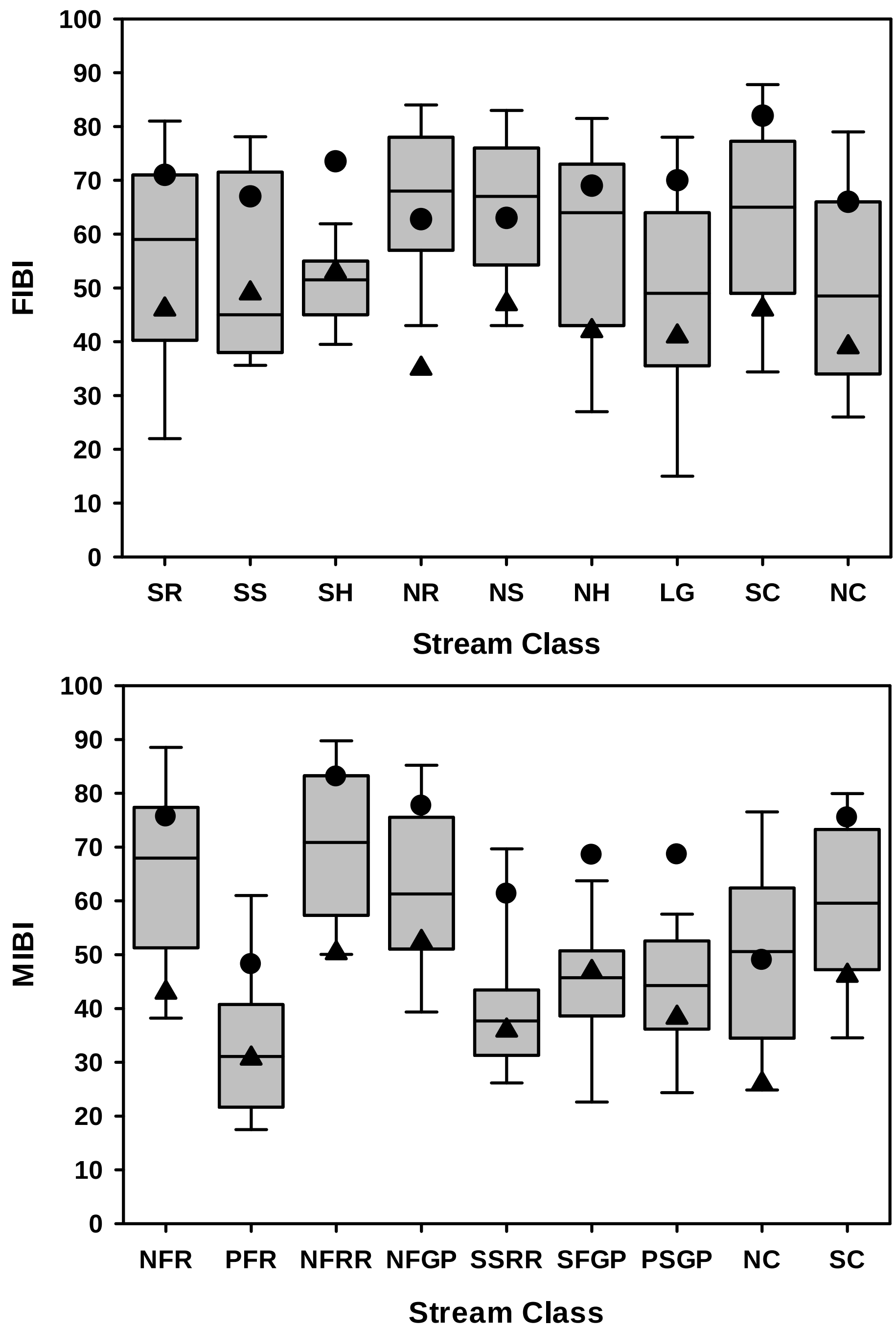


Figure 3-7. Frequency distribution of fish IBI (FIBI; upper) and macroinvertebrate IBI (MIBI; lower) scores at warmwater and cold water (SC and NC) reference sites in Minnesota by classification strata. The General biocriterion (▲) is set at the median of the class-specific BCG tier 4 for all classes. The Exceptional biocriterion (•) is set at the 75^{th} percentile of the class-specific BCG tier 3 for all classes. Symbols: upper and lower bounds of box = 75th and 25th percentiles, middle bar in box = 50th percentile, upper and lower whisker caps = 95th and 5th percentiles; Abbreviations: SR = Southern Rivers, SS = Southern Streams, SH = Southern Headwaters, NR = Northern Rivers, NS = Northern Streams, NH = Northern Headwaters, LG = Low Gradient Streams, SC = Southern Cold water, NC = Northern Cold water, NFR = Northern Forest Rivers, PFR = Prairie Forest Rivers, NFRR = High Gradient Northern Forest Streams, NFGP = Low Gradient Northern Forest Streams, SSRR = High Gradient Southern Streams, SFGP = Low Gradient Southern Forest Streams, PSGP = Low Gradient Prairie Streams, SC = Southern Cold water, NC = Northern Cold water.

that represents the attainable biological condition for these streams. In theory these streams represent the biological condition that is attainable in waters that have been legally modified and which have been subjected to a UAA. To identify these streams, landscape and reach level riparian condition measures were used to select channelized reference streams. Reaches with less than 80% of the riparian disturbed at both the watershed and reach scales were selected. A secondary filter of dissolved oxygen > 4 mg/L and < 12 mg/L was also used to remove reaches that were also impacted by the effects of excessive nutrients. Once these modified "reference" sites were selected, the 25th percentile of IBI scores was determined for each stream class. Nine of the stream classes had very few or no channelized streams and therefore it was determined that development of a Modified Use for these classes was not appropriate. These thresholds were then compared to the BCG and it was determined the reference condition most closely corresponded to the median of BCG level 5. This threshold was used as the Modified Use biocriterion for the classes to which it applies (Table 3-1).

Table 3-1. Draft numeric biocriteria for Minnesota rivers and streams organized by warmwater and cold water ecotypes, stream and river classification strata within each, and the corresponding Exceptional, General, and Modified Uses (NA – not applicable).

Class #	Class Name	EU	GU	MU
	Fish			
1	Southern Rivers	71	46	NA
2	Southern Streams	67	49	33
3	Southern Headwaters	74	53	32
4	Northern Rivers	63	35	NA
5	Northern Streams	63	47	32
6	Northern Headwaters	69	42	22
7	Low Gradient Streams	70	41	15
10	Southern Cold water	82	46	NA
11	Northern Cold water	66	39	NA
	Invertebrates			
1	Northern Forest Rivers	76	43	NA
2	Prairie Forest Rivers	48	31	NA
3	Northern Forest Streams RR	83	51	NA
4	Northern Forest Streams GP	78	49	36
5	Southern Streams RR	61	36	24
6	Southern Forest Streams GP	69	43	28
7	Prairie Streams GP	69	42	21
8	Northern Cold water	49	27	NA
9	Southern Cold water	75	45	NA

3.3.4 Determining Attainment of the TALU-Based Biocriteria

The proposed designated aquatic life use narratives state that attainment will be based primarily on the numeric biocriteria for each use tier and classification stratum. This is consistent with a TALU-based approach in that the biocriteria are the primary response variable while chemical and physical criteria function as indicators of stress and exposure and represent the implementable measures for water quality management. As such, the biocriteria function along the y-axis of the BCG whereas chemical/physical measures function along the x-axis of the BCG. Because this represents a change to the current assessment approach, MPCA may choose to phase biocriteria into the water body assessment process until sufficient assessments are accomplished to determine exactly how to implement the recommended rule language.

The current MPCA process for using biological data is detailed in the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305b Report and 303d List* (MPCA 2011). This guidance was the first attempt by MPCA to formally incorporate biological assessments into their water body assessment process. Furthermore, biological indicators are essentially treated as a co-factor with chemical/physical indicators which blurs the distinction between the defined roles of these indicators in a TALU-based approach. The current process for determining attainment and non-attainment is written as follows:

> *Overall assessment of whether an AUID adequately supports aquatic life involves the review of the parameter-level evaluations and data quality in conjunction with all available supporting information (flow, habitat, precipitation, etc.) to make an overall use-support determination. For a given AUID, there may be chemistry indicator data, biological indicator data, or both types of data available for assessment. The final assessment takes into consideration the strength of the various indicators and the quality of the data sets and, in addition, looks at upstream and downstream conditions to gain a better understanding of the interactions between the individual AUID and the larger water body and watershed.*
>
> *In general:*
>
> *a) A stream reach is considered to be fully supporting of aquatic life if:*
>
> - *IBI scores for all available assemblages indicate fully supporting conditions, or*
> - *the criteria for both dissolved oxygen and turbidity/t-tube/total suspended solids are adequately met, and*
> - *other lines of evidence considered comprehensively, including upstream/downstream conditions, do not contradict a finding of full support*
>
> *b) A stream reach is considered to be not supporting if:*
>
> - *IBI scores for at least one biological assemblage indicate impairment, or*
> - *one or more water chemistry parameters indicates impairment, and*
> - *other lines of evidence considered comprehensively, including*

upstream/downstream conditions, do not contradict a finding of non-support

c) If the above criteria are not met and the assessment is inconclusive, the result is a determination of insufficient information.

In cases where an assessment unit has been determined to be not supporting based on biological indicators, water-chemistry parameters are added to the list of impairments only when the chemical impairment is clear enough that the AUID would be considered impaired even without the biological evidence.

Additional guidelines are available in MPCA (2011) that clarify the process and outcome decisions for scenarios a through c above. The programmatic implications to the assessment program are discussed in Section 5.0.

For assessing impairments with biological data, the current procedure is to declare an impairment if the biocriterion for either the fish or macroinvertebrate assemblage is exceeded, a practice that we recommend continue. MPCA also considers confidence intervals around the numeric biocriterion in determining an impairment (Figure 3-8), a practice that we concur with.

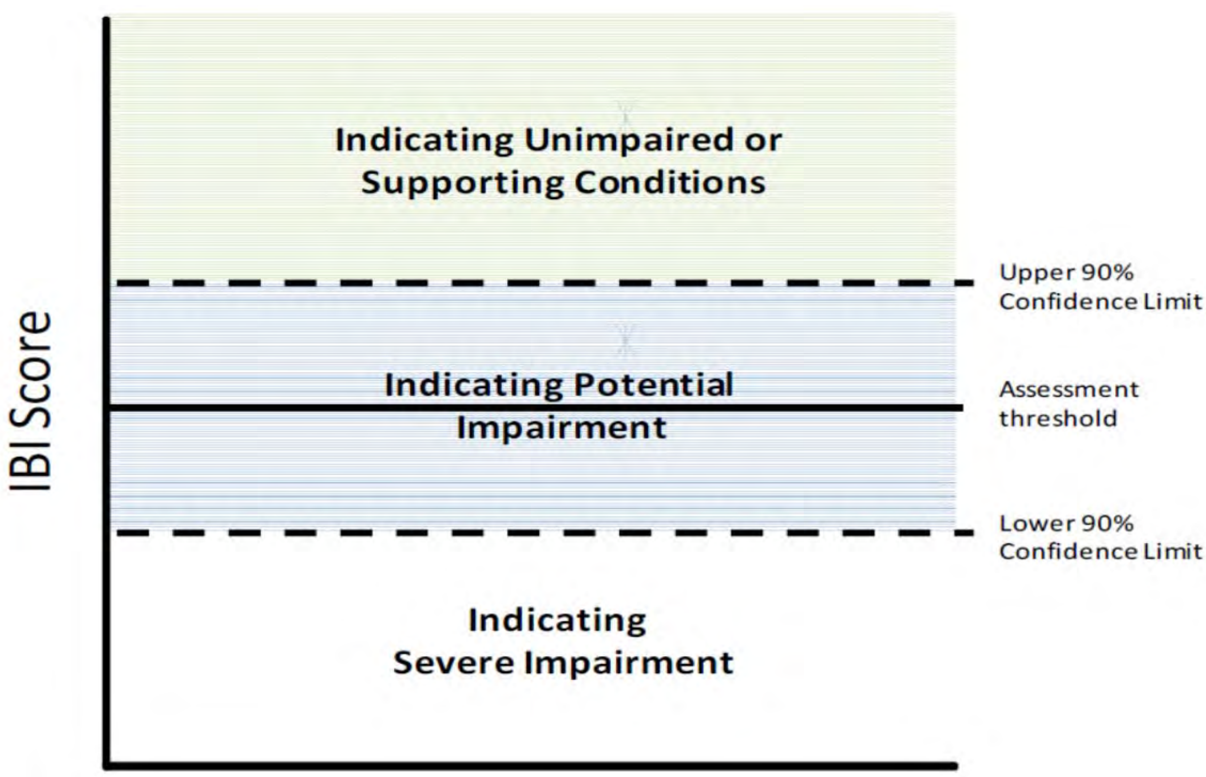


Figure 3-8. General diagram illustrating the characterization of individual biological indicator results (after MPCA 2011).

3.3.5 Biocriteria Application Language

The Minnesota WQS currently provide narrative language for the application of chemical, physical, and biological monitoring data at 7050.0150. As described previously MPCA uses bioassessment results to determine the status of the current general uses primarily for Section 305(b) and 303(d) purposes. Because the application of bioassessment data via a TALU-based approach extends beyond status and impairment listings, application language is recommended that clarifies the options available to water quality management programs in sufficient detail so as to not only be transparent to those programs and external stakeholders, but providing options for findings of attainment and non-attainment. The principles of this language in the Minnesota WQS were described in Section 2.3.6 and should be the basis for the proposed rule language. We feel that this clause is needed to more firmly clarify the roles of biological, chemical, and physical parameters and indicators than it is in the current assessment guidelines. While the potential stratification of certain chemical and physical parameters that result from task 5 of the TALU work plan may help to align chemical/physical and biological results, there will be situations where they do not “agree” hence a consistent and codified approach to how these findings are treated will be necessary.

4. TALU Implementation Strategy

The implementation of a TALU-based approach in Minnesota will most directly impact two major water quality management programs, WQS and M&A. The potential changes to the WQS as described in Section 3.0 are in the form of a revised structure of designated aquatic life uses primarily in the form of an increased number of subcategories of warm and cold water habitats and in "detaching" aquatic life from the current general use framework that combines it with recreational uses. Section 3 already provides the details about the content and substance of the aquatic life uses. What is left now is to refine and finalize the specific rule language and structure within a rule-making proposal.

How TALU affects the current MPCA M&A program is perhaps the more detail laden aspect of TALU adoption and implementation, hence this section is devoted to that issue. TALU implementation is entirely dependent on the state monitoring and assessment program hence an understanding about how TALU might impact the monitoring strategy is an essential next step.

4.1 Minnesota Monitoring Strategy

The MPCA and its partner agencies and organizations conduct numerous surface and groundwater monitoring activities to provide information about the status of the state's water resources and to identify potential or actual threats to the quality of surface and groundwater, choose options for protecting and restoring waters that are impaired, and evaluate the effectiveness of implemented management plans. The goal of the MPCA and its partners is to provide information to assess – and ultimately to restore or protect – the integrity of Minnesota's waters. The MPCA has been developing a watershed approach since 2007 as a key strategy and organizing principle to guide its surface and groundwater quality monitoring activities and many other aspects of the agency's water program (MPCA 2011). Two landmark events that have enabled the MPCA to develop and begin implementing the watershed approach are passage of Minnesota's Clean Water Legacy Act (CWLA) in 2006 and passage of the Clean Water, Land and Legacy Amendment (Amendment) in 2008. The CWLA and the Amendment have provided a structure and a source of revenue that have greatly improved the ability of the MPCA and its partner agencies and organizations to achieve the MPCA's strategic plan vision of clean, sustainable surface and groundwater.

Since preparation of the 2004 – 2014 Water Quality Monitoring Strategy, the MPCA has changed the organizing approach for its water program from the major river basin scale (there are portions of 10 major river basins within the state of Minnesota) to the "major," or eight-digit hydrologic unit code (HUC) level, watershed approach. There are 81 of these major watersheds in Minnesota. The MPCA and its partners began implementing the watershed approach in 2007 following a pilot monitoring study that was conducted in the Snake River Watershed in 2006. The MPCA's watershed approach involves intensively monitoring the streams and lakes within a major watershed and in an unbiased manner to:

- determine the overall health of these water resources;

- identify impaired waters, and,
- identify waters in need of additional protection efforts to prevent impairments.

Follow-up monitoring is then conducted in impaired sub-watersheds to determine the cause(s) of the impairments (i.e. the “stressors” impacting the biological community) and begin identification of pollutant sources and priority management zones. A restoration plan (Total Maximum Daily Load or TMDL) and/or protection strategy and implementation plan is then written for the watershed; following this, partnering agencies and watershed stakeholders can begin BMP improvements based on these efforts. Regulatory efforts continue throughout the process and are adjusted as needed to achieve the clean water goals. A key element of the watershed approach is the goal to assess the condition of Minnesota’s waters (all 81 watersheds) via a 10-year cycle that starts over again after the first 10-year cycle is complete. During the second 10-year cycle, the same progression of intensive monitoring to assess current condition and detect any changes, followed by updating of protection and restoration strategies, and then additional implementation efforts, is pursued in each watershed.

MPCA generally categorizes its monitoring activities according to monitoring purpose and how the monitoring data are assessed and used. Monitoring activities are characterized in accordance with one of three categories, as follows:

- Condition monitoring: This type of monitoring is used to identify overall environmental status and trends by examining the condition of individual water bodies or aquifers in terms of their ability to meet established standards and criteria. Condition monitoring may include chemical, physical, or biological measures. The focus of condition monitoring is on understanding the status of the resource, identifying changes over time, and identifying and defining problems at the overall system level. Examples include: the intensive watershed monitoring conducted in Minnesota’s major watersheds; probabilistic monitoring conducted at various scales to evaluate the quality of lakes, rivers, and wetlands; and ambient groundwater quality monitoring.

- Problem investigation monitoring: This monitoring involves investigating specific problems or protection concerns to allow for the development of a management approach to protect or improve the resource. Problem investigation monitoring is used to determine the specific causes of impairments to surface water, to evaluate the extent and magnitude of a contaminant plume in groundwater, and to quantify inputs/loads of contaminants to a water body from various sources. It is also used to determine the actions needed to return a resource to a condition that meets standards or goals. Examples include: stressor identification (ID) monitoring in a major watershed that contains impaired waters; monitoring of groundwater and possibly surface water at chemical release sites; and monitoring conducted for Clean Water Partnership and federal CWA Section 319 projects.

- Effectiveness monitoring: This type of monitoring is used to determine the effectiveness of a specific regulatory or voluntary management action taken to improve impaired

> waters or remediate contaminated groundwater. Effectiveness monitoring allows for the evaluation and refinement of a selected management or remedial action over time to ensure the approach is ultimately successful. Examples of effectiveness monitoring are monitoring conducted following implementation of watershed protection and restoration strategies or BMPs at various scales, such as the subwatershed, watershed, or basin. Also, effluent monitoring that is done to assess the compliance of a facility with a permit, rule or statute (i.e. compliance tracking); in this example, the monitoring data provide information about how regulatory actions applied to a facility affect the facility's contributions to the associated water bodies (not the effect of the facility's contribution on the water body itself).

Formal reviews of the MPCA monitoring and assessment program have been made as part of a detailed engagement with the Region V states by U.S. EPA for TALU development (MBI 2004, MBI 2010). As a result of that process, Minnesota has been exposed to the TALU development and implementation needs of their M&A and bioassessment program through this initiative. This process should utilize the most recent evaluation of the Region V state programs (MBI 2010) which included the most subsequent updates to the critical technical elements reviews, utilizing the latter as a tool to determine specific technical needs and as a tool to enhance a continuous improvement process. Some of these findings spurred the developmental elements that are part of the TALU work plan described in Section 1.

While MPCA has made a commitment to TALU development in their WQS, a similar commitment to TALU implementation M&A will be needed. Currently, the MPCA monitoring strategy emphasizes status monitoring, which is a characteristic of nearly all state programs. It is also a dichotomy in that some states have developed their M&A programs almost exclusively to support status assessments.

The current MPCA monitoring strategy does not specifically address the needs of a TALU-based approach to water quality management. A key challenge is for MPCA to adapt their M&A strategy to include TALU-based monitoring and assessment as a major category. Spatial design is an especially important aspect of TALU implementation since it affects the ability to obtain and apply data to specific streams and rivers and it also has an influence on the awareness and comprehension of multiple stressors. Having said that the MPCA strategy does recognize TALU as an M&A support need as evidenced by the following statement:

> *"The MPCA looks forward to future conversations with EPA as we continue to advance the watershed approach, develop and implement river eutrophication criteria and other new standards, incorporate biological indicators into our monitoring and assessment efforts, and develop and implement the TALU framework for assessing rivers and streams."*

How well the current MPCA watershed design actually supports TALU implementation is being explored as part of the TALU development process by piloting use designation reviews and implementing the newly developed TALU tools in selected watersheds.

4.2 TALU-Based Monitoring and Assessment (M&A)

State monitoring and assessment should be designed and operated to support "day-to-day" water quality management needs in addition to determining statewide status. However, to accomplish both it needs to be implemented such that it can be utilized at the statewide, regional, watershed, and site-specific scales. Besides fulfilling the assessment of status, a sustained TALU-based M&A program "naturally" incorporates strategic support functions and results in improved criteria, methods, tools, and policies. The resulting database it generates is comprised not only of the data, but of the experience gained by producing systematic assessments. It also includes the regular re-sampling of reference sites and the resulting long-term awareness of reference condition. The aggregate database generated by TALU-based M&A allows for comprehensive analysis and interpretation of spatial and temporal trends and tracking the effectiveness of water quality management programs both individually and in the aggregate. The overall program thereby fosters a continuous improvement process through adaptive management because sufficient information is collected at relevant spatial scales and the interpretation of that information is produced to affect management decisions (U.S. EPA 2005). We refer to this as adequate monitoring and assessment (Yoder 1998) the details of which are included herein as Appendix A.

A TALU-based monitoring program is designed and conducted to meet three principal objectives and in the following order:

1) determine if use designations presently assigned to a given water body are appropriate and attainable;
2) determine the extent to which use designations assigned in the state WQS are either attained or not attained; and,
3) determine if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or BMPs.

This sequence and array of objectives is implicitly different than under a non-TALU based approach in one important way – the assessment is used first to *validate the current designated use* as opposed to the usual approach of determining impairment based on the currently assigned use, which in many cases is an assumed "default" use. The problem with this latter approach is that any issues with the currently assigned use will not become apparent until an inaccurate management decision or application triggers a concern over the assigned use. We believe that by addressing the appropriateness of the current use assignment first, everything else automatically "falls into place" thereby eliminating the need for potentially costly and time consuming "after-the-fact" exercises such as TMDL delisting and even more costly use attainability analyses (UAA).

4.2.1 Spatial Design Considerations

Spatial scale is absolutely the most critical aspect of this type of M&A. As the complexity of stressors within a watershed increases, so does the need for increased spatial detail in the sampling design. In addition, TALU assignments can vary from stream to stream within the same watershed as has been shown elsewhere (U.S. EPA 2005, Appendix B, pp. 172-175). Thus a reliance on extrapolation from too few and spatially scattered sampling sites, the statistical integrity of the underlying spatial design notwithstanding, can result in incomplete or even erroneous TALU tier assignments. At the same time it is recognized that not all water bodies will be assessed ahead of certain water quality management actions, thus a prioritization of M&A needs to be integrated into the overall TALU implementation strategy so that the most important and high profile water quality management actions are based on the most accurate WQS. However, by aligning water quality management program schedules within a rotating basin approach to M&A, it should be possible to have most WQS use designation uncertainties resolved *prior to* developing management approaches and plans (e.g., permits, TMDLs, watershed plans, etc.). Ideally, having the management programs aligned with the watershed monitoring approach would be the most efficient approach. However, aligning the monitoring and permitting schedules has been determined to be impractical and instead watershed monitoring to collect the data needed to resolve use designations prior to the review of a permit will need to accommodate the reissuance schedule, even when it is outside of the watershed monitoring schedule.

4.2.2 TALU-Based Assessment Process

The data gathered by systematic TALU-based M&A is processed, evaluated, and synthesized in an assessment report. Each report contains a summary of major findings and recommendations for revisions to stream and river-specific use designations, future monitoring needs, or other actions which may be needed to address existing impairment(s) of designated uses. At the same time, the systematic execution of this type of M&A on a statewide basis builds a long-term database over space and time, creating and sustaining a resource for the development and improvement of tools, criteria, policies, and legislation. In addition TALU-based M&A inherently incorporates a stressor identification process based on having adequate chemical, physical, and biological data in hand when the biological impairments are encountered. Again, this is implicitly broader than status-based M&A that can leave biological impairments incompletely diagnosed or undiagnosed altogether. The compulsion to make as accurate a diagnosis as is feasible of biological impairments revealed by this type of M&A is an assumed part of the biocriteria application language described in Section 2.3.6. Once again, we recognize that this is a departure from current practice where stressor diagnosis is performed as a second year effort. However, we have found that some impairments do not require the same level of diagnosis, hence some situations are amenable to a "short hand" process. Again, this will occur with experience as these assessments are accomplished through time.

4.3 Incorporating M&A Findings into WQS Recommendations

How the monitoring and assessment data and analyses described above are used as an essential part of a TALU process has been generally described via case examples (U.S. EPA 2005) and is available from selected TALU state programs. Use designation reviews and revisions are a direct and routine result of the biological and water quality assessments that are conducted on a stream or river segment and/or watershed basis. Provided that the spatial design is adequate for the meaningful and accurate application of the sampling data to individual streams and stream segments, *the M&A results are the basis for TALU-based use designation* *assignments*. Aquatic life uses are generally designated based on the *demonstrated potential* to attain a particular use tier based on the following sequence (in order of importance):

1) attainment of the numeric biological criteria (if attaining a General use or higher – attainment of the Exceptional biocriteria for both assemblages is required to be designated as EWH); and,

2) if the applicable General use biocriterion is not met, the habitat potential is determined by an analysis of the Minnesota Stream Habitat Assessment (MSHA) habitat attributes which is used to determine the potential to attain the General use at a minimum.

As such this represents a "UAA type" of process even though a UAA is technically not required to designate uses at or above the "CWA minimum" (i.e., one of the General uses in Minnesota).

A TALU-based process is inherently data driven so that the same sequence of decision-making is executed regardless of the relationship of the current use designation to the minimum CWA goal. To designate uses less than General (i.e., Modified or Limited), a UAA ***is required*** and includes the consideration of the factors that essentially preclude General use attainment including the feasibility of restoring the water body. Under a TALU-based approach the following information and knowledge is required:

1) the present attainment status of the water body based on a biological assessment performed in accordance with the requirements of the biocriteria, the Minnesota WQS, and the TALU-based needs for Minnesota (the latter pertains to adequacy of the spatial design);
2) a habitat assessment to evaluate the potential to attain at least the applicable General use; and,
3) a reasonable relationship between the impaired state and the precluding anthropogenic activities or other factors based on an assessment of multiple indicators used in their appropriate indicator roles and a demonstration consistent with 40CFR Part 131.10 [g][1-6].

The above requires that adequately developed tools and processes be available within the State's M&A process in addition to having a TALU framework in the WQS. This represents the "merging of WQS and M&A" that is a signature of the TALU framework.

4.3.1 TALU Management Options Overview

To illustrate the practical options that MPCA will have for making stream or segment-specific TALU assignments based on the results of the M&A process described above, a matrix of TALU management options was developed (Table 4-1). We are assuming here that all Minnesota rivers and streams will have a TALU tier assigned following the adoption of the new designated use tiers. Virtually all rivers and streams will be assigned the most applicable General Use tier as a "default" in the absence of sufficient data. This will be a practical necessity so that other aspects of water quality management that rely on WQS can proceed apace. In practice the

General Use then becomes a default placeholder until an assessment of the "correct" TALU tier can be made.

Table 4-1. Tiered aquatic life use options based on evaluation of default uses currently in the Minnesota WQS and under a new system of tiered aquatic life uses (TALUs).

Current Designated Aquatic Life Use	Monitoring Results	Attains Designated Use?	Management Options Under New TALU-Based Approach
General[3]	**General Use Attainment**	YES	Retain General designation because biocriteria demonstrate attainability.
General	**General Use Non-attainment**	NO	If habitat assessment indicates General is attainable, then retain General use; OR If habitat is impaired & due to 40CFR131[g] factors, change use to Modified or Limited
General	**Exceptional Attainment**	YES	Revise use to Exceptional based on attainment of Exceptional biocriteria by *both* assemblages.
Class 7[4]	**General Use Attainment**	YES	Revise use to General based on attainment of General biocriteria by *both* assemblages.
Class 7	**General Use Non-attainment**	?	If habitat assessment indicates General is attainable, then revise to General use; **OR** -- if habitat is impaired & due to 40CFR131 [g] factors, change use to Modified or Limited[5].

The scenarios in Table 4-1 that start with either the applicable General (equivalent to the current 2A or 2B uses) or the Class 7 designated uses are the only options that can realistically

[3] General – either a General Warmwater or General Cold Water use designation.
[4] Class 7 will remain in place until a site-specific use determination is made.
[5] Limited will be assigned only when Modified is not attainable.

occur. As indicated before, the principal objective of a TALU-based monitoring and assessment program is to determine if the current designated use is appropriate and attainable, which will be either one of the General (2A or 2B) or Class 7 uses in nearly every case. Hence the biological assessment and the attendant habitat assessment tools will be essential in making this determination. If the General Use biocriteria are attained then that is the "best" demonstration that the General Use is attainable at a minimum. If the Exceptional Use biocriteria are attained *by both assemblages,* then that is justification for assigning an Exceptional Use. Both are consistent with the definition of existing use in 40CFR Part 131.1 as:

> *". . . those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards."*

If the General Use biocriteria are not attained, then the accompanying habitat assessment is used to determine if the habitat quality is capable of supporting the General Use. If habitat is sufficient, then General will be the assigned use. If habitat is not sufficient, then the UAA process is employed to determine if there are precluding factors under the EPA WQS regulations (40CFR Part 131.10[g]) that are essentially "permanent" preclusions to General Use attainment. In this case the options are to either effect proven restoration techniques or assign the Modified or Limited Use designations.

4.3.2 TALU Implementation Process Overview

The preceding description of the generally available TALU management options did not convey all of the important details about how TALU is to be implemented on a water body specific basis in Minnesota. The more detailed implementation process is described herein and focuses on a hierarchy of decision points that are described in Figures 4-1 through 4-3. Figure 4-1 is an overview of the first steps of the implementation process that starts with utilizing the results of the supporting biological assessment.[6] The design and execution of the sampling and analysis must be adequate for supporting the analytical and decision-making tasks that are a part of the TALU implementation process - it is an expected part of any state TALU process. The possible steps herein are consistent with the options described in Table 4-1.

4.3.2.1 Step I: Initial Application of Bioassessment in a TALU Process (Figure 4-1)

The initial decisions in Figure 4-1 focus first on biological status, specifically if the General Use biocriteria are attained or not. The reason for this is that the General Use biocriteria are the minimum condition that meets the baseline goal of the CWA, i.e., "the protection and propagation of fish, shellfish, and wildlife". This benchmark is also important because it determines the point at which a UAA is required even though the entire process that is outlined herein is "UAA like" and requires consideration of the same types of data and analyses. If the General Use biocriteria are fully attained by both assemblages, then this use will apply because meeting this
benchmark of attainability has been directly demonstrated. If biological attainment of the

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[6] A biological assessment as used herein includes biological indicators and chemical/physical indicators collected by following the adequate watershed monitoring and assessment approach discussed in Section 4.2.

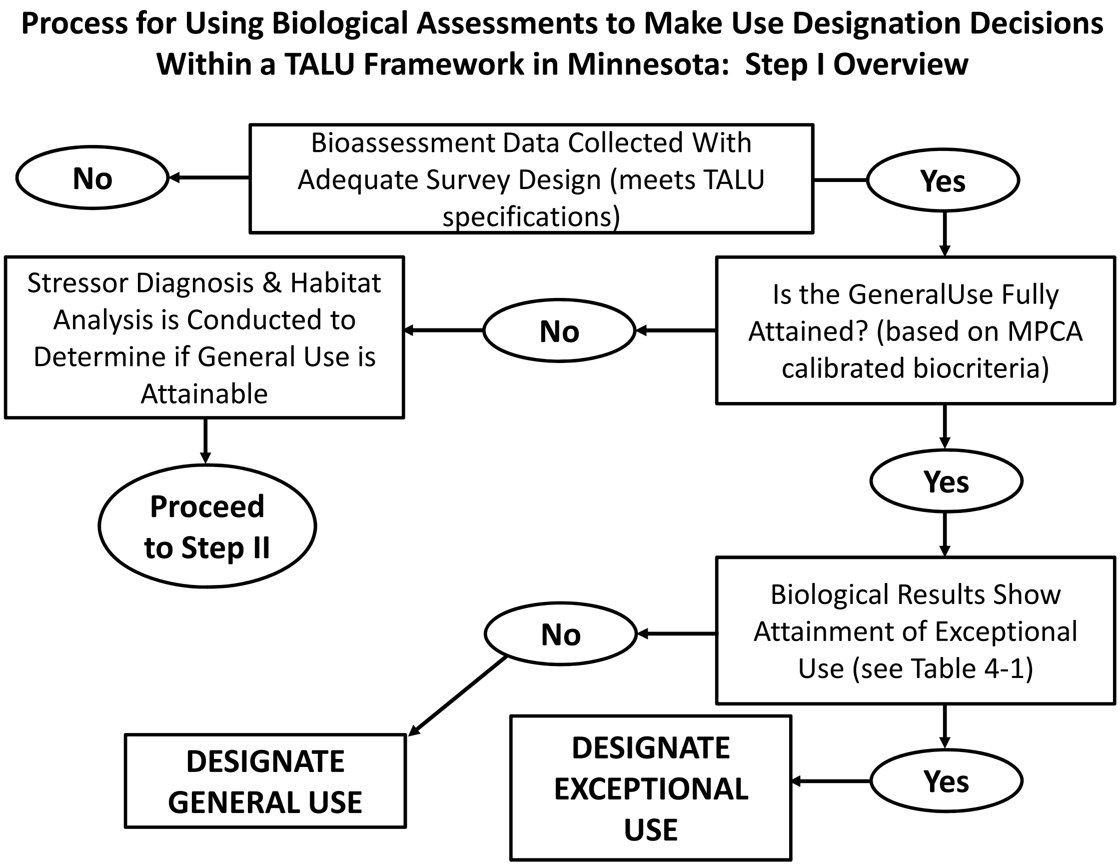


Figure 4-1. Step I: overview of the process for using biological assessments to make use designation decisions in Minnesota based on the proposed TALU framework.

Exceptional Use biocriteria is demonstrated *by both assemblages,* then this use is designated because the attainability of this TALU tier has likewise been demonstrated. Again, each is consistent with the definition of existing use in 40CFR Part 131.3. The Exceptional Use is unique among the TALU tiers in that it requires a showing a biological attainment to be designated as such. Hence it functions as a *preservation use* within a TALU framework, whereas General Use is by comparison a *restoration use.* Hence, attainment of either the General or Exceptional Use biocriteria triggers a straightforward decision to designate those uses (as is also indicated in Table 4-1). Non-attainment of the General Use biocriteria triggers a stressor diagnosis approach that is inherent to a TALU-based program in order to determine if General Use is attainable. This leads to step II -- the process is described in Figure 4-2.

4.3.2.2 Step II: Determining Limitations to General Use Attainment (Figure 4-2)

A finding that the General Use biocriteria are not attained leads to step II (Figure 4-2). The habitat assessment that is conducted as part of the biological assessment is now relied upon to provide the information and analysis that is needed to determine if General Use is indeed attainable. At this point in the process we are simply determining if the attributes of the extant

Process for Using Biological Assessments to Make Use Designation Decisions Within a TALU Framework in Minnesota: Step II

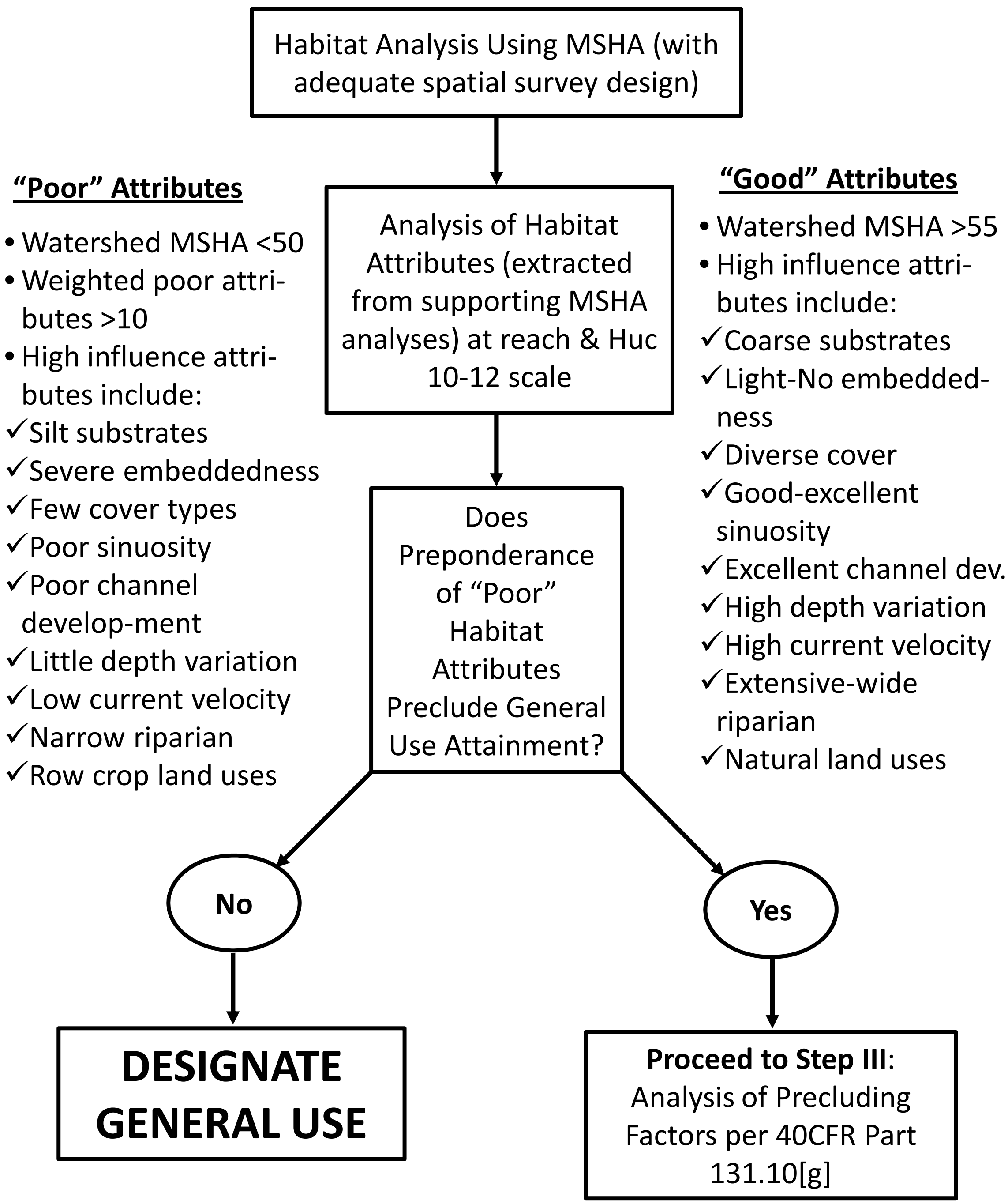


Figure 4-2. Step II: using the analysis of habitat attributes to make decisions about General use attainability.

habitat are sufficient to support biological assemblages consistent with the General Use biocriteria. This requires the use of the supporting analyses of the relationship between MSHA habitat attributes and the biological assemblages that yield sufficiently predictive relationships such that biological attainability can be determined. This descriptive work was accomplished at the stream and river class level utilizing the extant MPCA database and across a sufficiently diverse gradient of habitat quality from very poor to excellent conditions (Rankin and Yoder 2011).

Precedents already exist for this type of process and include the Ohio QHEI analyses by Rankin (1989, 1995). The Minnesota analyses yielded thresholds of MSHA scores that generally correspond to General Use attainment and identified which MSHA attributes provide for a *sufficiently accurate* prediction of General Use attainability. These attributes are expressed as "good" and "poor" attributes (Figure 4-2) the former being comprised of attributes that accumulate to promote biological attainment and the latter having the opposite effect, i.e., those attributes that deter biological assemblages consistent with General Use attainment. The MSHA thresholds and attributes derived for Minnesota (Rankin and Yoder 2011) are used in Figure 4-2. For example, a MSHA score ≥55 is an indication that General Use is attainable, but a score <50 indicates that biological attainment of General Use is less likely. Added to these index thresholds are the occurrence and preponderance of good and poor habitat attributes which help sharpen the decision about General Use attainability. Once this information is analyzed on a reach level basis, a decision about General Use attainability in the absence of direct General Use biological attainment can then be made. If the analysis indicates that habitat is not limiting, then General Use is the resulting decision. However, if the analysis indicates that the habitat attributes are insufficient and therefore limiting then an analysis of the precluding factors consistent with 40CFR Part 131.10[g] is performed (proceed to Step III, Figure 4-3). This process is formally known as a Use Attainability Analysis or UAA.

4.3.2.3 Step III: Use Attainability Analysis (Figure 4-3)

A use that is "lower" than what is recognized as consistent with the CWA, i.e., General Use or higher in Minnesota, can be assigned provided an acceptable UAA is conducted. A UAA is defined as

> *". . . a structured scientific assessment of the factors affecting the attainment of the use which may include physical, chemical, biological, and economic factors as described in §131.10[g]."*

Those criteria are as follows:

40CFR Part 131.10[g]: States may remove a designated use which is not an existing use, as defined in Section 131.3, or establish sub-categories of a use if the State can demonstrate that attaining the designated use is not feasible because:

1) *Naturally occurring pollutant concentrations prevent the attainment of the use; or*

2) *Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or*
3) *Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or*
4) *Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use; or*
5) *Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or*
6) *Controls more stringent than those required by sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact.*

Process for Using Biological Assessments to Make Use Designation Decisions Within a TALU Framework in Minnesota: Step III

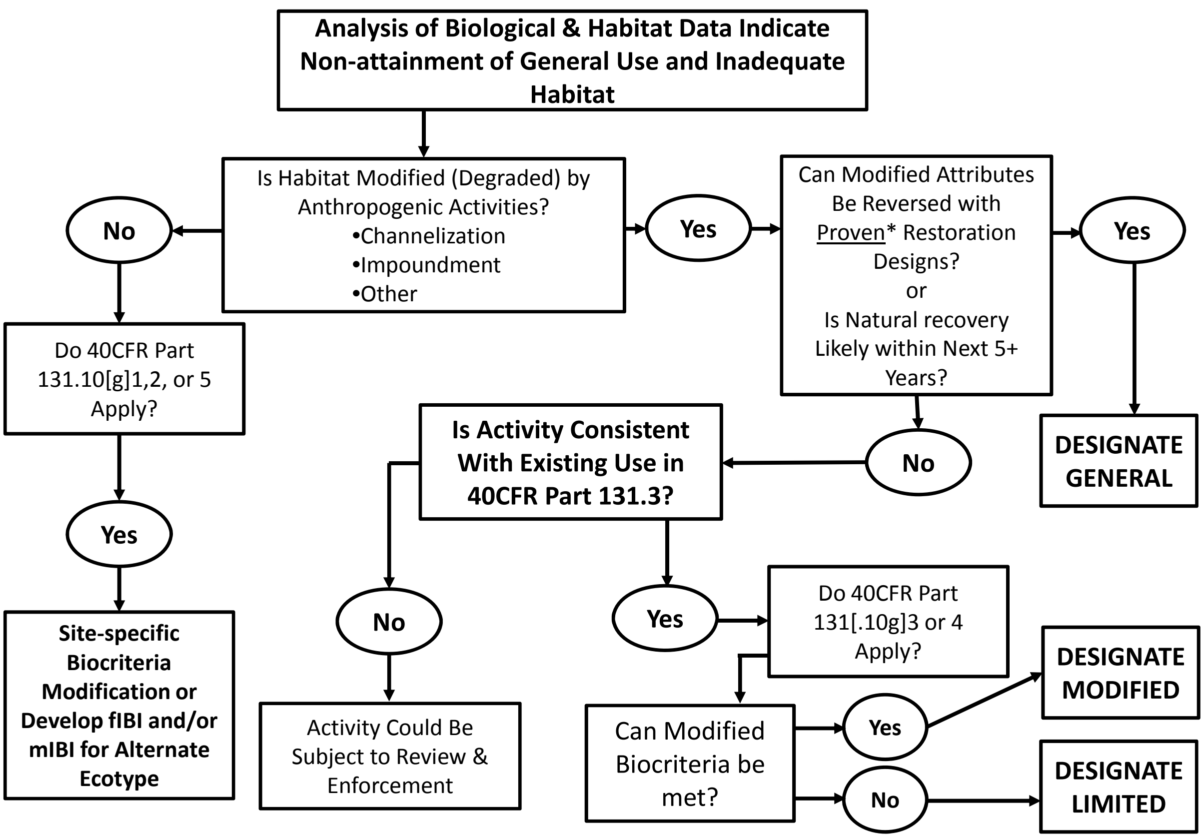


Figure 4-3. Step III: overview of the use attainability analysis parts of the use designation process in Minnesota.

The process arrives at this point because the biological assessment revealed non-attainment of the General Use biological criteria and the analysis of habitat attributes showed habitat to be deficient for supporting biological assemblages consistent with General Use. Since we have already determined that attributes of habitat are insufficient to support General Use, the next task is to determine the "origin" of the deficient habitat, i.e., is it of natural or of anthropogenic (i.e., human action) origin? If it is determined not to be the result of anthropogenic activities, then a determination of whether 40CFR Part 131.10[g][1], [2], or [5] apply is needed. These are considered to be "natural factors" that could preclude attainment of the General Use biological criteria. It would also suggest that either a site-specific modification of the biocriteria is needed or consideration of an alternate ecotype with a distinct biological assessment tool or index is needed. If this phenomenon is encountered on a regional or ecotype basis then the latter option is preferred. In all likelihood the stream and river class-specific development of the biological indices thus far should have "captured" most of these natural factors, but the process is available should something have been overlooked.

We expect almost any habitat caused non-attainment of General Use in Minnesota to be related to anthropogenic habitat impacts that are either of recent or legacy origins. If this is the case then it next needs to be determined if the habitat alterations can be reversed with *proven* restoration designs or if they are of recent enough origin that they are eligible for an enforcement action. By "proven" we are referring to restoration designs that have been shown to restore biological assemblage quality consistent with the General Use biological criteria endpoints and supported by an analysis of restored MSHA attributes. Simply assuming the General Use will be attained because a restoration activity has been undertaken is alone insufficient to satisfy this part of Step III. If there are indeed *proven* designs and these are effectively implemented then General Use could be deemed as attainable. If no restoration actions have been taken or are as yet unproven then the remaining parts of 40CFR Part 131.10[g] will need to be considered.

In Minnesota we expect that the majority of habitat alterations that lead to UAA considerations will most commonly include channelization in support of agricultural row cropping, channelization and other modifications designed to deal with surface runoff in urban settings, and possibly impoundment of riverine habitats by "run-of-river" low head dams (although these are currently not targeted for sampling by MPCA). Each of these has been shown to not only alter habitat such that CWA goals cannot be attained, but also can result in essentially permanent modifications. This is exemplified in 40CFR Part 131.10[g][3] and [4] in that these modifications are due to human actions that are perpetual in their tenure (e.g., [g][3]) and which represent hydrological modifications that cannot be operated in a manner consistent with the General use (e.g., [g][4]). If the actions are consistent with these parts of 40CFR Part 131.10[g] then either the Modified or Limited Uses will be designated. The distinction between Modified and Limited is largely based on the attainability of the Modified biological criteria which are less stringent than the General use biocriteria. A Limited Use biocriteria benchmark equivalent to the 75th percentile of BCG tier 6 is recommended.

4.3.3 Pilot TALU-Based Watershed Assessments

Using the just discussed TALU guidance framework and the technical tools developed to support this process, pilot testing was conducted with MPCA staff using 3 theoretical watersheds as a test of the framework and to determine the limitations of the current spatial monitoring design. The examples include watersheds with a mix of use attainment status (attaining and not attaining), use designation assignment recommendations, monitoring data, and land uses.

4.3.3.1 Agricultural Watershed

In this example there are 4 biological sites in an approximate 25 mile long reach of the primary stream and one location each in two tributaries. The results of applying a TALU framework shows that the General Warmwater Habitat (GWH) subcategory of the General Use suite of uses is the appropriate and attainable aquatic life use in the lower watershed. This is because of the consistent attainment of the General Use biological criteria for this stream class (Figure 4-4). It illustrates the process when biological attainment of at least the General Use occurs (see Fig. 4-1). The example also includes biologically impaired sites (with respect to the GWH biocriteria) that have sufficient habitat to confirm the GWH use where the MSHA indicates sufficient good quality attributes. Hence the restoration goal for these sites is to recover GWH attainment. Two sites in the upper watershed are biologically impaired due to channelization effects on stream habitat. In both cases the MWH use is recommended as the outcome of a UAA. The circumstances and the activities that resulted in the channelization meet the criteria for setting a use lower than the CWA minimum as described in Section 4.3.2. This example also includes unassessed reaches in the upper watershed where the designation will remain at the default use of GWH until sufficient data is collected to show otherwise.

4.3.3.2 Urban Watersheds

The second example is for a watershed predominated by urban land uses (Figure 4-5). In this example there are 3 biological sites on the primary stream and three sites on tributaries. The results indicate non-attainment of the applicable General use biocriteria at all six sites. The two downstream most sites exhibited sufficient habitat to attain the General use hence GWH was retained. At the remaining 4 sites habitat was found to be limiting GWH attainment due to channel modification activities. The Modified Warmwater Habitat (MWH) use is recommended for three of these sites and in accordance with the process in Figures 4-2 and 4-3. At one site flow limitations were such that the Limited use is recommended. The MWH designations were extended upstream only through the channelized reaches thus the unassessed upper portion of the watershed was assigned GWH as a default placeholder.

4.3.3.3 Forested Watershed

The third example is from a predominantly forested watershed with few anthropogenic impacts (Figure 4-6). In this example there are 4 biological sites, 3 on the primary stream and one on a tributary. In this case example the use designation decisions are based on attainment of the General and Exceptional use biocriteria. The downstream most sites attain the Exceptional Warmwater Habitat (EWH) use hence that use was recommended following the process in

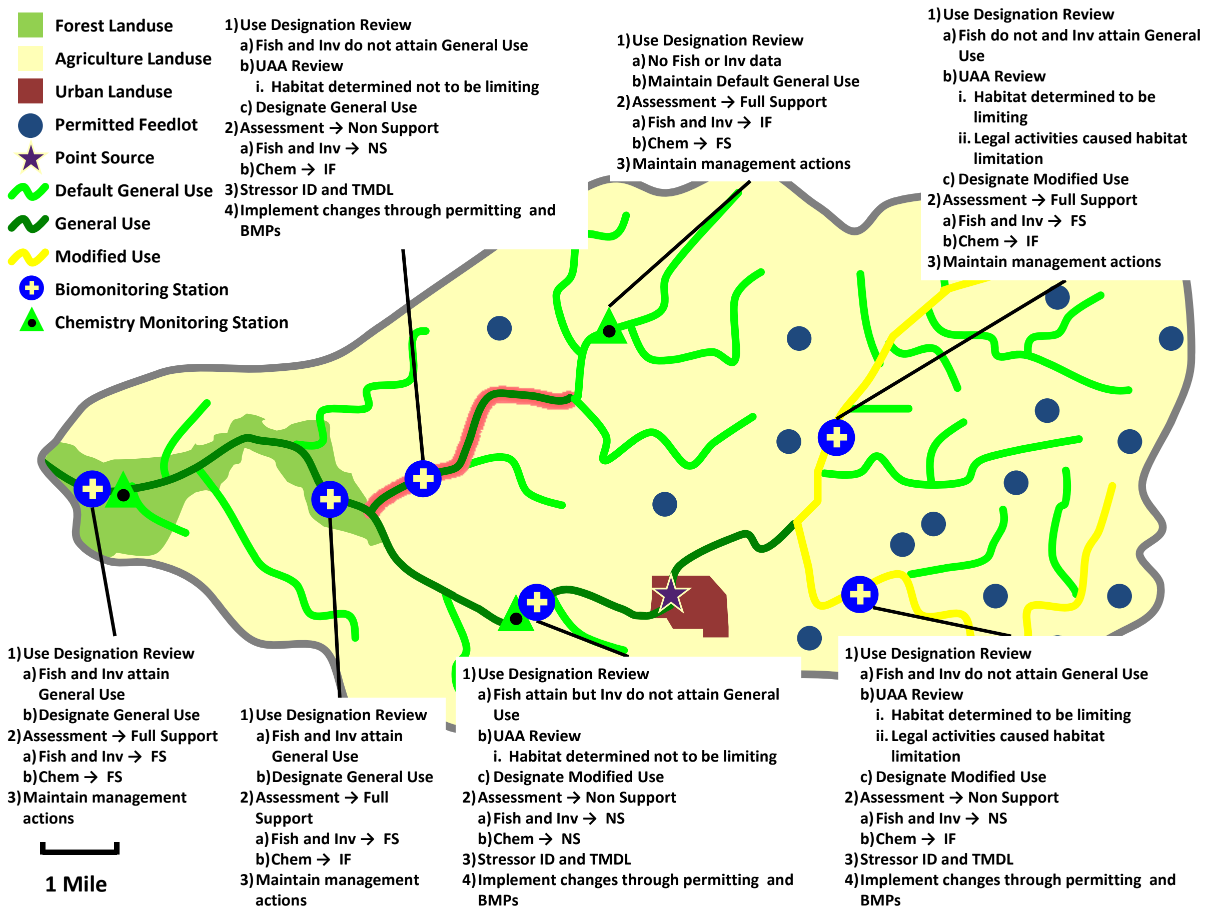


Figure 4-4. Results of applying the MPCA TALU assessment framework in a watershed predominated by agricultural land uses. The result of applying TALU at six sampling locations is described. Sampling sites are indicated by a ✪ symbol.

Figure 4-1. In this case both the fish and macroinvertebrate assemblages met the EWH biocriteria. At the upstream most site fish met the EWH biocriteria, but the macroinvertebrates met GWH, hence the GWH use was retained. The tributary site showed GWH attainment thus confirming that use tier. Several other tributaries were not sampled and are thus considered as unassessed hence the default GWH use was retained.

These three examples generally demonstrate how the designation of the TALU tiers will be conducted as a first step in using bioassessments to first evaluate the appropriateness of the currently assigned aquatic life use, make recommendations for the appropriate TALU-based use, and then conduct the assessment of status based on the recommended TALU tiers.

4.4 Checklist of Technical Tools & Needs

An inventory or checklist of technical tools and needs is discussed here in response to the ongoing development of a TALU-based framework in Minnesota. Some of this has already been accomplished by the evaluation of the Region V state programs (MBI 2004, 2010) and by the

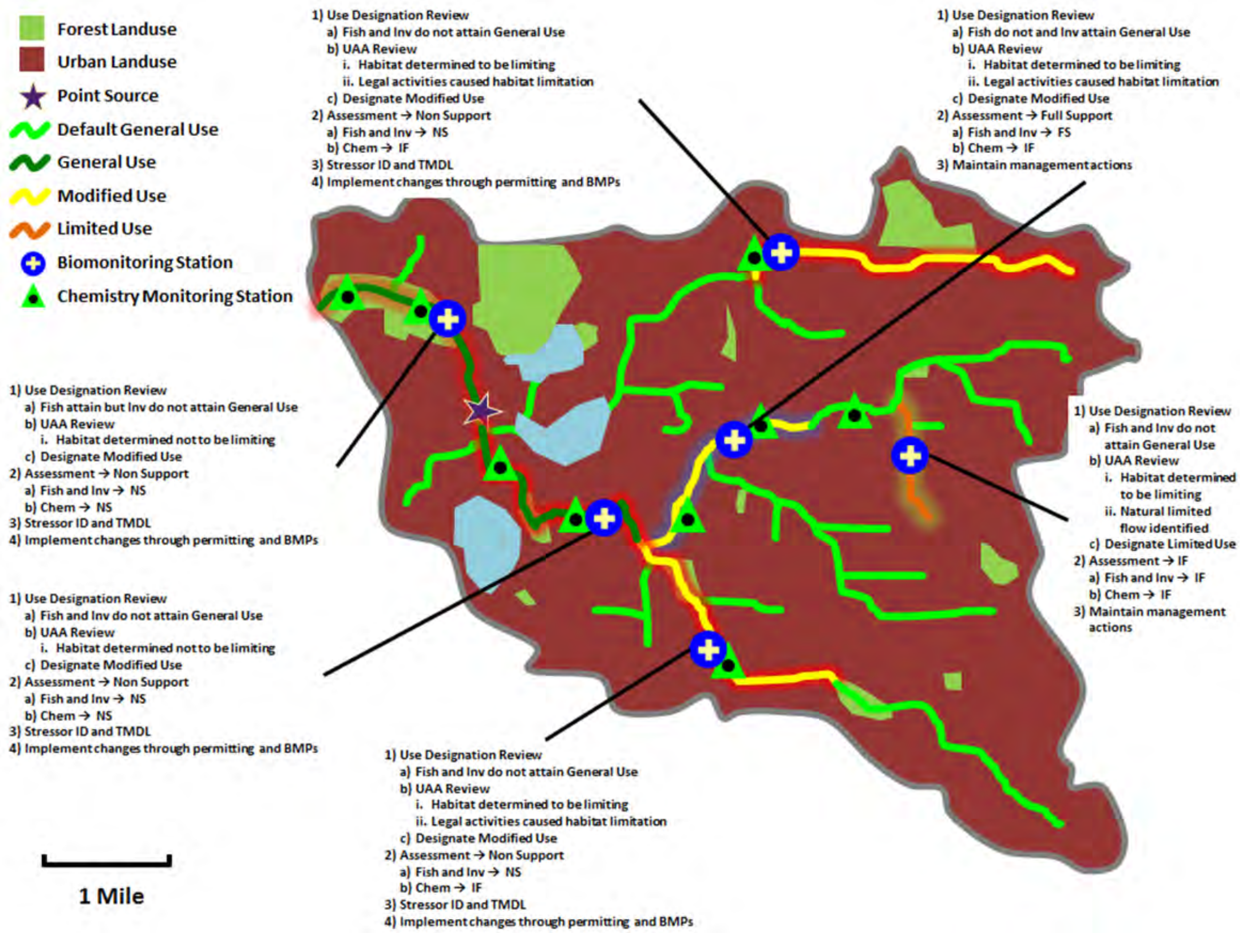


Figure 4-5. Results of applying the MPCA TALU assessment framework to a predominantly urban watershed. The biocriteria attainment status is indicated (GWH Attain) as is the use designation decision for the assessed portion of the streams in the watershed. Sampling sites are indicated by a ⊕symbol.

ongoing critical elements process (Yoder and Barbour 2009; Barbour and Yoder 2008). It should be noted here that the latest critical elements evaluation was based on information as of the 2010 Region V review and that was done as a "desk top" evaluation. A more formal process with the MPCA program needs to be updated to ensure that all developments are captured and understood and in context with the need for a level 4 program to implement a TALU-based approach. The critical elements and state evaluation process is an effective tool for determining the preparedness of a state to implement a TALU-based approach and we recommend that it be updated here to determine if the MPCA is "TALU ready". A mid-level 3 program is needed *at a minimum* to effectively execute a TALU framework and level 4 is the most comprehensive and reliable for that and other purposes including the determination of attainment and non-attainment, stressor identification, and the proper execution of the "UAA type" of process that is the primary driver of the TALU-based approach. The detailed work plan (Appendix A) was developed in part based on prior critical elements reviews conducted in 2002 and 2004 hence that process has influenced the awareness of the technical tools that are needed by MPCA to successfully implement a TALU-based approach.

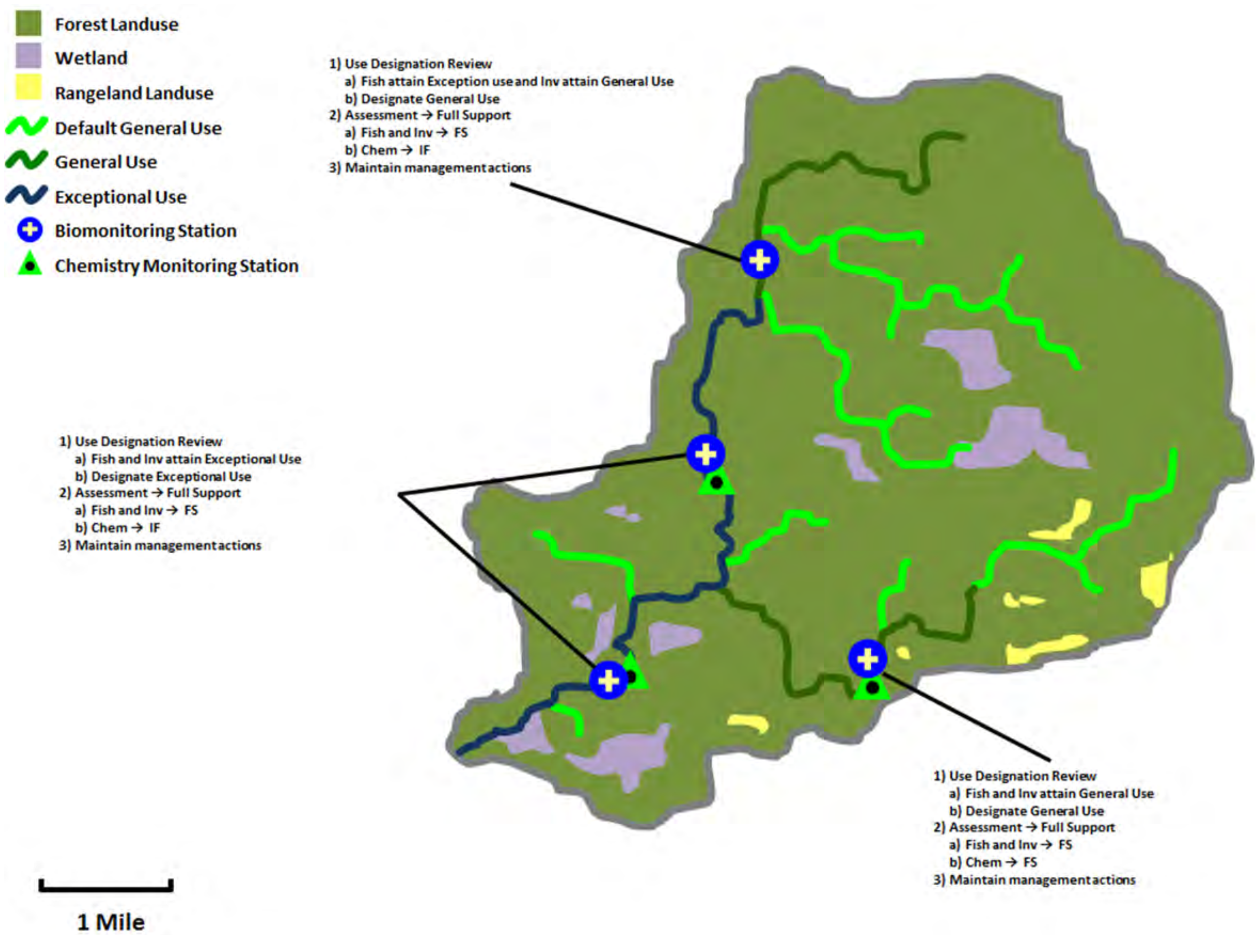


Figure 4-6. Results of applying the MPCA TALU assessment framework to a predominantly forested watershed. The biocriteria attainment status is indicated (EWH Attained and GWH Attained). Sampling sites are indicated by a ✪ symbol.

5. Incorporating TALU into Water Quality Management Programs

The "TALU-based approach" includes TALUs 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.

WQS are important determinants of both the direction and success of CWA management programs. As the principal custodians of CWA programs, states have the opportunity to determine the structure, content, and technical rigor of their WQS. As part of the state WQS, TALUs are an important component of all three of these aspects. This section focuses on how the adoption of TALUs in the Minnesota WQS might be expected to influence the direction and success of the MPCA CWA management programs.

A traditional view of how WQS affect management programs focuses exclusively on water quality criteria and how changes in these criteria within a "one-size-fits-all" framework will make management goals more or less "stringent". As such the perceptions about adopting a TALU structure in the WQS are "two-dimensional" in that changes in uses have the certain effect of stratifying water quality criteria which then translate directly to more or less stringent management goals and requirements. However, TALU also merges M&A with WQS and their application and as such results in multidimensional effects such that changes in TALU tiers are not necessarily accompanied by corresponding and proportionate changes in the application of water quality criteria. Regional, watershed, reach, and site-specific factors become more important dimensions as they are incorporated into and reflected by M&A results and as such will have a strong bearing on the application of WQS to specific sources and practices. Because a TALU-based approach includes more dimensions and factors than the traditional two-dimensional application of WQS the potential for outcomes that are governed more by regional and watershed level influences are now important considerations. The MPCA biological criteria will be structured into the Minnesota WQS and within the TALU framework. The biological criteria provide an ecologically derived endpoint that directly reflects attainment/non-attainment of designated aquatic life uses. As such, the "starting point" in the application of TALUs is the receiving water body whereas the starting point in traditional water quality management is the regulated activity.

A TALU-based approach when properly developed and implemented is a "modernization" of traditional approaches to setting and implementing WQS. What we term here as the traditional approach to WQS that has emanated from the early 1970s will be significantly modernized by the development and implementation of a TALU-based approach. The incorporation of biological criteria that are in turn defined by the specificity of the TALU tiers represents not only a technical improvement in the measurement of designated aquatic life use attainment, but is an opportunity to address the reality of multiple stressors as opposed to a single parameter or pollutant focused approach. As such it incorporates the concept of pollution[7] into assessments of condition and provides an opportunity to address the key stressors that are the most determinant of biological condition as a result of the accompanying stressor diagnosis aspects of TALU. This in turn better informs water quality management programs about not only which problems to address, but how to better address them from a pre-emptive standpoint. The details about how to develop the designated use language, the biological criteria application language, and the incorporation of biological criteria so that better management outcomes are assured were described in sections 3 and 4.

Figure 5-1. Major State CWA Management Programs and Their Primary Components

Basic Reporting	√ Status √ Trends
TMDLs	√ 303[d] listing √ TMDL dev. √ TMDL effect.
WQS	√ Uses √ UAA √ Criteria √ Antideg.
NPDES	√WQBELs √ Compliance √ Stormwater √ CSO/SSO
Other Permit	√ 401/404 √ State permits
Watersheds	√ NPS mgmt. √ BMP effect. √ Habitat √ Flow √ Priority setting √ Source water

5.1 CWA Management Programs Affected by TALU

WQS ultimately set the goals for management programs through the designation of uses and they provide for the chemical, physical, and biological endpoints that are used to develop management strategies and determine their effectiveness. The major CWA management programs that are part of any state program include basic reporting, WQS, nonpoint source management, watersheds & TMDLs, and permitting. There are important and recognizable components of each of these programs (Figure 5-1) and each are either directly or indirectly affected by the detail in state WQS.

Despite a myriad of attempts over the past 25 years to outline and implement an environmental indicators driven approach to water quality management, the effectiveness of water quality management programs continue to emphasize administrative outputs. These outputs include the quantity and timeliness of activities such as permits issues, backlogs reduced, number of TMDLs, grants awarded, etc. The net result is what we term here as an Administrative Outputs based approach to water quality management in which the goals and measures are based solely on administrative actions (Figure 5-2). In this domain the goal is the performance of a management is judged primarily by attaining administrative accomplishments as measured by programmatic "outputs"[8]. For example, a

[7] The Clean Water Act defines *pollution* as human-induced alteration of waters caused by pollutants as well as non-pollutant agents, such as flow alteration, physical habitat alteration, and introduction of alien taxa [CWA section 502(19)]. *Pollutants* are selected substances that are defined by CWA Section 502(6).

NPDES permitting program is measured by the number of permits issued or re-issued, compliance assistance actions, and the quantity and timing of backlogs. The result of this emphasis is to improve the performance of the program by focusing on the execution of administrative tasks such as efficiency in permit issuance or reductions of backlogs. An environmental indicators approach envisions this shifting this to a resource end "outcomes"[9] based approach (Figure 5-2) where the goal is the attainment of designated uses, which includes aquatic life uses that are a key component of a TALU-based approach. The measures are environmental and include biological, chemical, and physical indicator end-points each being used within their most appropriate role and indicators of stress, exposure, and response (Yoder and Rankin 1998). Under a TALU-based approach this means that the numerical biological criteria are the key response variable which is consistent with how they are defined and codified in the state WQS. Their relationship to other chemical and physical criteria is defined by the biocriteria application language that is a part of the TALU forged modernization of WQS. The overall results of this framework are made manifest when water quality management programs become a means to meeting biological condition goals, not an end in themselves.

Administrative Output vs. Resource Outcomes Based Management

	ADMINISTRATIVE OUTPUTS BASED	RESOURCE END OUTCOMES BASED
Goal:	**Program Performance** (Program execution)	**Environmental Performance** (Attain designated uses)
Measures:	**Administrative Actions** (Lists, Permits, Funding, Rules)	**Indicator End-points** (**Biological**, Chemical, Physical)
Results:	**Improve Programs** (Reduce backlogs, improve timeliness)	**Programs are Tools to Improve the Environment** (Admin. outputs evaluated by environmental end outcomes)

Figure 5-2. Administrative outputs are validated by an environmental based end outcomes approach that is fostered by a TALU framework (after MBI 2004).

States can best execute this approach when administrative program priorities have been sequenced with the monitoring and assessment schedule, usually with the latter being positioned to provide the necessary data and information far enough in advance of developing and then implementing management actions. This sequence especially allows for the designated uses under a TALU-based approach to be reconciled before management

[8] An output is a discrete administrative accomplishment such as the issuance of a permit or the completion of a TMDL, i.e., it counts the number of management program products.

[9] An outcome is a direct change in the receiving water body as indicated by a chemical, physical, or biological measurement or indicator. As such an outcome is related to an output by being its end result.

actions are designed and implemented. Too often, inadequacies in "one-size-fits-all" general designated uses are not apparent until the consequence of a management action is realized and perhaps too late to reconcile with a "UAA type" of process that is an embedded part of a TALU-based approach.

5.2 An Information Driven Approach to Water Quality Management

When fully designed and implemented, a TALU-based approach fosters an information driven process for developing and assessing the effectiveness of water quality management programs. While the logistics of such an approach first requires the right information to be available "in time" to affect water quality management programs, how such monitoring and assessment information is sequenced is also an important aspect. U.S. EPA has used Figure 5-3 extensively to illustrate the sequence of having monitoring and assessment information positioned so that it can affect the development and assessment of water quality management programs. While the sequence is essentially correct, this and like examples leave out critical details that are essential components of such a process.

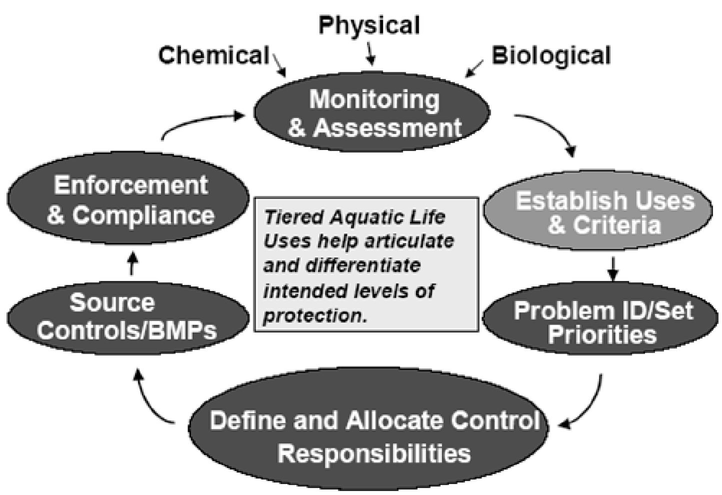


FIGURE 4-1. U.S. EPA Water Quality Based Approach to Pollution Control based on Chapter 7, Water Quality Standards Handbook.

Figure 5-3. The U.S. EPA depiction of how monitoring and assessment fits within a water quality based approach to pollution control and abatement (after U.S. EPA 2005).

5.2.1 Hierarchy of Surface Water Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators comprised of essential biological, chemical, and physical measures, can ensure that all relevant pollution sources are judged objectively and on the basis of environmental end outcomes. This integrated approach employs a hierarchical continuum that includes administrative and true environmental indicators with the latter arrayed in their "most appropriate roles" as indicators of environmental stress, exposure, and response, respectively (Figure 5-4). This framework was initially described by U.S. EPA (1995a). The framework includes six "levels" of indicators as follows:

Level 1 Actions taken by regulatory agencies (*e.g.,* permitting, enforcement, grants);

Level 2 Responses by the regulated community (*e.g.,* construction of treatment works, pollution prevention);
Level 3 Changes in discharged quantities (*e.g.,* pollutant loadings);
Level 4 Changes in ambient conditions (*e.g.,* water quality, habitat);
Level 5 Changes in uptake and/or assimilation (*e.g.,* tissue contamination, biomarkers, assimilative capacity); and,
Level 6 Changes in health, ecology, or other effects (*e.g.,* ecological condition, pathogenicity).

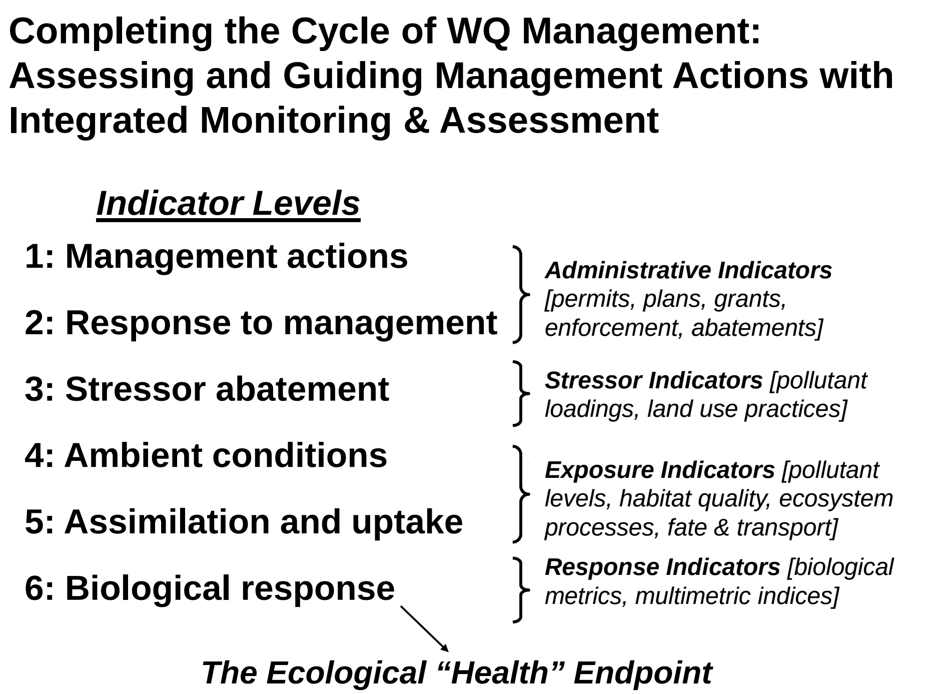


Figure 5-4. Hierarchy of indicators for determining the effectiveness of water quality management and maintaining appropriate relationships and feedback loops between different classes of indicators (modified from U.S. EPA (1995a).

In this process the execution of administrative activities (levels 1 and 2) are followed by changes in pollutant loadings and ambient water quality (levels 3, 4, and 5), all of which lead to measurable environmental "results" (level 6). The process is multi-directional with the level 6 indicators providing feedback about the completeness and accuracy of the process within the preceding hierarchy levels. While the U.S. EPA (1995a,b) hierarchy employs "point source" terminology, it is adaptable to nonpoint sources, other water resource issues, and media other than surface waters. Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators described by Yoder and Rankin (1998).

In order to supply this framework with the necessary biological, chemical, and physical data and assessments an adequate monitoring and assessment program that considers not only what is measured, but the spatial and temporal design of the data collection, the development and completeness of the chemical, physical, and biological indicators, the analytical and interpretive processes used to assemble the data and information into meaningful assessments, and the organizational infrastructure within which it is all accomplished is needed (Yoder 1998). As such, this overall framework includes more than the mere collection of environmental data, but rather emphasizes the development and thoroughness of the assessments that are constructed based on that data. This goes beyond the almost over-emphasized task of assessing statewide status and trends and includes the more detailed task of realizing the integration with water quality management programs on a day-to-day basis and ***at the same scale at which those management actions are applied.*** An important goal for a TALU-based framework is to have the effectiveness of individual water quality management actions and programs determined by environmental *end outcomes* as measured by the information and indicators gained from adequate monitoring and assessment. Inherently embedded in achieving this goal is the adequacy of the essential components of the water quality management infrastructure including WQS. This framework can support any water quality management program where the restoration of designated use attainment is the end goal.

5.2.2 Indicator Discipline – Adherence to Indicator Roles

An important factor in achieving the cost effective approach just described is using chemical, physical, and biological indicators in their most appropriate roles as stressor, exposure, or response indictors. The accurate portrayal of the condition of aquatic resources depends on wider development and use of response indicators and adequate spatial monitoring designs conducted at the same scale of water quality management. Part of the solution to these challenges is to use indicators within their most appropriate roles. The U.S. EPA Environmental Monitoring and Assessment Program (EMAP) first classified indicators as portraying stress, exposure, or response. Yoder and Rankin (1998) further organized the concept defining the most appropriate roles of parameters and measures when used in an adequate monitoring and assessment program. These are categorically described as follows:

Stressor indicators generally include activities and phenomena that impact, but which may or may not degrade or appreciably alter key environmental processes and attributes. These include point and nonpoint source pollutant loadings, land use changes, and other broad-scale influences that most commonly result from anthropogenic activities. Stressor indicators provide the most direct measure of the activities that water quality management attempts to regulate.

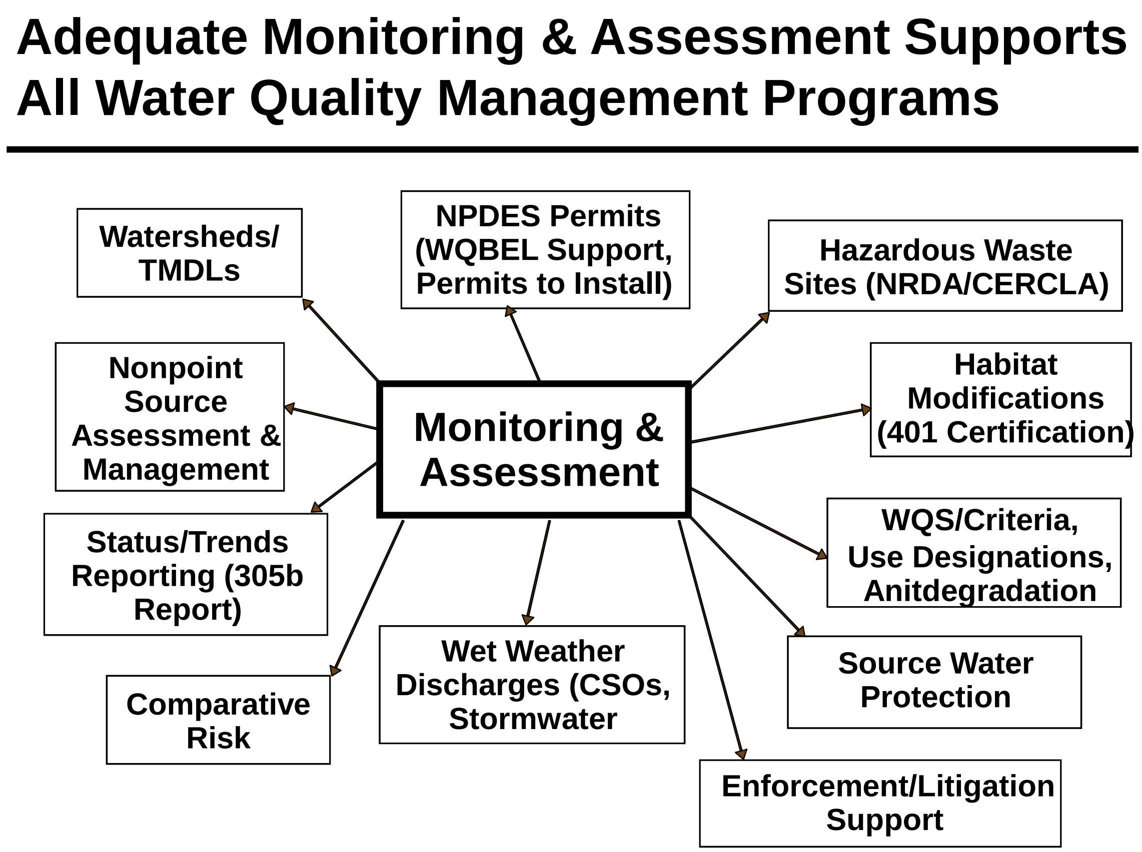
Exposure indicators include chemical-specific, whole effluent toxicity, tissue residues, and biomarkers, each of which suggest or provide evidence of biological exposure to stressor agents. Fecal bacteria also serve as exposure indicators and are used as surrogates for response where direct human response indicators are either lacking or their use would pose an unacceptable risk. These indicators are based on specific measurements that are taken either in the ambient environment or in discharges and effluents, either point or nonpoint source in origin are measures and parameters that reveal the level or degree of an exposure to a potentially deleterious substance or effect that was produced by a stressor event or activity. Chemical water quality parameters and the concentrations at which they occur in the water column fulfill this role. Water quality criteria for toxic substances are developed to indicate chronic, acute, and lethal exposures. Exceedences of these thresholds, either predicted or measured, provide design targets for planning and permitting and assessment thresholds for monitoring and assessment. Fecal bacteria fulfill this role as well, indicating the level of risk posed to humans and other animals by exposure to various levels and durations of potentially harmful pathogens.

Response indicators are measures that most directly relate to an endpoint of concern, i.e., ecological and human health. They are most commonly biological indicators, e.g., aquatic assemblage measures for aquatic life uses and human health for recreational uses and are the most direct measures of the status of designated uses. For aquatic life uses the assemblage and population response parameters that are represented by the biological indices that comprise biological criteria are examples of response indicators. For other designated uses such as recreation and drinking water, symptoms of deleterious effects exhibited by humans would serve as the most direct response indicator, albeit these might prove more difficult to develop and manage. Response indicators represent the synthesis of stress and exposure and are commonly used to represent overall condition or status. The key to implementing a successful indicators and watershed approach that serves as a basis for developing a synthesized "report card" is to ensure that indicators are used within the roles that are the *most appropriate* for each. The inappropriate substitution of stressor and exposure indicators in the surrogate role of response indicators is at the root of the national problem of widely divergent 305(b) and 303(d) statistics reported between the states (NRC 2001). Mapping these indicators to their functional role in monitoring and assessment is best visualized in the hierarchy of indicators depicted in Figure 5-4. This combines their role in a technical sense with their application is a management sense.

5.2.3 Strategic Considerations

Adequate monitoring and assessment is an inherently strategic process. To fully realize its benefits requires an understanding of the multiple uses of information in the management of water resources. A fundamental tenet of adequate monitoring and assessment is that the same set of core resources, methods, standards, data, and information should support multiple program management needs (Figure 5-5). It also requires a commitment to program maintenance and upkeep (i.e., maintenance of adequate resources, facilities, and professionalism) over the long term. Professionalism includes the qualifications of the monitoring and assessment personnel and their ability to carry out all tasks, including data analysis and the sequencing and interpretation of multiple indicators (see Figure 5-4). Indicator usage typically requires specialized expertise in terms of data collection, field observations, laboratory methods, taxonomic practice, and data analysis and interpretation skills. Thus the professional qualification of the personnel who execute and manage a program is a pivotal issue.

Adequate monitoring and assessment provides functional support to individual management programs in two important ways. The first includes "baseline CWA program support" tasks such as determinations of status at multiple scales, UAAs, supporting the regulation and management of specific sources, and providing information to guide watershed planning and restoration programs. The second is that of providing "CWA strategic support" via the systematic accumulation of data, information, knowledge, and experience across various temporal and spatial scales. This includes resources devoted to such tasks as sampling and maintenance of reference sites for determining regional reference condition and developing reference benchmarks for key biological, physical, and chemical indicators and parameters.



program support needs with the same core base of indicators, parameters, and designs.

Many contemporary management needs are not well supported by conventional approaches to water quality criteria and modeling, thus new ways of developing and applying benchmarks and criteria are needed. Developing criteria for nutrients and both clean and contaminated sediments are examples. Other issues such as urbanization and habitat concerns will require landscape and riparian level indicators and objectives. All require robust spatial and temporal datasets. Coupled with this is the need to conduct ongoing applied research and exploratory data analysis with the monitoring program datasets, including the aggregate experience of the program. The ongoing accumulation of data, information, and assessment across different spatial scales provides both the datasets and the assessment experiences. This comprises the strategy for delivering the criteria and benchmarks that will not be delivered by the conventional approach to developing national water quality criteria. Task 5 of the MPCA TALU work plan is an example of this process.

Finally, the recognition that the most important product of adequate monitoring and assessment is the assessment, not just the data, is critical to achieving success. Data by itself has limited usefulness to environmental decision-making unless it is converted to useful information. This means having decision criteria and benchmarks fully integrated into the monitoring and assessment program. It also means adhering to the indicator sequencing and linkage processes that were previously described and most importantly, using indicators within their most appropriate roles. An integrated assessment should serve the needs of multiple programs by the same set of assessments, without the need to generate new or different datasets for each and every management issue.

5.3 How TALU Can Affect Major MPCA Water Quality Management Programs

While we cannot now predict all impacts that the adoption and implementation of TALU will have on MPCA water quality management programs, some general conclusions and descriptions are possible. These are derived in part by knowing how TALU will affect current management processes and also how it has worked where TALUs have been a part of state programs for many years. We will follow the breakdown of major CWA programs as it is depicted in Figure 5-1.

5.3.1 Monitoring and Assessment

Monitoring and assessment is a key component of a TALU approach, but it is also a major CWA program function. States are expected to develop and implement a monitoring strategy that covers the next 10 years of development and implementation. U.S. EPA guidance (U.S. EPA 2003) specified 10 elements that each strategy is to include. MPCA accomplished this recently with their update to the Minnesota Monitoring Strategy (MPCA 2011). The document is both comprehensive and thorough in its attempt to reflect the U.S EPA (2003) guidance. While the strategy describes a stratified approach to the spatial design of surface water monitoring it does not fully describe the TALU specific aspects primarily because it is currently in development. The initial pilot testing described in Section 4 revealed some technical items with monitoring design that includes the following considerations:

1. Spatial density of sampling sites in some watersheds should be improved for assessing the assignment of TALU tiers in selected rivers and streams – this should also improve the delineation of pollution gradients;
2. Having data on both biological assemblages was not available for every site (although it was available at most) – this should be done as a matter of practice given the dual assemblage approach that TALU requires;
3. Chemical/physical data was not able to be paired with every biological site and in some cases this totaled multiple sites in some watersheds – chemical/physical data will need to be paired with biological data and at a sufficient frequency; and,
4. Intensive surveys of specific stream and river segments to assess specific point sources or localized aggregations of impact sources is not included and is only infrequently employed.

These highlight where some modification or supplementation of key aspects of the MPCA monitoring design will be needed and determining this is an important part of the development process and ultimately TALU implementation.

A template for an annual watershed assessment process is depicted in Table 5-1 from the selection of specific watersheds for assessment through detailed study planning, field sampling, data management, data analysis, and reporting are described in their respective sequence.

Table 5-1. Important timelines and milestones in the planning and execution of a watershed assessment process on an annual basis in support of a TALU-based approach.

Timeline	Milestone
December - February: (Months 1-3)	Initial screening of the major hydrologic areas takes place by soliciting input from the various program offices and other stakeholders.
February - March: (Months 3 thru 4)	Final prioritization of issues and definition of specific study areas. Resource allocation takes place and study team assignments are made.
March - May: (Months 4 thru 5)	Study planning takes place and consists of detailed map reconnaissance, review of historical monitoring efforts, and initial sampling site selection by the study team. Final study plans are reviewed and approved.
May - June: (Months 5 thru 6)	Final study plans are used to develop logistics for each field crew. Preparations are made for full-scale field sampling.
June - October: (Months 6 thru 10)	Field sampling takes place with field crews operating somewhat independently on a day-to-day basis, but coordinated by the study plan and the team leader. Study team communication takes place as necessary, especially to resolve unexpected situations.
October - February: (Months 10 thru 14)	Laboratory sample analysis takes place for chemical and biological parameters. Raw data is entered into databases for reduction and analysis. The study team meets to review the information base generated by the field sampling and to coordinate the data analysis and reporting effort.
November - May: (Months 11 thru 17)	Information about indicator levels 3-6 is retrieved, compiled, and used to produce analyses that will support the evaluation of status and trends and causal associations within the study area. Integration of the information (*i.e.,* assessment) is initiated.
May - December: (Months 17 thru 24)	The assessment process is completed by producing working copies of the assessment for review by the study team and a final edit for an internal peer review. Final assessment approved by management for use within and outside of the agency. It is used to support 305b /303d, NPDES permitting, water quality standards (*e.g.,* use designation revisions), and other programs where surface water quality is of concern.

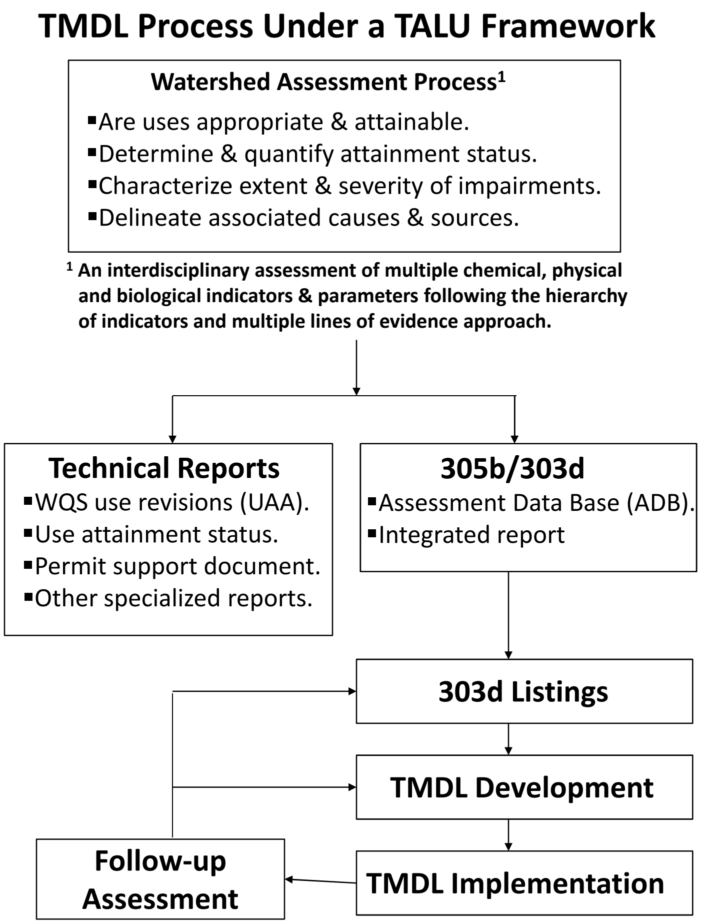


Figure 5-6. Key steps in a TMDL implementation framework within a TALU based framework.

5.3.2 Total Maximum Daily Loads (TMDLs)

The anticipated effect of TALU implementation on TMDLs includes the obvious effect of adding biological assessments to the determination of impairments and the expectation that more and different impairments will be identified (Karr and Yoder 2004). However, the totality of the TALU approach and its influence on the design, conduct, and outcomes of monitoring and assessment will perhaps exert changes in the process of watershed assessment. That process and how it specifically relates to TMDLs is depicted in Figure 5-6. In this approach it is the watershed assessment that is the domain of the TMDL process beginning with the determination of the appropriate and attainable aquatic life uses. This is an essential prerequisite to the determination of impairment under TALU since the attainment/non-attainment biocriteria vary with the use designation tier and within the newly developed stream and river classifications. Instead of using a narrative biocriterion that was applied on a statewide basis, the new biocriteria under the proposed TALU framework are now more detailed and stratified across Minnesota. Hence what may have been considered impaired or not under the former approach may have a different result under the proposed structure of TALUs and biocriteria.

Also included in the watershed assessment process in addition to the use and impairment determinations are the characterization of the severity and extent of impairments and the delineation of causes and sources. While MPCA currently employs a process to delineate stressors associated with findings of impairment via an additional year of investigation, addressing the issue identified in Section 5.3.1 with the inequities of indicator coverage at each site should enable some impairments to be more readily diagnosed with that dataset. This issue certainly bears more detailed examination and pilot testing and it seems plausible to accomplish this in the initial stages of TALU implementation.

The key product of a TALU focused watershed assessment is a technical report that details the WQS use revisions including their location and the basis for any changes to existing assigned uses under the WQS. It also documents use attainment status in a logical array of how stream and river segments occur in the watershed and a summary of the causes and sources that are associated with the observed impairments. The assessment results can be arranged in a manner such that they are directly transferable to the 305b water body inventory (Assessment Database) and the Integrated Report. This information then supports the listing of impaired water bodies as required by the 303d process and the details of the assessment of biological, chemical, and physical data feeds into the development of TMDLs in response to the observed impairments. Ideally, TMDL implementation is followed afterward by follow-up assessments which then provide feedback to the TMDL listing and development process.

5.3.3 Water Quality Standards

While TALUs are a major aspect of state WQS once they are developed and adopted there are other parts of the WQS that can be affected by the TALU approach. This most commonly includes chemical and physical water quality criteria and the nondegredation policy.

5.3.3.1 Refined Water Quality Criteria

Both numeric and narrative water quality criteria can be affected by the adoption of TALUs in the state WQS. This mostly involves the "tiering" of criteria for selected parameters in accordance with the attributes ascribed by the TALU narratives. However, relying on the national criteria development methodology (Stephan et al. 1985) does not necessarily result in the derivation of tiered criteria for the different TALU tiers. The reason for this is that the Stephan et al. (1985) method relies on laboratory data for representative species that actually have data available and this never includes the entirety of an aquatic assemblage. In fact, these databases are usually overrepresented by species that are highly to intermediately tolerant of pollution, seldom including highly intolerant species members of these assemblages. In addition, the differences between TALU tiers are not completely explained by differences in species, but rather by shifts in the relative abundances between the same species. Because the representative species in the Stephan et al. (1985) all count as "equal" contributors, i.e., they are included on a presence/absence basis, the relative abundance influences are not accounted for in the traditional derivation of water quality criteria. Thus the species members of two adjacent TALU tiers may be similar enough that no differences are produced by the conventional method of deriving chemical criteria.

The alternate approach is to develop relationships between the biological criteria endpoints and field measurements of the parameter(s) of interest. Techniques to relate the response of the biological assemblages to single chemical/physical parameters have been developed and used to derive tiered criteria in concert with the adoption of TALUs. These include "wedge plot analysis" and more recently quantile regression (Terrell et al. 1996, Cade and Noon 2003, Bryce et al. 2008, Heiskary et al. 2010). An example using pricewise quantile regression or additive quantile regression smoothing is included in Figure 5-7 which was used as part of an analysis to develop nutrient criteria for rivers in Minnesota (Heiskary et al. 2010). A sufficiently robust spatial and temporal database of paired bioassessment and chemical/physical parameter specific data is needed to accomplish this type of criteria derivation. Furthermore, the full gradient of quality (excellent to very poor) as reflected by both the biological assemblage response and the chemical/physical parameter in question needs to be available. It is for this latter reason that only the most commonly occurring parameters are usually included in this type of process. This would include dissolved oxygen, ammonia-nitrogen, common heavy metals (Cu, Cd, Pb, Zn, Fe), and other parameters such as total suspended solids, total dissolved solids, sulfates, chlorides, and turbidity. This type of analysis is depicted in task 5 of the work plan described in section 1.

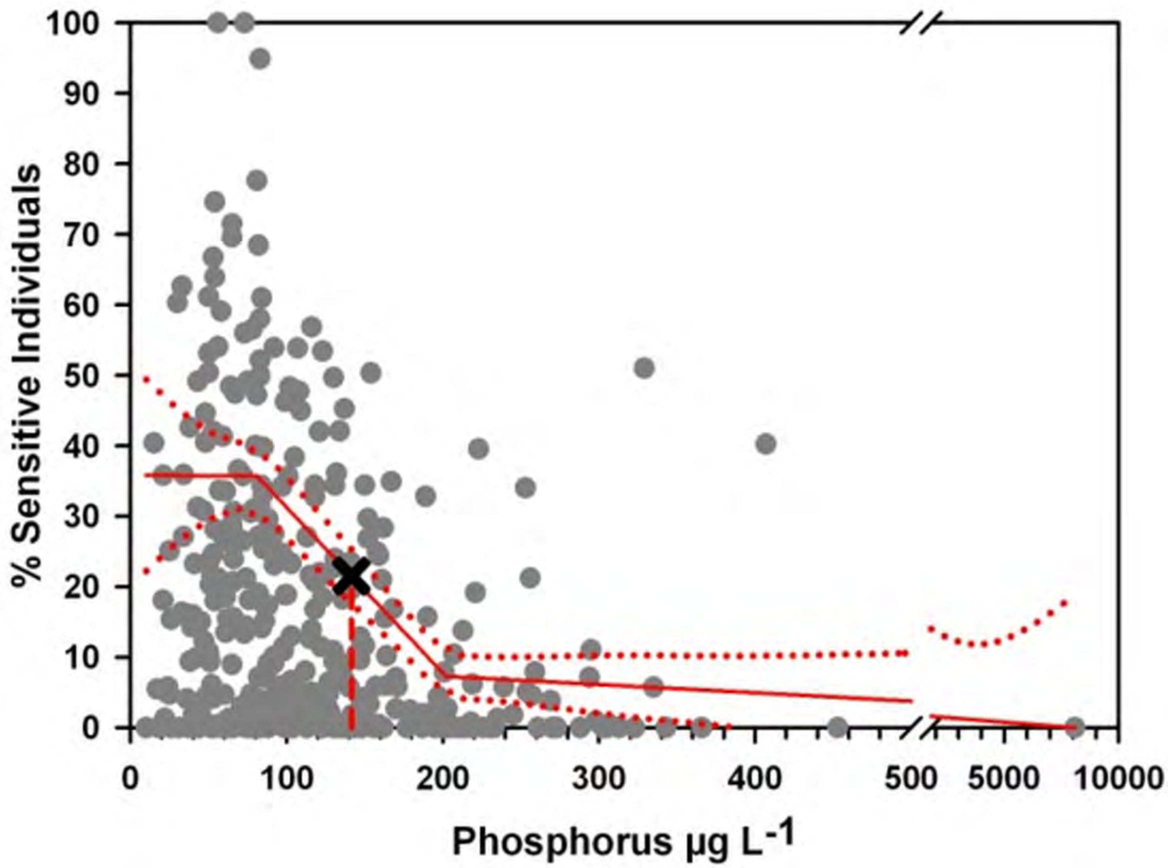


Figure 5-7. Example of 75th percentile additive quantile regression smoothing for percent sensitive fish for the Central Hardwood and Driftless Area ecoregions (solid line = AQRS fit; dotted lines = 90% confidence bands).

5.3.3.2 Antidegradation

TALU is also relevant to antidegradation in particular the assignment of specific water bodies to antidegradation tiers. The same biological data that is used to derive and implement the numeric biocriteria can be used for stratifying the antidegradation tiers while at the same time highlighting the occurrence of unique and sensitive species populations that otherwise may be "obscured" by the biocriteria indices alone.

5.3.3.3 Use Attainability Analysis (UAA)

Section 4.3.2 essentially described in detail a "UAA type" of process for using the results of bioassessment to determine if the currently applicable aquatic life use is both appropriate and attainable. In strict terms a UAA is employed when a use less than a CWA Section 101[a][2] use is being proposed, which in our case would be the Modified Warmwater Habitat (MWH) or Limited Resource Water use tiers (LRW). However, in a TALU-based approach the same data, tools, and stepwise process are used to answer the broader question about the applicability of the currently applicable use as defined by chapter 7050. As was discussed in Section 4.3, the starting point will almost always be class 2B (or class 2A in the case of cold water streams) which is roughly equivalent to the General Warmwater use tier. As such the same process will be used to assign a higher than CWA minimum use as it will to assign a less than CWA minimum use.

5.3.4 NPDES Permitting

The Nation's stream and rivers were grossly polluted by raw and under-treated wastewater discharges from industrial and municipal sources prior to the passage of the Federal Water Pollution Control Act (FWPCA) amendments of 1972. Referred to herein as the CWA it led to the institutionalization of a federal system of discharge permits known as the NPDES. This federal system of permitting developed out of a nearly quarter-century long legislative process that was spurred by an increasing recognition of visibly polluted rivers and streams both by the public and the research community. Pioneering works about the biological effects of water pollution included early studies by Bartsch (1948), Doudoroff and Warren (1951), and a series of studies compiled by the Federal Water Pollution Control Administration (Keup et al. 1967). These and many other investigations raised a keen public awareness about the grossly polluted state of many rivers and streams and spurred the development of legislation aimed at reducing and controlling the adverse impacts on public health, recreation, and aquatic ecosystem health.

The adoption of a TALU-based approach[10] by MPCA presents the opportunity to prioritize and streamline NPDES permit actions using ambient monitoring and assessment information with an emphasis on biological criteria as the key endpoint for determining overall permitting effectiveness. For the purposes of this project, permitting actions include the aggregate of permit development and issuance, compliance, and enforcement. Biological assessment includes the biological, chemical, and physical assessment of receiving waters on a river reach and/or watershed basis with biological criteria serving as the key response variable and as the arbiter of designated aquatic life use attainment. The process is generally illustrated in Figure 5-2 with a TALU-based approach representing the Resource End-Outcomes sequence. The current NPDES program represents the Administrative Outputs sequence with administrative outputs being used as the arbiter of program success.

Presently, the prioritization and effectiveness of NPDES permitting activities in Minnesota is based primarily on administrative processes, indicators, and measures. U.S. EPA and others have acknowledged the potential value of basing permitting and other priorities on ambient monitoring and assessment results *as they can be related to administrative actions*. The framework for a workable process (see Figure 5-4) first emerged out of prior U.S. EPA

[10] 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.

environmental indicators initiatives (U.S. EPA 1990, 1995) and selected pilot projects (Ohio EPA 1997). However, these frameworks have seen neither widespread application nor acceptance by EPA or the states. The lack of a broader and more creative use of ambient monitoring and assessment data and information for these purposes can be attributed to:

1) the lack of a sufficiently developed indicator process in the states;
2) the lack of sufficient and readily available monitoring and assessment data;
3) a cultural adherence to and preference for administrative measures and processes; and,
4) legislative mandates and management directives that reinforce and perpetuate a continued reliance on administrative processes.

In terms of the MPCA program, number 1 is being addressed via the adoption of biological indicators and numeric biocriteria. Number 2 is being addressed via the recommendation to add M&A designs that address specific point sources and in a manner that allows those assessments to serve as the environmental end outcomes in Figure 5-1. Number 3 can be addressed by more fully adopting an environmental end outcomes approach, but only if the right types of M&A data are brought to bear in receiving water assessments. If numbers 1-3 are addressed with MPCA, number 4 becomes a less relevant impediment especially since this new process is not a replacement of administrative measures. Those will continue to be a vital part of the overall NPDES permitting process. One of the first and most important baseline goals of a TALU-based approach is to provide direct support to NPDES permitting, thus the fundamental monitoring design will need to be sufficient for conducting retrospective analyses of the effectiveness of NPDES permitting over the preceding time period. Such an approach should serve as an important “reality check” on some of the administrative process improvements envisioned in the EPA report entitled *“Report on State-EPA Permit Re-engineering and Streamlining”* (October 28, 2002) and subsequent efforts to streamline NPDES permitting.

5.3.4.1 Spatial Survey Design

The key data and information requirements for a TALU-based approach are produced by adherence to the adequate monitoring and assessment framework that was previously described in Section 5.2. This underscores the multiple uses of the same data and indicators provided the spatial M&A design is adequate to the task. As such, multiple assessment issues can be simultaneously addressed by the same survey design. These include ensuring that the designated aquatic life use is appropriate and attainable, determining the severity and extent of impairments, and relating the relevance of sources to the observed impairments. If it is properly developed and executed a TALU-based approach should deliver assessments of specific point sources that fulfill the determination of the environmental effectiveness of NPDES permitting. Specific to this survey design is the recognition of how point source discharges affect the chemical/physical and biological characteristics of a receiving stream or river. Figure 5-8 illustrates a number of important concepts about how point sources of common constituents like oxygen demanding wastes (i.e., as measured by biochemical oxygen demand [BOD]) and ammonia-N react in a downstream direction via the process of pollutant fate and transport. At the same time, and depending on the discharged loadings and resulting instream concentrations, an effect on the dissolved oxygen (D.O.) regime is produced. Finally, the response of the aquatic assemblages can be measured against these chemical gradients and in proximity to the point source of these pollutants. Not only can the severity and extent of any impacts be measured, the type of response can also be visualized with this type of monitoring design. A response to toxicity is suggested by an immediate decline in the biological measures whereas a more D.O. driven response is suggested by a "delayed" response that corresponds to the D.O. "sag" that occurs some distance downstream as the effect of bacterial processing of excess oxygen demanding wastes occurs. The capacity to detect such "pollution gradients" is only possible by having an adequate survey design that employs a longitudinal pollution survey design as depicted in Figure 5-8. The typical "upstream/downstream" designs that have traditionally been used to assess NPDES permitted entities are simply inadequate for this level of characterization.

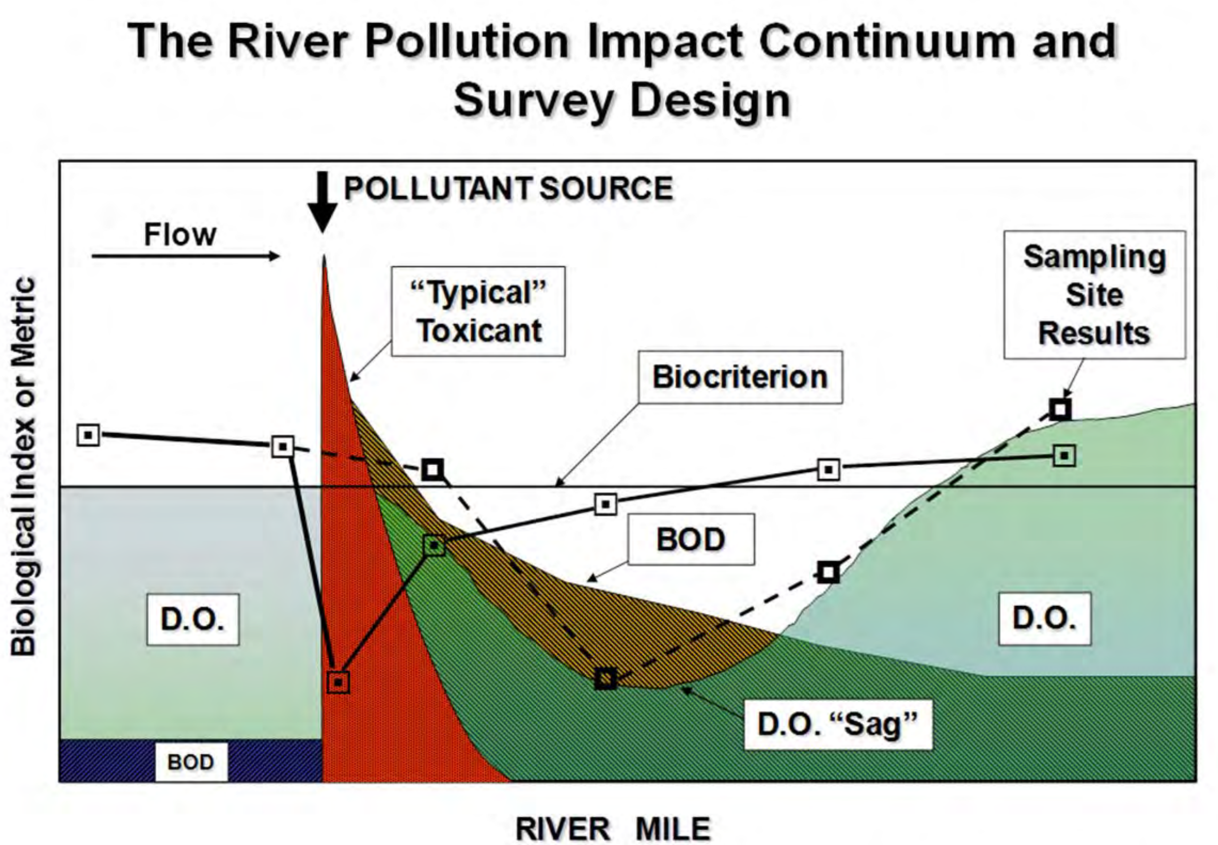


Figure 5-8. The river pollution impact continuum and survey design adapted from the original description of pollution zonation by Bartsch (1948). In addition to how pollutants typically react when discharged in a lotic system, suggested sampling design and two different biological responses are depicted.

Once an impact is characterized a stressor diagnosis process is then applied as part of a TALU-based approach. This consists of assessing multiple lines of evidence that relate to the observed biological impairment. This includes the process depicted in Figure 5-9 as an example of using affiliated tools such as biological response signatures (Simon 2003; Yoder and DeShon 2003; Riva-Murray et al. 2002; Yoder and Rankin 1995b) to categorically classify the type of biological response and then focusing in on key parameters that are either directly contributing or which serve as markers for the type of effluent process that is likely contributing. In addition, using facility information about effluent quality is vital to this diagnosis and includes information about trends in effluent quality and operational issues if any. Frequently, and depending on the type of discharge that is involved, knowledge from similar settings and assessments can be applied in support of the overall diagnosis. This lends support to taking any number of actions with a permit including enforcement, revisiting the water quality based effluent limits (WQBEL), and regulating previously under or unregulated activities.

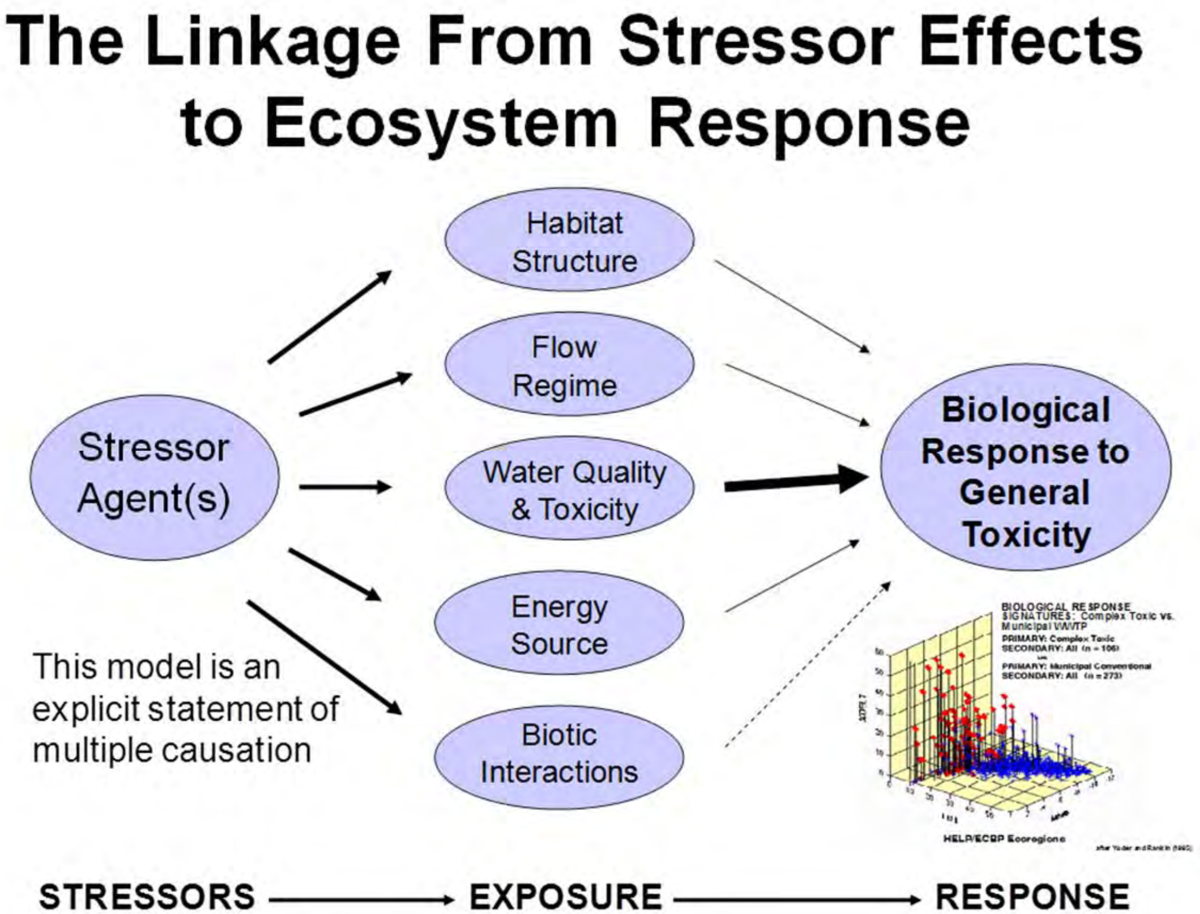


Figure 5-9. The process for relating a biological response indicative of generalized toxicity to the stressor source and via a lines of evidence approach supported by adequate monitoring and assessment data and information.

5.3.4.2 Designated Aquatic Life Use Impacts

Another anticipated impact of a TALU-based approach on NPDES permitting is the designated aquatic life use tier of the receiving stream or river. While this does affect the application of a bioassessment impact analysis by the numerical biocriteria that is applied in an impact assessment as just described, it can also directly affect the derivation of WQBEL if the pollutant specific water quality criteria vary by the different use tiers. However, this will be true only if the water quality criteria are indeed varied by the applicable use tiers.

In addition to the potential effect on WQBELs of differing chemical criteria by use tier is their application to an NPDES permit. A concern that has been expressed in Minnesota and which we have encountered elsewhere is situations where a permit was originally based on a lower tier and the bioassessment documents an upgrade to the current use tier. The assumption is that this automatically makes the WQBELs proportionately more stringent. However, if the biological impact assessment shows that the new use tier biocriteria are attained, then this brings in the biocriteria application language where full attainment is the finding. This could result in the maintenance of existing effluent quality in keeping with the finding of full attainment of the newly proposed use tier. As such, changes in use tiers do not necessarily nor automatically result in more stringent effluent limits. Table 5-2 outlines some general NPDES permit scenarios based on changes to the current designated use under the new TALU-based framework.

Table 5-2. Possible NPDES permit actions based on plausible use change scenarios under the new Minnesota TALU framework.

Current Use Class	New Use Class	Biology	Action
Class 7	Modified/General/Exceptional	Attains	Maintain Permit
Class 7	Modified/General	Does Not Attain	Review Permit[1]
Class 7	Limited Use	Attains	Maintain Permit
Class 2A/2B	Exceptional	Attains	Maintain Permit
Class 7/2B	General CW	Attains	Maintain Permit
Class 7/2B	General CW	Does Not Attain	Review Permit[1]
Class 2A	General WW	Attains	Maintain Permit
Class 2A	General WW	Does Not Attain	Review Permit[1]
Class 2A/2B	Modified	Attains	Maintain Permit
Class 2A/2B	Modified	Does Not Attain	Review Permit[1]
Class 2A/2B	Limited Use	Attains	Maintain Permit

[1] Permit review could result in more stringent effluent limits or if the discharge is not the cause of nonattainment then the effluent limits can be held at current levels.

5.3.4.3 Illustrating Permitting Effectiveness

Provided there is sufficient temporal data accomplished with the preceding M&A designs, bioassessments can be useful to demonstrate the environmental end outcomes of NPDES permitting. This is simply a manifestation of the processes previously described in Figures 5-2 through 5-4. The example in Figure 5-10 illustrates the full success of NPDES permitting over a nearly 30 year period of time for a major metropolitan wastewater treatment plant (WWTP) in Ohio. This especially illustrates the process depicted in Figure 5-4 where the initial actions of issuing and reissuing an NPDES permit (Level 1) coupled with actions taken by the regulated entity to reduce discharged loadings (Levels 2 and 3) improved water quality (Level 4) and assimilative capacity (Level 5) in the receiving river which was followed by an incremental improvement in biological assemblage condition to the full attainment of the designated TALU tier (Level 6). Furthermore, this illustrates an example where the biological improvement was

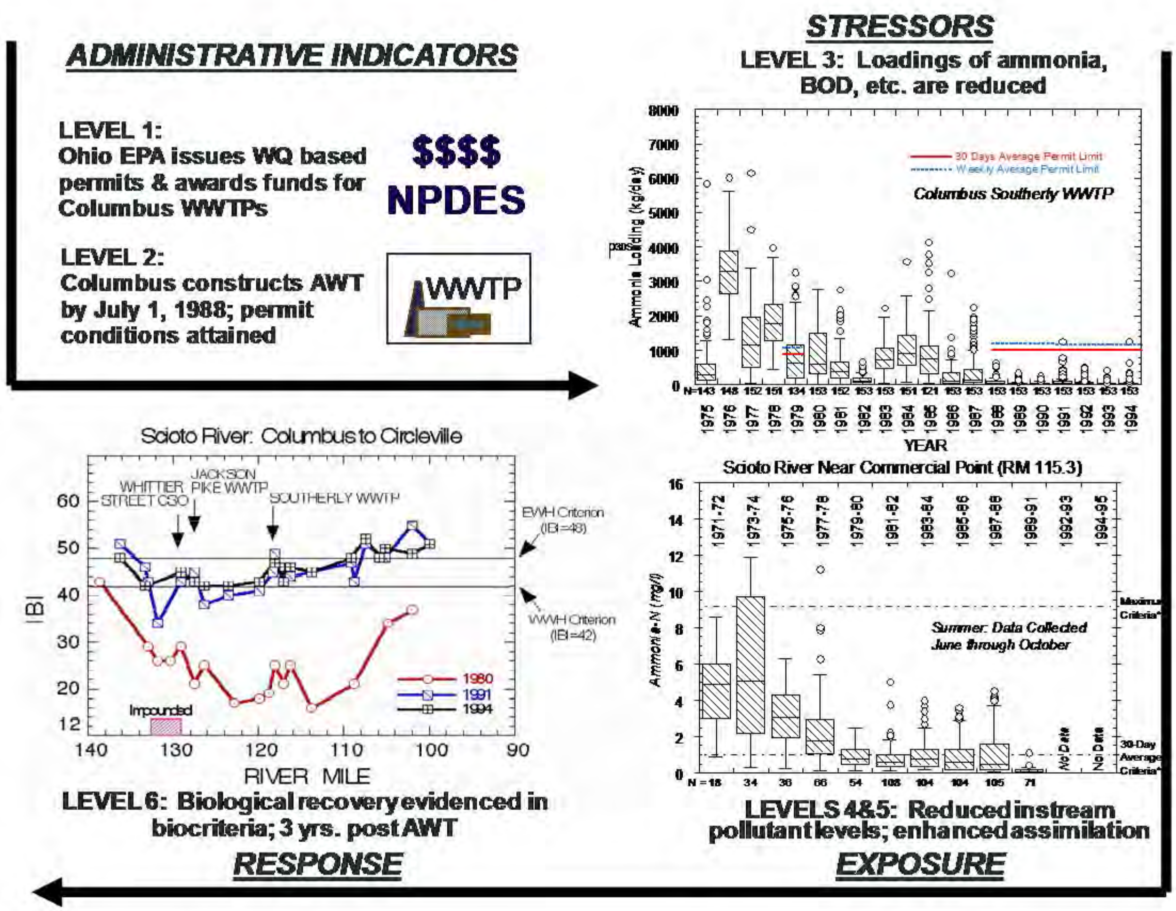


Figure 5-10. Example of using the hierarchy of indicators framework (see Figure 5-4) to demonstrate the sequence of events using level 1 through 6 indicators. This example is for the city of Columbus Southerly WWTP and bioassessment information from the receiving river (Scioto River) collected and assessed by Ohio EPA. It demonstrates a successful environmental outcome of NPDES permitting.

such that an upper TALU tier (Exceptional Warmwater) has been recommended for a portion of the receiving river. This same sequence of improvements in response to WQBELs for municipal WWTPs has been documented in multiple examples and has resulted in a 72% increase in full attainment of the biocriteria in Ohio non-wadeable rivers (Ohio EPA 2010). This level of documentation of full improvement does several things in addition to documenting the aggregate impact of WQBELs at Ohio WWTPs as follows:

1. It provides solid proof that advanced wastewater treatment is both implementable and assures environmental outcomes; and.
2. It provides proof that effluent dominated rivers can meet and exceed CWA goal uses.

The unheralded value of these observations is that the demonstrated successes herein have erased the historical debates about the efficacy of advanced wastewater treatment and the attainment of CWA goal uses in effluent dominated rivers. Prior to the push for WQBELs in the late 1970s and early 1980s, both were seen as barriers to that level of pollution control and at

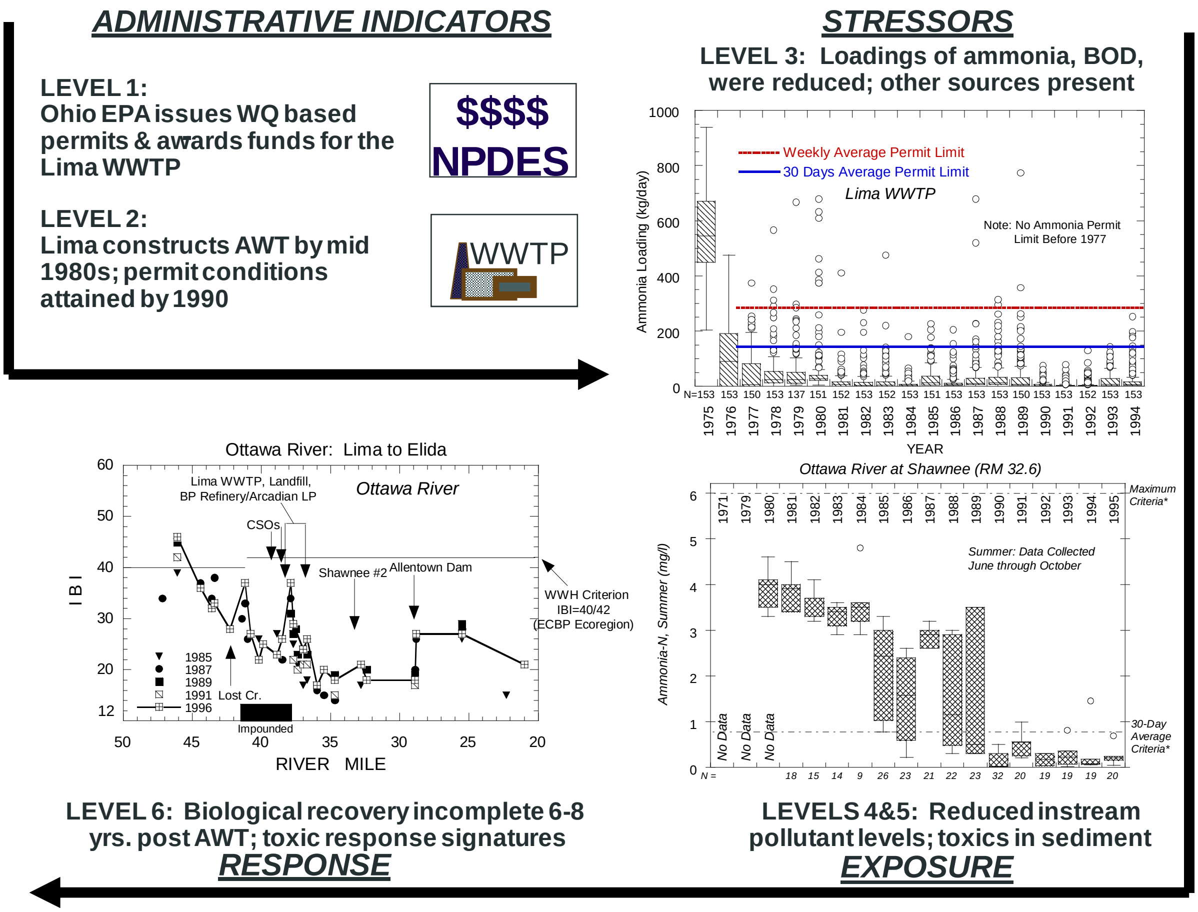


Figure 5-11. Example of using the hierarchy of indicators framework (see Figure 5-4) to demonstrate the sequence of events using level 1 through 6 indicators. This example is for the city of Lima WWTP and bioassessment information from the receiving river (Ottawa River) collected and assessed by Ohio EPA. It demonstrates an unsuccessful environmental outcome of NPDES permitting.

least temporarily resulted in the application of limited uses. Using a long term dataset produced by a sustained TALU-based M&A program illustrates the intangible benefits to a key water quality management program.

While the example in Figure 5-10 illustrates a virtually complete success of water quality based permitting for municipal WWTPs, there are some examples where this “conventional” approach for dealing with steady-state discharges was not completely successful. Figure 5-11 illustrates a municipal setting in Ohio where the same type of permitting and abatement actions were applied to a WWTP. In this case, biological impairment persisted despite attainment of WQBELs at the WWTP. Two adjacent industrial facilities with NPDES permits were suspected of contributing to the non-attainment, but neither was in “significant” noncompliance. The biological response furthermore indicated a toxic response which pointed to contaminants from either or both facilities. The lines of evidence approach (Figure 5-12) that is employed as part of the stressor identification process confirmed the presence of toxic substances in the effluents, water column, and sediments (Yoder and DeShon 2003). The question then became how did and do these substances enter the river if they are not being detected by the required effluent monitoring? Further investigations revealed on site contamination of the soils, legacy landfill disposal sites, and intermittent pulses via stormwater outfalls. As such, it took a lack of the expected biological attainment coupled with the type of biological response and the stressor identification process to guide the process of determining sources of the observed impairments. Preliminary data from Ohio EPA indicates that management interventions aimed at the categorical problems with toxicity have been followed by partial biological recovery, in particular the reduction in deformities, erosions, lesions and tumors (DELT) anomalies on fish which is a key part of the toxic response signature exhibited in the 1980s and 1990s.

Multiple Indicators Matrix: Ottawa River

	DES. USE	RESPONSE INDICATORS				EXPOSURE INDICATORS						STRESSORS				
SEGMENT	Attainment Status	QHEI	IBI	MIwb	ICI	Water Chem.	Sediment Chem.	Toxicity	% DELT	Fish Tiss.	Biomarker	# Dams/ Pools	Urban Indust. Landuse	Cumulative Loads	Spills	CSO SSOs
Ottawa River mainstem (1996)																
Thayer Rd to Sugar St.	FULL-PART	68	Fair-Good	Fair-Good	Good	Nitrates	Low	NA	Mod High	Mercury	Low	Moderate	Low	Low	Low	Low
Sugar St. to Lima WWTP dam	**NON**	47	**Poor to Fair**	**Poor to Fair**	**Poor to M.G.**	CBOD TSS D.O.	As,Cr Cd,Cu Ni,Zn	Moderate	**High**	Pesticides	BUN Naph B(a)p	**High**	**High**	Moderate	Moderate	**High**
Lima WWTP dam to Allentown dam	**NON**	72	**Poor**	**Poor to Fair**	Fair to Good	Amm. CBOD TSS D.O. Nitrates Phos Chrom PAH Pesticid	As,Cr Cd,Cu Ni,Zn PAH	Moderate	**Very High**	Selenium Pesticides	EROD Naph B(a)p BUN	Moderate	**High**	**High**	**High**	**High**
Allentown dam to Kalida	PARTIAL	69	**Poor-Fair**	Fair-Good	Good-Exc.	TSS	Low	NA	**High**	Pesticides	Low	Low	Low	**High**	Low	Low
Kalida to mouth	FULL	69	Good	Good	Exc.	TSS	Low	NA	**Very High**	Pesticides	Low	Low	Low	**High**	Low	Low

Figure 5-12. A matrix of stressor, exposure, and response indicators for the Ottawa River mainstem based on data collected in 1996 (after Ohio EPA 1998). The darkness of shading indicates the degree of severity in effect expressed by an indicator.

5.3.4.4 Other Types of NPDES Permitting

While the preceding examples were based on NPDES permitting of major point sources, the same principles can be applied to other types of permitting such as stormwater and CAFOs (Combined Animal Feeding Operations). This all applies provided that the design of the M&A is spatially adequate for these tasks, but the same pollution survey design at the watershed or mainstem river segment scale should satisfy the information needs of these applications.

5.3.5 Other Permitting and Review

Other permitting and review functions can also be supported by the TALU-based approach. An example is the review of projects that require a CWA Section 404 permit and a 401 certification by the state WQS agency. A 401 certification indicates that state WQS will be maintained by the subject activity. For rivers and streams these usually include the modification of in channel habitat which is jurisdictional under Section 404 reviews. Given that there is a sufficiently predictable relationship between the MPCA biological criteria endpoints and the MSHA, the effect of any activity subject to review under 404 and 401 will be predictable in terms of meeting and maintaining the Minnesota WQS, the aquatic life designated use in particular. Projects that are predicted to result in an impairment of the biologically based designated use cannot be allowed per the provisions of the existing use clause in the federal water quality regulations (40CFR Part 131). Such activities will need to be modified such that they are compatible with maintenance of the designated use. At the same time it is recognized that not every 404/401 decision will either have or require a review at this level of detail. Operationally this works best when the public notice is jointly reviewed by the 401 and biological monitoring staff. In addition to site-specific reviews, the administration of nationwide permits can also be influenced by the TALU-based approach. Some examples are exempting higher tier uses and antidegradation tiers from the nationwide permit, the effect of which is to require site-specific reviews for these waters.

5.3.6 Watershed Planning and Management

The information from a TALU-based approach is also valuable to watershed planning and management through any number of programs. TALU can affect these in the following ways:

1. The biological data and assessments can communicate about intrinsic condition and quality thus being useful for setting priorities for protection;
2. The biological measures employed in a TALU-based approach can measure incrementally thus providing a way to gauge progress as management programs are applied; and,
3. Indicator units that portray degradation units can be extracted and used in setting priorities for management and restoration projects.

Essential to using TALU-based data and information is the concept of incremental improvement. Incremental improvement is defined here to represent a measurable and technically defensible, positive change in the condition of an impaired water body within which an improvement has been measured, but which does not yet fully meet all applicable WQS. The general principles are defined as follows:

- ***measurement of incremental improvement*** can be accomplished in different ways, provided the measurement method is scientifically sound, appropriately used, and sufficiently sensitive enough to generate data from which signal can be discerned from noise;

- ***measurable parameters and indicators*** of incremental improvement may include biological, chemical, and physical properties or attributes of an aquatic ecosystem that can be used to reliably indicate a change in condition; and,

- ***a positive change in condition*** means a measurable improvement that is related to a reduction in a specific pollutant load, a reduction in total number of impairment causes, a reduction in an accepted non-pollutant measure of degradation, or an increase in an accepted measure of water body condition relevant to designated use support.

The methods, parameters, and tools to implement such an approach are an inherent part of the TALU-based approach and as such it is "ready" to support incremental measurement and comprehension.

A protocol for the documentation of incremental improvements in impaired waters is a major need of watershed management and other surface water protection programs. The evaluation of program success has almost exclusively focused on the full restoration of listed impairments. While this seems a straightforward process based on the removal of all impairment causes and meeting all WQS, it is presently difficult to account for improvements that have occurred as a result of project specific restoration actions, but which do not yet meet all WQS. This can result in the perception that the program seems staked to an "all or nothing" end result with no recognition of any positive movement towards full attainment of WQS. Furthermore, failing to recognize that waters are improving and are on a positive trajectory can lead to erroneous conclusions about the attainability of CWA goals and the viability of certain management practices. Hence, developing ways to measure and display incremental improvement would be beneficial to watershed management programs in a number of different ways. While the TMDL program is the primary water program that is dedicated to the delineation and tracking of the status of impaired surface waters and the progress of their restoration to meet CWA goals, other EPA water programs can also benefit from the measurement of incremental change. The TALU-based framework in development and use now should deliver that capability. Table 5-3 is a listing of the programmatic "clientele" that should benefit from this framework.

The significant challenges in addressing the need for a framework and protocol for measuring incremental change center on the inherently competing concepts of desiring a readily available and tractable process for reporting and the equally important, but frequently overlooked need to have it based on sound data and information (i.e., "credible scientific data"). A TALU-based approach emphasizes the integrity and strength of the underlying data and information upon which the incremental change indicators are founded. One problem with the current situation nationally is that a wide variety of different approaches are essentially homogenized by existing programmatic expressions of designated use attainment. This is commonplace within CWA program reporting and prior examples include state variability in 305[b] reporting from the previous 30 years and the litany of "lists" that have been produced from the same baseline data for a variety of purposes.

Table 5-3. "Clientele" for a framework that includes incremental improvement measurement concepts and methods (after Yoder and Rankin 2008).

Clientele	Reason for Interest
TMDL program managers (primary clientele)	Demonstrate partial recoveries as program results in outcomes potentially earlier and in larger numbers than full recovery (i.e., a recognition that all stressors cannot be remediated in the same time frames).
NPS program managers	Related to qualifying for NPS success stories recognition; also demonstrate more 319 progress and results.
Monitoring program managers	Once documented as partially recovered, help orient limited monitoring funds to measuring waters more likely to have completely recovered. Also documenting incremental improvement is a primary component of post- project effectiveness monitoring.
4b projects (controls other than TMDL are in place)	Demonstrate progress being made within a reasonable time period so as not to revert from 4b to 5/4a process.
EPA Surface Water Strategic Planners and Watershed Managers Forum	Clarify and help defensibility of counting rules on partial restoration measures (W, Y). Also, aid the consideration of possible new measures concerning incremental improvement.
States	Additional consideration in performance partnership agreements & reporting to EPA.
WQS program	Related to determination of highest attainable use for the purpose of designating aquatic life uses; essential in UAA considerations.

A fundamental problem with these past approaches has been the homogenization of technically different baseline inputs in designated use status reporting. Many states base their assessments of status either wholly or partially on chemical/physical parameters and indicators while others employ bioassessment results, yet each is distilled to a common terminology and "currency" expressed as the proportion of a water body unit that partially or fully attains designated aquatic life use support. As has been shown in prior comparability studies (Rankin and Yoder 1990; Rankin 2003; Karr and Yoder 2004) such assessments based on chemical/physical indicators can be substantially different than biologically based assessments, the differences being up to 50% in some cases. In such cases, biological assessment contributed to the avoidance of a type II assessment error that is inherently propagated in chemical/physical assessments, which results in the significant under-reporting of aquatic life use impairments. Current practice in effect obliterates these important differences by effectively homogenizing fundamentally different assessment protocols. There are additional differences in state programs that also contribute to the uncertainty about the reliability of status assessments and these include differences in spatial sampling design and the level of rigor of state M&A programs. These almost certainly contribute to an as yet undocumented degree of variability and uncertainty in consolidated measures of management program effectiveness. An advantage of the TALU-based approach is how it relates baseline chemical, physical, and biological measures and indicators in an integrated assessment process that will result in improved accuracy and consistency in the type of reporting that is to be accomplished by measures SP-11 and SP-12 (aka measures W and Y). This is an important prerequisite to assuring that "credible scientific data" are effectively used in the measurement of incremental change within these reporting frameworks.

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Appendix A: Detailed TALU Work Plan

March 29, 2011

The following are descriptions of the major tasks that are proposed as part of this project. A detailed work plan was developed in cooperation with MPCA and resulted in the following tasks:

Task 1 – Internal and External Stakeholder Meetings

MBI will lead a series of meetings with internal MPCA and external state and local agency and non-governmental stakeholders to coordinate and foster input and support for the principal objectives of this project. These meetings are described as follows:

Task 1a: Initial MPCA Coordination

MBI will participate in meetings and discussions with key MPCA managers and staff to discuss the specific tasks outlined in this detailed work plan and the projected timeline for various subtasks and final delivery of project work products. It includes detailed planning and consultation with MPCA staff in order to determine the key issues that are likely to be of the most interest to internal and external stakeholders. This task also includes the initial development of an implementation plan that communicates how the new biological criteria and WQS will affect their current stakeholder activities. We anticipate one introductory meeting at MPCA and follow-up conference calls as necessary.

Task 1b: Introductory external stakeholder meetings

MBI will lead discussions with stakeholders that include presentations and materials to communicate the scientific and regulatory foundation for biological criteria and TALUs and identifying the potential impacts to stakeholder interests. This task also includes communicating an implementation plan that communicates how the new biological criteria and WQS may affect their current activities. Approximately 7-10 stakeholder meetings are estimated by MPCA to take place mostly in year 1 of the project. As part of this task MBI and its subcontractor will provide on demand technical assistance to MPCA with external stakeholder issues as they arise.

To facilitate discussion and enhance the understanding of the new system MBI will develop a series of presentations to include at a minimum:

- an introduction to biological standards and tiered uses;
- the regulatory background that forms the foundation for biological standards and tiered uses;
- benefits of the new system of biological standards and uses;
- history and outcome of adopting biological standards and TALU by other states; and,
- the proposed Minnesota system of standards and uses.

Task 1c: Follow-up with MPCA Program
This task will involve interacting with the key MPCA staff and managers to foster their understanding about how the new biological criteria and TALUs will affect their principal areas of interest. MBI and Tetratech will apply their experience in this area with other state programs via the EPA national program. We anticipate 1-2 of these meetings at MPCA late in year 1 or during year 2.

Task 1d: Follow-up with external stakeholders
This task will involve conducting follow-up meetings with selected external stakeholders as the project develops and to answer their questions and concerns as the implementation plan, policies, and standards are developed. We anticipate 2-3 follow-up meetings to take place in various Minnesota locations to be determined at a later date.

Task 2 – Exploratory Data Analyses and Indicator Development

MBI will provide technical support that will include exploratory data analysis and summarization and a review of technical tools and products completed by MPCA staff including:

- a review of the statewide IBI for fish and invertebrates as well as the criteria used to define impairment thresholds;
- a review of technical elements and criteria used to define TALU categories;
- assist MPCA staff with calibration of the biological condition gradient for fish and invertebrates;
- data analysis and summarization of large river IBI fish protocols used by the MDNR and MPCA;
- data analysis and summarization of the MPCA qualitative habitat data to identify habitat attributes that are indicative of modified (i.e. less than Clean Water Act interim goal) and exceptional (greater than CWA goal) uses.

Each of these subtasks are further described as follows:

Task 2a – Review statewide indices & biocriteria
This task will involve first understanding the technical basis and characteristics of the MPCA biological indices including their calibration and derivation and spatial patterns across the state. This will next include examining index thresholds including sensitivity analyses for those thresholds. These in turn become the numeric biocriteria for different TALUs and other strata such as stream and river types, cold and warm water, etc.

Task 2b – Review TALU technical elements & criteria
This will include a review of the descriptiveness of the designated use narratives and suggestions for language that better ties the technical process for deriving numerical biological criteria to the designated use narratives.

Task 2c – Calibrate BCG for fish & macroinvertebrates

Calibrating a regionally applicable BCG requires adjustment of the generalized conceptual model (Davies and Jackson, 2006; U.S. EPA, 2005) to regional conditions. This includes components that construct a coherent ecological description of response to stressors in keeping with ecological theory and empirical observation that includes:

- Describe the native aquatic assemblages under natural, undisturbed conditions. The description of natural conditions requires biological knowledge of the region, a natural classification of the assemblages, and, if available, historical descriptions of the habitats and assemblages.
- Identify regional stressors. A description of regionally dominant stressors will help define expectations for biological responses that are likely to occur. This step considers sources of physical and chemical stressors and causes of land use disturbance.
- Assign taxa and other measurements (if available) in the state database to BCG attributes.
- Quantitative description of BCG levels that are the system responses to anthropogenic stressors.

The development process is iterative, and may require several passes through the process to converge on a coherent, locally calibrated BCG that is scientifically defensible.

Task 2d – Large rivers fish IBI data analysis; MPCA/MDNR protocols

This will include examining the data characteristics and methodological properties of the MPCA and MDNR large river fish sampling methods. We can bring the experience of the Region V comparability study to this task. This will include examining key data attributes in addition to the potential impact to the MPCA large river fish IBI.

Task 2e – Analysis of MPCA habitat data; relate to TALUs

An important aspect of a TALU approach is the task of determining if an existing designated use is appropriate and attainable. Key to this process is determining the realistic biological potential of a specific water body or segment. Habitat is a fundamental issue in that it governs the determination of potential for setting appropriate and attainable uses. Therefore a relationship between the indices used to determine attainment and the habitat assessment mechanism must be established in order to develop the required predictive tools and process. MBI proposes to subject the MPCA database to analyses similar to how Ohio EPA developed these relationships.

Task 3 – Develop plan for making transition to TALU

MBI will assist MPCA with the development of a detailed implementation plan for the eventual adoption of biocriteria and TALUs in the Minnesota WQS. Ideally, the implementation TALUs will be sequenced with the annual execution of river and stream assessments and the analysis of that data and information. This will involve anticipating the potential impacts to various stakeholder groups and their activities related to water resource usage. It will also include determining the impact to MPCA obligations such as the Integrated Report and the resulting list of impaired waters under Section 303d.

MBI will develop an implementation plan in the form of a report or reports that will guide stakeholders through the transition into the new system of standards and uses. The implementation plan will include at a minimum:

- identification of processes or procedures that will be impacted by the new system including a description of the process, an explanation of how the process will be affected by the new system and a recommendation of steps necessary to integrate into the new system; and,
- a report that will include a timeline that identifies the sequencing of action items to extend through the rulemaking process.

MBI will work with stakeholders throughout the process to ensure that each recommendation is both necessary and reasonable.

Task 4 – Lead stakeholder TALU implementation meetings

MBI will use the information learned and developed in the preceding tasks to communicate to stakeholders about the implications of the new biological criteria and TALUs. This will consist of 3-5 meetings with selected stakeholder groups.

Task 5 - Exploration and determination of relationships between key biological response variables and environmental stressors

Completion of this task requires that we understand the relationship between key biological response variables and environmental stressors including chemical, physical, hydrology, and watershed land use factors. The development of stressor-response models derived through this type of analysis would support MPCA objectives related to:

- WQS under a TALU framework. (e.g., specific tiered dissolved oxygen criteria derived through analysis of the class specific IBI data)
- Ecological flow modeling (e.g., association between specific biological attributes and hydrologic data will support the development of ecologically sustainable flows).
- Stressor ID to identify the likely stressors affecting the biology at impaired sites and suggest reasonable goals to move the water body back into compliance with CWA objectives.

The analysis phase of this work will consider various analysis techniques to investigate relationships between the stressor and response variables including the percentile method (commonly used by bioassessment programs to derive goal setting criteria), quantile regression, linear regression, logistic regression, species sensitivity distribution, conditional probability analysis, and Threshold Taxa Indicator ANalysis (TITAN). A description of each of these techniques as well as examples of the application of these techniques using field data is found in Cormier, et al (2008) Using Field Data and Weight of Evidence to Develop Water Quality Criteria. Integrated Environment Assessment and Management 4(4), pp 490-504.

Possible stressor variables data sources:

Chemical	Conventional parameters including Nutrients, DO, pH, conductivity. Primary data source is STORET
Physical variables	Stream habitat variables from MPCA quantitative habitat, MSHA, and Rosgen geomorphology variables Data sources include MPCA biological database for habitat data, MPCA and MDNR for geomorphology variables.
Land use	Human disturbance variables including ditching, land use percentages, prevalence of point sources, feedlots, etc. Data source includes MPCA biological database, MDNR, NRRI, etc.
Hydrology	Exploration of flow gauging data including minimum flows and measures of flow variability and timing. Data from Minnesota DNR, MPCA and USGS.

The nature of the stressor-response relationships as well as data limitations will determine when it is reasonable to develop a stressor-response model and which analytical techniques are most appropriate/illustrative for use in developing criteria or benchmarks. Close interaction between MPCA lead biologists and MBI throughout each sub task will maximize the potential benefits associated with the final product. Final products will include reports and associated materials (e.g., statistical coding, data files) for each subtask. The reports will be formatted to allow diagnosis of the cause of an impairment through evaluation of taxa, metrics, and IBI scores for response variables that were tested. When relationships are present graphics will be provided that describes the relationship between the biological measure and the stressor variable. This task also includes an assessment of the adequacy of the existing ambient databases to support such analyses. To complete this task, 2-3 meetings that require travel by MBI personnel are planned to discuss database development and to discuss and review the analyses and products.

Task 5a: Assessment of relationships between chemical and biological data and development of tiered water quality criteria

MPCA staff with consultation from MBI will develop databases with chemical data linked to biological data. The data analysis phase will be led by MBI with consultation from MPCA. Exploratory analyses will identify relationships between biological measures (e.g., indices, metrics, and taxa) and chemical measures. Additional statistical analyses described above will be used to develop models (e.g., regressions) and thresholds between biological and chemical parameters for use in stressor identification and the development of tiered water quality criteria.

The new biological standards and TALU framework will highlight the need to develop tiered water quality criteria for selected pollutants and parameters. This subtask contract will include data analysis of selected chemical parameters, summarization of findings, and recommendations for water quality criteria changes that correspond to the TALU framework.

Task 5b: Assessment of the relationships between physical and biological data
As with sub task 5a, MPCA staff with consultation from MBI will develop databases with biological data linked to biologically relevant physical measures (e.g., stream habitat and geomorphology). The data analysis phase will be led by MBI with consultation from MPCA. Exploratory analyses will identify relationships between biological measures (e.g., indices, metrics, and taxa) and physical measures. Additional statistical analyses will be used to develop models (e.g., regressions) and thresholds between biological and physical parameters for use in stressor identification. The objectives and analytical techniques for subtask 5b are slightly different than those under task 2e.

Task 5c: Exploratory assessment of the relationships between biological data and hydrology
This subtask will be a preliminary assessment of the relationship between flow and biological condition using available flow data (e.g., minimum flows, flow variability and timing). An element of this subtask will be to identify data needs for developing more complete models of the relationship between hydrology and biological condition. Although available flow data may not be sufficient to fully develop the association between specific biological attributes and hydrologic data to support the development of ecologically sustainable flows, this subtask will provide the groundwork to develop these tools.

Tiered Aquatic Life Uses Timeline

Task	2007	2008	2009	2010	2011	2012
1. Regional Framework Analysis						
1a. Literature review						
1b. Statistical analysis and selection of classification system			X			
1c. Calculation of Human Disturbance Score			X			
2. Data Gap Analysis and Sampling						
2a. Identify data gaps	X	X	X	X		
2b. Sample sites to fill data gaps	X	X	X	X		
3. Development of Biological Condition Gradient						
3a. Development of warmwater BCG models			XXX	XXXX		
3b. Development of cold water BCG models				XXX	X	
3c. Examine IBI/BCG relationship				XXXX	XXX	
4. Statewide IBI Development						
4a. Define temperature criteria for cold water streams	X					
4b. Metric selection and calibration – warmwater streams			XX	XX		
4c. Metric selection and calibration – cold water streams				XX	X	
4d. Determine warmwater IBI confidence intervals				X		
4e. Determine cold water IBI confidence intervals					X	
4f. Develop criteria for selection of reference sites				X		
4g. Develop biocriteria for General Use warmwater streams				XX		
4h. Develop biocriteria for General Use cold water streams					XXX	
4i. Assess IBIs				XX	XXXX	
4j. Write IBI development document(s)					XX	XX
5. Tiered Aquatic Life Use Development						
5a. Identify modified use "reference sites"				XX	XX	
5b. Develop biocriteria for modified uses					XXX	
5c. Examine characteristics of exceptional use class waters				XX	XX	
5d. Develop biocriteria for exceptional uses				X	XXX	
5e. Analyze and tier priority chemical criteria					X	XX
5f. Pilot assessment of tiered uses					XX	XX
5g. Write biocriteria development document					XXX	XX
6. Designation and Assessment of TALUs						
6a. Habitat analysis (UAA)				XX	XXXX	
6b. Develop use designation guidance for TALUs (including UAAs)					XXX	
6c. Develop and write assessment guidance for TALUs					XXX	
7. Begin Administrative Rule Process						XX

General Rule Making Timeline

2012	**Establish In-house workgroup to consider and amend proposal**
2013	**Take proposal to stakeholder groups**
	Draft rule language
	Solicitation of public opinion in state register
	Define impact to state agencies
	Complete SONAR
	Promulgation of proposed standards in state register
Summer 2014	**Public hearings, hearing dates in front of ALJ**
	Post hearing comment period and response
	Receive ALJ report
	MPCA board