United States
Environmental Protection
Agency

Summary of Biological Assessment Programs and Biocriteria Development for States, Tribes, Territories, and Interstate Commissions: Streams and Wadeable Rivers

EPA-822-R-02-048
December 2002

Office of Environmental Information & Office of Water
U.S. Environmental Protection Agency
Washington, DC 20460

Notice

This document has been reviewed and approved in accordance with U.S. Environmental Protection Agency policy. Mention of trade names, products, or services does not convey and should not be interpreted as conveying, official USEPA approval, endorsement, or recommendation for use.

Appropriate Citation:

USEPA. 2002. Summary of Biological Assessment Programs and Biocriteria Development for States, Tribes, Territories, and Interstate Commissions: Streams and Wadeable Rivers. EPA-822-R-02-048. U.S. Environmental Protection Agency, Office of Environmental Information and Office of Water, Washington, D.C.

Cover photo by Wayne Davis, USEPA. This document can be downloaded from EPA's website for Biological Indicators of Watershed Health:

http://www.epa.gov/bioindicators/

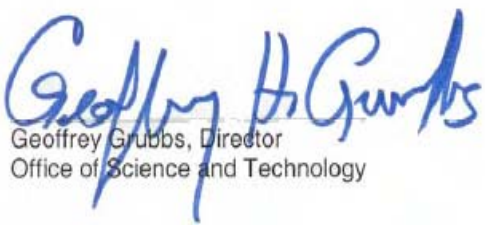
Foreword

We are pleased to release the 2002 ***Summary of Biological Assessment Programs and Biocriteria Development for States, Tribes, Territories, and Interstate Commissions: Streams and Wadeable Rivers.*** This summary, a joint project by the Office of Water and the Office of Environmental Information, provides an abundance of technical and programmatic information which illustrates the progress States, Tribes, Territories and Interstate Commissions are making in the utilization of biological assessments and criteria in their water programs.

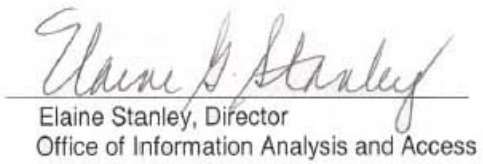
Biological assessments and criteria are crucial tools for measuring the health of water bodies and for protecting aquatic life. Biological assessments evaluate the condition of a water body using surveys and other direct measurements of aquatic life—aquatic vegetation and algae, fish, insects, crayfish, salamanders, frogs, worms, snails, mussels, etc. Biological criteria are numeric or narrative targets that can be set to define the desired biological condition of a water body and can even be adopted into State and Tribal water quality standards. In combination with other available water quality tools, such as chemical pollutant criteria, the use of biological assessments and criteria give States, Tribes and Interstate Commissions better tools than ever before for restoring and maintaining the quality of our Nation's water bodies.

The progress made by the States, Tribes and Interstate Commissions as reported in this Summary is impressive. Since our previous assessments in 1995 and 1989, significant progress has been made by virtually every State and an increasing number of Tribes and Interstate Commissions. Biological assessments and criteria are in the mainstream of water management programs throughout the Country. More States than ever before are using biological criteria in their water quality programs as definitive standards.

We encourage you to take time to review this Summary to appreciate the progress that is being made. The information in the report is valuable to assess the progress of one program relative to other programs across the country. In addition, it may be possible to learn of new and different ways to employ biological assessments and criteria by better understanding what others have done. This Summary is another example of the value of public access to information and data. EPA firmly believes that analysis of and access to such information is the key to better environmental decision making. And lastly, since every State, Tribe and Interstate Commission reported in the Summary helped assemble the information, we thank you for your help and participation.



Geoffrey Grubbs, Director
Office of Science and Technology



Elaine Stanley, Director
Office of Information Analysis and Access

THIS PAGE INTENTIONALLY LEFT BLANK

Acknowledgments

Development and production of this document, *Summary of Biological Assessment Programs and Biocriteria Development for States, Tribes, Territories, and Interstate Commissions: Streams and Wadeable Rivers*, was coordinated by USEPA's Office of Environmental Information in partnership with the Agency's Biocriteria Team, comprised of members from the Office of Water (Office of Science & Technology, Office of Wetlands, Oceans, and Watersheds) and the Office of Environmental Information. The goal of the project was to obtain the current status of biological assessment programs and biocriteria development for streams and wadeable rivers.

The project team for this document was comprised of members from the USEPA offices listed above as well as members from the Midwest Biodiversity Institute (MBI); the Technology, Planning, and Management Corporation (TPMC); and Tetra Tech, Inc. (Tt). This work was completed under USEPA Contract No. 50-CMAA-900065 to Technology Planning and Management Corporation (TPMC).

The project team extends its most sincere appreciation to all of the State, Tribal, Territorial, and Interstate Basin Commission biological monitoring staffs for their willingness to complete surveys, participate in follow-up interviews, and review numerous interim drafts. Also, we would like to recognize the numerous personnel at EPA headquarters and Regional offices for their time in developing the initial survey and reviewing various drafts. We are particularly grateful to members of EPA's Biocriteria Team, as well as the EPA Regional Biocriteria Coordinators and Regional Indian Program Coordinators, who provided guidance on document structure and the process for gathering information. We also acknowledge the efforts of Brandon Peebles, an EPA intern with the Office of Water's Office of Science and Technology. In addition, the following Tetra Tech staff were essential in the progress and completion of this document: Catherine Cresswell, Brenda Decker, and Kristen Pavlik.

Most of all, we would like to recognize the spirit of collaboration evident throughout the development of this project.

Project team:

Elizabeth Jackson	USEPA Office of Environmental Information; Environmental Analysis Division
Wayne Davis	USEPA Office of Environmental Information; Environmental Analysis Division
Treda Smith	USEPA Office of Water; Office of Science and Technology
William Swietlik	USEPA Office of Water; Office of Science and Technology
James Campbell	Technology, Planning, and Management Corporation
Michael Barbour	Tetra Tech, Inc.
Abby Markowitz	Tetra Tech, Inc.
Margo Andrews	Tetra Tech, Inc.
Maggie Craig	Tetra Tech, Inc.
Chris Yoder	Midwest Biodiversity Institute, Inc.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

FOREWORD i
ACKNOWLEDGMENTS iii
TABLE OF CONTENTS v
LIST OF TABLES AND FIGURES vi

Chapter 1. INTRODUCTION 1-1
1.1 Bioassessment and Biocriteria in Water Resource Assessment and Management 1-1
1.2 Introduction to the Process 1-5

Chapter 2. SUMMARY OF FINDINGS 2-1
2.1 Summary of Current Biological Assessment Programs 2-1
2.2 Bioassessment Program Success from 1989, to 1995, to 2001 2-3

Chapter 3. PROGRAM SUMMARIES 3-1
States 3-1
Territories 3-205
Tribes 3-215
Interstate Basin Commissions 3-231

Chapter 4. RELEVANT EXCERPTS FROM WATER QUALITY STANDARDS AND BIOCRITERIA LANGUAGE 4-1
States 4-1
Territories 4-72
Tribes 4-76
Interstate Basin Commissions 4-80

Chapter 5. LIST OF ACRONYMS AND DEFINITION OF TERMS 5-1
5.1 Acronyms 5-1
5.2 Definition of Terms 5-2

Chapter 6. LITERATURE CITED AND ADDITIONAL RESOURCES 6-1
6.1 Literature Cited 6-1
6.2 Additional Resources 6-2

Appendix A. BIOASSESSMENT PROGRAMS FOR STREAMS AND WADEABLE RIVERS (2001) A-1
Appendix B. EPA CONTACTS B-1
Appendix C. ORIGINAL CHECKLIST TEMPLATE C-1
Appendix D. PROGRAM SUMMARY TEMPLATE D-1

LIST OF TABLES AND FIGURES

TABLES

Table 1 National summary of bioassessment programs for streams and wadeable rivers in 2001 2-2

Table 2 National summary of bioassessment programs for streams and wadeable rivers in 1989, 1995, 2001, and the interim change 2-4

FIGURES

Figure 1 *Use of bioassessments to assess water quality*
Figure 1a. Percent of total stream/river miles assessed in each State using bioassessments 2-6
Figure 1b. Use of bioassessment to determine aquatic life use (ALU) for 305(b) reporting 2-6

Figure 2 *Biocriteria development*
Figure 2a. Narrative biocriteria development 2-7
Figure 2b. Narrative biocriteria in WQS with quantitative implementation procedures 2-7
Figure 2c. Numeric biocriteria development 2-8

Figure 3 *Assemblages assessed*
Figure 3a. Fish 2-9
Figure 3b. Benthic macroinvertebrates 2-9
Figure 3c. Periphyton 2-10
Figure 3d. Number of assemblages assessed 2-10

Figure 4 Use of ecoregional reference conditions 2-11

Figure 5 Development of biological multimetric indices 2-11

1. INTRODUCTION

1.1 Bioassessment and Biocriteria in Water Resource Assessment and Management

The Historical Context

During the last half of the 20th century, the terms "environmental protection" and "natural resource management" underwent a profound evolution both conceptually and as applied to decision-making. Two landmark pieces of legislation, the 1948 Federal Water Pollution Control Act (WPCA) and its 1972 amendments contained in the Clean Water Act (CWA), stand out as milestones in this process. Until 1948, water quality management decisions were based primarily on society's economic and public health priorities (Davis 1995). The passage of the 1948 WPCA marked the first time that the *propagation of fish and other aquatic life* was articulated as a stand-alone objective of water resource protection. It was a significant turning point because federal law recognized the importance of protecting waterbodies and aquatic life for their own intrinsic value, not just for their value to human society.

The 1972 Federal Water Pollution Control Act (the Clean Water Act) set far-reaching ideals for restoring the health of our Nation's waters, as outlined in Section 101(a) Declaration of Goals and Policy:

> The objective of this Act is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. In order to achieve this objective it is hereby declared that, consistent with the provisions of this Act –
>
> 1) it is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985;
> 2) it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish and wildlife and provides for the recreation in and on the water be achieved by July 1, 1983…

Why Bioassessment?

Aquatic life (fish, insects, plants, shellfish, frogs, salamanders, etc.) integrate the cumulative effects of both point source and nonpoint source (NPS) pollution's multiple stressors. Biological assessments, or bioassessments, consisting of surveys and other direct measures of aquatic life, are the most effective way to measure the aggregate impact of these stressors on waterbodies. Bioassessments are an extremely useful tool to evaluate the biological integrity of a waterbody, commonly defined as

> "the ability to support and maintain a balanced, integrated, and adaptive community with a biological diversity, composition, and functional organization comparable to those of natural aquatic ecosystems in the region" (Frey 1977, Karr and Dudley 1981, and Karr et al. 1986).

Because biological communities are affected by all of the environmental factors to which they are exposed over time, bioassessments provide information on perturbations not always revealed by water chemistry measurements or toxicity tests. Thus, they are crucial for determining not only biological health but the *overall* health, or ecological integrity, of a waterbody.

In the mid-1980s, a national workgroup of EPA regional and state agency biologists was convened to provide oversight in the development of technical guidance for biological assessment. The result of the workgroup was the 1989 publication of EPA's Rapid Bioassessment Protocols (RBPs) (USEPA 1989). The RBPs provide a technical framework for using biological assemblage data as a direct indicator of ecological health. The RBPs synthesized existing methods for monitoring fish and benthic macroinvertebrates in streams and wadeable rivers, and presented some innovative ways to assess the biological and physical aspects of streams. The RBP methods were designed to be cost effective, reliable, efficient, applicable nationwide, and easily understood by various stakeholders (USEPA 1999). In addition, the 1990 publication of *Biological Criteria: National Program Guidance for Surface Waters*

provided states with an organized approach for addressing their responsibilities as outlined in the CWA (USEPA 1990). In 1992, EPA issued procedures for initiating narrative biological criteria that explained how states and tribes could adopt narrative biocriteria in their water quality standards (USEPA 1992).

Since the 1989 RBPs were published, the use of bioassessments in water resource programs has continued to grow. In 1996, EPA published a guidance document for the development of biocriteria for streams and small rivers (USEPA 1996a). In 1998, EPA produced bioassessment technical guidance for lakes and reservoirs (USEPA 1998a), followed by similar guidance for estuarine and coastal marine waters in 2000 (USEPA 2000) and a series of guidance modules for biological assessments and index development for wetlands in March 2002 (USEPA 2002). The increased use of bioassessment in water monitoring programs nationwide led to the 1999 revision of the original RBPs for streams and wadeable rivers (USEPA 1999). Guidance for large rivers and coral reefs is currently under development.

Over the last 50 years, the science of environmental protection has come a long way both in theory and in practice. As a society, the United States has come to understand that protecting aquatic life is a critical resource management goal in its own right. We have adopted ecological integrity as a barometer of waterbody health. Resource management agencies at the local, state, tribal, and national levels have recognized the importance of biological assessments in the evaluation of water quality and ecological integrity. This evolution has brought us closer to realizing the CWA's goal of restoring and maintaining the physical, chemical, and biological integrity of the Nation's waters.

Current Legal Authority

The CWA and its amendments through 1987 provide the legal authority for the use of biological assessments and criteria in state and tribal water quality programs primarily under the provisions of sections 303 and 304. Under Section 303(c), states are required to have water quality standards that consist of designated uses, criteria to protect those uses, and an antidegradation policy. Also under section 303(c), states are required to review their standards every three years and revise them as needed to achieve the purposes of the Act, including the ecological integrity objective.

Section 303(c)(2)(B), enacted in 1987, requires states to adopt numeric criteria for toxic pollutants for which EPA has published 304(a)(1) criteria if such pollutants interfere with, or may be expected to interfere with, attainment of designated uses. The section further requires that, where numeric 304(a) criteria are not available, states adopt criteria based on biological assessment and monitoring methods consistent with information published by EPA under 304(a)(8).

Section 304(a)(8) directs EPA to develop and publish information on methods for establishing and measuring water quality criteria for toxic pollutants on bases other than pollutant-by-pollutant. This includes biological monitoring and assessment methods that evaluate:

> the effects of pollutants on aquatic community components ("...plankton, fish, shellfish, wildlife, plant life...") and community attributes ("...biological community diversity, productivity, and stability...");
>
> factors necessary "...to restore and maintain the chemical, physical, and biological integrity of all navigable waters..." for "...the protection of fish, shellfish, and wildlife for classes and categories of receiving waters..."
>
> appropriate "...methods for establishing and measuring water quality criteria for toxic pollutants on other bases than pollutant-by-pollutant criteria, including biological monitoring and assessment methods."

The Uses of Bioassessment and Biocriteria in the Clean Water Act

Biocriteria, derived from bioassessment data, are narrative descriptions and numeric values that describe the desired condition for the aquatic life inhabiting waters with a designated aquatic life use. Biocriteria are an effective tool for addressing water quality problems by providing regulatory mechanisms to assess

and help protect the biological resources at risk from chemical, physical, or biological impacts. These narrative and/or numeric biocriteria may be formally adopted into water quality standards along with an antidegradation policy intended to protect waters from further deterioration.

As required in the Clean Water Act, states, tribes, and territories report on the quality of their waters through a biennial report referred to as the "305(b) report". USEPA compiles and analyzes this information in the *National Water Quality Inventory Report to Congress*, the primary vehicle for reporting water quality conditions throughout the United States. To assess water quality, states and other jurisdictions compare their monitoring results to the water quality standards they have set for their waters.

Bioassessments help states, tribes, and other entities develop expectations for acceptable biological conditions through a technical process of establishing aquatic life goals, referred to as *aquatic life uses* (ALUs). Designated uses to support aquatic life can cover a broad range of biological conditions; not only do they protect intact communities in a waterbody, but they also can establish restoration goals for compromised ecosystems. Using several types, or tiers, of ALUs allows the allocation of limited resources to waterbodies in proportion to their need for protection.

Although the 305(b) report includes information on the nationwide status of aquatic life use attainment (i.e., state water quality standards), the results reported do not consistently present the information necessary to determine the ecological/biological condition of the Nation's water resources. As currently reported in 305(b) water quality assessments, aquatic life use attainment may be determined solely by chemical parameters and in comparison to chemical water quality criteria. However, since attainment of chemical water quality standards alone may not ensure a healthy biological condition, most states are working to integrate a greater amount of biological information in their aquatic life use attainment determinations (Yoder and Rankin 1995).

Under Section 303(d) of the CWA, a second reporting mechanism requires states, tribes, and territories to provide lists of all impaired waters. These lists are then used to prioritize restoration activities through the development of Total Maximum Daily Loads (TMDLs). TMDLs are calculations of the amount of a pollutant that a waterbody can receive and still meet water quality standards. Bioassessments and biocriteria play a critical role in enabling states, tribes, and territories to develop and implement protection and management strategies needed to fulfill these, and other, requirements of the Clean Water Act, including:

- determining impacts from nonpoint sources [i.e., Section 304(f) "(1) guidelines for identifying and evaluating the nature and extent of nonpoint sources of pollutants, and (2) processes, procedures, and methods to control pollution..."];
- developing lists of waters unable to support "balanced population(s) of shellfish, fish and wildlife..." [(304(l)];
- conducting assessments of lake trophic status and trends, [Sec. 314];
- listings of waters that cannot attain designated uses without nonpoint source controls, [Sec. 319];
- developing management plans and conducting monitoring in estuaries of national significance [Sec. 320];
- determining the impacts and efficacy of NPDES permit controls [Section 402];
- issuing permits for ocean discharges and monitoring ecological effects [Sec. 403(c) and 301(h)(3)]; and,
- determining acceptable sites for disposal of dredge and fill material [Sec. 404].

The 2001 Bioassessment Summary

During 1994-1995, EPA prepared an inventory of state bioassessment programs for streams and wadeable rivers, *Summary of State Biological Assessment Programs for Streams and Rivers* (USEPA

1996b). The purpose of the document was to determine how many states, and in what fashion, were using biological assessments and criteria in water management programs. EPA used the information from that report to evaluate state bioassessment/biocriteria capabilities and their needs for technical support.

During the second half of the 1990s as additional methods, guidance, and information on the use of biological assessments and criteria were issued by EPA, the Office of Water made it a national priority for state and tribal water quality standards programs to adopt biocriteria to better protect aquatic life in all waters where biological assessments methods were available (USEPA 1998b). In 1999, EPA's Office of Water declared the following goals and objectives for the biocriteria program:

- All states/tribes will use bioassessments/biocriteria to evaluate the health of aquatic life in all waterbodies.
- Bioassessment data will be used by all states/tribes to better define aquatic life uses.
- Numeric biocriteria will be adopted in all state/tribal water quality standards to protect aquatic life uses.
- Biocriteria/bioassessments will be used in ongoing regulatory programs.
- Biocriteria/bioassessments will be used to assess the effectiveness of water quality management efforts.
- Bioassessment data and biocriteria will be used to better communicate the health of the Nation's waters.

In the late 1990s, momentum to develop and adopt biocriteria grew, and pressures increased from the Total Maximum Daily Load (TMDL) Program to have well-established biocriteria in water quality standards to support listings of impaired waterbodies. The Office of Water and the Office of Environmental Information determined it would be valuable to re-assess the progress states were making in developing and adopting biological assessments and criteria into their water quality management programs. In 2001, Geoffrey Grubbs, Director of the Office of Water, Office of Science and Technology, stated that the key goal of the biocriteria program should be to accelerate the adoption of biocriteria in state and tribal water quality standards programs to better support regulatory programs. Therefore, in late 2001, the Office of Environmental Information and the Office of Water initiated this effort to update the 1994-95 survey information. This project was also supported by the Office of Wetlands, Oceans, and Watersheds and was coordinated through USEPA Regional Offices.

The goal of the 2001 update was to compile a comprehensive re-assessment of state use of bioassessments and biocriteria for protecting streams and wadeable rivers. The update also illustrates changes and improvements in bioassessment capabilities over the past six years, and serves as an important measure of program advancement and EPA's bioassessment technical transfer efforts. This documentation will enable USEPA to better focus its water quality standards and criteria development and implementation strategy for the next several years, target new program priorities, and assess the present technical support needs of states, tribes, territories, and interstate commissions. EPA will also use this documentation to prepare a summary report card of national progress in adopting biocriteria into water quality standards.

As you will see from this report, the use of biological assessment and criteria for managing the Nation's waterbodies has progressed significantly in the past six years and is equipping states, tribes, territories, interstate commissions, and EPA with a more effective set of monitoring and standards tools for determining and protecting the health of the Nation's waters.

1.2 Introduction to the Process

This project was coordinated by EPA's Office of Environmental Information in partnership with the Agency's Biocriteria Team, composed of members from the Office of Water (Office of Science & Technology, Office of Wetlands, Oceans, and Watersheds) and the Office of Environmental Information. The goal of the project was to obtain the current status of biological assessment programs and biocriteria

development for streams and wadeable rivers. The project team also coordinated with EPA Regional Biocriteria Coordinators and Regional Indian Program Coordinators. Because identical information would be solicited from all 50 states, the District of Columbia, US territories, selected tribes, and selected interstate commissions, this project was covered under the Water Quality Standards Program Information Collection Request (ICR No. 0988.07) in compliance with the 1995 Paperwork Reduction Act.

In June 2001, the project team developed a "checklist" of 57 questions covering six different categories (Appendix C contains a blank copy of the checklist):

- contact information (including points of contact for biological programs for other waterbody types – nonwadeable rivers, lakes, reservoirs, estuaries/near coastal marine, and wetlands)
- programmatic elements
- ALU decision making process
- field and lab methods
- data analysis and interpretation
- information management

Throughout the autumn of 2001, email "packets" were distributed to over 75 points of contact in states, tribes, territories, and interstate commissions (provided by EPA Regional offices). These packets consisted of an introductory memo, the checklist, and relevant excerpts from each entity's water quality standards (where applicable). Recipients were asked to complete the checklist and review the standards excerpts for completeness and accuracy. As completed checklists were returned, members of the project team followed-up by phone and email with each entity to clarify, verify, and document information and to fill in gaps where necessary. Contacts from a total of 65 entities responded and provided the information included in this document.

As was done for the 1996 document, the project team created a template "program summary" used to translate and display the information gathered from each entity. The summary pages for each responding entity consist of a narrative program description, documentation and further information, as well as a three page fact sheet. Program summaries for all 65 entities are found in Chapter 3 (there are only 64 actual program summaries because Puerto Rico and the U.S. Virgin Islands are combined into one). The information in the program summaries was organized into several sections as shown below (Appendix D contains a blank program summary coded with the corresponding sections of the original checklist):

Contact Information

Program Description

Documentation and Further Information

Programmatic elements

- Uses of bioassessment within overall water quality program
- Applicable monitoring designs

Stream Miles

- Total miles
- Total perennial miles
- Total miles assessed for biology
  - fully supporting for 305(b)
  - partially/non-supporting for 305(b)
  - listed for 303(d)
  - number of sites sampled
  - number of miles assessed per site

Aquatic Life Use (ALU) Designations and Decision Making

- ALU designation basis
- ALU designations in water quality standards
- Narrative Biocriteria in WQS
- Numeric Biocriteria in WQS
- Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)
- Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU

Reference Site/Condition Development

- Number of reference sites
- Reference site determinations
- Reference site criteria
- Characterization of reference sites within a regional context
- Stream stratification within regional reference conditions
- Additional information

Field and Lab Methods

- Assemblages assessed (no. of samples/year, level of rigor)
- Benthos (sampling gear, habitat selection, subsample size, taxonomy)
- Fish (sampling gear, habitat selection, sample processing, subsample, taxonomy)
- Periphyton (sampling gear, habitat selection, sample processing, taxonomy)
- Habitat assessments
- Quality assurance program elements

Data Analysis and Interpretation

- Data analysis tools and methods
- Multimetric thresholds
  - transforming metrics into unitless scores
  - defining impairment in a multimetric index
- Multivariate thresholds
  - defining impairment in a multivariate index
- Evaluation of performance characteristics
- Biological data
  - Storage
  - Retrieval and analysis

In addition, selected relevant excerpts from state, tribal, territorial and interstate commission water quality standards excerpts were compiled into a separate chapter for inclusion in the document (see Chapter 4: Relevant Excerpts from Water Quality Standards and Biocriteria Language).

In April 2002, a preliminary draft of the document containing the Definition of Terms and Acronyms, Program Summaries, Water Quality Standards and Biocriteria Language, Literature Cited, and List of Contacts was distributed to the full Biocriteria Team for an editorial and technical review. Individual program summaries and water quality excerpts were distributed to the relevant EPA Regional contacts and the point of contact for each responding entity for review and comment. During the summer of 2002, the project team compiled, organized, and incorporated the feedback received from all reviewers.

This document, *Summary of Biological Assessment Programs and Biocriteria Development for States, Tribes, Territories, and Interstate Commissions*: *Streams and Wadeable Rivers*, represents this project's final product. The document's value lies not only in the wealth of information it contains but also in the lessons learned from the process. In the near future, EPA hopes to initiate similar projects to assess the status of bioassessment and biocriteria programs for lakes, reservoirs, estuaries, and wetlands. The effectiveness and efficiency of those efforts will be enhanced by the development of this reference document.

THIS PAGE INTENTIONALLY LEFT BLANK

2. SUMMARY OF FINDINGS

2.1 Summary of Current Biological Assessment Programs and Biocriteria Development

This report summarizes the national breadth of biological monitoring and assessment in stream and wadeable river management programs based on 2001 program information (Table 1). Since this summary pertains to more than just "states," the term "entity" is used to refer to the combination of states, tribes, territories, and interstate commissions. Survey responses were received from 65 entities (50 states, District of Columbia, four territories, six tribes, and four interstate commissions – see Appendix A for a complete list).

Although ranging across a wide spectrum – from initial pilot studies to comprehensive assessment – 57 of the 65 entities have bioassessment programs for streams and wadeable rivers, and two (Puerto Rico and the Nez Perce Tribe) have programs under development. Nearly 440,000 river and stream miles nationwide are assessed using biological data (see Figure 1a for state-by-state percentages). More importantly, as shown in Table 1, 40 entities use bioassessment to help determine aquatic life use support (ALUS) for their 305(b) reporting (Figure 1b), and six states (AK, CA, HI, MT, NV, OK) are developing processes for using biological data to interpret ALU. Thirteen entities, including seven states (AZ, AR, CO, DE, LA, SD, UT) either don't have *comprehensive* statewide bioassessment programs in place, or they don't yet use bioassessment data to determine the condition of their waters.

A total of 29 entities have incorporated narrative biocriteria into their WQS (Figure 2a). The 11 entities (AZ, CO, HI, IL, IN, IA, MD, MT, NV, WA, Pyramid Lake Paiute Tribe) in a developmental phase of adopting narrative biocriteria into their WQS are at various stages in this process. While some may have already developed biocriteria and are working on promulgating the statements into their WQS, others are awaiting state or federal approval, or are in the earlier stages of developing narrative biocriteria to be submitted for review. Although 20 entities do not have narrative biocriteria in their WQS, several of these have incorporated general aquatic life statements. The following five entities – ICPRB, SRBC, Nez Perce Tribe, Oneida Nation of Wisconsin and Passamaquoddy Tribe - Pleasant Point Reservation – do not have federally approved WQS and are not currently working toward that end. Therefore, these entities are not included in any biocriteria counts.[1]

Of the 29 entities with narrative biocriteria incorporated into their WQS, 22 have also developed quantitative implementation procedures or translators, and eight are working to develop them (Figure 2b). These procedures can be found in various documents including WQS, SOPs, 305(b) guidelines, and other agency documents. While numeric procedures are not numeric *biocriteria* per se, they do provide a quantitative basis for assessing attainment of specific designated aquatic life uses and are an important step in biocriteria development.

[1] While the Oneida Nation does not have federally approved water quality standards, the Tribe is currently using bioassessments to implement their water quality program under tribal law. Inclusion of narrative and numeric biocriteria into the Tribe's WQS is under development.

Table 1. National summary of bioassessment programs for streams and wadeable rivers in 2001

PROGRAMMATIC ELEMENT	NUMBER OF ENTITIES			
	In-place	Under development	None	Not applicable
Use of Bioassessments				
Water resource management	57	2	6	0
Interpret aquatic life use attainment	40	6	13	6[2]
Narrative biocriteria in WQS	29	11	20	5[3]
Narrative biocriteria in WQS with quantitative implementation procedures or translators	22	8	30	5[4]
Numeric biocriteria in WQS	4	11	45	5[4]
Assemblage Used				
Fish	41	0	16	8[4]
Benthic macroinvertebrates	56	1	0	8[5]
Algae (periphyton, diatoms)	20	5	32	8[5]
More than one assemblage	45	5	7	8[5]
Reference Conditions				
Ecoregional	42	2	12	9[5]
Site-specific	19	1	37	8[6]
State-wide or basin-specific	7	1	46	11[6]
Analysis				
Biological metrics	54	1	1	9[7]
Multivariate	22	2	32	9[8]
Assessment				
Multimetric index	41	3	12	9[8]
Habitat assessment	57	0	0	8[3]

[2] DRBC and ICPRB are not regulatory authorities. Nez Perce Tribe, Oneida Nation of Wisconsin, Passamaquoddy Tribe - Pleasant Point Reservation, and Pyramid Lake Paiute Tribe do not have federally approved WQS.

[3] ICPRB, SRBC, Nez Perce Tribe, Oneida Nation of Wisconsin and Passamaquoddy Tribe - Pleasant Point Reservation do not have federally approved WQS and are not currently working toward that end.

[4] The following entities do not use biological assessment methods as a means to assess stream and river water quality: American Samoa (AS), Puerto Rico (PR), U.S. Virgin Islands (USVI), Confederated Tribes of the Colville Reservation, Nez Perce Tribe, Passamaquoddy Tribe - Pleasant Point Reservation, and Seminole Tribe of Florida. The Commonwealth of Northern Mariana Islands (CNMI) has a bioassessment program for marine systems only; bioassessment for freshwater is not applicable.

[5] Virginia did not provide complete reference condition information. American Samoa, CNMI, Puerto Rico, U.S. Virgin Islands, Confederated Tribes of the Colville Reservation, Nez Perce Tribe, Passamaquoddy Tribe - Pleasant Point Reservation, and Seminole Tribe of Florida do not have bioassessment programs.

[6] AS, CNMI, PR, USVI, Confederated Tribes of the Colville Reservation, Nez Perce Tribe, Passamaquoddy Tribe - Pleasant Point Reservation, and Seminole Tribe of Florida do not have bioassessment programs.

[7] Pyramid Lake Paiute Tribe has not yet analyzed or evaluated their biological data. AS, CNMI, PR, USVI, Confederated Tribes of the Colville Reservation, Nez Perce Tribe, Passamaquoddy Tribe - Pleasant Point Reservation, and Seminole Tribe of Florida do not have bioassessment programs.

Four entities (FL, OH, OK, DRBC) have numeric biocriteria incorporated into their WQS (Figure 2c).[8] And of the 11 entities for which numeric biocriteria is categorized as "under development," Maine and Wyoming have developed and incorporated numeric biocriteria into other program documents, such as SOPs and monitoring guidance manuals, and have been using the numeric limits to maintain designated uses.

The three major groups of biological organisms or assemblages monitored as part of comprehensive biological assessment programs are fish, benthic macroinvertebrates, and algae (periphyton). Macroinvertebrates are the most common indicator assemblage used by state water quality agencies and are a part of all but Hawai`i's bioassessment program, where it is currently under development (Figure 3a). The second most common assemblage monitored is fish, followed by periphyton (Figures 3b and 3c). Forty-five entities monitor for at least two assemblages, and another five (AK, HI, NV, UT, WY) currently use one, but are developing the capability of using a second (Figure 3d).

One of the key elements in bioassessment programs is the establishment of reference conditions to help discern human impacts from natural variation. The two types of reference conditions currently used in biological surveys are regional and site-specific. The Ecoregion Concept, a common regionalization approach, recognizes geographic patterns of similarity among ecosystems and the subsequent distribution of biological communities grouped on the basis of environmental variables such as climate, soil type, physiography, and vegetation. Forty-two entities have adopted this method of stream stratification/ characterization in developing reference conditions (Figure 4). Site-specific reference conditions typically consist of condition measurements taken upstream of a point source discharge or from a "paired" watershed. However, their usefulness is limited since they have only site-specific value (USEPA 1999). Only nine entities primarily use this approach to determine reference conditions.

Biological metrics and multivariate analysis are two types of data analysis tools/methods used to reduce a wealth of raw data into workable indicators of biological condition. Nearly all of the entities with bioassessment programs have developed biological metrics. In addition, just under half use multivariate analysis (techniques that look at the pattern of relationships among several variables simultaneously, such as principal components analysis (PCA) and non-metric multidimensional scaling (NMS)). Of the 54 entities that select and calculate biological metrics, 41 aggregate these metrics into a multimetric index (such as fish or macroinvertebrate IBIs) to assess biological condition and water quality, and to discriminate between impaired and unimpaired conditions (Figure 5). Finally, all entities with bioassessment programs also assess the physical habitat quality at their sample sites, usually employing visual based methods (such as QHEI and RBPs) in combination with other measurements.

2.2 Bioassessment Program Success from 1989 to 2001

In 1989, when developing the *Rapid Bioassessment Protocols for Use in Streams and Rivers*, USEPA summarized the bioassessment and biomonitoring capabilities in state regulatory programs (USEPA 1989). While the 1989 summary did not determine the actual use of the bioassessment data for all states, it did provide an estimate based upon past knowledge of state programs and on the documentation gathered during its development.

The *Summary of State Biological Assessment Programs for Streams and Rivers,* based on 1995 data, compiled a more comprehensive assessment of state uses of bioassessments and biocriteria in water management programs (USEPA 1996). The document serves as the baseline for determining changes and improvements in bioassessment capabilities over the past six years. Table 2 presents a summary of the 1989 and 1995 results alongside the 2001 data from Table 1. The incremental change (from 1989 to

[8] Florida has made substantial progress in developing new multimetric indices for streams (Stream Condition Index and BioRecon), lakes (Lake Condition Index), and wetlands for eventual inclusion in the Florida Administrative Code. When the new indices are adopted as water quality standards, the role of Shannon-Weaver diversity as a numeric standard will be re-evaluated.

Macroinvertebrate biocriteria were developed for DRBC's Special Protection Waters rules issued in 1990, but the criteria were later found to be based upon inconsistent and non-representative methods and have not been used as envisioned during development of the Commission's antidegradation policies. Program redesign recommendations were recently made to improve effectiveness and applicability of the criteria.

1995, and 1995 to 2001) appears in parentheses, and an additional column indicates the net change from 1989 to 2001. For the purposes of comparison, Table 2 only contains program information from the original 52 entities surveyed in 1989 and 1996 (50 states, the District of Columbia, and ORSANCO). Refer to Table 1, Chapter 3, and Appendix A for programmatic information on the additional entities surveyed for this document.

There has been extensive progress in the development and use of biological assessments and criteria as revealed by virtually all measures of the survey as shown in Table 2. All 52 entities contained in this table have incorporated bioassessment in their water resource management programs. This is up over 30% from a count of 37 in 1989. Although the number of states that used bioassessments to determine aquatic life use attainment in 1989 is unknown, these numbers did increase noticeably from 1995 to 2001. And despite the fact that the number of entities with numeric biocriteria in their WQS has only increased by two over the past 12 years, 18 entities have developed and implemented quantitative procedures or translators for use in their water quality management programs (Figure 2b), and sixteen are in the process of developing narrative and/or numeric biocriteria for their standards.

Since 1989, the number of entities sampling at least one of the three major assemblages has steadily grown. Almost every entity surveyed in 1995 now conducts benthic macroinvertebrate assessments (Figure 3a). Even periphyton sampling, which declined from 1989 to 1995, rose sharply from 1995 to 2001. Studies have found that assessing only one assemblage can only achieve roughly 80 to 85% effectiveness at identifying aquatic life use attainment or nonattainment. Thus, since 1995, USEPA has recommended the use of multiple assemblages, especially in larger streams (USEPA 1996). The number of entities using more than one assemblage in 2001 reached 41 (an increase of 15 in just five years); and 20 of these 41 entities sample for at least three, and even four, assemblages, such as phytoplankton, macrophytes and zooplankton (Figure 3d).

One of the major advancements since 1989, and especially since 1995, has been the increased use of regional reference conditions as a basis for making comparisons and detecting use impairment. Only four states were actively using ecoregional reference conditions in 1989, and still only 15 in 1995. However, by 2001, 39 entities characterized reference conditions using a composite or aggregation of least or minimally impaired sites within distinct ecoregions (Figure 4). And conversely, 11 fewer entities used a site-specific approach alone to determine reference conditions.

The number of entities using biological metrics for data analysis increased by eight in 2001, in step with a sharp increase of 39 between 1989 and 1995. Today, all but two of the surveyed entities contained in Table 2 have developed biological metrics.

Finally, for the 2001 survey, we narrowed the definition of what constitutes narrative biocriteria in WQS to exclude general aquatic life statements. We adhered to the definition of narrative biocriteria as “narrative expressions that describe biological integrity of aquatic communities inhabiting waters of a given classification or designated aquatic life use.” We also required entities to clarify how the criteria were operationally defined in their WQS. This examination yielded a count of 28 entities with narrative biocriteria in their WQS, one entity less than was reported in 1995. However, had we used the 1995 definition of narrative biocriteria, these 28 entities would grow to 40, resulting in an increase of 11 between 1995 and 2001.

Refer to Appendix A for a summary of pertinent information for each entity surveyed. This information is captured in greater detail and clarity in the individual program summaries found in Chapter 3.

Table 2. National summary of bioassessment programs for streams and wadeable rivers in 1989, 1995, 2001 and the interim change [9]

PROGRAMMATIC ELEMENT	NUMBER OF ENTITIES (see note below)											
	In-place				Under Development				None			
	1989	1995	2001	net change	1989	1995	2001	net change	1989	1995	2001	net change
Use of Bioassessments												
Water resource management	37	41 (+4)	52 (+11)	+11	7	8 (+1)	0(-8)	-3	8	3 (-5)	0(-3)	-8
Interpret aquatic life use attainment	unk	31	39 (+8)	+8	unk	8	6 (-2)	-2	unk	13	7 (-6)	-6
Narrative water quality standard	unk	29	28 (-1)	-1	unk	11	10 (-1)	-1	unk	12	14 (+2)	+2
Numeric water quality standard	1	2 (+1)	3 (+1)	+2	unk	15	10 (-5)	-7	49	35 (-14)	39 (+4)	-8
Organism Group Used												
Fish	23	29 (+6)	37 (+8)	+15	1	5 (+4)	0 (-5)	-1	28	18 (-10)	15 (-3)	-13
Benthic macroinvertebrates	39	44 (+5)	51 (+7)	+12	3	5 (+2)	1 (-4)	-2	10	3 (-7)	0 (-3)	-10
Algae (periphyton, diatoms)	7	4 (-3)	19 (+15)	+12	0	3 (+3)	5 (+2)	+5	45	45 (+0)	28 (-17)	-16
More than one assemblage	24	26 (+2)	41 (+15)	+17	4	10 (+6)	5 (-5)	+1	26	16 (-10)	6 (-10)	-20
Reference Conditions												
Ecoregional	4	15 (+11)	39 (+24)	+35	2	26 (+24)	2 (-24)	0	44	11 (-33)	11[10] (0)	-33
Site-specific	unk	31	19 (-12)	-12	unk	0	1 (+1)	+1	unk	21	32[10] (+11)	+11
State-wide or basin-specific	unk	6	6 (0)	0	unk	0	0	0	unk	46	46[10] (0)	0
Multiple Metrics for Data Analysis												
Biology	3	42 (+39)	50 (+8)	+47	11	6 (-5)	1 (-5)	-10	35	4 (-31)	1 (-3)	-34

NOTE: The same 52 entities were used for each of the years for the most accurate comparison of changes over time.

[9] The incremental change (from 1989 to 1995, and 1995 to 2001) appears in parentheses, and the "net change" column indicates the total change from 1989 to 2001, or 1995 to 2001 where 1989 data is unknown.

[10] The *Ecoregional* and *State-wide or basin-specific* elements are not applicable to New York and Virginia's programs (Virginia did not complete this section). The *Site-specific* element is not applicable to Utah's program. For the purposes of comparison, each has been counted as *None* in this table.

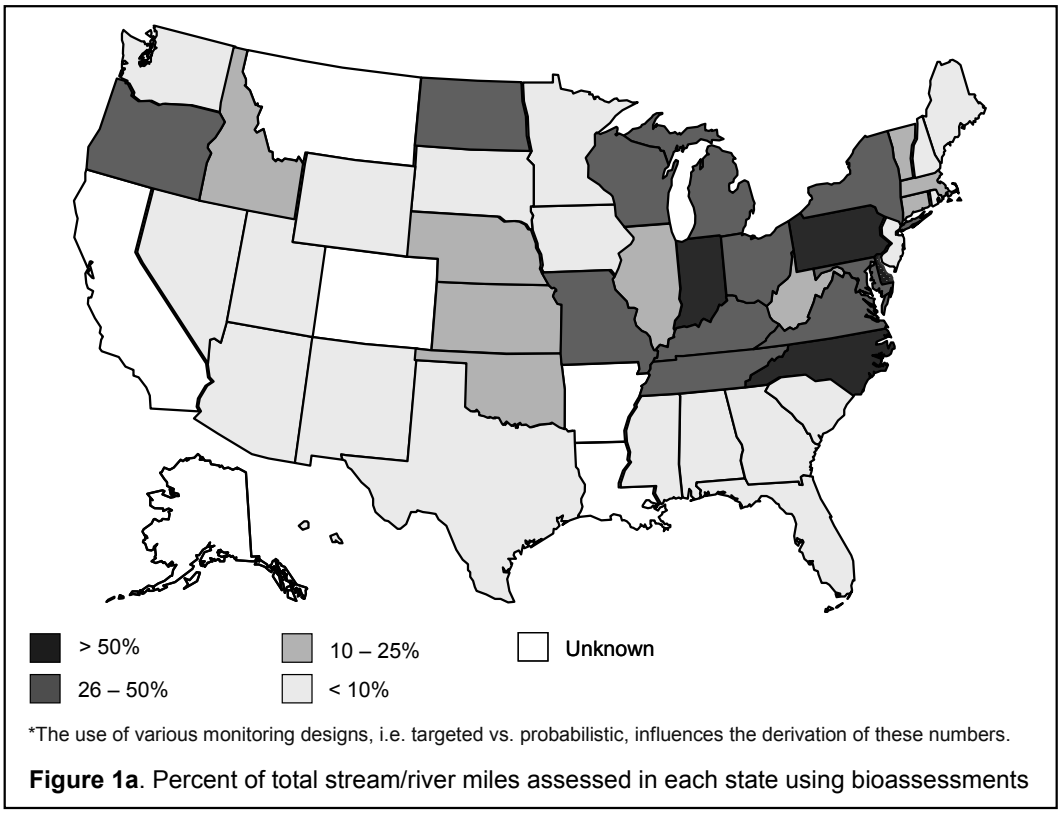


Figure 1a. Percent of total stream/river miles assessed in each state using bioassessments

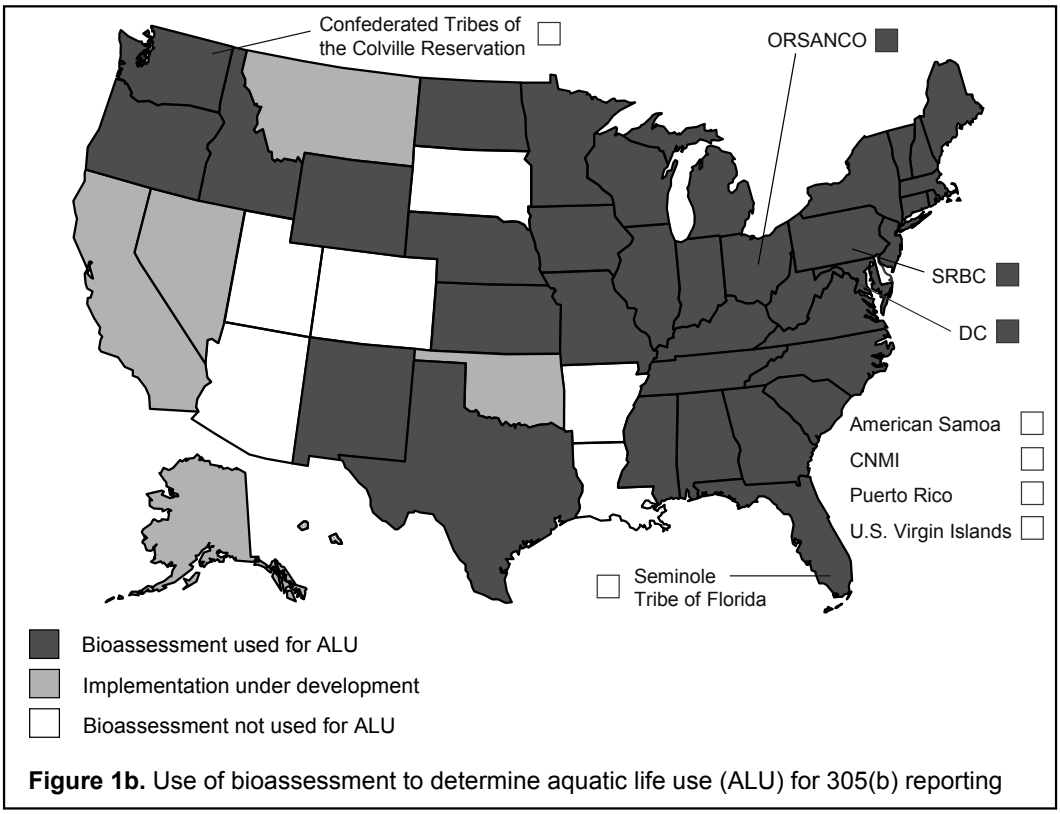


Figure 1b. Use of bioassessment to determine aquatic life use (ALU) for 305(b) reporting

Figure 1. Use of bioassessments to assess water quality

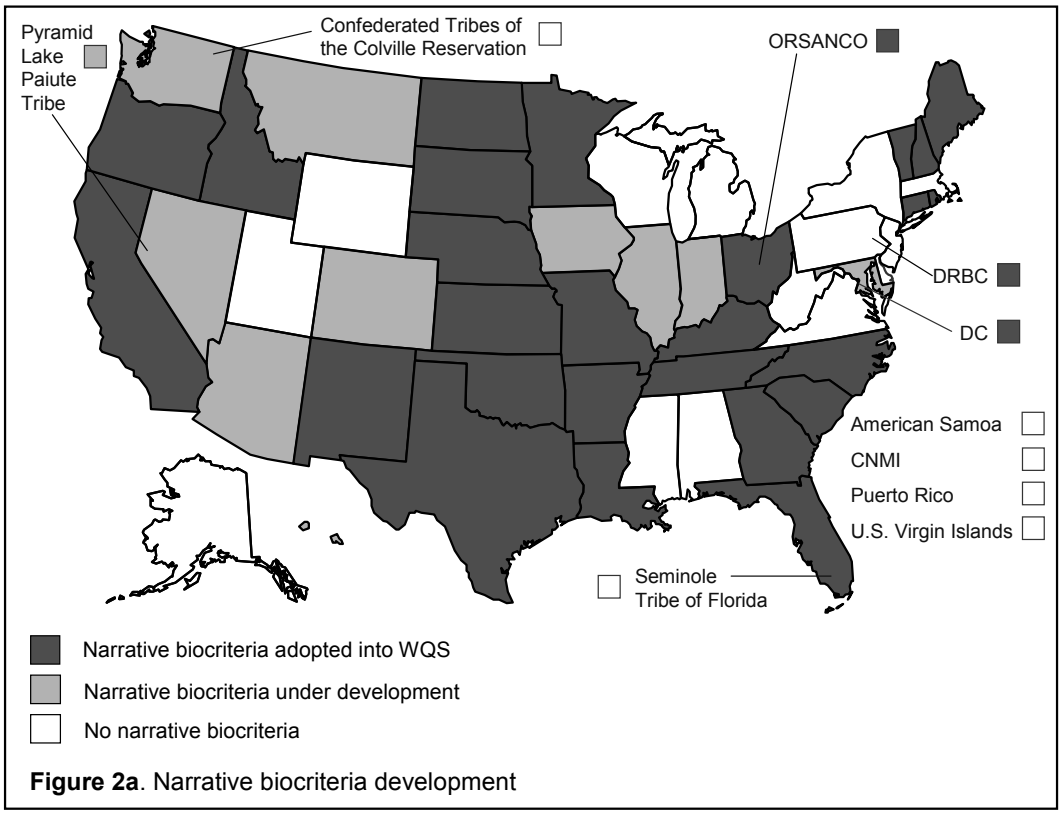


Figure 2a. Narrative biocriteria development

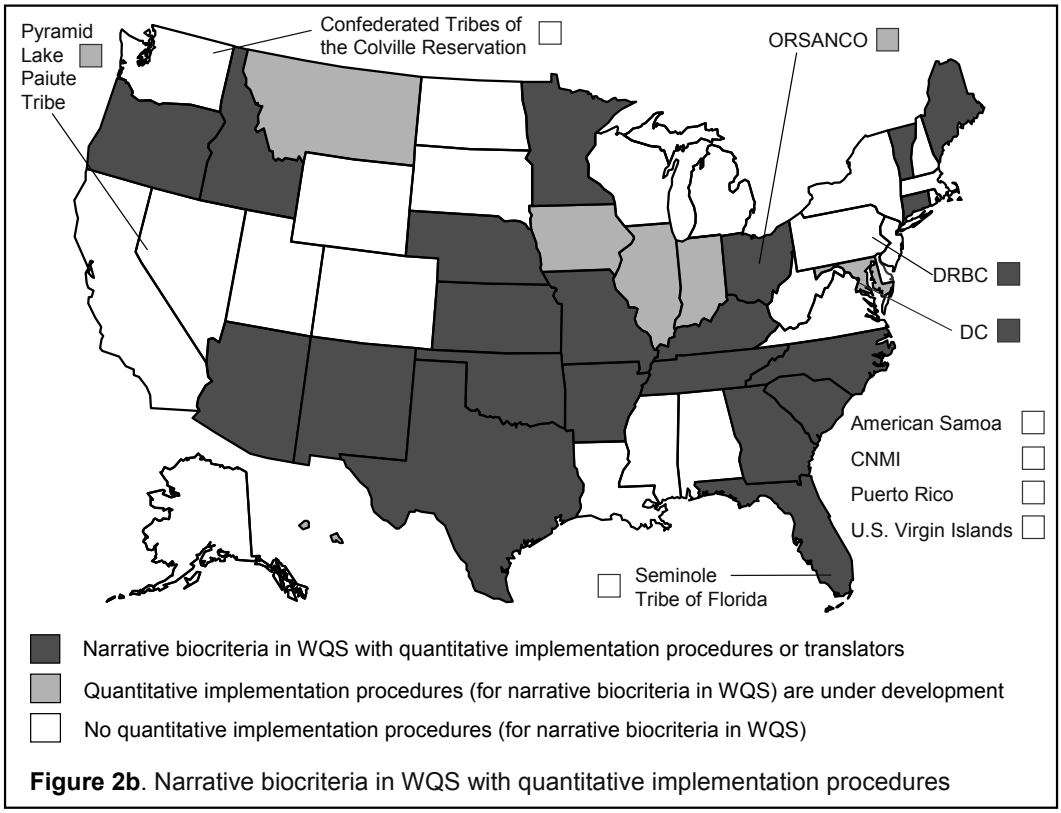


Figure 2b. Narrative biocriteria in WQS with quantitative implementation procedures

Figure 2. Biocriteria development

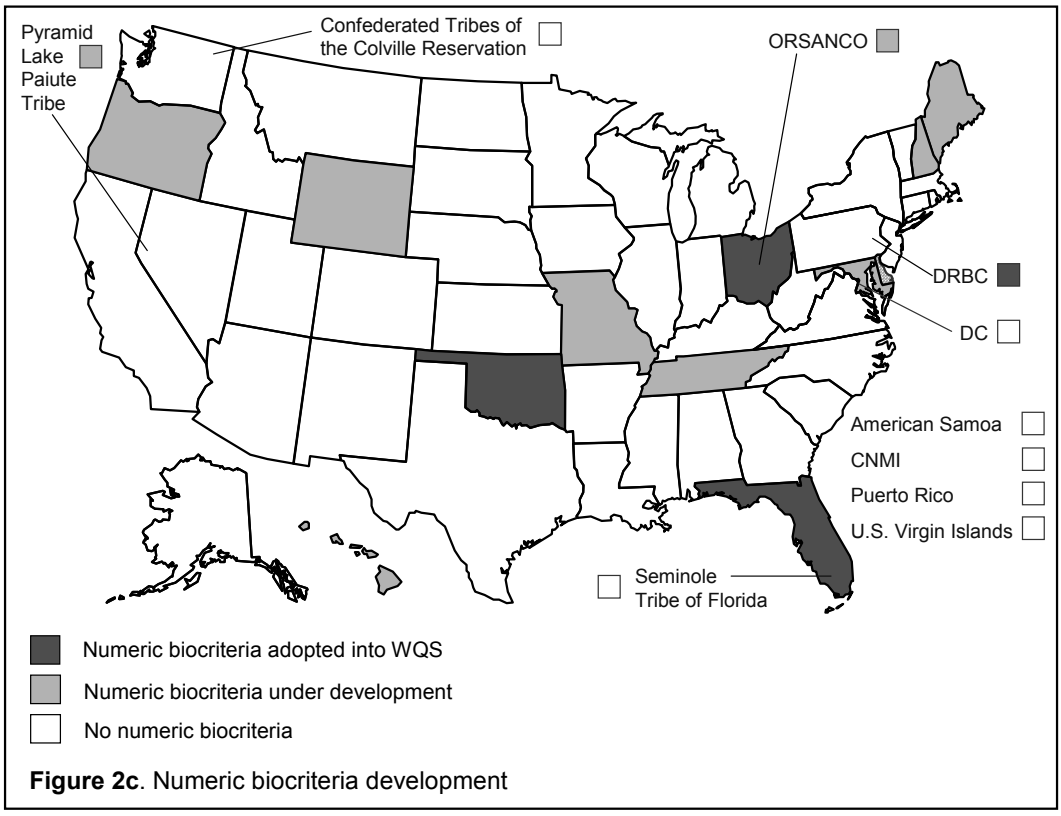


Figure 2c. Numeric biocriteria development

Figure 2 (cont). Biocriteria development

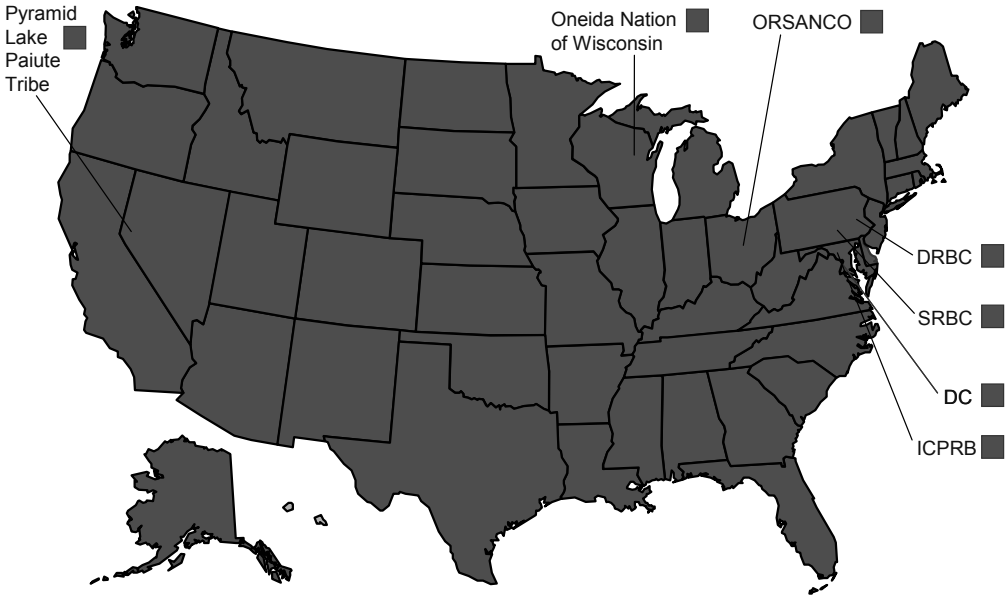


Figure 3a. Benthic macroinvertebrates

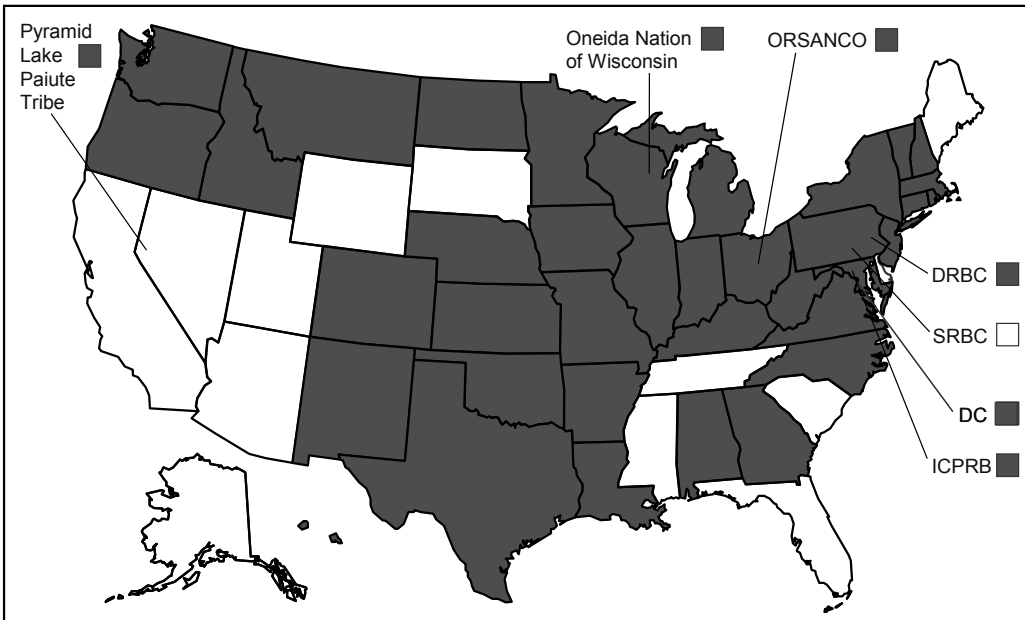


Figure 3b. Fish

Figure 3. Assemblages assessed

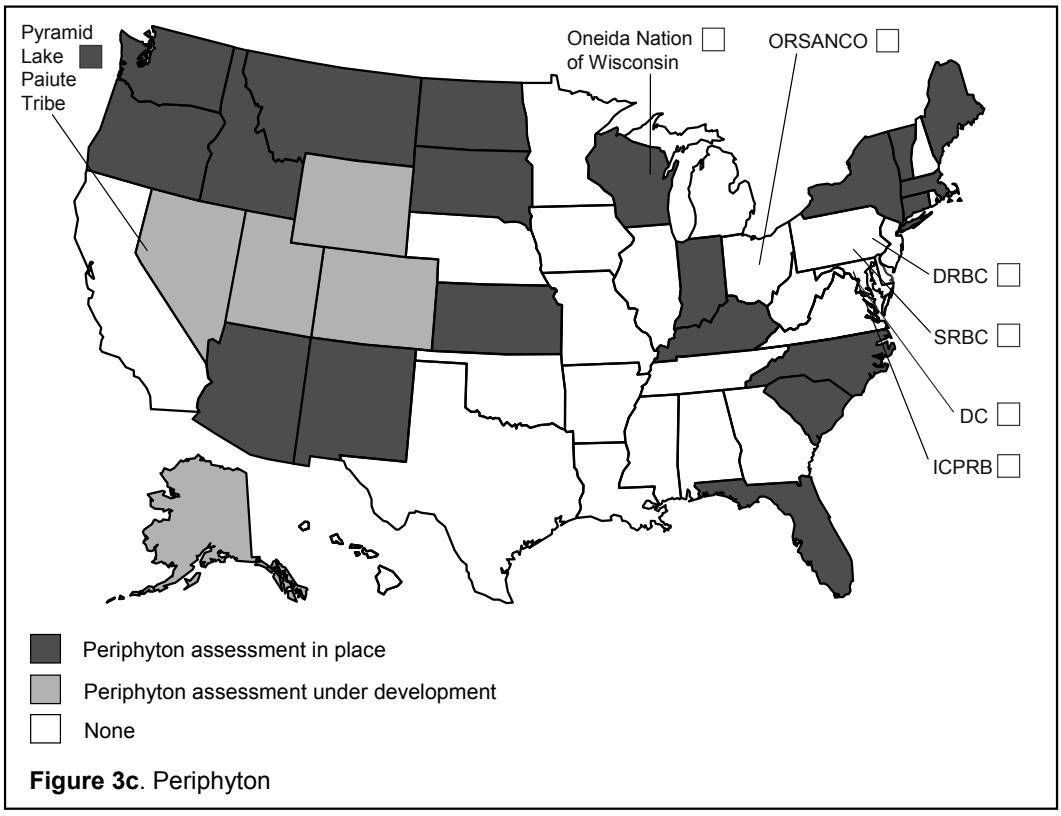


Figure 3c. Periphyton

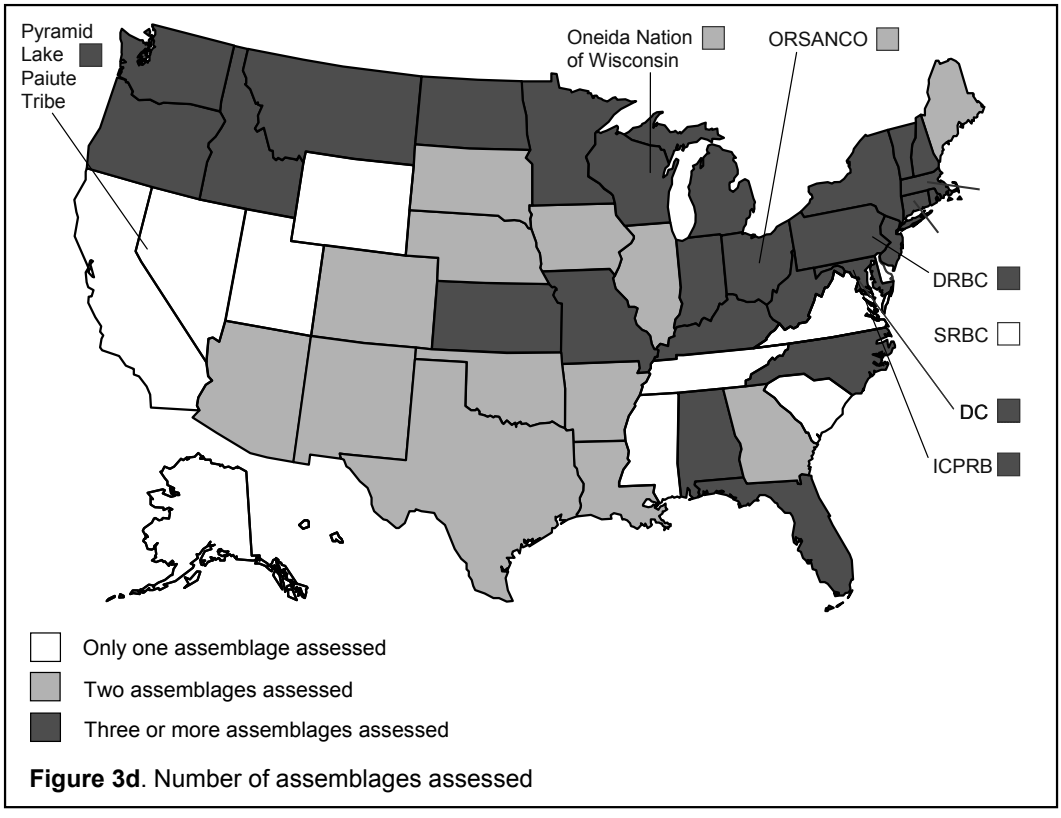


Figure 3d. Number of assemblages assessed

Figure 3 (cont). Assemblages assessed

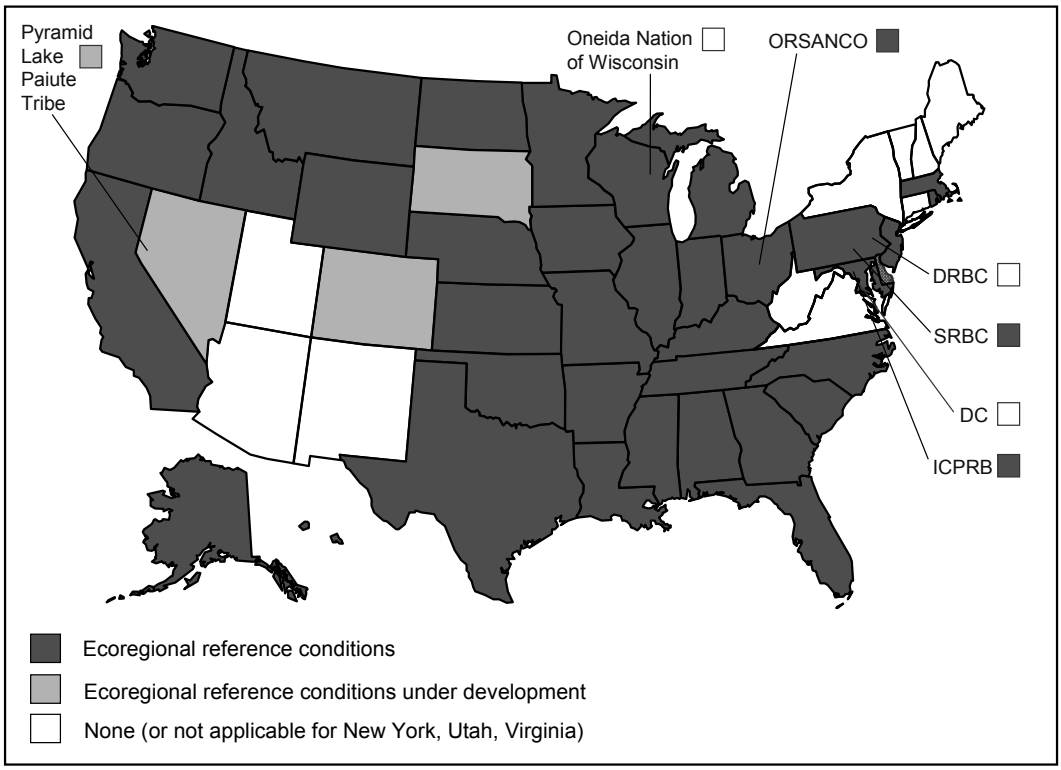


Figure 4. Use of ecoregional reference conditions

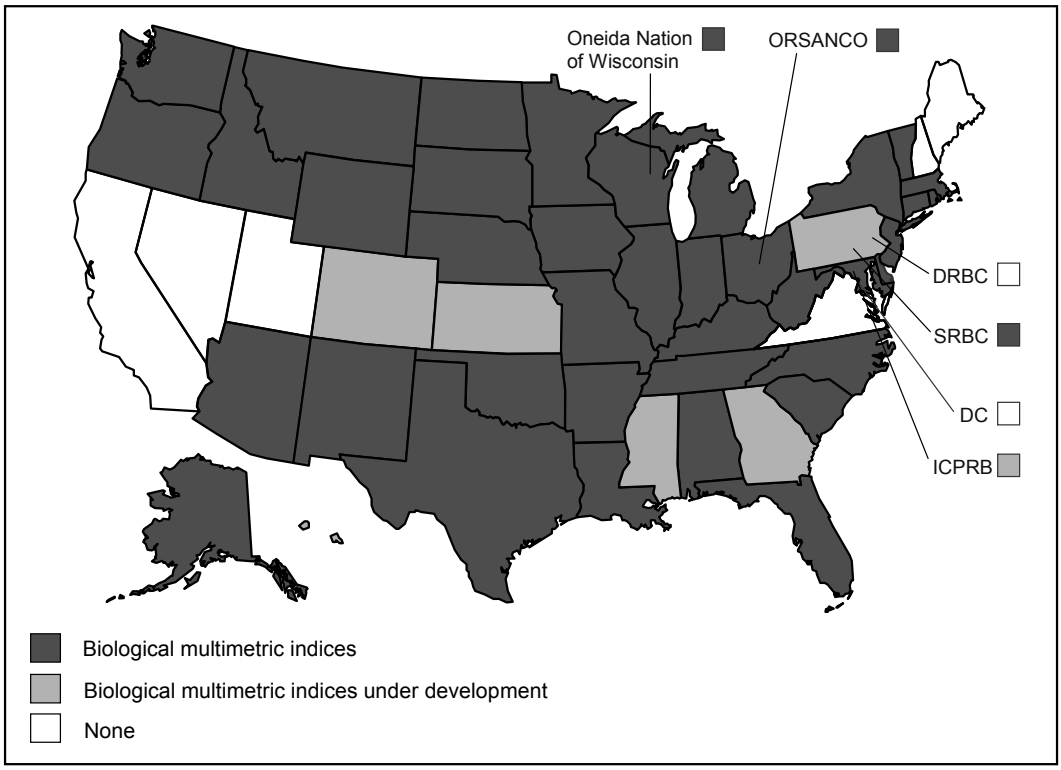


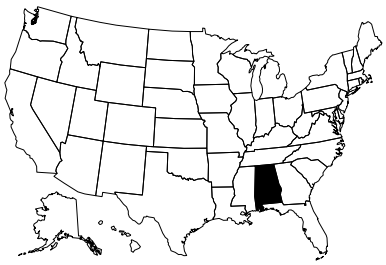
Figure 5. Development of biological multimetric indices

THIS PAGE INTENTIONALLY LEFT BLANK

3. PROGRAM SUMMARIES

THIS PAGE INTENTIONALLY LEFT BLANK

ALABAMA



Contact Information

Fred Leslie, Chief - Aquatic Assessment Unit
Alabama Department of Environmental Management (ADEM)
P.O. Box 301463 ■ Montgomery, AL 36130-1463
Phone 334/260-2752 ■ Fax 224/272-8131
email: fal@adem.state.al.us
ADEM Water Quality homepage:
http://www.adem.state.al.us/WaterDiv/Water%20Quality%20Info/WQMainInfo.htm

Program Description

In the last five years the Alabama Department of Environmental Management (ADEM) has assessed more than 1,100 river and stream locations as a part of six major long-term riverine-focused monitoring programs:

- Nonpoint Source Assessment Program
- Source Assessment Program
- Ecoregion Reference Assessment Program
- Upland Alamap Monitoring and Assessment Program
- Clean Water Act §303(d) Support Assessment/Monitoring Program
- Fixed Ambient Trend Monitoring Program

The Field Operations Division's (FOD) benthic macroinvertebrate assessment program is an integral part of the Department's biological monitoring effort. A Multihabitat Bioassessment Protocol is currently utilized to sample wadeable and nonwadeable streams. All methods utilized are documented in the Department's *Standard Operating Procedures* and *Quality Control Assurance Manual, Volume II* (ADEM 1999).

The Department has developed assessment criteria based on a ten-year ecoregional reference database. These assessments are then used to determine the Aquatic Life Use Designations. These comparisons have aided the Department in evaluating the "best attainable biotic community" within an ecoregion. The Department uses macroinvertebrates and a multi-habitat fish community assessment to evaluate water quality. Periphyton bioassessment methods are currently being tested as a more direct assessment of nutrient enrichment.

Biological integrity and water quality are directly affected by physical habitat. In addition, the assessment of habitat quality is an important step in documenting the adverse impacts of nonpoint source pollution. The Department utilizes the Habitat Assessment Matrices developed by EPA (USEPA 1989) and Barbour and Stribling (1994) in conjunction with physical characteristics and water quality parameters to evaluate and document the habitat quality of each wadeable bioassessment sampling site. More intensive assessment of geomorphological survey methods are currently being implemented (in 2002) to evaluate sedimentation impacts.

Through contracts and cooperative efforts, other agencies have contributed valuable information, time, data, and other resources to the surface and ground water management program. These contributions have included sampling and analysis efforts; flow information; data contribution and management; and GIS development. The Alabama Water Watch (AWW) Program and Association routinely provides quality citizen volunteer monitoring data to ADEM. With so much water to manage and diminishing program funds, the "Alabama Water Watchers" play a key role in identifying waters that need immediate or long-term attention.

Documentation and Further Information

2000 Water Quality Report to Congress, 305(b) Report:
http://www.adem.state.al.us/WaterDiv/Water%20Quality%20Info/305b/WQ305bReport.htm

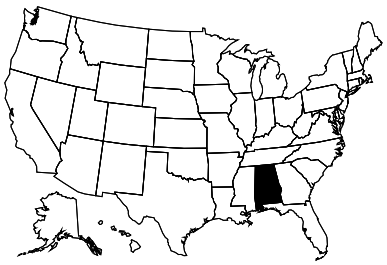
1996, 1998 and 2000 303(d) lists, listing and delisting criteria, and maps of listed waters:
http://www.adem.state.al.us/WaterDiv/Water%20Quality%20Info/303d/WQ303d.htm

ADEM. 1999. *Standard Operating Procedures and Quality Control Assurance Manual Volume II – Freshwater Macroinvertebrate Biological Assessment*. Field Operations Division ADEM, Montgomery, Alabama.

O'Neil, P.E., and T.E. Shepard. 1998. *Standard operating procedure manual for sampling freshwater fish communities and application of the index of biotic integrity for assessing biological condition of flowing, wadeable streams in Alabama*. ADEM Contract No. AGY7042. Geological Survey of Alabama, Tuscaloosa, Alabama.

Barbour, M.T., and J.B. Stribling. 1994. A technique for assessing stream habitat structure. Pages 156-178 in *Conference proceedings, Riparian ecosystems in the humid U.S.: Functions, values, and management.* National Association of Conservation Districts, Washington, D.C. March 15-18, 1993, Atlanta, Georgia.

ALABAMA



Contact Information

Fred Leslie, Chief - Aquatic Assessment Unit
Alabama Department of Environmental Management (ADEM)
P.O. Box 301463 ■ Montgomery, AL 36130-1463
Phone 334/260-2752 ■ Fax 224/272-8131
email: fal@adem.state.al.us

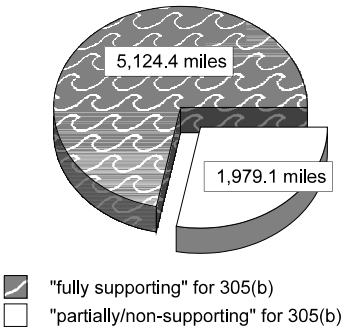
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects and specific river basins or watersheds)*
	✓	fixed station (i.e., water quality monitoring stations) *(special projects and comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(special projects and specific river basins or watersheds)*
		other:

Stream Miles

Total miles	**77,274**
Total perennial miles	47,077
Total miles assessed for biology*	**7,103.5**
fully supporting for 305(b)	5,124.4
partially/non-supporting for 305(b)	1,979.1
listed for 303(d)	1,979.1
number of sites sampled *(on an annual basis)*	200
number of miles assessed per site	–

7,103.5 Miles Assessed for Biology



*The above miles are the total river and stream miles assessed for biological *and* other (chemical, physical, etc.) effects. Strictly biological miles are as follows: 2,992.1 *monitored* miles and 5,524 *evaluated* miles were determined as "fully supporting" for 305(b) using bioassessment data. These miles do not include fish tissue monitoring data from streams and rivers.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Fishery Based Uses	
ALU designations in state water quality standards	Three designations: Outstanding Alabama Water, Fish & Wildlife, Limited Warmwater Fishery	
Narrative Biocriteria in WQS	none - A narrative scale of condition is used to support criteria decisions. Draft guidelines, based upon ecoregional reference conditions, are used in the evaluation of aquatic macroinvertebrate community assessments.	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	none	

Reference Site/Condition Development

Number of reference sites	**48 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria	Local Soil and Water Conservation District (SWCD) estimates of landuse, animal densities, and sedimentation rates, etc. and departmental databases are used to identify potentially least-impaired sub-watersheds.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

Field and Lab Methods

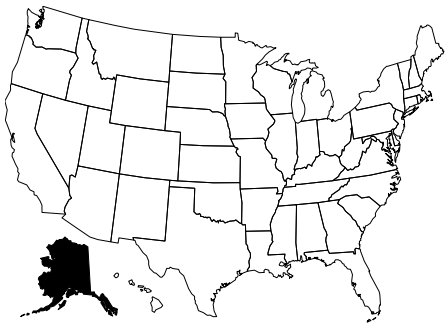
Assemblages assessed	✓	benthos *(100-500 samples/year; multiple seasons, multiple sites - broad coverage for watershed level)*
	✓	fish *(<100 samples/year; multiple seasons, multiple sites - broad coverage for watershed level)*
		periphyton *(currently being tested for assessment of nutrient enrichment)*
	✓	other: phytoplankton *(100-500 samples/year; multiple seasons, multiple sites - broad coverage for watershed level)*
Benthos		
sampling gear		wash bucket, dipnet and kick net (1 meter); 500-600 micron mesh
habitat selection		multihabitat
subsample size		100 per habitat
taxonomy		family and genus
Fish		
sampling gear		backpack electrofisher and seine; 3/16" mesh
habitat selection		pool/glide and riffle/run (cobble)
sample processing		biomass - batch
subsample		none
taxonomy		species
Habitat assessments		visual based; performed both with, and independent of, bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index and return single metrics)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		95th percentile of reference population
defining impairment in a multimetric index		The 2000 305(b) report states that sampling results equal to or less than fair/moderately impaired for the macroinvertebrate index and chemical/physical field data indicate an impairment ("excellent, good, fair, poor, very poor" or "unimpaired, slightly impaired, moderately impaired, severely impaired") and will be considered non-support and placed on the 303(d) list.
Evaluation of performance characteristics	✓	repeat sampling *(sampling - multiple crews same site/same day)*
	✓	precision *(sampling, assessment and identification)*
	✓	sensitivity *(sampling and assessment; standard level of identification)*
	✓	bias *(identification - 10% peer review)*
	✓	accuracy *(identification - 10% peer Quality Assurance; lab pick - 100% recheck; field pick - 10% returned to lab for re-check)*
Biological data*		
Storage		Aquatic macroinvertebrate data from 1990 to present are stored in a PACE mainframe database. ADEM has very recently developed an MS Access Fish IBI database and will begin data entry of this information as time allows. Historical macroinvertebrate data are stored in paper files. Fish IBI data are mostly in spreadsheets, but will eventually be included in the Access database.
Retrieval and analysis		Both databases mentioned above include automated metric calculation. The macroinvertebrate database also allows some comparison of taxa lists between stations.

*Additional resources are necessary to develop an in-house biological database module in Oracle that would be compatible with the Oracle Surface Water Quality Database currently under development. The current aquatic macroinvertebrate dataset and the fish community data would be migrated into this database module. STORET will not be used as the primary biological data storage and retrieval system.

ALASKA



Contact Information

Kent Patrick-Riley, Section Leader - NPS Protection and Impairment
Alaska Department of Environmental Conservation (ADEC)
555 Cordova Street ■ Anchorage, AK 99501
Phone 907/269-7554 ■ Fax 907/269-7508
email: kent_patrick-riley@envircon.state.ak.us
ADEC Division of Air and Water Quality homepage:
http://www.state.ak.us/local/akpages/ENV.CONSERV/dawq/dec_dawq.htm

Program Description

The State of Alaska is in the early stages of using bioassessments in water quality management. The lead agency funding bioassessment work is the Alaska Department of Environmental Conservation (ADEC); with the bulk of the development work done by the University of Alaska (UAA) Environment and Natural Resources Institute (ENRI). To date, bioassessments have not been used for biocriteria. Key accomplishments of Alaska's program include:

- method development and testing, resulting in the Alaska Stream Condition Index
- successful interagency involvement and supplemental funding
- extensive outreach and educational opportunities
- development of regional reference conditions for the Cook Inlet Ecoregion
- stream type differences incorporated into the framework for assessment
- index development incorporating multiple community attributes
- water quality assessments for Cook Inlet Ecoregion
- database development compatible with STORET for the water quality information
- relationship between degradation and habitat quality
- nutrient enrichment issues
- impervious surface areas influences to water quality

Documentation and Further Information

Alaska's bioassessment program is being developed in conjunction with UAA-ENRI. For consistency and to avoid duplicate information, refer questions on protocols and reference sites to them. Their web site is:
http://www.uaa.alaska.edu/enri/bmap

Alaska Stream Condition Index: Biological Index Development for Cook Inlet, Summary 1997 - 2001, August 2001:
http://www.uaa.alaska.edu/enri/bmap/pdfs/AK_SCI_2001.pdf

Quality Assurance Project Plan, Alaska Biological Monitoring and Assessment Program, February 2002:
http://www.uaa.alaska.edu/enri/bmap/pdfs/ENRI_QAPP_2-02.pdf

ALASKA

Contact Information

Kent Patrick-Riley, Section Leader - NPS Protection and Impairment
Alaska Department of Environmental Conservation (ADEC)
555 Cordova Street ■ Anchorage, AK 99501
Phone 907/269-7554 ■ Fax 907/269-7508
email: kent_patrick-riley@envircon.state.ak.us

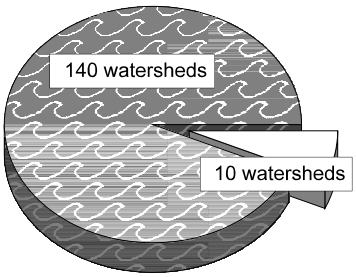
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
		monitoring the effectiveness of BMPs
		ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(comprehensive use throughout jurisdiction, special projects and specific river basins or watersheds)*
		fixed station (i.e., water quality monitoring stations)
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
		rotating basin
		other:

Stream Miles

Total miles *(determined using National Hydrography Database)*	**>3 million**
Total perennial miles	unknown
Total watersheds assessed for biology	**150**
watersheds fully supporting for 305(b)	140
watersheds partially/non-supporting for 305(b)	10
watersheds listed for 303(d)	10
number of sites sampled	300
number of miles assessed per site*	10

150 Watersheds Assessed for Biology



"fully supporting" for 305(b)
"partially/non-supporting" for 305(b)

*For the purposes of decision making, a 100 meter reach represents approximately 10 stream miles.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class system (A,B,C)–Every AK stream is designated for ALL uses (including drinking water) unless specifically exempted.	
ALU designations in state water quality standards	One designation in A: 3) aquaculture; One designation in C: 1) growth and propagation of fish, shellfish, other aquatic life, and wildlife	
Narrative Biocriteria in WQS	none	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
		cause and effect determinations
		permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Alaska is just beginning to use bioassessment information to help with assessment/monitoring and in management decisions.	

Reference Site/Condition Development

Number of reference sites	**43 total**	
Reference site determinations	✓	site-specific
		paired watersheds
		regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	no channelization; no upstream impoundments; no known point-source discharges; DO > 5 ppm; urban land use <15% in catchment; mining or logging in <15% of catchment; forest or natural land use >50% in catchment; riparian buffer width >18m	
Characterization of reference sites within a regional context		historical conditions
		least disturbed sites
		gradient response
		professional judgment
	✓	other: minimally disturbed*
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
	✓	stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
		reference sites/condition referenced in water quality standards
		some reference sites represent acceptable human-induced conditions

*Alaska's reference sites are considered "minimally" disturbed; variation in results is due to natural and environmental influences.

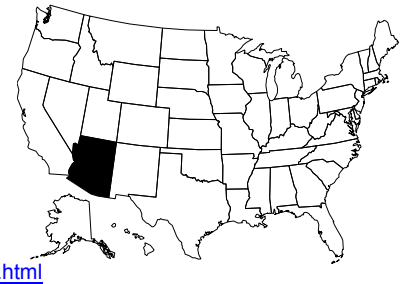
Field and Lab Methods

Assemblages assessed	✓	benthos *(100 to 500 samples/year; single and multiple seasons, multiple sites - broad coverage)*
		fish
	UD	periphyton
		other:
Benthos		
sampling gear	d-frame; 200 - 400 micron mesh	
habitat selection	multihabitat	
subsample size	300-count target	
taxonomy	genus level	
Habitat assessments	visual based, hydrogeomorphology; performed with bioassessments	
Quality assurance program elements	standard operating procedures, quality assurance plan (in progress), periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival	

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores	95th percentile of all sites	
defining impairment in a multimetric index	first quartile from the 95th percentile	
Evaluation of performance characteristics		repeat sampling
	✓	precision *(sampling replicates)*
		sensitivity
		bias
		accuracy
Biological data		
Storage	EDAS	
Retrieval and analysis	EDAS	

ARIZONA



Contact Information

Patti Spindler, Aquatic Ecologist
Arizona Department of Environmental Quality (ADEQ)
1110 West Washington St. 5415A-1 ■ Phoenix, AZ 85007
Phone 602/771-4543 ■ Fax 602/771-4528
email: phs@ev.state.az.us
ADEQ Water Quality Division homepage: http://www.adeq.state.az.us/environ/water/index.html

Program Description

The Biocriteria Program at the Arizona Department of Environmental Quality (ADEQ) has been sampling benthic macroinvertebrates since 1992. Data has been collected for biocriteria standards development and 305(b) assessment purposes for the past ten years. ADEQ has only one dedicated biocriteria staff person, however six other water quality monitoring staff assist in biological data collection during the spring as part of the ambient watershed monitoring program.

ADEQ does not yet have narrative or numeric biocriteria. However, sampling methods and Indexes of Biological Integrity have been developed with the assistance of USEPA and contractor support. The cold and warm water Indexes of Biological Integrity will be used to support two designated uses, Aquatic and Wildlife (cold water fishery) (A&Wc) and Aquatic and Wildlife (warm water fishery) (A&Ww), which are currently listed in Arizona's surface water quality standards. ADEQ plans to develop a narrative biocriterion for the next triennial review of standards and these indexes will serve as the implementation guidance for such a standard. ADEQ has also developed an approach to using bioassessments plus habitat assessments to implement the narrative bottom deposit standard, which will be proposed during a separate rulemaking on implementation guidance documents for all narrative standards during 2002.

In the water quality standards rules that are currently under review by USEPA, ADEQ has updated definitions for A&Wc and A&Ww based upon "macroinvertebrate regions" identified in Spindler 2001. The 5000' elevation contour marks the threshold for a change in community type from warm to cold, as determined by statistical analysis of empirically derived statewide biological data. These macroinvertebrate regions will be used instead of ecoregions for predicting community types in Arizona. Addition of the elevation range in the A&Wc and A&Ww standards definitions allows Arizona to use the elevation model to better predict the correct A&W use type. Revisions to the "list of surface waters and designated uses" have correspondingly been made in the 2001 standards rule.

ADEQ does not have a biocriteria standard and has subsequently been unable to assess biological integrity in Arizona's 305(b) report or 303(d) list. As a result of a lawsuit, ADEQ is preparing an "impaired waters rule" this year which will specifically outline assessment and listing procedures. Rules for conducting bioassessments will also have to be developed as part of this impaired waters rule, in addition to the surface water quality standard before bioassessments can be fully implemented in our assessment and listing process in Arizona. ADEQ is also partnering with the US Forest Service and Bureau of Land Management to standardize macroinvertebrate sample collection and analysis methods in order to share data on this important ecosystem indicator.

Future program directions include refining narrative bottom deposit standard implementation guidance for rule development, developing narrative biocriterion, starting a diatom bioassessment pilot project, refining reference condition, and developing bioassessments for intermittent streams and large rivers.

Documentation and Further Information

Status of Water Quality In Arizona - Clean Water Act Section 305(b) Report: June 2000:
http://www.adeq.state.az.us/environ/water/assess/305/index.html

Draft Status of Water Quality in Arizona - 2002, Arizona's Integrated 305(b) Assessment and 303(d) Listing Report:
http://www.adeq.state.az.us/environ/water/assess/hsa.html#draft

WQD Biocriteria Program information: http://www.adeq.state.az.us/environ/water/assess/monit.html

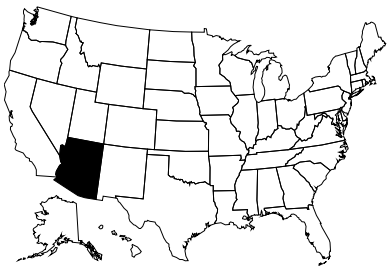
ADEQ. 2001. *DRAFT Quality Assurance Program Plan for the Biocriteria Program. ADEQ*, Phoenix, AZ.

Spindler, P.H. 2001. *DRAFT Narrative bottom deposit standard implementation guidelines for Arizona*. ADEQ, Phoenix, AZ.

Spindler, P.H., 1996. *Using ecoregions for explaining macroinvertebrate community distribution among reference sites in Arizona*, 1992. ADEQ OFR-95-7, Phoenix, AZ.

Other accomplishments include macroinvertebrate community distribution among reference sites in AZ (2001), development of Arizona EDAS biological database (2001), development and testing of a biological index for coldwater streams of AZ (2000), development and testing of a biological index for warmwater streams of AZ (1998), and Macroinvertebrate Photocatalog on CD (1998).

ARIZONA



Contact Information

Patti Spindler, Aquatic Ecologist
Arizona Department of Environmental Quality (ADEQ)
1110 West Washington St. 5415A-1 ■ Phoenix, AZ 85007
Phone 602/771-4543 ■ Fax 602/771-4528
email: phs@ev.state.az.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	UD	nonpoint source assessments
	UD	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	UD	promulgated into state water quality standards as biocriteria
		support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects, specific river basins or watersheds)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout* jurisdiction)
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(specific river basins or watersheds)*
		other:

Stream Miles

Total miles	**127,505**
Total perennial miles	4,980
Total miles assessed for biology*	**0**
fully supporting for 305(b)*	n/a
partially/non-supporting for 305(b)*	n/a
listed for 303(d)*	n/a
number of sites sampled	324
number of miles assessed per site	site specific

*Arizona does not have formal biocriteria and will not be using bioassessments in the 2002 305(b) or 303(d) reports. However, a proposal to use bioassessment plus habitat assessment as the implementation procedure for the narrative bottom deposit standard will be considered during a rulemaking (2002-03), which is separate from the just completed triennial review of standards. The next 305(b) report may include bioassessments in support of the narrative bottom deposit standard, if this implementation procedure is approved.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Warm water vs. Cold Water	
ALU designations in state water quality standards	Aquatic and Wildlife (A&W) cold, A&W warm, A&W-effluent dependent water, A&W-ephemeral (AZ has acute and chronic categories for each except ephemeral in which only acute applies.)	
Narrative Biocriteria in WQS	under development – ADEQ has developed a cold water and warm water Index of Biological Integrity to support these two designated uses, which are currently listed in the surface water quality standards. However ADEQ does not yet have established biocriteria. These indexes will become the implementation guidance for proposed biocriteria in the next triennial review of standards.	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	UD	assessment of aquatic resources
	UD	cause and effect determinations
	UD	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	none	

Reference Site/Condition Development

Number of reference sites	**89 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria	For initial site selection, the following guidelines were used in the early 1990s: a site must be accessible (within a 2-hour walk or 3-4 miles from nearest 4-wheel drive road), > 0.5 km downstream of road crossings, no known discharges upstream, no major impoundments upstream, no channel alterations at the site, and be only minimally impacted by land use activities and nonpoint sources. All of the following criteria must be attained in the field assessment of potential sites for a site to be accepted as reference: site should be truly perennial (indicators: fish, univoltine insects, riparian indicators), site should be free of local land use impacts, site should be free of channel alterations, no violations of pH or dissolved oxygen water quality standards, and habitat assessment index score > 14 using ADEQ's 2001 5-parameter habitat index.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
	✓	professional judgment
	✓	other: minimally disturbed
Stream stratification within regional reference conditions		ecoregions (or some aggregate)
	✓	elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

Field and Lab Methods

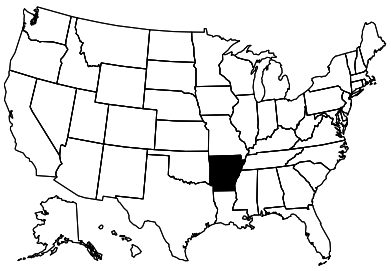
Assemblages assessed	✓	benthos *(<100 samples/year; single season, multiple sites - watershed level)*
		fish
	✓	periphyton *(<100 samples/year; single season, multiple sites - watershed level)*
		other:
Benthos		
sampling gear		d-frame net; 500 micron mesh
habitat selection		riffle/run (cobble)
subsample size		500 - 600 count target
taxonomy		combination level; EPT taxa are identified to genus or species
Periphyton		
sampling gear		**natural substrate**: brushing/scraping device (razor, toothbrush, etc.) **artificial substrate**: microslides or other suitable substratum
habitat selection		riffle/run (cobble); artificial substrate
sample processing		taxonomic identification
taxonomy		diatoms only; identified at species level
Habitat assessments		visual based, quantitative measurements, hydrogeomorphology; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings, training for biologists, sorting and taxonomic proficiency checks, and specimen archival

Data Analysis and Interpretation

Data analysis tools and methods		summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		95th percentile of reference population
defining impairment in a multimetric index		25th percentile of reference population
Evaluation of performance characteristics*	✓	repeat sampling *(duplicate samples collected for 10% of sites annually)*
		precision
	✓	sensitivity (*standard level of identification used by lab)*
	✓	bias *(ADEQ uses a standard mesh size, the lab locates small organisms, using a 6-12x dissecting microscope and a Caton tray to randomly obtain fractions of the total sample)*
	✓	accuracy *(any questionable identifications are sent to nationally recognized taxonomic experts for confirmation and a voucher specimen collection is maintained*)
Biological data		
Storage		AZ-EDAS
Retrieval and analysis		Systat, EDAS

*Though multiple performance characteristics are evaluated, ADEQ has not incorporated this information into a QA/QC document.

ARKANSAS



Contact Information

William Keith, Water Quality Planning Branch Manager
Jim Wise, Program Manager
Chris Davidson, Water Quality Specialist
Arkansas Department of Environmental Quality (ADEQ)
P.O. Box 8913 ■ Little Rock, AR 72219-8913
Phone 501/682-0656 ■ Fax 501/682-0910
email: Keith@adeq.state.ar.us, Wise@adeq.state.ar.us and Davidson@adeq.state.ar.us
ADEQ Water Division homepage: http://www.adeq.state.ar.us/water/

Program Description

As part of the Water Division of the Arkansas Department of Environmental Quality (ADEQ), the Water Quality Planning Branch has seven biologists/ecologists and two geologists on staff. This branch deals with a variety of issues related to water quality monitoring, standards development, and groundwater and wasteload allocations. The Branch is responsible for conducting water quality surveys, assessing the State's water quality for surface and ground water, and 305(b) reporting. The Branch is also responsible for the development of water quality and biological criteria for water quality use attainability analysis and for water quality standards development. In addition, the Branch is responsible for developing TMDLs (303d) for those waters not meeting water quality standards. Finally, the Branch is responsible for the biomonitoring aspect of the NPDES program.

Biological and habitat monitoring are currently restricted to special project needs associated with synoptic watershed surveys or for the development of additional data to support the establishment of biological criteria. For the 2000 305(b) report, portions of 106 stream segments from 17 planning segments were assessed for aquatic life use support using biological communities. These stream segments were either located above or below a point source discharge, or were part of intensive water quality surveys. Survey objectives were to determine the impacts of the discharge, evaluate the biological community in ecoregional reference streams, determine use attainment in previously listed water bodies of concern or those waters not currently meeting all designated uses.

Macroinvertebrates were collected and evaluated following EPA's *Rapid Bioassessment Protocols (*USEPA 1989). Habitat considerations were used in the evaluation of the macroinvertebrate communities through percent comparability evaluation techniques at all sites. An upstream-downstream comparison of the communities, and a comparison of the community to a least disturbed reference stream were also used to make the assessments. Fish communities were analyzed following EPA's *Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analysis* (USEPA 1983). Direct comparisons were made with ecoregional fish community data outlined in the Department's *Physical, Chemical, and Biological Characteristics of Least-Disturbed Reference Streams in Arkansas' Ecoregions, 1987.* In addition, an upstream-downstream comparison of the communities was made and compared to a least-disturbed reference stream.

Documentation and Further Information

Water Quality Inventory Report 2000, 305(b) Report:
http://www.adeq.state.ar.us/water/pdfs/documents/305(b)_2000.pdf

2002 Proposed 303(d) List: http://www.adeq.state.ar.us/water/pdfs/documents/303(d)_list_proposed_020426.pdf

1998 Arkansas 303(d) List: http://www.adeq.state.ar.us/water/303drprt.htm

Water Quality Standards for Surface Waters, effective Feb.1998, amended January 2001:
http://www.adeq.state.ar.us/regs/files/reg02_final_010917.pdf

Physical, Chemical, and Biological Characteristics of Least-Disturbed Reference Streams in Arkansas' Ecoregions, Volume 1: Data Compilation, and *Volume 2: Data Analysis*. ADEQ Water Division. 1987.

Water Quality Planning Branch, list of publications: http://www.adeq.state.ar.us/water/pdfs/documents/publist.pdf

ARKANSAS

Contact Information

William Keith, Water Quality Planning Branch Manager
Jim Wise, Program Manager
Chris Davidson, Water Quality Specialist
Arkansas Department of Environmental Quality (ADEQ)
P.O. Box 8913 ■ Little Rock, AR 72219-8913
Phone 501/682-0656 ■ Fax 501/682-0910
email: Keith@adeq.state.ar.us, Wise@adeq.state.ar.us and Davidson@adeq.state.ar.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects and specific river basins or watersheds)*
	✓	fixed station (i.e., water quality monitoring stations)
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin
		other:

Stream Miles

Total miles *(determined using RF3 and the National Hydrography Database)*	**87,617**
Total perennial miles	28,408
Total miles assessed for biology*	**245 stream segments**
fully supporting for 305(b)	n/a
partially/non-supporting for 305(b)	n/a
listed for 303(d)	n/a
number of sites sampled *(on an annual basis)*	~450
number of miles assessed per site	–

*Currently, biological monitoring occurs as either 1) part of intensive watershed survey where water quality problems have been previously identified; 2) part of a site specific survey, wasteload allocation; and 3) most recently as part of expanding ecoregion reference stream data. Biological data are not used to list any 303(d) waters.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Single Aquatic Life Use, Fishery Based Uses and Warm Water vs. Cold Water	
ALU designations in state water quality standards	Two designations: Ecologically sensitive waterbodies protecting endangered, threatened, and endemic aquatic species. Fisheries are divided into Trout, Lakes and Reservoirs, and Streams (further subdivided by ecoregion).	
Narrative Biocriteria in WQS	Procedures used to support narrative biocriteria are currently found in the project specific QAPP. Additional methods and SOPs are being developed. NOTE: The development of criteria and standards is ongoing.	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
		monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Currently, baseline data has been collected from numerous locations prior to BMP implementation and NPDES limit changes. Follow-up monitoring has occurred at some locations below point sources. No follow-up monitoring has occurred at nonpoint source locations.	

Reference Site/Condition Development

Number of reference sites	**75 total**	
Reference site determinations	✓	site-specific
	✓	paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
	✓	other: upstream/downstream
Reference site criteria	Water quality and habitat is typical of background ecoregion conditions. Watershed is somewhat undisturbed.	
Characterization of reference sites within a regional context	✓	historical conditions
	✓	least disturbed sites
		gradient response
	✓	professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
	✓	stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: watershed size, habitat, water quality
Additional information	✓	reference sites linked to ALU
	✓	reference sites/condition referenced in water quality standards *(found in ADPC&E 1987 - WQ87-06-01 & 02)*
	✓	some reference sites represent acceptable human-induced conditions

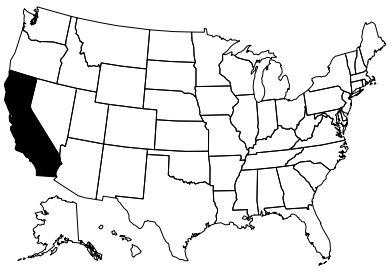
Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - watershed level and broad coverage; multiple seasons, multiple sites)*
	✓	fish *(<100 samples/year; single season, multiple sites - watershed level and broad coverage)*
		periphyton
		other:
Benthos		
sampling gear	D-frame; 200-400 micron mesh	
habitat selection	riffle/run (cobble), multihabitat and woody debris	
subsample size	100 count	
taxonomy	combination - family, genus and species	
Fish		
sampling gear	backpack and boat electrofisher, pram unit (tote barge) and seine; 3/16" and 1/4" mesh	
habitat selection	pool/glide, riffle/run (cobble), and multihabitat	
sample processing	anomalies	
subsample	whole samples are sorted and identified to species	
taxonomy	species and life stage	
Habitat assessments	visual based with limited quantitative measurements and hydrogeomorphology, pebble counts, flows and canopy cover; performed with bioassessments	
Quality assurance program elements	quality assurance plan, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival, and standard operating procedures (in development stage)	

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index and return single metrics - use endpoint for each single metric)*
	✓	disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores	As a percent of either the reference site or based on ecoregion data dependent upon standard deviation units	
defining impairment in a multimetric index	As a percent of either the reference site or based on ecoregion data dependent upon standard deviation units	
Multivariate thresholds		
defining impairment in a multivariate index	As a percent of either the reference site or based on ecoregion data dependant upon standard deviation units	
Evaluation of performance characteristics		repeat sampling
		precision
Not currently evaluated		sensitivity
		bias
		accuracy
Biological data		
Storage	Microsoft databases	
Retrieval and analysis	none	

CALIFORNIA



Contact Information

Del Rasmussen, TMDL Section
California State Water Resources Control Board (SWRCB)
1001 I Street, P.O. Box 944213 ■ Sacramento, CA 95812
Phone 916/341-5545 ■ Fax 916/341-5550
email: rasmd@dwq.swrcb.ca.gov
website: http://www.swrcb.ca.gov/quality.html

Jim Harrington, State Water Quality Biologist
California Department of Fish and Game (CA DFG)
2005 Nimbus Road ■ Rancho Cordova, CA 95670
Phone 916/358-2862 ■ Fax 916/985-4301
email: jharring@ospr.dfg.ca.gov
California Aquatic Bioassessment Workgroup homepage: http://www.dfg.ca.gov/cabw/cabwhome.html

Program Description

Historically, the use of bioassessment data in California water regulations and decision-making has not been a high priority. California's tremendous range of ecological diversity and its equally complex history of land and water use have confounded progress towards implementation of a state-wide bioassessment program. The recent organization of California's Surface Water Ambient Monitoring Program (SWAMP) is providing the impetus to implement a better organized and standardized biological assessment and monitoring program throughout the state. Current concerns over hydroaugmentation and use attainability analyses of targeted waterbodies will foster a greater dependence upon bioassessment information in making informed decisions regarding the protection and restoration of California's streams.

Nine regional boards are essentially independent regulatory entities within the California State Water Resources Control Board (SWRCB). Not all regional boards are at the same level of development regarding bioassessment. One of the first management actions advancing bioassessment in CA was in 1993 when the Lahontan Regional Water Quality Control Board (RWQCB 6) required the use of EPA's Rapid Bioassessment Protocols in a fish hatchery permit. Since that time, the use of bioassessment in water resource decision-making has steadily increased. Presently, bioassessment is used by several RWQCBs for a variety of purposes, including to: assess the impacts of human activities on the biological integrity of streams and rivers; evaluate the effectiveness of restoration efforts, BMP implementation, and permit conditions; develop narrative and numeric biocriteria; establish reference conditions; provide baseline data on the benthic macroinvertebrate community in regional streams; determine the biological health of streams relative to land use in specific watersheds; help identify aquatic life stressors and associated development of ecological indicators in agriculturally dominated and effluent dominated waterbodies; and as an additional tool to NPDES and stormwater permitting to supplement the chemical and toxicological information obtained to address chemical standards.

The California Department of Fish and Game's (CA DFG) Water Pollution Control Laboratory and its Aquatic Biological Assessment Laboratory (ABAL) perform macroinvertebrate sampling and identification, fish surveys, physical/habitat surveys, toxicity testing, sedimentation studies, and tissue and water chemistry. Since 1992, the ABAL has conducted projects covering many different applications of biological monitoring throughout California. These projects have demonstrated bioassessment and promoted the effectiveness of bioassessment in the State.

In 1993, ABAL distributed a set of standard protocols for assessing biological and physical conditions of wadeable streams. The California Stream Bioassessment Procedures (CSBP) are regional adaptations of the national USEPA Rapid Bioassessment Protocols. The DFG, in cooperation with the SWRCB and USEPA Region 9, also established the California Aquatic Bioassessment Workgroup (CABW) to provide input and guidance for the development of a state-wide bioassessment program. The Workgroup was formed in 1994 to coordinate scientific and policy-making efforts towards implementing aquatic bioassessment in California. Members of the CABW consist of biologists from universities, consulting firms, industry, and representatives of state and federal agencies responsible for assessing, monitoring and protecting the biological integrity of surface waters. Through its Steering Committee and annual meetings, CABW participants develop objectives and strategies for implementing aquatic bioassessment in California.

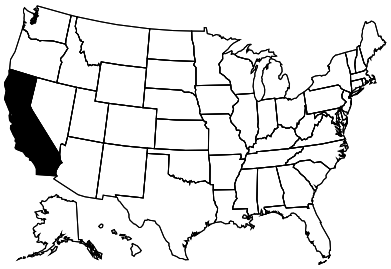
Documentation and Further Information

State Water Resources Control Board. October 2000. *2000 California 305(b) Report on Water Quality*. Sacramento, CA: SWRCB.

Status of Aquatic Bioassessment in California and the Development of a State-wide Bioassessment Program, prepared by the California Department of Fish and Game Aquatic Biological Assessment Laboratory: http://www.dfg.ca.gov/cabw/status.html

California Stream Bioassessment Procedure (CSBP): http://www.dfg.ca.gov/cabw/protocols.html

CALIFORNIA



Contact Information

Del Rasmussen, TMDL Section
California State Water Resources Control Board (SWRCB)
1001 I Street, P.O. Box 944213 ■ Sacramento, CA 95812
Phone 916/341-5545 ■ Fax 916/341-5550
email: rasmd@dwq.swrcb.ca.gov

Jim Harrington, State Water Quality Biologist
California Department of Fish and Game (CA DFG)
2005 Nimbus Road ■ Rancho Cordova, CA 95670
Phone 916/358-2862 ■ Fax 916/985-4301
email: jharring@ospr.dfg.ca.gov

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(specific river basins or watersheds)*
	✓	fixed station (i.e., water quality monitoring stations) *(specific river basins or watersheds)*
	✓	probabilistic by stream order/catchment area *(specific river basins or watersheds)*
	✓	probabilistic by ecoregion, or statewide *(specific river basins or watersheds)*
	✓	rotating basin *(comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles	**211,513**
Total perennial miles	64,438
Total miles assessed for biology*	**unknown**
fully supporting for 305(b)	unknown
partially/non-supporting for 305(b)	unknown
listed for 303(d)	unknown
number of sites sampled	unknown
number of miles assessed per site	unknown

*Due to a comprehensive, statewide overhaul of California's database system, SWRCB was unable to break out numbers for stream miles assessed using biology.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Fishery Based Uses, Warm Water vs. Cold Water	
ALU designations in state water quality standards	Regional Water Quality Boards have a Basin Planning function. Therefore, water quality standards are regionally specific for establishing functional uses, criteria, and implementation plans.	
Narrative Biocriteria in WQS	Regional water quality standards contain generic statements for the overarching protection of biological communities with an emphasis on, but not limited to, fisheries. Procedures to support narrative biocriteria are regionally specific.	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Limited to select studies where biological data are used for management decisions regarding urban development.	

Reference Site/Condition Development

Number of reference sites	**~ 200 - 300 total**	
Reference site determinations		site-specific
		paired watersheds
		regional (aggregate of sites)
	✓	professional judgment
	✓	other: CA DFG is in the process of developing a more quantitative method of selecting reference sites on a regional basis using GIS land use analyses and quantitative physical habitat measures.
Reference site criteria	under development	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: stream order
Additional information		reference sites linked to ALU
	✓	reference sites/condition referenced in water quality standards *(varies by region)*
	✓	some reference sites represent acceptable human-induced conditions

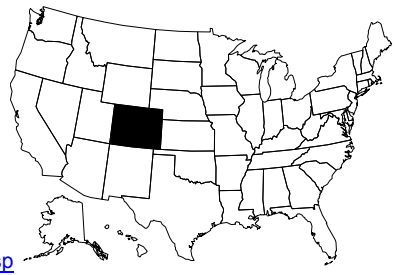
Field and Lab Methods

Assemblages assessed	✓	benthos *(>500 samples/year; varying levels of rigor)*
		fish
		periphyton
		other:
Benthos		
sampling gear		D-frame; 200 - 400 micron mesh (Sierra Nevada Aquatic Research Laboratory), 500 - 600 micron mesh (California Stream Bioassessment Procedure)
habitat selection		riffle/run (cobble)
subsample size		300 - 500 count (Sierra Nevada Aquatic Research Laboratory), 300 count (CSBP)
taxonomy		lowest possible, usually genus or species
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, sorting and taxonomic proficiency checks

Data Analysis and Interpretation

Data analysis tools and methods		summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(return single metrics – use endpoint for each single metric)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		bar graph distribution function
Multivariate thresholds		
defining impairment in a multivariate index		under development
Evaluation of performance characteristics		repeat sampling
	✓	precision
		sensitivity
		bias
		accuracy
Biological data		
Storage		Central Coast Ambient Monitoring Program (CCAMP) regional database
Retrieval and analysis		CalEDAS

COLORADO



Contact Information

Robert McConnell, Monitoring Unit Manager
Colorado Department of Public Health and Environment (CDPHE)
4300 Cherry Creek Drive South ■ Denver, CO 80246
Phone 303/692-3578 ■ Fax 303/782-0390
email: robert.mcconnell@state.co.us
CDPHE Water Quality Control Division website: http://www.cdphe.state.co.us/wq/wqhom.asp

Program Description

The Monitoring Unit of the Water Quality Control Division, Colorado Department of Public Health and Environment (CDPHE), is responsible for designing studies and collecting chemical, physical, and biological data from a statewide network of sampling stations. Personnel from the Assessment Unit of the Water Quality Control Division evaluate this information, along with data from other agencies. Using a watershed-specific approach, the seven major watersheds within the State of Colorado are assessed sequentially as part of the triennial review of water quality standards and classifications. In addition, specific waterbodies are assessed as part of targeted synoptic studies, site-specific studies, and as required for evaluating waterbodies listed on the State of Colorado's 303(d) list.

Most biological assessments are performed to evaluate aquatic life use classifications and to support standards development. Biological assessments have occasionally been used to determine attainment of aquatic life uses or attainment of provisional sediment standards. However, chemical information from surface water samples is primarily used to assess use support determinations as reported in the State of Colorado's biennial Status of Water Quality report. Biologists in the Monitoring Unit are actively developing biocriteria to more effectively utilize biological information as part of the State of Colorado's water quality standards program. Initially, biocriteria will be developed for benthic macroinvertebrates. Over the last four years, biologists in the Monitoring Unit have collected benthic macroinvertebrate samples from approximately 300 potential reference/least impaired sites from all dominant ecoregions within the State of Colorado. This data is currently being evaluated. Combined with information on physical habitat and water chemistry, this benthic macroinvertebrate data will be used to develop provisional region-specific biocriteria. Once developed, these provisional biocriteria will be evaluated using new benthic macroinvertebrate information, and further refined as needed. It is anticipated that benthic macroinvertebrate biocriteria will be used as an assessment tool to support the water quality standards and classification programs within the State of Colorado. Biocriteria based on fishery information may be developed in the future.

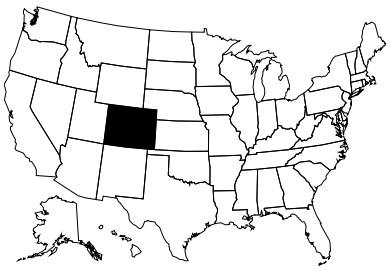
Documentation and Further Information

Colorado's 2002 305(b) report and 1998 303(d) list: http://www.cdphe.state.co.us/op/wqcc/wqresdoc.html

Draft 2001 Unified Assessment Methodology, *Guidance on Data Requirements and Data Interpretation Methods Used in Stream Standards and Classification Proceedings*, July 1993:
http://www.cdphe.state.co.us/wq/Assessment/assessment_practices_and_methods.htm

Water Quality in Colorado 2000: http://www.cdphe.state.co.us/wq/waterqualitybooklet.pdf

COLORADO



Contact Information

Robert McConnell, Monitoring Unit Manager
Colorado Department of Public Health and Environment (CDPHE)
4300 Cherry Creek Drive South ■ Denver, CO 80246
Phone 303/692-3578 ■ Fax 303/782-0390
email: robert.mcconnell@state.co.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	UD	promulgated into state water quality standards as biocriteria
		support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
	✓	other: determine attainment of narrative sediment (clean) standard
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(comprehensive use throughout jurisdiction, specific river basins or watersheds, and special projects)*
	✓	fixed station (i.e., water quality monitoring stations) *(specific river basins or watersheds)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles *(determined using RF3)*	**107,403**
Total perennial miles	31,415
Total miles assessed for biology*	**n/a**
fully supporting for 305(b)	n/a
partially/non-supporting for 305(b)	n/a
listed for 303(d)	85.1
number of sites sampled *(on an annual basis)*	~70 -100
number of miles assessed per site	–

*Colorado does not use bioassessment in 305(b) assessments with some exceptions. Since Colorado's water quality standards are chemically oriented, the majority of use support determinations are based on chemical data. Bioassessments are conducted as part of the Triennial Standards Review process for Colorado's seven major watersheds; a few are used in the determination of aquatic life use and sediment standards attainment. The majority of CDPHE's work in the field is spent conducting bioassessments in preparation for the review process. During the review process, the Water Quality Control Commission uses biological data to determine the appropriate aquatic life use classification for 636 stream segments. Once classifications are set, all further water quality monitoring and assessment is chemical.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class System, Warm Water vs. Cold Water	
ALU designations in state water quality standards	Three classifications: Class 1 Cold Water Aquatic Life, Class 1 Warm Water Aquatic Life, Class 2 Cold and Warm Water Aquatic Life	
Narrative Biocriteria in WQS	under development*	
Numeric Biocriteria in WQS	none*	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
		monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria uses in making management decisions regarding restoration of aquatic resources to a designated ALU	Bioassessment endpoints are used as targets in the attainment of the sediment standard (e.g. TMDL development).	

*ALU classifications are defined in Colorado's water quality standards but are not considered to be formal narrative biocriteria in the CO regulatory process. Colorado is presently developing biocriteria through a stakeholder workgroup process.

Reference Site/Condition Development**

Number of reference sites	**300 total potential reference/least impaired sites**	
Reference site determinations	✓	site-specific
		paired watersheds
		regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	The condition of candidate sites is verified through field evaluation using a "checklist" of stream attributes that include, but are not limited to, measures of riparian condition, Rosgen channel type, land use, basin characteristics, physical habitat, substrate, chemistry, geology, vegetation, and climate.	
Characterization of reference sites within a regional context	✓	historical conditions
	✓	least disturbed sites
		gradient response
	✓	professional judgment
	✓	other: minimally disturbed***
Stream stratification within regional reference conditions	UD	ecoregions (or some aggregate)
		elevation
	✓	stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	n/a	reference sites linked to ALU
	n/a	reference sites/condition referenced in water quality standards
	n/a	some reference sites represent acceptable human-induced conditions

**Reference condition is used on a limited basis in Colorado. Currently, it is used as a key component in determining sediment deposition impacts to aquatic life and has been used in the first stages of biocriteria development, to locate sampling sites, as part of various EMAP studies underway in CO, and in the development of regional nutrient criteria. The reference condition approach is not developed enough to be an established part of biological assessments or the standards setting process in Colorado. Most, if not all, assessments are conducted on a case-by-case or site-specific basis, and although CO does attempt to characterize the "expected condition" for a particular waterbody, it is not treated as a formal reference condition.

***Sediment guidance suggests 3 tiers for reference conditions like those described in the 1996 EPA technical guidance for biological criteria: 1) minimally disturbed, 2) best available (least disturbed), and 3) none acceptable ("hypothetical explanation"). These can be considered individually and in combination.

Field and Lab Methods*

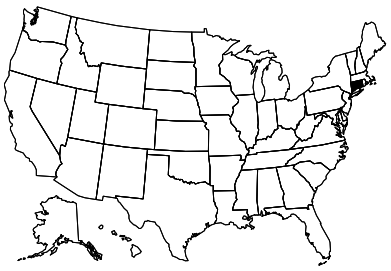
Assemblages assessed	✓	benthos *(100 - 500 samples/year; single season, multiple sites - watershed level)*
	✓	fish *(<100 samples/year; single season, multiple sites - not at watershed level)*
	UD	periphyton *(<100 samples/year; single season, multiple sites - watershed level)*
		other:
Benthos		
sampling gear	Surber, dipnet; 500 - 600 micron mesh	
habitat selection	riffle/run (cobble) or most productive habitat if riffle/run is not available	
subsample size	300 count	
taxonomy	lowest possible level with positive identification	
Fish		
sampling gear	backpack electrofisher	
habitat selection	multihabitat	
sample processing	length measurement	
subsample	none	
taxonomy	species	
Periphyton		
sampling gear	**natural substrate**: brushing/scraping device (razor, toothbrush, etc), collect by hand	
habitat selection	riffle/run (cobble)	
sample processing	chlorophyll *a*/ phaeophytin, taxonomic identification	
taxonomy	all algae, species level	
Habitat assessments	visual based, hydrogeomorphology, pebble counts; performed with bioassessments	
Quality assurance program elements	standard operating procedures, periodic meetings and training for biologists, specimen archival	

*Field and lab methods reported are those used by the Monitoring Unit of the CDPHE Water Quality Control Division and are patterned after the EPA RBP approach. They do not apply to any of the other agencies collecting biological data in Colorado.

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(return single metrics)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores	impairment thresholds determined on case-by-case basis as part of site-specific analyses	
defining impairment in a multimetric index	Colorado is currently exploring possible metrics and indices through a workgroup process.	
Evaluation of performance characteristics		repeat sampling
	✓	precision *(replicate samples collected at 10% of sites)*
		sensitivity
		bias
		accuracy
Biological data		
Storage	Currently moving all biological and habitat data into EDAS	
Retrieval and analysis	EDAS, Excel, Minitab	

CONNECTICUT



Contact Information

Ernest Pizzuto, Jr., Supervising Environmental Analyst
Guy Hoffman, Environmental Biologist
Connecticut Department of Environmental Protection (CT DEP)
79 Elm Street ■ Hartford, CT 06106-5127
Phone 860/424-3715 ■ Fax 860/424-4055
email: ernest.pizzuto@po.state.ct.us
CT DEP Bureau of Water Management website: http://dep.state.ct.us/wtr/index.htm

Program Description

The Connecticut Ambient Biological Monitoring Program characterizes water quality by evaluating the biological integrity of resident communities of aquatic organisms. This information is used as the primary indicator to meet reporting requirements for assessment of aquatic life use support and impairment under Sections 305(b) and 303(d) of the Clean Water Act. There are currently about 3.5 full time employees dedicated to biological assessment of rivers. Biological monitoring has been conducted by the CT DEP Bureau of Water Management since the early 1970s and has focused primarily on the benthic invertebrate community of wadeable stream segments. Narrative criteria for benthic invertebrates were incorporated into the CT water quality standards in 1987. Assessments are based on community structure characteristics using techniques intended to minimize the influence of variables such as habitat, seasonality and sampling method. Since 1989, methodology has followed a modified version of the USEPA Rapid Bioassessment Protocol (RBP) III (USEPA 1989).

A total of 302 sites on 153 rivers have been monitored to date (February 2002). Pursuant to the five-year rotating basin monitoring strategy that began in 1996, benthic invertebrate monitoring was conducted at approximately 50 sites each year for the five-year period ending in 2000. Since biological monitoring integrates environmental conditions over an extended time period, each site was sampled only once, primarily during the fall. Spring sampling is conducted on a limited basis for special studies or to supplement fall sampling. Sampling site selection is based on a targeted approach that considers sub-basin size, location of wastewater discharges, land use, and resource value. In addition to the rotating basin schedule, approximately ten regional reference sites located across the State are sampled annually, as well as a limited number of sites to support special projects.

The Bureau of Water Management recognizes the need to obtain a broader perspective of biological integrity by incorporation of fish community assessment data into the biological monitoring process. This has been accomplished to a limited degree by a cooperative working relationship with the CT DEP Division of Inland Fisheries. Fish sampling information obtained by fisheries biologists for purposes consistent with the fisheries management program has been utilized in the form of best professional judgment assessments which CT DEP considers to be generally equivalent to USEPA RBP IV (USEPA 1989). Funds obtained through an EPA 104(b)(3) grant have supported part of a Fisheries Division staff position since 1999. This effort has provided for approximately 24 fish community surveys, roughly equivalent in effort to annual RBP V assessment. This project is intended to support development of fish community structure metrics that will provide a more quantitative approach to the assessment process.

The CT DEP also promotes and directs a monitoring program for volunteers from which usable assessment information is obtained. The details of this program, *A Tiered Approach to Citizen-Based Monitoring of Wadeable Streams and Rivers*, can be obtained from the CT DEP Bureau of Water Management or viewed online at http://dep.state.ct.us/wtr/volunmon/tierapp.pdf

Section 305(b) of the CWA requires that states provide a description of the water quality of all navigable waters within their boundaries. Even with program improvements resulting from the rotating basin approach and incorporation of volunteer data, a complete census of State waters is not possible based on this focused approach to monitoring. To accomplish the goal of comprehensive monitoring, CT DEP is currently utilizing funds and technical assistance from USEPA to conduct a pilot statewide probabilistic monitoring program during 2002-2003. This project will sample the benthic invertebrate, fish, and periphyton communities at approximately 60 randomly selected sites. Through probabilistic monitoring, this statistically valid sample of wadeable streams in Connecticut will provide an estimate of conditions of all wadeable streams in the State. During this two-year period, the rotating basin approach will be suspended. However, limited focused monitoring will continue for reference sites, special projects, intensive surveys and to support TMDL development.

Documentation and Further Information

DRAFT *2002 List of Connecticut Waterbodies Not Meeting Water Quality Standards*, 303(d) list, May 2002: http://dep.state.ct.us/wtr/wq/implist.pdf

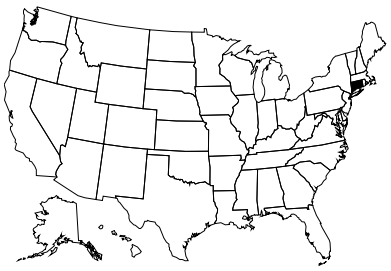
Draft Consolidated Assessment and Listing Methodology for 305(b) and 303(d) Reporting, April 2002: http://dep.state.ct.us/wtr/wq/method.pdf

Quality Assurance Project Plan for Ambient Biological Monitoring, March 1996. CT DEP Bureau of Water Management, Planning and Standards Division, CT06106.

Beauchene, M. 2002. *Quality Assurance Project Plan, Ambient Biological Monitoring -- Fish Community Structure*. CT DEP Bureau of Water Management.

Ambient Monitoring Strategy for Rivers and Streams, Rotating Basin Approach. CT DEP 1999.

CONNECTICUT



Contact Information

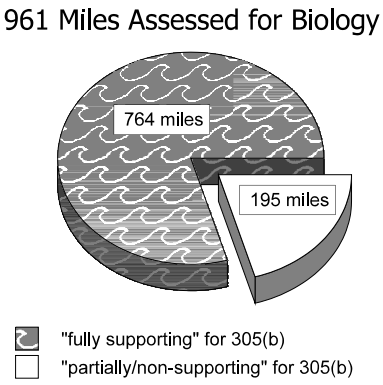
Ernest Pizzuto, Jr., Supervising Environmental Analyst
Guy Hoffman, Environmental Biologist
Connecticut Department of Environmental Protection (CT DEP)
79 Elm Street ■ Hartford, CT 06106-5127
Phone 860/424-3715 ■ Fax 860/424-4055
email: ernest.pizzuto@po.state.ct.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) (*special projects, specific river basins and watersheds, and comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) (*special projects, specific river basins and watersheds, and comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
	✓	probabilistic by ecoregion, or statewide *(comprehensive use throughout jurisdiction beginning in 2002 and 2003)*
	✓	rotating basin (*comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles *(State based determinations)*	**5,830**
Total perennial miles	5,484
Total miles assessed for biology	**961**
fully supporting for 305(b)	764
partially/non-supporting for 305(b)	195
listed for 303(d)*	n/a
number of sites sampled*	311
number of miles assessed per site*	site specific



*The existing 303(d) doesn't use mileage, although it contains a subset of partially/non-supporting stream miles listed in the 305(b). These numbers will be the same in the next report. Of the 311 sites sampled, 221 were sampled by the state, 30 by contractors and 60 by volunteers. The number of miles assessed per site is site specific and varies according to land use, geomorphology, etc.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class System (A,B,C)	
ALU designations in state water quality standards	"Fish and Wildlife Habitat" is the only ALU designation, but narrative criteria are provided for "benthic invertebrates which inhabit lotic waters" for classifications AA, A, and B while more general descriptive narrative is provided for C and D.	
Narrative Biocriteria in WQS	Procedures used to support narrative biocriteria located in *SOPs for ambient biological monitoring*	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Bioassessment/biocriteria have been used in specific cases to determine if formerly impaired waters are meeting ALU.	

Reference Site/Condition Development

Number of reference sites	**12 total**	
Reference site determinations	✓	site-specific
		paired watersheds
		regional (aggregate of sites)
		professional judgment
	✓	other: within major drainage basin
Reference site criteria	Least impacted by human influence. Size: ± one stream order or one order of magnitude in drainage area with similar gradient.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions		ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: major drainage basin, gradient
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

Field and Lab Methods

Assemblages assessed	✓	benthos *(<100 samples/year; single season, multiple sites - watershed level; multiple seasons, multiple sites - broad coverage for watershed level)*
	✓	fish *(<100 samples/year; single season, multiple sites - broad coverage)*
	✓	periphyton *(<100 samples/year; single season, multiple sites - broad coverage)*
	✓	other: phytoplankton and macrophytes *(<100 sample/year; single season, multiple sites - not at watershed level)*
Benthos		
sampling gear		Rectangular kick net, 1.5 ft. wide, 800-900 micron mesh. Surber and multiple plate samplers used prior to 1989. Rock baskets used for special projects.
habitat selection		richest habitat, riffle/run (cobble)
subsample size		200 count
taxonomy		benthic identification is primarily to species
Fish		
sampling gear		backpack electrofisher, pram unit (tote barge)
habitat selection		multihabitat
sample processing		length measurement, anomalies
subsample		none
taxonomy		species
Periphyton		
sampling gear		**natural substrate**: brushing/scraping device (razor, toothbrush, etc.)
habitat selection		riffle/run (cobble)
sample processing		chlorophyll *a*/ phaeophytin; biomass; taxonomic identification; semi-quantitative field-based rapid periphyton survey
taxonomy		all algae, species level if possible
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		Use scoring criteria table from 1989 Rapid Bioassessment Protocol (RBP) guidance (Figure 6.3-4). CT DEP recognizes the need to refine scoring criteria and impairment thresholds.
defining impairment in a multimetric index		Use biological condition table from 1989 RBP guidance (Figure 6.3-4): >54% of reference score = non-impaired for purposes of 305(b)/303(d)
Evaluation of performance characteristics	✓	repeat sampling *(duplicate samples at reference sites)*
		precision
		sensitivity
		bias
		accuracy
Biological data		
Storage		Initial sample data is entered into an Excel spreadsheet then transferred to MS Access. Currently working on migration from MS Access to STORET.
Retrieval and analysis		Spreadsheet used for metric calculation. Formerly used SAS. Currently shopping for less expensive statistical package.

DELAWARE

Contact Information

Ellen Dickey, Environmental Scientist
Delaware Department of Natural Resources and Environmental Control (DNREC)
89 Kings Highway ■ Dover, DE 19901
Phone 302/739-4771
email: ellen.dickey@state.de.us
DNREC Surface Water Quality Management homepage:
http://www.dnrec.state.de.us/dnrec2000/Divisions/Water/WaterQuality/WQM.htm

Program Description

Water quality and biological data for Delaware's surface waters are collected under Delaware's Ambient Surface Water Quality Monitoring Program and Biological Monitoring Program within the Delaware Department of Natural Resources and Environmental Control (DNREC). Several active citizen monitoring programs have also been developed throughout Delaware that augment the data collected by DNREC. The purpose of the Ambient Surface Water Quality Monitoring Program is to collect data on the chemical, physical, and biological characteristics of Delaware's surface waters. The information collected under this program is used to:

- Describe general water quality conditions in the State;
- Identify long-term trends in water quality;
- Determine the suitability of Delaware's waters for water supply, recreation, fish and aquatic life, and other uses;
- Monitor achievement of water quality standards;
- Identify and prioritize high quality and degraded waters;
- Support Total Maximum Daily Load Program; and
- Evaluate the overall success of Delaware's water quality management efforts.

DNREC recognizes the need to use its personnel and financial resources efficiently and effectively. To that end, surface water quality monitoring is conducted in a manner that focuses available resources on the Whole Basin Management concept. This program calls for the Department, in partnership with other governmental entities, private interests, and all stakeholders, to focus its resources on specific watersheds and basins (groups of watersheds) within specific time frames. The Whole Basin Management Program in Delaware operates on a 5-year rotating basis. In addition to the planning and preliminary assessment steps, Whole Basin Management will include intensive basin monitoring, comprehensive analyses, management option evaluations, and resource protection strategy development. Public participation and ongoing implementation activities will occur throughout the Whole Basin Management process. This new approach enables DNREC to comprehensively monitor and assess the condition of the State's environment with due consideration to all facets of the ecosystem.

Biological assessment monitoring is one of five major components of Delaware's Surface Water Quality Monitoring Program. The biological monitoring program is a major tool used by the Department to assess the conditions of surface waters. It includes the assessment of indigenous biological communities and physical habitats of streams, ponds, estuaries and wetlands. The goal of the program is to establish numeric biological criteria in State water quality standards to complement both existing chemical criteria and other assessments focused on fish tissue monitoring and bioassay testing. Standard methods have been developed and tested for assessing the biological community and habitat quality of nontidal streams, and draft numeric criteria are under development. Efforts over the next few years will focus on the development of methods for assessing estuaries and ponds and for assessing the quality and quantity of wetlands.

Documentation and Further Information

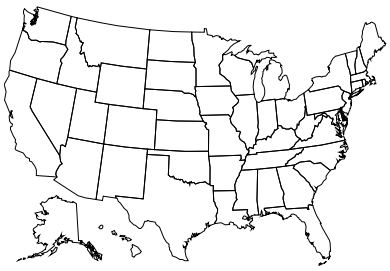
State of Delaware 2000 Watershed Assessment 305(b) Report and 1998 303(d) List:
http://www.dnrec.state.de.us/water2000/Sections/Watershed/TMDL/305and303.htm

DE Surface Water Quality Standards: http://www.dnrec.state.de.us/water/wqs1999.pdf

State of Delaware Fiscal Year 2000 Surface Water Quality Monitoring Plan:
http://www.dnrec.state.de.us/dnrec2000/Library/Water/swmonpro.pdf

Division of Water Resources 2000 Annual Report: http://www.dnrec.state.de.us/water2000/Public/2000AnnualReport/index.htm

DELAWARE



Contact Information

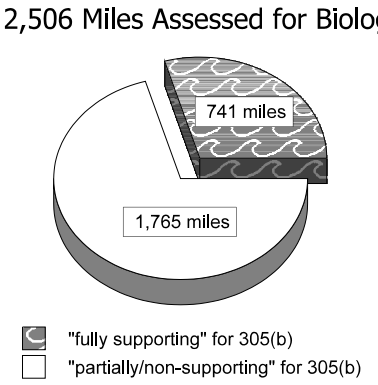
Ellen Dickey, Environmental Scientist
Delaware Department of Natural Resources and Environmental Control (DNREC)
89 Kings Highway ■ Dover, DE 19901
Phone 302/739-4771
email: ellen.dickey@state.de.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
		nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
		ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
	✓	fixed station (i.e., water quality monitoring stations) *(specific riverbasins or watersheds)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
		rotating basin
	✓	other: probabilistic by specific county *(used comprehensively throughout state)*

Stream Miles

Total miles *(determined using RF3)*	**2,506**
Total perennial miles	1,778
Total miles assessed for biology*	**2,506**
fully supporting for 305(b)*	741
partially/non-supporting for 305(b)*	1,765
listed for 303(d)*	1,173
number of sites sampled *(1991 - 2001)***	195
number of miles assessed per site	–



*All of DE's streams were assessed for the 2000 305(b) Report. These numbers represent the miles assessed for aquatic life support using a combination of physical, chemical, and biological data.

**These sampling stations were EMAP based. Of the 195 total sites sampled, 49 sites have not yet been assessed. Of the 146 sites assessed, 27 are fully supporting and 119 are partially/non-supporting.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Single Aquatic Life Use and Warm Water vs. Cold Water	
ALU designations in state water quality standards	Two designations: 1) Fish, Aquatic Life, and Wildlife; 2) Cold Water Fish	
Narrative Biocriteria in WQS	none - Procedures used to support general aquatic life statements in WQS are those developed by the Mid Atlantic Coastal Streams (MACS) Workgroup.	
Numeric Biocriteria in WQS	Draft numeric criteria are under development.	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
		cause and effect determinations
		permitted discharges
		monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Some streams have been placed on the State's 303(d) list for poor biology/habitat.	

Reference Site/Condition Development

Number of reference sites	**13 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	Least impacted, land use, habitat score >110 out of 140, no point source discharge, no known direct discharge from animal feedlots or urban runoff, professional judgment.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

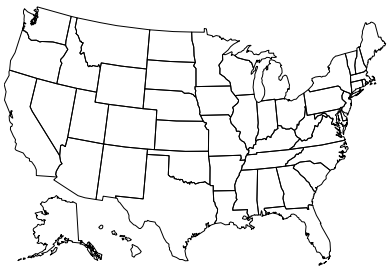
Field and Lab Methods

Assemblages assessed	✓	benthos *(<100 samples/year; single season, multiple sites - broad coverage)*
		fish
		periphyton
		other:
Benthos		
sampling gear		D-frame and kick net (1 meter); 500-600 micron mesh
habitat selection		riffle/run (cobble) in Piedmont ecoregion, and multihabitat in Coastal Plain ecoregion
subsample size		200 count
taxonomy		genus
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, periodic meetings and training for biologists, sorting proficiency checks, specimen archival, and a QAPP for biological work is under development

Data Analysis and Interpretation

Data analysis tools and methods		summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		95th percentile of all sites
defining impairment in a multimetric index		< 67% of reference is impaired to some degree
Evaluation of performance characteristics	✓	repeat sampling *(replicate samples are collected at every 10 sites by the same team, at the same reach or an adjacent reach)*
		precision
		sensitivity
		bias
		accuracy
Biological data		
Storage		MS Access and Excel
Retrieval and analysis		Excel

DISTRICT OF COLUMBIA



Contact Information

Nicoline Shulterbrandt, Water Quality Division
Department of Health (DC DOH)
51 N Street, NE, 5th Floor■ Washington, DC 20002
Phone 202/535-2194 ■ Fax 202/535-1363
email: nicoline.shulterbrandt@dc.gov
DOH Water Quality Division homepage:
http://dchealth.dc.gov/services/administration_offices/environmental/services2/water_division/index.shtm

Program Description

The mission of DC's Department of Health (DC DOH), Environmental Health Administration, Water Quality Division is to restore and protect the surface and ground waters of the District of Columbia. The program, established under the authorities of the DC Water Pollution Control Act and the federal Clean Water Act (CWA), has three principal components:

Water Quality Control
The Water Quality Control component fulfills the function of policy planning as well as regulatory control. In addition, it conducts special studies on pollutant fate and transport to identify probable sources and impacts, river/stream sediment and water column quality not covered by ambient monitoring, wet weather nonpoint source runoff quantity and quality, and discharge-related facility inspections. It also tracks permit violations.

Water Quality Monitoring
Water Quality Monitoring functions encompass waterbody assessment; collection of ambient water quality data; periodic fish tissue analysis for parameters of concern such as PCB, chlordane, and DDT; periodic submerged aquatic vegetation survey; and bioassessment of wetlands and river fringes.

Environmental Laboratory
The Environmental Laboratory is charged with the analysis of samples for a variety of chemical parameters.

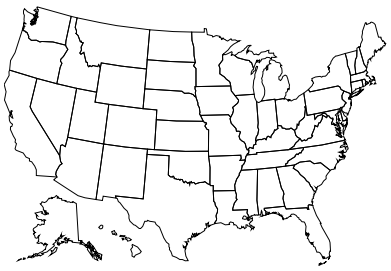
Documentation and Further Information

District of Columbia 2000 305(b) Report, Executive Summary:
http://dchealth.dc.gov/services/administration_offices/environmental/services2/water_division/pdf/00-305bexsumm.shtm

District of Columbia Water Quality Standards:
http://dchealth.dc.gov/services/administration_offices/environmental/services2/water_division/pdf/WaterQualityStandards.shtm

District of Columbia Water Quality Monitoring Regulations (Chapter 19 of DC Municipal Regulations):
http://dchealth.dc.gov/services/administration_offices/environmental/services2/water_division/pdf/WaterQualityMonitoring.shtm

DISTRICT OF COLUMBIA



Contact Information

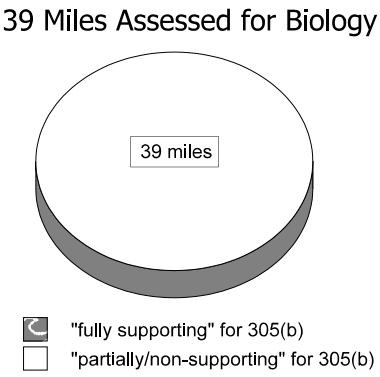
Nicoline Shulterbrandt, Water Quality Division
Department of Health (DC DOH)
51 N Street, NE, 5th Floor■ Washington, DC 20002
Phone 202/535-2194 ■ Fax 202/535-1363
email: nicoline.shulterbrandt@dc.gov

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
		nonpoint source assessments
		monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
		rotating basin
		other:

Stream Miles

Total miles *(determined using state based GIS coverage)*	**39**
Total perennial miles	–
Total miles assessed for biology	**39**
fully supporting for 305(b)	0
partially/non-supporting for 305(b)	39
listed for 303(d)	unknown
number of sites sampled	unknown
number of miles assessed per site	unknown



Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Single Aquatic Life Use	
ALU designations in state water quality standards	One designation: Protection and propagation of fish, shellfish and wildlife	
Narrative Biocriteria in WQS	Formal/informal numeric procedures are used to support narrative biocriteria	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)		assessment of aquatic resources
		cause and effect determinations
		permitted discharges
		monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	unknown	

Reference Site/Condition Development

Number of reference sites	**2 total**	
Reference site determinations		site-specific
		paired watershed
		regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	DC DOH does not have reference site criteria. All streams in DC are contaminated. DC DOH compares streams to reference streams in Prince Georges and Montgomery Counties in Maryland.	
Characterization of reference sites within a regional context *Information not provided*		historical conditions
		least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions		ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
	✓	jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

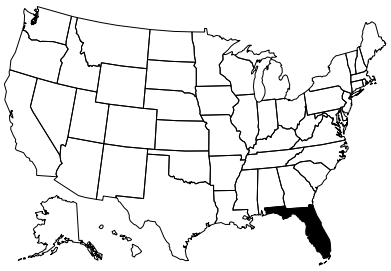
Field and Lab Methods

Assemblages assessed	✓	benthos *(<100 samples/year; single observation, limited sampling)*
	✓	fish *(<100 samples/year; single observation, limited sampling)*
		periphyton
	✓	other: phytoplankton and zooplankton *(<100 samples/year; single observation, limited sampling)*
Benthos		
sampling gear		D-frame, kick net (1 meter); mesh size information not provided
habitat selection		riffle/run (cobble)
subsample size		100 count
taxonomy		family
Fish		
sampling gear		backpack electrofisher
habitat selection		pool/glide, riffle/run (cobble)
sample processing		length measurement, biomass – individual
subsample		none
taxonomy		species
Habitat assessments		hydrogeomorphology; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists

Data Analysis and Interpretation

Data analysis tools and methods		summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		*Information not provided*
defining impairment in a multimetric index		*Information not provided*
Multivariate thresholds		
defining impairment in a multivariate index		*Information not provided*
Evaluation of performance characteristics		repeat sampling
		precision
Information not provided		sensitivity
		bias
		accuracy
Biological data		
Storage		paper files only
Retrieval and analysis		data retrieved from paper files

FLORIDA



Contact Information

Russel Frydenborg, Environmental Administrator
Florida Department of Environmental Protection (FDEP)
2600 Blair Stone Road ■ Tallahassee, FL 32399-2400
Phone 850/921-9821 ■ Fax 850/922-4614
email: russel.frydenborg@dep.state.fl.us
FDEP Bioassessment homepage: http://www.dep.state.fl.us/water/bioassess/index.htm

Program Description

Biological sampling has been one component of the Florida Department of Environmental Protection's (FDEP) overall monitoring strategy since the early 1970s. The Bioassessment Program, in its current manifestation, has been in existence since 1992, in response to the need for tools that would detect and characterize the nature and extent of nonpoint source pollution (*sensu* the 319 program). The primary goal of FDEP's bioassessment activities are to determine the biological health, or degree of impairment, in the State's surface waters. The biological assessment results are heavily utilized by a number of FDEP programs for making informed environmental decisions:

- Total Maximum Daily Load (303(d)) program – determining the impairment status of waterbodies for potential inclusion on the 303(d) list
- The National Pollutant Discharge Elimination System (NPDES) program – determining effectiveness of discharge permit limits
- Nonpoint Source Program – targeting areas with nonpoint source problems and determining the effectiveness of Best Management Practices
- Rotating Basin Assessment program – overall assessment of all human activities in a watershed
- Mine Reclamation program – determining the success of mitigation efforts
- FDEP's Division of Waste Management – ensuring that clean up efforts are sufficient to protect aquatic life adjacent to waste clean up sites (e.g., RCRA).

Biological data are used in Florida's 305(b) report as one of the key pieces of Aquatic Life Use Support (ALUS) information for determining if a waterbody meets its designated use. Bioassessment data are also used for establishing the impairment status of a waterbody for 303(d) listing purposes.

After recalibration of bioassessment metrics and indices (currently underway), it is anticipated that Florida's water quality standards (Rule 62.302 Florida Administrative Code) will be revised accordingly. Although the primary target community for the bioassessment program is currently benthic macroinvertebrates, Florida is also working on potential assessment methods that use algal and vascular plant assemblages. While multimetric biological indices are currently complete for streams, rivers, and lakes, it is anticipated that ongoing index development for wetlands and estuaries will be finalized over the next several years.

The most important recent accomplishment of the Bioassessment Program has been the inclusion of the Stream Condition Index, the BioRecon, and Lake Condition Index as impairment indicator tools in Florida's Impaired Waters Rule (IWR), Rule 62-303, FAC. The IWR is a new administrative code that provides detailed specifications for how surface waters are determined to be impaired for Section 303(d) listing. Future challenges include incorporating the bioassessment tools into a Statewide probabilistic survey design, as well as continuing to meet the increasing demands for biological tools and data.

Documentation and Further Information

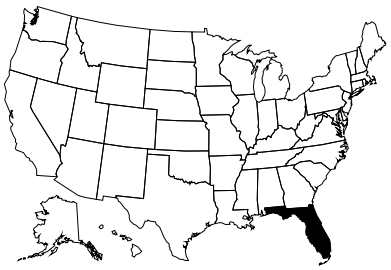
2000 Florida Water Quality Assessment 305(b) Report: http://www.dep.state.fl.us/water/305b/index.htm

Numerous technical reports are available online at http://www.dep.state.fl.us/labs/reports/index.htm and http://www.dep.state.fl.us/water/bioassess/pubs.htm

For an online collection of FDEP standard operating procedures, go to: http://www.dep.state.fl.us/labs/qa/sops.htm

Surface Water Quality Classifications: http://www.dep.state.fl.us/water/surfacewater/index.htm

FLORIDA



Contact Information

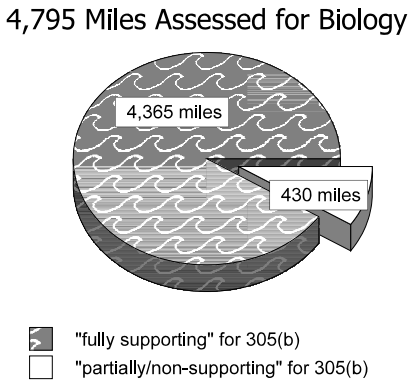
Russel Frydenborg, Environmental Administrator
Florida Department of Environmental Protection (FDEP)
2600 Blair Stone Road ■ Tallahassee, FL 32399-2400
Phone 850/921-9821 ■ Fax 850/922-4614
email: russel.frydenborg@dep.state.fl.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
	✓	other: biocriteria development
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(comprehensive use throughout jurisdiction)*
		fixed station (i.e., water quality monitoring stations)
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(5-year rotation, comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles *(determined using waterbody identification- segment of stream, generally 5 mile increments)*	**51,858**
Total perennial miles	22,993
Total miles assessed for biology	**4,795**
fully supporting for 305(b)	4,365
partially/non-supporting for 305(b)	430
listed for 303(d)	430
number of sites sampled (over 2 years)	959
number of miles assessed per site	5



Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Single aquatic life use	
ALU designations in state water quality standards	One designation: propagation of a healthy, well balanced fish and wildlife community	
Narrative Biocriteria in WQS	Procedures used to support narrative biocriteria located in FDEP's Standard Operating Procedures	
Numeric Biocriteria in WQS	Numeric biocriteria located in Rule 62-302 Florida Administrative Code – "Shannon-Weaver diversity shall not be reduced more than 25% of background conditions" *	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	TMDLs, restoration/mitigation studies, BMP effectiveness studies, discharge permit renewal	

*Florida has made substantial progress in developing new multimetric indices for streams (Stream Condition Index and BioRecon), lakes (Lake Condition Index), and wetlands for eventual inclusion in the Florida Administrative Code. When the new indices are adopted as water quality standards, the role of Shannon-Weaver diversity as a numeric standard will be re-evaluated.

Reference Site/Condition Development

Number of reference sites	**150 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	least impaired by human activities in a region, optimal habitat, benign land use in watershed, uncontaminated water quality, undisturbed hydrology	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
	✓	gradient response *(for recalibration of existing indexes)*
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

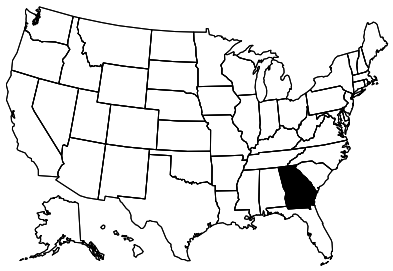
Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - watershed level)*
		fish
	✓	periphyton *(100-500 samples/year; single season, multiple sites - not at watershed level)*
	✓	other: phytoplankton, macrophytes *(100-500 samples/year; single observation, limited sampling)*
Benthos		
sampling gear		d-frame, dipnet (500-600 micron mesh), multiplate (Hester-Dendys)
habitat selection		multihabitat (snags, roots, leaf packs, aquatic vegetation)
subsample size		100-count target
taxonomy		species level (where possible)
Periphyton		
sampling gear		**natural substrate**: brushing/scraping device (razor, toothbrush, etc.), collect by hand **artificial substrate**: periphytometer, microslides or other suitable substratum
habitat selection		multihabitat
sample processing		chlorophyll *a*/phaeophytin, taxonomic identification
taxonomy		all algae, species level (diatoms to variety level)
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival, habitat assessment tests, sampling field audits, sampling variability studies, performance testing program for bioassessment

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
	✓	disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		25th percentile of reference population
defining impairment in a multimetric index		quadrasection of best score
Evaluation of performance characteristics	✓	repeat sampling *(same team, same reach; different teams in same reach)*
	✓	precision *(coefficient of variation)*
		sensitivity
		bias
	✓	accuracy *(species accumulation)*
Biological data		
Storage		custom Oracle-based program, “S-BIO”
Retrieval and analysis		custom Oracle-based program, “S-BIO”

GEORGIA



Contact Information

Kathy Methier, Ambient Monitoring Unit Manager
Georgia Department of Natural Resources (GA DNR)
4220 International Parkway, Suite 101 ■ Atlanta, GA 30354
Phone 404/675-6236 ■ Fax 404/675-6244
email: kathy_methier@dnr.state.ga.us
GA DNR Environmental Protection Division: http://www.dnr.state.ga.us/dnr/environ/

Program Description

The Georgia Department of Natural Resources (GA DNR) Environmental Protection Division (EPD) monitoring program integrates physical, chemical, and biological monitoring to provide information for water quality, use attainment assessments, and basin planning. EPD monitors the surface waters of the state to collect baseline and trend data, document existing conditions, study impacts of specific discharges, determine improvements resulting from upgraded water pollution control plants, support enforcement actions, establish wasteload allocations for new and existing facilities, verify water pollution control plant compliance, document water use impairment and reasons for problems causing less than full support of designated water uses, and develop TMDLs. Intensive surveys; lake, coastal, biological, fish tissue, toxic substance, and trend monitoring; and facility compliance sampling are the major monitoring tools used by EPD.

Long-term, trend, and ambient monitoring of streams at strategic locations throughout Georgia, was initiated by EPD during the late 1960s. This work was and continues to be accomplished to a large extent through cooperative agreements with federal, state, and local agencies who collect samples from groups of stations at specific, fixed locations throughout the year.

In 1995, EPD adopted and implemented significant changes to the strategy for trend monitoring in Georgia. The changes were implemented to support the River Basin Management Planning program. The number of fixed stations statewide was reduced in order to focus resources for sampling and analysis in a particular group of basins in any one year in accordance with the basin planning schedule. This approach provides the framework for identifying, assessing, and prioritizing water resource issues, developing implementation strategies, and providing opportunities for targeted, cooperative actions to reduce pollution, enhance aquatic habitat, and provide a dependable water supply.

The Watershed Planning and Monitoring Section of the EPD Water Protection Branch performs the following tasks:

- Conducts monitoring of Georgia streams, rivers, lakes and estuaries for use with wasteload allocations and to determine compliance with water quality standards;
- Develops River Basin Management Plans for river basins in Georgia;
- Conducts water quality modeling for wasteload allocations, water use classifications, and water quality standards in Georgia; and
- Collects samples of facility discharges for laboratory testing of samples.

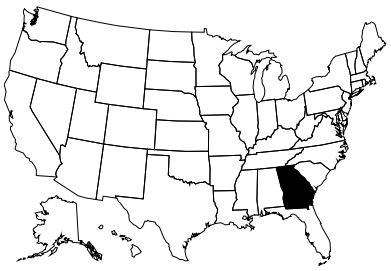
Currently, reference site selection and biocriteria development are being carried out under contract with Columbus State University. The project is in Phase III with projected completion in 2003. The final phase, Phase IV, is projected to be completed in 2004.

Documentation and Further Information

Georgia's 2000 305(b) Report, *Water Quality in Georgia, 1998-1999;* the *Final Georgia 2000 305(b)/303(d) List Documents*, including *Summary of Changes from the 2000 to 2002 305(b)/303(d) List*, can be found under Georgia's Environment, Water Quality in the Table of Contents at the following site: http://www.dnr.state.ga.us/dnr/environ/

2000. DRAFT *Standard Operating Procedures for Freshwater Macroinvertebrate Biological Assessment*. Georgia Department of Natural Resources, Water Protection Branch, Atlanta, GA.

GEORGIA



Contact Information

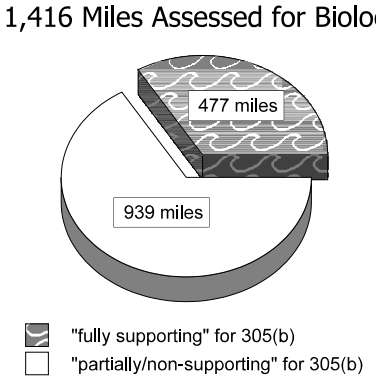
Kathy Methier, Ambient Monitoring Unit Manager
Georgia Department of Natural Resources (GA DNR)
4220 International Parkway, Suite 101 ■ Atlanta, GA 30354
Phone 404/675-6236 ■ Fax 404/675-6244
email: kathy_methier@dnr.state.ga.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(specific river basins or watersheds)*
	✓	fixed station (i.e., water quality monitoring stations) *(specific river basins or watersheds, and comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles *(determined using state based coverage)*	**70,150**
Total perennial miles	44,056
Total miles assessed for biology*	**1,416**
fully supporting for 305(b)	477
partially/non-supporting for 305(b)	939
listed for 303(d)	–
number of sites sampled *(in 2000)*	153
number of miles assessed per site	varies



*In 2000, 72 stations were sampled and a total of 477 miles were assessed as fully supporting for 305(b) (6.6 miles assessed/station); 75 stations were sampled and a total of 799 miles were assessed as partially supporting (10.7 miles assessed/station); 6 stations were sampled and 140 miles were assessed as not supporting (23.3 miles assessed/station). This results in a total of 153 stations and 1,416 stream miles assessed in 2000 (9.25 miles assessed/station). The stream miles listed above are not divided into those monitored for biology versus chemistry because 305(b) reporting requirements use both types of data. The sampling length per site varies and the length of stream represented by each sample is determined by the surrounding hydrography.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis		Fishery Based Uses
ALU designations in state water quality standards		Three designations: Coastal fishing; fishing, propagation of fish, shellfish, game, and other aquatic life; primary and secondary trout waters
Narrative Biocriteria in WQS		Procedures used to support narrative biocriteria are located in the Environmental Protection Division's SOPs for macroinvertebrates and DNR/Wildlife Resources Division's IBI protocols for fish
Numeric Biocriteria in WQS		none
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU		Fish IBI and macroinvertebrate assessments were conducted to evaluate approximately 80 previously 303(d)-listed sites in the last two years. While some sites were removed from the list others, found to be impaired due to (clean) sediment deposition, remained on the list.

Reference Site/Condition Development

Number of reference sites		**Reference site selection is under development.**
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria		Columbus State University is using several criteria for selecting reference sites, including minimum overall habitat score, managed land, urban land, minimum forested riparian zone width, forested riparian zone in catchment, silviculture activity, and point source discharges. Reference sites would be defined as least-disturbed according to these criteria.
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

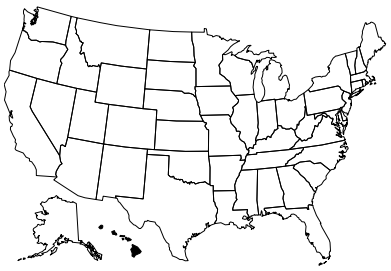
Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - watershed level)*
	✓	fish *(100-500 samples/year; single season, multiple sites - watershed level)*
		periphyton
		other:
Benthos		
sampling gear	collect by hand and D-frame; 500-600 micron mesh	
habitat selection	multihabitat	
subsample size	200 count	
taxonomy	genus	
Fish		
sampling gear	seine, backpack electrofisher, pram unit (tote barge); 3/16" and 1/4" mesh	
habitat selection	Sample all habitats within a sample reach that is 35X the mean stream width. Habitat assessments are broken out between riffle/run and glide/pool based on the ecoregion in which the sample is located.	
sample processing	biomass – batch, anomalies	
subsample	none	
taxonomy	species	
Habitat assessments	visual based and zig-zag pebble count; performed with bioassessments	
Quality assurance program elements	standard operating procedures, quality assurance plan, periodic meetings and training for biologists, sorting and taxonomic proficiency checks	

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
	UD	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores	under development	
defining impairment in a multimetric index	under development	
Multivariate thresholds		
defining impairment in a multivariate index	under development	
Evaluation of performance characteristics		repeat sampling
		precision
Not currently evaluated		sensitivity
		bias
		accuracy
Biological data		
Storage	EDAS and Excel	
Retrieval and analysis	EDAS	

HAWAI`I



Contact Information

Katina Henderson, Water Quality Management Planner
Hawai`i State Department of Health (HIDOH)
919 Ala Moana Boulevard, Room 312 ■ Honolulu, HI 96814
Phone 808/587-4337 ■ Fax 808/587-4370
email: khenderson@eha.health.state.hi.us
HIDOH Environmental Planning Office homepage: http://www.hawaii.gov/health/eh/epo

Program Description

The primary objective of the Hawai`i State Department of Health (HIDOH) Bioassessment Program is to augment the commonly used physical and chemical water quality assessments performed (during ambient monitoring, use attainability studies, and other investigations) for classification, evaluation and regulation of water bodies. The program primarily utilizes the Hawai`i Stream Bioassessment Protocol (HSBP) 3.01 developed by Mike Kido and the Hawai`i Natural Resources Conservation Service (NRCS) Visual Assessment protocol for characterization of streams. HIDOH currently uses these protocols in conjunction with water quality data to establish TMDLs in the State of Hawai`i. In the future the HSBP and the Hawai`i NRCS protocol will be used in conjunction with physical and chemical water quality data to classify streams and determine exceedances of narrative criteria.

The HSBP includes both habitat and biotic metrics. The general approach of the HSBP is to compare measures of community characteristics and habitat of a study stream to a minimally impacted ecoregional reference condition. An Index of Biotic Integrity, currently focused on fish, composes the biotic portion of the protocol. Much of the basis for evaluation is the presence or absence of native taxa and the introduction of non-native species. Low abundance or low diversity of native fauna suggests diminished biological integrity. The habitat portion of the HSBP includes standard habitat metrics, including bank stability, embeddedness, canopy cover and presence of fine and coarse organic material. The State of Hawai`i will soon be working with USGS to census the macroinvertebrate community in Hawai`i and develop metrics for the Hawai`i Bioassessment Program, which will add a component to measure pollution tolerance. The macroinvertebrate community in Hawai`i is quite different from that of the mainland United States; therefore, the metric may be quite unlike that of any other state.

As a preliminary evaluation of sites and to compliment the HSBP habitat component, the Hawai`i NRCS Visual Assessment protocol is applied. This is a modified version of the national NRCS visual assessment protocol.

The State Water Quality Management Planner, along with a Stream Bioassessment Intern, primarily perform these assessments. Additionally, other scientists from HIDOH, scientists from other local, state and federal agencies, local university students and professors, and skilled community members volunteer their time to help perform these protocols. The time demand of each task is dependent upon the number of aquatic organisms in the stream, the size of the stream, and other local conditions. HIDOH currently sponsors training courses in the protocols to those with a scientific background on a limited basis.

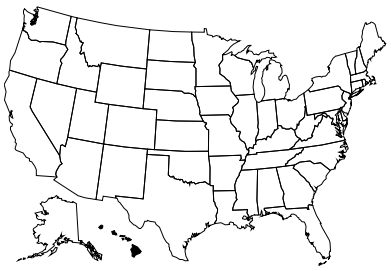
Documentation and Further Information

excerpts from *Hawai`i 2000 305(b) Report*: http://www.hawaii.gov/health/eh/cwb/2000-305b/index.html

Proposed 2001 revisions to *Hawai`i Water Quality Standards, January 2002 Indicators of Environmental Quality Report:* http://www.hawaii.gov/health/eh/epo/wqrev.htm

Hawai`i Stream Bioassessment Protocol, Michael Kido, Version 3.01, January 2001:
http://www.state.hi.us/doh/eh/epo/kawa.pdf

HAWAI`I



Contact Information

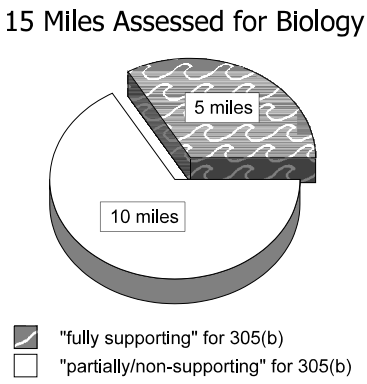
Katina Henderson, Water Quality Management Planner
Hawai`i State Department of Health (HIDOH)
919 Ala Moana Boulevard, Room 312 ■ Honolulu, HI 96814
Phone 808/587-4337 ■ Fax 808/587-4370
email: khenderson@eha.health.state.hi.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
		monitoring the effectiveness of BMPs
		ALU determinations/ambient monitoring
	UD	promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
		fixed station (i.e., water quality monitoring stations)
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(specific river basins or watersheds)*
		other:

Stream Miles

Total miles *(determined using state based coverage)*	**249**
Total perennial miles	249
Total miles assessed for biology	**15**
fully supporting for 305(b)	5
partially/non-supporting for 305(b)	10
listed for 303(d)	10
number of sites sampled *(on an annual basis)*	17
number of miles assessed per site*	<1



*Less than 1 mile assessed per site was determined by dividing the 15 total miles assessed for biology by the 17 sites sampled, which equals roughly .88 miles.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis		Class System (A,B,C)
ALU designations in state water quality standards		Two designations: 1) Protection of native breeding stock, and 2) Support and propagation of aquatic life
Narrative Biocriteria in WQS		under development
Numeric Biocriteria in WQS		under development – Hawai`i is currently proposing to add numeric biocriteria to WQS
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
		cause and effect determinations
		permitted discharges
		monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU		none

Reference Site/Condition Development

Number of reference sites	**3 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria	Minimally impacted and most pristine. Always scores near 100% when using the Hawai`i Stream Bioassessment Protocol no matter when and where sampled.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate) *(the entire State of Hawai`i is one ecoregion)*
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

Field and Lab Methods

Assemblages assessed	UD	benthos *(Hawai`i will soon be working with USGS to census the macroinvertebrate community in Hawai`i and develop metrics)*
	✓	fish *(<100 samples/year; single season, multiple sites - watershed level)*
		periphyton
		other:
Fish		
sampling gear		backback electrofisher and snorkel
habitat selection		multihabitat
sample processing		length measurement and biomass - individual
subsample		selected species
taxonomy		species
Habitat assessments		visual based, habitat availability, substrate embeddedness, Fine and Coarse Particulate Organic Matter (FPOM/CPOM) characterization, velocity-depth combinations, channel flow status, channel alteration, bank stability, riparian vegetative zone width, riparian understory coverage, and percent native riparian plant coverage; performed with bioassessments
Quality assurance program elements		standard operating procedures, periodic meetings and training for biologists, and taxonomic proficiency checks

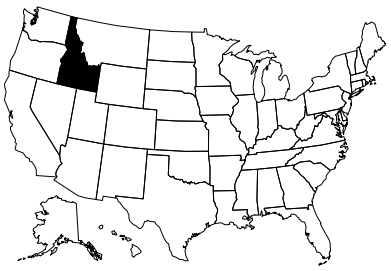
Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		under development
defining impairment in a multimetric index		under development*
Evaluation of performance characteristics		repeat sampling
		precision
Not currently evaluated		sensitivity
		bias
		accuracy
Biological data		
Storage		Excel
Retrieval and analysis		Statistica

*The following are the *proposed* impairment thresholds:

	Class 1a (mainly undeveloped, "unimpaired")	**Class 2a (mainly developed, "unimpaired")**
Habitat	greater than or equal to 75% of reference condition	between 50% and 75% of reference condition
Biotic integrity	greater than or equal to 70% of reference condition	between 30% and 70% of reference condition

IDAHO



Contact Information

Cynthia Grafe, Water Quality Assessment Program Coordinator
State of Idaho Department of Environmental Quality (IDEQ)
1410 North Hilton ■ Boise, ID 83706
Phone 208/373-0163 ■ Fax 208/373-0576
email: cgrafe@deq.state.id.us
IDEQ Water Quality homepage: http://www2.state.id.us/deq/water/water1.htm

Program Description

The Idaho surface water program uses biological information extensively to determine use support and impairment. In 1993, the Idaho Department of Environmental Quality (IDEQ) implemented a rapid bioassessment program aimed at integrating biological and chemical monitoring with physical habitat assessment as a way of characterizing water quality and stream integrity. This program, know as the Beneficial Use Reconnaissance Program (BURP), closely follows concepts and methods described in the *Rapid Bioassessment Protocols for Use in Streams and Rivers* (USEPA 1999). The main purpose of BURP is to provide consistency in monitoring, collecting data, and reporting. Specifically, biological along with physical, chemical, and landscape data are used to address the following objectives:

- Determine the degree of beneficial use support of the water body
- Determine the degree of biological integrity using biological information or other measures
- Compile descriptive information about the water body and data used in the assessment.

IDEQ has formal monitoring and assessment methods in place for large rivers and small streams. Methods for lakes and reservoirs are in development. For rivers and streams, there are a total of 8 multimetric indices for benthic macroinvertebrates, periphyton, fish, habitat, and physicochemical measures. Indices are integrated into attaining or non-attaining use support determinations. The integration uses a weight-of-evidence approach combined with individual minimum benchmarks for each assemblage and numeric criteria exceedances.

IDEQ has several plans to improve the current monitoring and assessment program. A draft statewide monitoring strategy will be introduced in July 2002. Future plans include incorporating a probabilistic monitoring design for screening purposes as well as adding methods for other water body types (e.g., wetlands, intermittent streams, springs, etc.). Implementation of these plans is dependent on agency priorities and available resources.

Documentation and Further Information

Idaho's 1998 303(d) List: http://www2.state.id.us/deq/water/1998_303d/303dlist.pdf

Grafe, C.S.et al. 2002. *Water body assessment guidance, 2nd edition*. Idaho Department of Environmental Quality. Boise, Idaho. 113 pp. http://www2.state.id.us/deq/water/surface_water/wbag/WBAG2001.htm

Grafe, C.S. (editor) April 2002. *Idaho small stream ecological assessment framework: an integrated approach*. Idaho Department of Environmental Quality. Boise, Idaho. 304 pp.
http://www2.state.id.us/deq/water/surface_water/wbag/WBAG_AssessmentFramework.htm

Grafe, C.S. (editor). April 2002. *Idaho river ecological assessment framework: an integrated approach*. Idaho Department of Environmental Quality. Boise, Idaho. 222 pp.
http://www2.state.id.us/deq/water/surface_water/wbag/WBAG_AssessmentFramework.htm

Beneficial Use Reconnaissance Program (BURP) 2001 Annual Work Plan for Wadeable (Small) Streams, 2001:
http://www2.state.id.us/deq/water/surface_water/2001_BURP_annual_work_plan_wadeable_streams.pdf

BURP Quality Assurance Plan for Field Data Sheets on Wadeable (Small) Streams, 2001:
http://www2.state.id.us/deq/water/surface_water/BURP_QualityAssurancePlan.pdf

1999 BURP Workplan for Wadeable Streams (Methods Manual):
http://www2.state.id.us/deq/water/surface_water/99_BURP_WORKPLAN.pdf

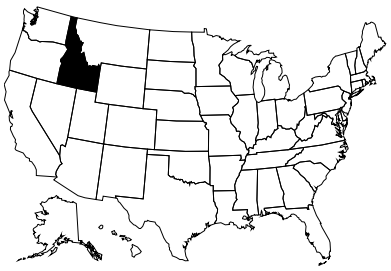
Streams: 1999 Post-Field Evaluation Summary Report (BURP), 2001:
http://www2.state.id.us/deq/water/surface_water/BURP_streams_Field_Report_99.pdf

Public Involvement and Response to Comment Summary:
http://www2.state.id.us/deq/water/surface_water/wbag/WBAG2001.htm

IDAHO

Contact Information

Cynthia Grafe, Water Quality Assessment Program Coordinator
State of Idaho Department of Environmental Quality (DEQ)
1410 North Hilton ■ Boise, ID 83706
Phone 208/373-0163 ■ Fax 208/373-0576
email: cgrafe@deq.state.id.us



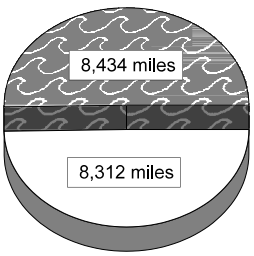
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects, specific river basins or watersheds, and comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(special projects only)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
		rotating basin
		other:

Stream Miles

Total miles *(determined using the National Hydrography Database)*	**96,200**
Total perennial miles	49,500
Total miles assessed for biology	**16,742**
fully supporting for 305(b)	8,434
partially/non-supporting for 305(b)	8,312
listed for 303(d)	8,312
number of sites sampled	4,500
number of miles assessed per site	~3.5

16,742 Miles Assessed for Biology



"fully supporting" for 305(b)
"partially/non-supporting" for 305(b)

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Warm Water vs. Cold Water	
ALU designations in state water quality standards	Sub-categories are cold water, seasonal cold water, warm water, modified (UAA required), and salmonid spawning.	
Narrative Biocriteria in WQS	IDEQ's "Waterbody Assessment Guidance" and supporting technical reports are used to interpret and implement WQS, including ALU assessment. Although the term "biocriteria" is not used, functional elements are included in the WQS and in implementing ALU designation and support status guidance. Please see: http://www2.state.id.us/adm/adminrules/rules/IDAPA58/58INDEX.HTM	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Used as restoration criteria in CERCLA cleanup monitoring effectiveness plans/consent decrees; bioassessment is required prior to removing 303(d) listed waters Most TMDLs have ALUS biomonitoring as part of implementation; one recent example is the North Fork of the Coeur d'Alene River.	

Reference Site/Condition Development

Number of reference sites	**200 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	Reference site criteria based on nearby road condition, riparian vegetation complexity, channel morphology and complexity, habitat structure complexity, evidence of chemical stressors, substrate heterogeneity, and evidence of point and nonpoint sources. Also, land satellite images are reviewed for evidence of disturbance in the watershed (see IDAPA 58.01.02.003.85).	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
	✓	professional judgment
	✓	other: mostly least disturbed sites, but also minimally disturbed sites in some bioregions
Stream stratification within regional reference conditions		ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: bioregions based on groupings of ecoregions. Some of the indices classify by elevation and stream type.
Additional information	✓	reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - broad coverage)*
	✓	fish *(100-500 samples/year; single season, multiple sites - broad coverage)*
	✓	periphyton *(100-500 samples/year; single season, multiple sites - broad coverage)*
		other:
Benthos		
sampling gear		Surber, Hess, Slack (0.5 meter, in rivers only); 500-600 micron mesh
habitat selection		richest habitat
subsample size		500 count
taxonomy		species
Fish		
sampling gear		backpack electrofisher
habitat selection		multihabitat
sample processing		length measurement, biomass - individual, biomass - batch and anomalies
subsample		none; full sample work-up
taxonomy		species (count and keep voucher specimens for species that are not identified in the field)
Periphyton		
sampling gear		**natural substrate**: brushing/scraping device (razor, toothbrush, etc.)
habitat selection		selected near macroinvertebrate sample
sample processing		taxonomic identification
taxonomy		species level
Habitat assessments		visual based, canopy closure (densiometer), Wolman pebble count, pool complexity (width, depth), stream width/depth, large woody debris; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival

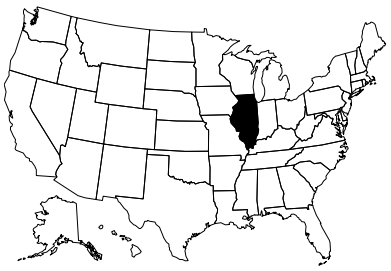
Data Analysis and Interpretation*

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
	✓	disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		Varies by index - a combination of 95th percentile of reference and cumulative distribution function used to scale metrics scores is most frequently used.
defining impairment in a multimetric index		25th percentile of reference population**
Evaluation of performance characteristics	✓	repeat sampling
	✓	precision *(variability study of reference conditions)*
	✓	sensitivity
	✓	bias
	✓	accuracy
Biological data		
Storage		MS Access, changing to Oracle/Visual Basic indexed to NHD
Retrieval and analysis		Custom interface (Biological Assessment Tool) developed to calculate metrics, indices, and physical and biological summary statistics. Systat is also used.

*Formal methods have been developed for non-wadeable rivers and wadeable streams. Lentic methods are under development. A total of eight multimetric indices for bugs, diatoms, fish, habitat, and physicochemical measures have been developed or adapted for rivers and streams. Indices are integrated into attaining or non-attaining use support determinations.

**Idaho uses a measure of CONDITION, which aggregates 3 different indices - Habitat, Benthos and Fish. Each index is compared to the median of reference condition and is given a score of 1, 2 or 3. All three scores are then combined (averaged). If > or = 2, then fully supporting; if <2, then not supporting.

ILLINOIS



Contact Information

Gregg Good, Manager - Surface Water Section
Illinois Environmental Protection Agency (IEPA)
1021 North Grand Avenue East ■ Springfield, Illinois 62794-9276
Phone 217/782-3362 ■ Fax 217/785-1225
email: gregg.good@epa.state.il.us
IEPA Bureau of Water homepage: http://www.epa.state.il.us/water/

Program Description

Illinois EPA (IEPA) conducts intensive river basin surveys on a five-year rotational basis in cooperation with the Illinois Department of Natural Resources (IDNR). These surveys are a major source of information for annual 305(b) assessments. Illinois has 33 major river basins within its borders. Stations sampled by IEPA and IDNR are selected on the basis of where intensive data are currently lacking or historical data need updating. Water chemistry and biological (fish and macroinvertebrate) data along with qualitative and quantitative instream habitat information, including stream discharge, are collected to characterize stream segments within the basin, identify water quality conditions, and evaluate aquatic life use impairment. Fish tissue contaminant and sediment chemistry sampling are also conducted to screen for the accumulation of toxic substances.

Illinois' "biological expectations" are based on a regional reference site approach that enables within-region comparisons between the aquatic community at any stream site and the reference expectation. The regional reference site approach is a key component of biocriteria. The approach ensures reasonably attainable biological goals that recognize and account for the unique combination of regional land form, land use, and physical habitat characteristics, which influence the distribution of fish, macroinvertebrates and other aquatic organisms. Illinois is currently developing this framework, which includes refinement of existing biological assessment tools and, where needed, development of new state-of-the-art monitoring approaches.

Illinois EPA is working with IDNR, USEPA, members of the agricultural, industrial, academic and regulated communities, as well as outside contractors, and other interested parties to develop biological criteria for streams and rivers. This approach to biocriteria will enable IEPA to better assess the ecological/environmental quality of Illinois rivers and streams and should allow the Agency to continue to update and refine the stream use designations contained in Illinois' water quality standards.

Documentation and Further Information

Illinois Water Quality Report 2002 (CWA Section 305(b) Report), July 2002, IEPA, Bureau of Water*:*
http://www.epa.state.il.us/water/water-quality/report-2002/305b-2002.pdf

2001 305(b) Summary Report (1999 data), Rivers and Streams:
http://www.epa.state.il.us/water/water-quality/report-2001/report-2001.pdf

Condition of Illinois Water Resources - menu of Illinois 305(b) Reports and Assessments, including maps and graphs: http://www.epa.state.il.us/water/water-quality/index.html

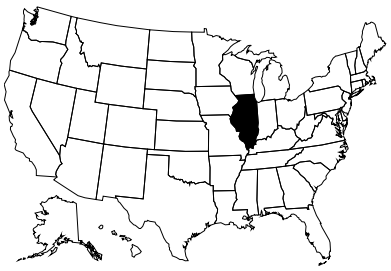
Illinois Targeted Watershed Approach: http://www.epa.state.il.us/water/targeted-watershed/index.html

IEPA Bureau of Water, Surface Water Quality Monitoring and Assessment Programs homepage:
http://www.epa.state.il.us/water/surface-water/index.html

IEPA Bureau of Water, River and Stream Monitoring Program homepage, with links to biocriteria development and other relevant information: http://www.epa.state.il.us/water/surface-water/river-stream-mon.html

Hite, R.L. and B.A. Bertrand. 1989. *Biological Stream Characterization (BSC): A Biological Assessment of Illinois Stream Quality*, Special Report No. 13 of the Illinois State Water Plan Task Force. Illinois Environmental Protection Agency.

ILLINOIS



Contact Information

Gregg Good, Manager - Surface Water Section
Illinois Environmental Protection Agency (IEPA)
1021 North Grand Avenue East ■ Springfield, Illinois 62794-9276
Phone 217/782-3362 ■ Fax 217/785-1225
email: gregg.good@epa.state.il.us

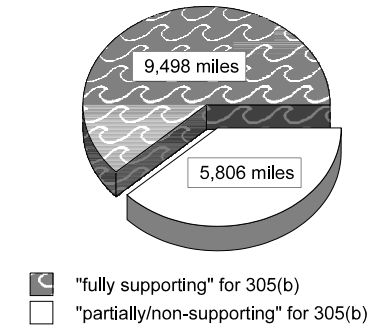
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
		monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	UD	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects and specific river basins or watersheds)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles *(determined using RF3 and existing maps)*	**86,021**
Total perennial miles	30,246
Total miles assessed for biology	**15,304**
fully supporting for 305(b)	9,498
partially/non-supporting for 305(b)	5,806
listed for 303(d)*	–
number of sites sampled	115
number of miles assessed per site**	site specific

15,304 Miles Assessed for Biology



*Total miles listed for 303(d) is a subset of the miles partially/non-supporting for 305(b) and will be determined in the next update.

**10 miles for wadeable sites and 25 miles for non-wadeable sites with some site-specific detailing following the 1997 305(b) guidance.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Single Aquatic Life Use	
ALU designations in state water quality standards	Secondary contact and indigenous aquatic life use waters (IL Title 35, Subtitle C, Chapter I, Part 303.204)	
Narrative Biocriteria in WQS	under development - IEPA has written guidelines and thresholds for fish and invertebrate indices that are not part of the WQS, but are in the 305(b) guidelines (see flowchart). These numeric biological measures are used as decision criteria to determine attainment of ALU.	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Data have been used to make permitting and nonpoint source BMP decisions. Illinois DNR's Biological Stream Characterization (BSC) program is used to determine antidegradation tiers and to influence IDNR natural heritage area designations.	

Reference Site/Condition Development*

Number of reference sites	**120 total**	
Reference site determinations*	✓	site-specific
		paired watersheds
		regional (aggregate of sites)
		professional judgment
	✓	other: watershed measures of physical and chemical disturbance
Reference site criteria	Illinois EPA is in the process of formally defining reference criteria.*	
Characterization of reference sites within a regional context	✓	historical conditions
	✓	least disturbed sites
		gradient response
	✓	professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
	✓	stream type
	✓	multivariate grouping
	✓	jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

*IEPA currently does not use "reference conditions" for making use-support decisions. Reference conditions were not explicitly defined or used for the present stream IBIs. A not-yet completed reevaluation of Illinois IBIs used reference conditions to develop the new indices. IEPA uses a general concept of least impacted reference condition where there are no data available; no further quantitative development has been done.

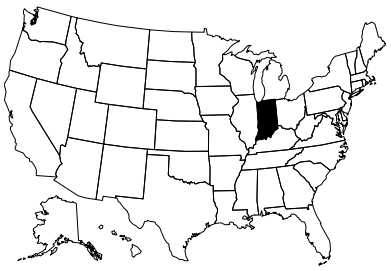
Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites – not at watershed level)*
	✓	fish *(100-500 samples/year; single season, multiple sites – not at watershed level)*
		periphyton
		other:
Benthos		
sampling gear		collect by hand, dipnet; 500-600 micron mesh
habitat selection		richest habitat, rifle/run (cobble), multihabitat and woody debris
subsample size		300 count and entire sample
taxonomy		combination - order, family, genus and species
Fish		
sampling gear		backpack and boat electrofishers, and seine; 1/4" and 3/8" mesh
habitat selection		pool/glide, riffle/run (cobble) and multihabitat
sample processing		length measurement, biomass - individual and batch
subsample		none
taxonomy		species
Habitat assessments		visual based and quantitative measurements; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, sorting and taxonomic proficiency checks

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
	✓	disturbance gradients
	✓	other: nonparametric statistical tests
Multimetric thresholds		
transforming metrics into unitless scores		Metric values representing least-disturbed conditions statewide are stratified by region; within-region regression of each metric vs. environmental covariate, e.g., stream size and slope, defines benchmark for defining metric-scoring ranges.
defining impairment in a multimetric index		Thresholds are based on the possible index scoring range divided into discrete categories and are not driven by reference sites.
Evaluation of performance characteristics		repeat sampling
		precision
Not currently evaluated		sensitivity
		bias
		accuracy
Biological data		
Storage		IEPA database and spreadsheets
Retrieval and analysis		SAS, Systat, database, spreadsheet, statistical-analysis and statistical-graphics applications, including MS Access, FoxPro, Excel, QuattroPro, Minitab, and Sigma Plot

INDIANA



Contact Information

C. Lee Bridges, Chief - Biological Studies Section
Indiana Department of Environmental Management (IDEM)
P.O. Box 6015 ■ Indianapolis, IN 46206-6015
Phone 317/308-3183 ■ Fax 317/308-3219
email: lbridges@dem.state.in.us
IDEM Office of Water Quality homepage: http://www.IN.gov/idem/water/

Program Description

The Biological Studies Section (BSS) of IDEM's Office of Water Quality conducts studies of fish and macroinvertebrate communities, as well as stream habitats. These data are used to help develop biological criteria to which all other streams can be compared in order to identify impaired streams or watersheds. BSS also conducts fish tissue and sediment sampling to monitor sources of toxic and bioconcentrating substances too low to be detected in other environmental media. Fish tissue data serve as the basis for fish consumption advisories issued to protect the health of people who consume fish caught in Indiana waters. Fish tissue data are also useful for wildlife health risk assessments for fish-eating birds and mammals, and for providing the information needed to develop models for assessing changes in the quality of Indiana ecosystems.

The BSS is responsible for determining the biological integrity of aquatic communities of Indiana streams and lakes. This is accomplished through a variety of field and laboratory studies that involve several different forms of aquatic life. These data are used to determine compliance with the existing narrative biological criteria in Indiana's current water quality standards, to determine the use attainability, and to make correlations to physical and/or chemical impairments which may exist.

The BSS participates in the review of requests for site-specific water quality criteria for waters influenced by NPDES discharges. In the course of its various monitoring and assessment field activities, the staff finds point and nonpoint source-related problems, which are then referred to the appropriate IDEM programs. The Section also cooperates in the monitoring and assessment of the Ohio River in conjunction with the Ohio River Valley Water Sanitation Commission (ORSANCO), and other state and federal agencies.

Lake and reservoir assessments prior to 1989 were conducted by the State and have since been contracted to Indiana University, School of Public and Environmental Affairs. From 1990 through 1995, the State in conjunction with USEPA - Region 5, conducted a statewide ecoregion-based fish community study. Indiana has historically collected macroinvertebrate community samples at a network of fixed stations. In addition the State has been conducting macroinvertebrate community assessments at wadeable stream sites since 1990. Since 1996 the biological assessments for fish and invertebrate community assessments have been conducted using probabilistic sampling on a rotational watershed basis as per Indiana's *Surface Water Quality Monitoring Strategy*. In 2000 the State participated in a study to determine if fish and macroinvertebrate indices could be developed for lakes and reservoirs. Conclusions are still pending.

Documentation and Further Information

Indiana 2001 - 2005 Surface Water Quality Monitoring Strategy:
http://www.in.gov/idem/water/assessbr/016surfwaterqualmonstrat.pdf

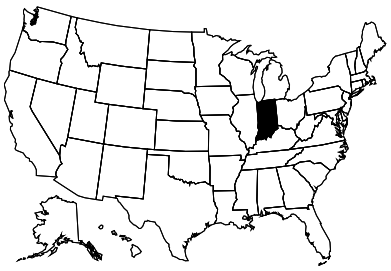
Indiana 303(d) List of Impaired Waterbodies, information and links:
http://www.in.gov/idem/water/planbr/wqs/303d.html

Indiana Water Quality 305(b) Report, general information: http://www.IN.gov/idem/water/planbr/wqs/quality.html

Indiana Water Quality Standards: http://www.state.in.us/legislative/iac/title327.html

IDEM Office of Water Quality's Assessment Branch - Biological Studies Section homepage, with numerous links to relevant fact sheets and reports: http://www.in.gov/idem/water/assessbr/biostud/index.html

INDIANA



Contact Information

C. Lee Bridges, Chief - Biological Studies Section
Indiana Department of Environmental Management (IDEM)
P.O. Box 6015 ■ Indianapolis, IN 46206-6015
Phone 317/308-3183 ■ Fax 317/308-3219
email: lbridges@dem.state.in.us

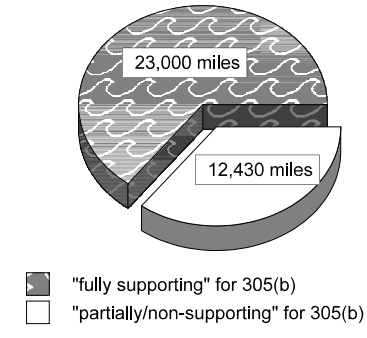
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	UD	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(specific river basins or watersheds and comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(specific river basins or watersheds and comprehensive use throughout jurisdiction)*
	✓	probabilistic by stream order/catchment area *(specific river basins or watersheds and comprehensive use throughout jurisdiction)*
	✓	probabilistic by ecoregion, or statewide *(specific river basins or watersheds and comprehensive use throughout jurisdiction)*
	✓	rotating basin *(specific river basins or watersheds and comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles *(determined using RF3 and the National Hydrography Database)*	**35,673**
Total perennial miles	21,094
Total miles assessed for biology	**35,430**
fully supporting for 305(b)	23,000
partially/non-supporting for 305(b)	12,430
listed for 303(d)	unknown
number of sites sampled *(on an annual basis)*	< 200
number of miles assessed per site	site specific

35,430 Miles Assessed for Biology



Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Warm Water vs. Cold Water	
ALU designations in state water quality standards	Two designations: Well balanced warmwater aquatic community and Cold water put-and-take trout waters	
Narrative Biocriteria in WQS	under development - The narrative biocriteria in Indiana have only been proposed and are not formal. They are loosely defined by 327 IAC 2-1-3(a)(2), 327 IAC-2-1-9 (49); and for the Great Lakes waters 327 IAC 2-1.5-5(a)(2) and (3), and 327 IAC 2-1.5-2 (92). IDEM uses informal numeric procedures to support narrative biocriteria (see http://www.in.gov/IDEM/water/planbr/wqs/quality.html).	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
		permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Biological assessment data are used for 305(b)/303(d) purposes and was used for the FY 2000 Unified Watershed Assessment (updated 2001), which was used for the Watershed Restoration Action Strategies.	

Reference Site/Condition Development*

Number of reference sites	**unknown**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	Deviation from central tendencies on multimetric indices and the qualitative habitat evaluation index (QHEI) is also taken into consideration when evaluating impairment. Field chemistry is measured and probabilistic sites are sampled for broad chemical analysis.	
Characterization of reference sites within a regional context	✓	historical conditions**
	✓	least disturbed sites
	✓	gradient response
		professional judgment
	✓	other: IBI is calibrated on drainage area for headwater streams, wadeable rivers, large rivers and great rivers
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
	✓	multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: 8 digit USGS Hydrologic Unit Codes
Additional information	✓	reference sites linked to ALU *(in a statistical sense)*
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions *(it is understood that all sites have a human-induced condition)*

*IDEM uses a non-typical process for developing reference condition: reference condition is represented by a percentage of the total population of the sites sampled. The number of reference sites in Indiana is not available at this time.

**Reference condition is defined by a historical cross-section of sample sites representing the full gradient of ecological conditions as they existed during statewide or ecoregion specific investigation.

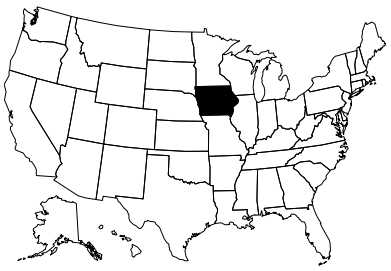
Field and Lab Methods

Assemblages assessed	✓	benthos *(<100 samples/year; single season, multiple sites - broad coverage)*
	✓	fish *(<100 samples/year; single season, multiple sites - broad coverage)*
	✓	periphyton *(<100 samples/year; solely through a pilot contract with USGS)*
	✓	other: phytoplankton and zooplankton *(<100 samples/year; single observation, limited sampling)*
Benthos		
sampling gear		multiplate, dipnet, and kick net (1 meter); 243-600 micron mesh
habitat selection		riffle/run (cobble) and artificial substrate in the absence of riffle/run
subsample size		100 count and proportional/volume
taxonomy		family
Fish		
sampling gear		backpack, boat, longline and pram unit (tote barge) electrofishers; and 1/8" mesh seine
habitat selection		multihabitat
sample processing		enumeration, length measurement, biomass - batch, and anomalies
subsample		none
taxonomy		species
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
	✓	disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		cumulative distribution function
defining impairment in a multimetric index		cumulative distribution function and use various break points for impairments
Multivariate thresholds		
defining impairment in a multivariate index		significant departure from mean of reference population
Evaluation of performance characteristics	✓	repeat sampling *(watersheds are sampled on 5 yr rotational basis)*
	✓	precision *(Standard Error, 95% Confidence Interval and Relative Percent Difference)*
		sensitivity
		bias
	✓	accuracy *(10% field duplicates, 10% laboratory duplicates)*
Biological data		
Storage		Assessment Information Management System (AIMS), MS Access based utility, and some historical data still in paper files
Retrieval and analysis		Statistica and MINITAB for cluster analysis of large matrices

IOWA



Contact Information

Tom Wilton, Water Quality Specialist
Iowa Department of Natural Resources (IDNR)
502 East 9th Street ■ Des Moines, IA 50319-0034
Phone 515/281-8867 ■ Fax 515/281-8895
email: tom.wilton@dnr.state.ia.us
IDNR Water Quality Bureau: http://www.state.ia.us/dnr/organiza/epd/wtrq/wtrqbur.htm

Program Description

Since 1994, the Iowa Department of Natural Resources (IDNR) and the University Hygienic Laboratory (UHL) have conducted a biological assessment program for Iowa's wadeable streams and rivers. So far, biological sampling has been conducted at 289 stream locations throughout the state. Biological data are collected for a variety of purposes including: ambient monitoring, problem investigation, evaluation of point source and nonpoint source pollution control measures, and TMDL development. The IDNR uses bioassessment information to assess the status of stream aquatic life designated uses for the Section 305(b) report and the Section 303(d) list of impaired waters.

Benthic macroinvertebrates and fish serve as indicators of stream biological integrity. Standardized sampling procedures are used to collect species composition and proportional abundance data from which a suite of biological metrics is calculated. Individual metric values are aggregated to obtain scores for the Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI) and the Fish Index of Biotic Integrity (FIBI). Biological impairment thresholds are based on the statistical distribution of biotic index scores obtained from stream reference site sampling. Currently, the IDNR has identified 96 reference sites that represent least disturbed stream conditions in Iowa's ten ecological regions.

Until 2002, a targeted approach was used to select sampling locations for Iowa's stream biological assessment program. From 1994 through 1998, the program emphasized candidate reference site and test (impacted) site sampling, which provided data for evaluating and calibrating biological data metrics. From 1999-2001, the emphasis shifted toward site-specific problem investigation and follow-up. Beginning in 2002, IDNR and UHL are initiating a probabilistic survey that will provide an unbiased, statistically powerful assessment of Iowa's perennial streams and rivers. The survey design calls for sampling 56 randomly-selected sites per year through 2005. During this period, IDNR and UHL also plan to resample the existing network of reference streams at a rate of 20-25 sites per year.

The IDNR is working toward incorporating narrative and numeric stream biocriteria in Iowa's water quality standards. The bioassessment framework that is currently used for 305(b) assessments can potentially serve as a foundation for biocriteria. The 2002-2005 probabilistic survey will provide useful data from non-wadeable streams and rivers for biocriteria development. Biocriteria development for Iowa's lakes, reservoirs, and wetlands has not been initiated.

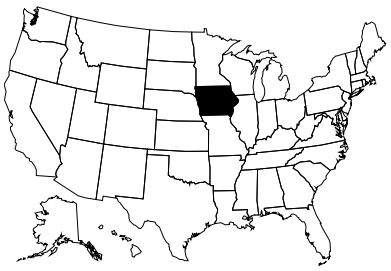
Documentation and Further Information

Water Quality in Iowa During 1998 and 1999 (Iowa's 2000 Section 305(b) report): http://www.state.ia.us/dnr/organiza/epd/wtrq/305b00/index.htm

Final Approved Iowa 1998 303(d) List: http://www.state.ia.us/dnr/organiza/epd/wtresrce/files/303dlist.pdf

Iowa's STORET Database (ambient water quality program dataset): http://wqm.igsb.uiowa.edu/storet/

IOWA



Contact Information

Tom Wilton, Water Quality Specialist
Iowa Department of Natural Resources (IDNR)
502 East 9th Street ■ Des Moines, IA 50319-0034
Phone 515/281-8867 ■ Fax 515/281-8895
email: tom.wilton@dnr.state.ia.us

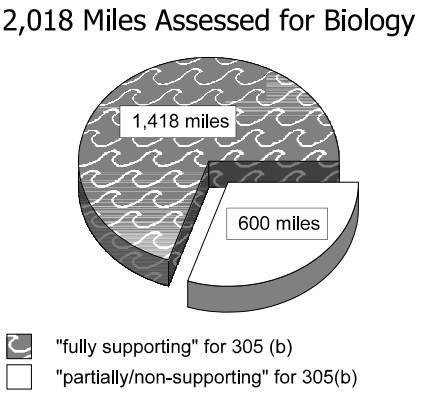
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	UD	promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs*	✓	targeted (i.e., sites selected for specific purpose) *(special projects, specific river basins or watersheds, comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(specific river basins or watersheds)*
		probabilistic by stream order/catchment area
	✓	probabilistic by ecoregion, or statewide *(comprehensive use throughout jurisdiction)*
		rotating basin
		other:

*In 2002, IDNR will initiate a REMAP probabilistic survey of perennial streams and rivers.

Stream Miles

Total miles *(State based determination)*	**71,665**
Total perennial miles	26,630
Total miles assessed for biology*	**2,018**
fully supporting for 305(b)	1,418
partially/non-supporting for 305(b)	600
listed for 303(d)	n/a
number of sites sampled	149
number of miles assessed per site	0.1 - 0.22



*Stream miles reported are based on Iowa's 2000 305(b) assessment. A 303(d) list was not prepared in 2000.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class System (A, B, C), Warm Water vs. Cold Water	
ALU designations in state water quality standards	Four designations: B(LR) - limited resource warmwater streams/rivers; B(WW) - significant resource warmwater streams/rivers; B(CW) - coldwater streams; B(LW) - lakes and wetlands	
Narrative Biocriteria in WQS	under development (Iowa's water quality standards include language associated with ALUs but it was not intended to be formal narrative biocriteria. IA is moving toward incorporating narrative biocriteria into the State's water quality standards.)	
Numeric Biocriteria in WQS	none (IA uses thresholds to report data in 305(b) report, but not formal numeric biocriteria.)	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
		permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	303(d) listing, to address point source impacts, and to support TMDL development	

Reference Site/Condition Development

Number of reference sites	**96 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	Regionally representative and least disturbed by human activities, consider impact of livestock waste, wastewater, channel alterations, riparian land use, and quality of instream habitat	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

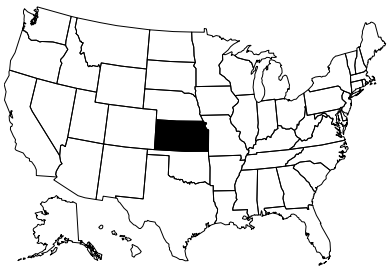
Field and Lab Methods

Assemblages assessed	✓	benthos *(100 - 500 samples per year; single season, multiple sites - broad coverage)*
	✓	fish *(<100 samples per year; single season, multiple sites - broad coverage)*
		periphyton
		other:
Benthos		
sampling gear		Surber, Hess, multiplate, collect by hand; 500 - 600 micron mesh
habitat selection		riffle/run (cobble), multihabitat, artificial substrate
subsample size		100 count, entire sample
taxonomy		combination - order, family, genus, species
Fish		
sampling gear		backpack electrofisher, pram unit (tote barge); 3/16" mesh
habitat selection		multihabitat
sample processing		anomalies, species abundance
subsample		none
taxonomy		species
Habitat assessments		visual based, quantitative measurements; performed with bioassessments
Quality assurance program elements		standard operating procedures, periodic meetings/training for biologists, taxonomic proficiency checks, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis *(for data exploration only)*
	✓	biological metrics *(aggregate metrics into an index)*
	✓	disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		linear interpolation between optimum (95%) reference population level and the minimum level
defining impairment in a multimetric index		25^{th} percentile of reference population
Evaluation of performance characteristics	✓	repeat sampling
	✓	precision
	✓	sensitivity
		bias
		accuracy
Biological data		
Storage		EDAS (benthic macroinvertebrate data) and MS Access (fish, physical habitat, and water chemistry data)
Retrieval and analysis		STATISTIX (Analytical Software) and Excel

KANSAS



Contact Information

Steve Cringan, Environmental Scientist III
Kansas Department of Health and Environment (KDHE)
1000 SW Jackson Street, Suite 430 ■ Topeka, KS 66612-1367
Phone 785/296-5571 ■ Fax 785/291-3266
email: scringan@kdhe.state.ks.us
KDHE Bureau of Environmental Filed Services homepage:
http://www.kdhe.state.ks.us/befs/index.html

Kristen Hase, Stream Monitoring Program Coordinator
Kansas Department of Wildlife and Parks (KDWP)
512 SE 25th Avenue ■ Pratt, KS 67124
Phone 620/672-0710 ■ Fax 620/672-2972
email: KristenM@wp.state.ks.us
website: http://www.kdwp.state.ks.us

Program Description

Kansas has maintained a stream biological monitoring program since 1972. Since 1980, the program has remained primarily unchanged. Program data are evaluated and incorporated in five year increments into the 305(b) report and 303(d) list. Data is used to determine aquatic life use support status in combination with chemical water quality data. Further details may be found in the program Quality Management Plan (see documentation below).

Contemporary Program Objectives
The stream biological monitoring program endeavors to provide scientifically defensible information on the quality of flowing waters in Kansas through the analysis of aquatic macroinvertebrate communities. This information is intended for use in:

(1) complying with the water quality monitoring and reporting requirements of 40 CFR 130.4 and sections 106(e)(1), 303(d) and 305(b) of the federal Clean Water Act;

(2) evaluating waterbody compliance with the Kansas surface water quality standards (K.A.R. 28-16-28b *et seq.*);

(3) identifying point and nonpoint sources of pollution contributing most significantly to water use impairments in streams;

(4) documenting spatial and temporal trends in surface water quality resulting from changes in land use patterns, resource management practices, pollutant loadings, and climatological conditions;

(5) developing scientifically defensible environmental standards, wastewater treatment plan permits, and waterbody/watershed pollution control plans; and

(6) evaluating the efficacy of pollution control efforts and waterbody remediation/restoration initiatives implemented by the department and other agencies and organizations.

The Kansas Department of Health and Environment's (KDHE) Bureau of Environmental Field Services is responsible for macroinvertebrate data collection and analysis. The Bureau also analyzes fish community data that are collected by the Kansas Department of Wildlife and Parks (KDWP). KDHE is currently working with the Central Plains Center for BioAssessment (CPCB) at the University of Kansas, to develop both a systematic approach to the identification of reference sites and a regionally standardized approach to habitat assessment.

Documentation and Further Information

Division of Environment Quality Management Plan Part III: Stream Biological Monitoring Program Quality Assurance Management Plan, December 2000: http://www.kdhe.state.ks.us/environment/qmp_2000/download/SBMP_QAMP.pdf

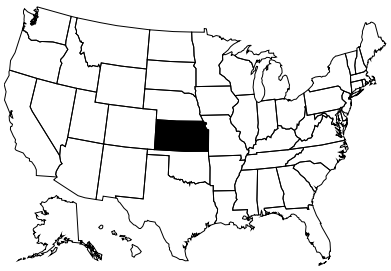
2002 Kansas Water Quality Assessment (305(b) report), April 2002:
http://www.kdhe.state.ks.us/befs/305b_2002/ks305b2002f.pdf

Guidance Document for Use Attainability Analyses, December 2001: http://www.kdhe.state.ks.us/befs/uaas/UAAGuidance.pdf

Draft 2002 303(d) Methodology and List: http://www.kdhe.state.ks.us/tmdl/303d.htm

Kansas State Water Quality Standards: http://www.kdhe.state.ks.us/water/index.html

KANSAS



Contact Information

Steve Cringan, Environmental Scientist III
Kansas Department of Health and Environment (KDHE)
1000 SW Jackson Street, Suite 430 ■ Topeka, KS 66612-1367
Phone 785/296-5571 ■ Fax 785/291-3266
email: scringan@kdhe.state.ks.us

Kristen Hase, Stream Monitoring Program Coordinator
Kansas Department of Wildlife and Parks (KDWP)
512 SE 25th Avenue ■ Pratt, KS 67124
Phone 620/672-0710 ■ Fax 620/672-2972
email: KristenM@wp.state.ks.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
	✓	other: trend analysis
Applicable monitoring designs*	✓	targeted (i.e., sites selected for specific purpose) *(comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
	✓	probabilistic by ecoregion, or statewide *(comprehensive use throughout jurisdiction)*
	✓	rotating basin *(comprehensive use throughout jurisdiction)*
	✓	other: rotational sites, statewide *(comprehensive use throughout jurisdiction)*

*KDWP uses a combination of probabilistic design, rotating basin, and fixed sites; KDHE relies primarily on a targeted design, including fixed and rotational sites statewide.

Stream Miles

Total miles *(determined using RF3)*	**134,338**
Total perennial miles	23,731
Total miles assessed for biology*	**23,731**
fully supporting for 305(b)	n/a
partially/non-supporting for 305(b)	n/a
listed for 303(d)	n/a
number of sites sampled	178 targeted over 22 years (KDHE); several hundred probabalistic (KDWP)
number of miles assessed per site	site specific

*Because KDWP uses a probabilistic sampling design, it can be said that all 23,731 perennial stream miles in Kansas are being assessed for biology. KDHE is working with KDWP to incorporate the latter agency's findings into Kansas' 305(b) reports and 303(d) lists. Kansas' 2002 305(b) report is based on four years of ambient stream chemistry data (1998-2001) and only acute aquatic life use support application.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis		Class System (A,B,C)
ALU designations in state water quality standards		Three designations: special aquatic life use, expected aquatic life use, restricted aquatic life use
Narrative Biocriteria in WQS		Procedures used to support narrative biocriteria are located in the most recent 305(b) reports
Numeric Biocriteria in WQS		none (Numeric biocriteria have not been adopted into the state standards, but are nevertheless used for diagnostic purposes and in 305(b) assessments.)
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU		Various point source upgrades and TMDL-related applications

Reference Site/Condition Development

Number of reference sites		**44 total**
Reference site determinations*		site-specific
		paired watersheds
		regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria		To date, sites have been selected on the basis of land cover and land use, known hydrological properties and channel characteristics, general absence of confined animal feeding operations, point sources and urban areas, and favorable water quality attributes (low levels of total suspended solids, biochemical oxygen demand, fecal coliform bacteria, total phosphorus, inorganic nitrogen, herbicides, and other contaminants). Rare taxa and historically occurring key species are mainly used for validation purposes. Reference sites, by definition, should also be minimally impacted by anthropogenic phenomena and approach the presettlement condition in terms of hydrology, water quality, available biological habitat, surrounding landscape and watershed attributes, and historically documented plant and animal communities.
Characterization of reference sites within a regional context	✓	historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: stream size
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

*Currently working with the Central Plains Center for BioAssessment (CPCB) at the University of Kansas to develop a more systematic approach to the identification of reference sites.

Field and Lab Methods

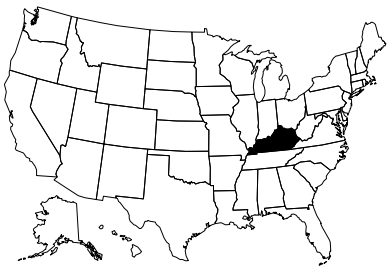
Assemblages assessed	✓	benthos *(100 - 500 samples/year; single season, multiple sites - broad coverage; multiple seasons, select sites)*
	✓	fish *(<100 samples/year; single season, multiple sites - broad coverage by KDWP only)*
	✓	periphyton *(100 - 500 samples/year; multiple seasons, multiple sites - broad coverage for watershed level)**
	✓	other: phytoplankton
Benthos		
sampling gear		collect by hand, D-frame; 500 - 600 micron mesh
habitat selection		richest habitat, riffle/run, multihabitat, woody debris, random sampling by KDWP only
subsample size		entire sample, 100 count minimum
taxonomy		genus/species where practical
Fish		
sampling gear		seine, backpack electrofisher, pram unit (tote barge); 1/8" and 3/16" mesh
habitat selection		multihabitat
sample processing		length measurement, biomass – batch
subsample		batch (generally do not subsample)
taxonomy		species
Periphyton*		
sampling gear		**natural substrate**: suction device, bar clamp sample; **artificial substrate**: periphytometer
habitat selection		wadeable area within stream segment that is designated based on other sampled biota
sample processing		chlorophyll *a/* phaeophytin, taxonomic identification (limited use)
taxonomy		diatoms only
Habitat assessments		visual based (KDHE), quantitative measurements (KDWP); performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings/training for biologists, sorting and taxonomic proficiency checks, specimen archival, replicate sampling, field audits, and staff certification program

*Periphyton sampling is a new venture for the Kansas Biological Survey and the Central Plains Center for BioAssessment. Whole stream respiration as well as net and gross production via the DO diel cycle method are also determined. Software has been built to support these calculations using large continuous data sets of several weeks to months.

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(return single metrics)*
		disturbance gradients
	✓	other: regressions, correlations, trends, and other statistical applications
Multimetric thresholds		
transforming metrics into unitless scores		cumulative distribution function
defining impairment in a multimetric index		Kansas returns single metrics but is exploring various indices.
Evaluation of performance characteristics	✓	repeat sampling
	✓	precision
Refer to Quality Management Plan for SOPs and further information.	✓	sensitivity
	✓	bias
	✓	accuracy
Biological data		
Storage		Lotus Notes, Excel
Retrieval and analysis		Minitab, spreadsheet graphics, ArcView, ArcGIS, GARP (pending)

KENTUCKY



Contact Information

Terry P. Anderson, Manager - Water Quality Branch
Kentucky Division of Water
14 Reilly Road ■ Frankfort, KY 40601
Phone 502/564-3410 ■ Fax 502-564-0111
email: terryp.anderson@mail.state.ky.us
KY Division of Water homepage: http://water.nr.state.ky.us/dow/dwhome.htm

Program Description

A 100 point scale multi-metric index is under development in order to give equal weight to the three assemblages collected (fish, macroinvertebrates and algae). KY Division of Water is also working in conjunction with USEPA/Cincinnati to develop boatable water collection methods for the larger rivers as a first phase of biocriteria and assessment methods for larger rivers. There is a long term goal of establishing response relationships between biological indicators and nutrients in wadeable and boatable waters in order to investigate the feasibility of establishing nutrient criteria in these waters.

The Division of Water has shifted to a watershed approach in assessing stream miles. At this time about two fifths of the stream miles assessed have been entered in the data base, and data from another two fifths are being inputted. The first round of watershed sampling (the last fifth) will be completed in summer 2002. Somewhere between 30,000 to 40,000 actual miles will have been assessed by the time this project is completed.

Probabilistic sampling is also being conducted in all major watersheds. When this is completed, KY Division of Water will be able to estimate the number of stream miles meeting and not meeting designated uses. KY Division of Water was able to carry out this expansion thanks to valuable partnerships with Universities and the Kentucky Department of Fish and Wildlife Resources. These data are used to assess use support for Kentucky's 305(b) Report and for listing streams on the 303(d) list. Biological data can override chemical data if they are contradictory. There is a strong belief that the biological data collected and the collection methods used paint a truer picture of use attainment than chemical data.

Another important application of increased biological knowledge of waters in Kentucky has been the development of biological endpoints for successful stream restoration projects undertaken as a result of environmental damage incidents.

Documentation and Further Information

2000 Kentucky Report to Congress on Water Quality, 305(b) report:
http://water.nr.state.ky.us/wq/305b/2000/2000_305b.htm

1998 303(d) List of Waters for Kentucky, June 1998: http://water.nr.state.ky.us/303d/

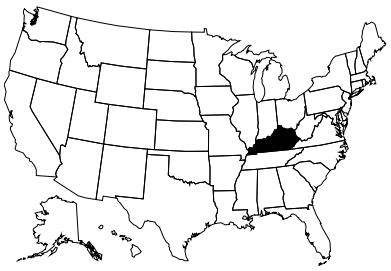
1998-1999 Monitoring Strategy: Kentucky River Basin Management Unit, March 2000:
http://www.uky.edu/WaterResources/Watershed/KRB_AR/PDF_Files/Monitoring%20Report.PDF

For a list and links to more references and documents, conduct a search on the *Kentucky Natural Resources and Environmental Protection Cabinet (NREPC)* publication site:
http://www.kyenvironment.org/nrepc/publications/publications.asp

Kentucky Watershed Management Framework

Other documents include Reference Reach Reports on Algae, Fish and Macroinvertebrates; Division of Water SOP manuals; Consultant reports; USFWS surveys; Kentucky State Nature Preserve Commission surveys; Kentucky Department of Fish and Wildlife Resources surveys; Federal Register notices on Federal T&E listings.

KENTUCKY



Contact Information

Terry P. Anderson, Manager - Water Quality Branch
Kentucky Division of Water
14 Reilly Road ■ Frankfort, KY 40601
Phone 502/564-3410 ■ Fax 502-564-0111
email: terryp.anderson@mail.state.ky.us

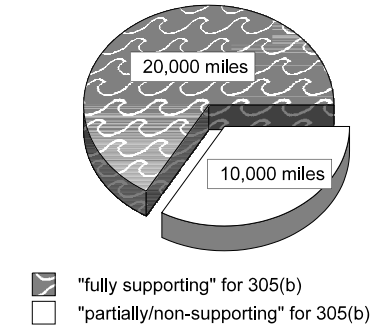
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only, specific river basins or watersheds, and comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
	✓	probabilistic by ecoregion, or statewide *(specific river basins or watersheds)*
	✓	rotating basin *(specific river basins or watersheds)*
		other:

Stream Miles

Total miles *(determined using the National Hydrography Database)*	**89,431**
Total perennial miles	34,334
Total miles assessed for biology*	**~30,000**
fully supporting for 305(b)	~20,000
partially/non-supporting for 305(b)	~10,000
listed for 303(d)	7,500
number of sites sampled	1,750
number of miles assessed per site	–

30,000 Miles Assessed for Biology



*Kentucky has shifted to a basin approach in assessing stream miles. At this time about 2/5ths of the stream miles assessed have been entered in the database, which translates to 10,200 actual miles assessed. There is also data from another 2/5ths that is presently being inputted into the database. The first round of watershed sampling (the last 1/5th) will be completed this summer. 30,000 to 40,000 actual miles will have been assessed upon completion. Probabilistic sampling is also being conducted in all major watersheds. The number of stream miles meeting and not meeting designated uses can be estimated when this is completed.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Warm water vs. Cold water	
ALU designations in state water quality standards	Two designations - Warm water and Cold water	
Narrative Biocriteria in WQS	Numeric procedures used to support narrative biocriteria referenced in KAR 5:030, and in Division publications and SOP manuals.	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Bioassessments have been used to delist streams from the 303(d) list.	

Reference Site/Condition Development

Number of reference sites	**140 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria	Minimally impacted from point and nonpoint pollution, natural habitat with high forest density relative to other land uses. Other criteria listed in KY's reference reach report on fish communities. Also depends on ecoregion: habitat score - conductivity (region specific) - nutrients (in some cases).*	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
	✓	other: minimally impacted*
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
	✓	multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
	✓	reference sites/condition referenced in water quality standards *(found in 401 KAR 5:030 Section 1(1)(b)4)*
	✓	some reference sites represent acceptable human-induced conditions

*KY tries to use minimally impacted reference sites whenever possible, but least disturbed sites are used to set targeted conditions when there are no minimally impacted sites in a subecoregion.

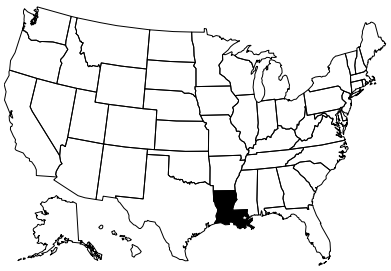
Field and Lab Methods

Assemblages assessed	✓	benthos *(<100 samples/year; single season, multiple sites - broad coverage)*
	✓	fish *(<100 samples/year; single season, multiple sites - broad coverage)*
	✓	periphyton *(<100 samples/year; single season, multiple sites - broad coverage)*
		other:
Benthos		
sampling gear		D-frame, dipnet, kick net (1 meter), collect by hand; >800 micron mesh
habitat selection		multihabitat
subsample size		entire sample
taxonomy		combination - family, genus, species
Fish		
sampling gear		seine, backback electrofisher, boat electrofisher, pram unit (tote barge), gill nets, trammel nets; 3/16" mesh
habitat selection		multihabitat
sample processing		none
subsample		none
taxonomy		species
Periphyton		
sampling gear		**natural substrate**: suction device, brushing/scraping device (razor, toothbrush, etc.), collect by hand; **artificial substrate**: periphytometer (in non-wadeable waters)
habitat selection		multihabitat
sample processing		taxonomic identification
taxonomy		species
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods		summary tables, illustrative graphs
		parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		95th percentile of all sites-standard based on a 100 unit scale
defining impairment in a multimetric index		25th percentile of reference population (100 point scale multi-metric index is under development)
Evaluation of performance characteristics	✓	repeat sampling *(annual variability)*
	✓	precision *(repeatability)*
	✓	sensitivity *(Box-Whisker distributions)*
		bias
	✓	accuracy *(% test sites - nonreference, impaired - validation)*
Biological data		
Storage		EDAS
Retrieval and analysis		SAS, Systat, EDAS, Excel, MVSP (Multi-Variate Statistical Package), Statigraphics

LOUISIANA



Contact Information

Dugan Sabins, Senior Environmental Scientist - Office of Environmental Assessment
Jennifer Lindquist, Environmental Scientist III
Keith Sepulvado, Environmental Scientist III
Louisiana Department of Environmental Quality (LDEQ)
P.O. Box 82178 ■ Baton Rouge, LA 70884-2178
Phone 225/765-0246 ■ Fax 225/765-0617
email: dugan_s@deq.state.la.us
LDEQ Planning homepage: http://www.deq.state.la.us/planning/

Program Description

In Louisiana, bioassessments have been used principally to characterize and delineate reference streams. Bioassessments have also been used for assessing the biological conditions of waterbodies being evaluated for site-specific standards development and use attainability analysis. Bacterial monitoring is conducted for swimming use assessment, Periodic toxicity testing is also conducted. In a very special case, biocriteria were developed for specific wetlands to receive treated disinfected wastewater for wetland restoration.

Further development of bioassessment procedures is dependent on the legal responsibilities and outcome of a consent decree on the Louisiana TMDL program. Any additional development will have to be compatible with TMDL deadlines and deliverables. Since Louisiana does not have biocriteria, there is not a great need for LDEQ to conduct large scale bioassessments to determine criteria attainment. When the concept of biocriteria is adequately thought out and developed for use in state permitting and TMDL programs, then LDEQ will have a larger, more inclusive, bioassessment program. The use and revision of chemical/physical criteria, standards, and assessment procedures are considered the present priority.

The Louisiana Department of Wildlife and Fisheries (LDWF) monitors fishery resources on large rivers and in coastal waters of the state for management purposes and for establishing commercial and recreational regulations on harvest. However, these assessments are not conducted to determine compliance with the Clean Water Act. Environmental agencies are increasing collaboration and coordination with LDWF and are hoping to begin combining monitoring efforts and sharing biological data at a future date.

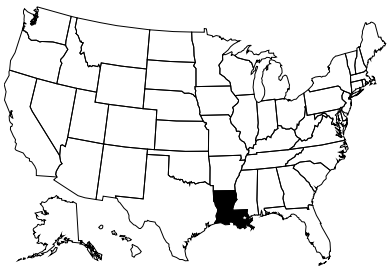
Documentation and Further Information

State of Louisiana Water Quality Management Plan Water Quality Inventory Section 305(b) 2000: http://www.deq.state.la.us/planning/305b/2000/index.htm

Dewalt, R. E. 1997. *Fish and macroinvertebrate taxonomic richness, habitat quality, and in-situ water chemistry of ecoregion reference streams in the Western Gulf Coastal Plains and Terrace Upland Ecoregions of Southern Louisiana*. Prepared for the Louisiana Department of Environmental Quality. Baton Rouge, LA. 72 pages.

Dewalt R. E. 1995. *Biological communities of reference streams in the South Central Plains and Upper Mississippi Alluvial Plains ecoregions of Louisiana*. Prepared for the Louisiana Department of Environmental Quality. Baton Rouge, LA. 85 pages.

LOUISIANA



Contact Information

Dugan Sabins, Senior Environmental Scientist - Office of Environmental Assessment
Jennifer Lindquist, Environmental Scientist III
Keith Sepulvado, Environmental Scientist III
Louisiana Department of Environmental Quality (LDEQ)
P.O. Box 82178 ■ Baton Rouge, LA 70884-2178
Phone 225/765-0246 ■ Fax 225/765-0617
email: dugan_s@deq.state.la.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
		nonpoint source assessments
		monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
		TMDL assessment and monitoring
	✓	other: ecoregion reference stream delineation, public education, bacteria assessment for swimming use, occasional toxicity testing, wetlands criteria
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects and specific river basins or watersheds)*
		fixed station (i.e., water quality monitoring stations)
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
		rotating basin
		other:

Stream Miles

Total miles *(State based estimation)*	**66,294**
Total perennial miles	–
Total miles assessed for biology*	**–**
fully supporting for 305(b)	n/a
partially/non-supporting for 305(b)	n/a
listed for 303(d)	n/a
number of sites sampled	–
number of miles assessed per site	–

*Bioassessments are not used for 305(b)/303(d) reporting purposes or biocriteria development. Louisiana's 2000 305(b) report listed 7,228 total river and stream miles assessed using chemical/physical criteria for fish and wildlife propagation and limited aquatic life/wildlife designated uses: 1,118 miles fully supporting and 6,110 miles partially/non-supporting for 305(b).

Aquatic Life Use (ALU) Designations and Decision-Making*

ALU designation basis	Class System (A,B,C)	
ALU designations in state water quality standards	Two designations: 1) Fish and wildlife propagation, 2) Limited aquatic/wildlife (a subcategory of fish and wildlife propagation)	
Narrative Biocriteria in WQS	A qualitative and/or narrative scale of condition that supports narrative biocriteria decisions is found in Louisiana's water quality standards, LAC 33:IX.1111.C and 1113.B.12	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
		cause and effect determinations
		permitted discharges
		monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Bioassessments have been used to delineate reference streams, which in turn have been used in management decisions for setting DO criteria across ecoregions.	

*Aquatic life use is assessed using chemical/physical numerical and general criteria. Louisiana does have general (narrative) criteria for biological and aquatic community integrity.

Reference Site/Condition Development

Number of reference sites	**16 total**	
Reference site determinations	✓	site-specific
		paired watersheds
		regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	Least impacted wadeable streams, determined using best professional judgment ("common sense criteria")	
Characterization of reference sites within a regional context	✓	historical conditions *(when information is available)*
	✓	least disturbed sites
		gradient response
		professional judgment
	✓	other: wadeable streams
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
	✓	reference sites/condition referenced in water quality standards *(found in LAC 33 33:IX.1113.B.12)*
	✓	some reference sites represent acceptable human-induced conditions

Field and Lab Methods

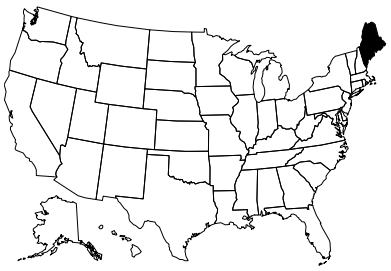
Assemblages assessed	✓	benthos *(<100 samples/year; multiple seasons, multiple sites - broad coverage for watershed level)*
	✓	fish *(<100 samples/year; multiple seasons, multiple sites - broad coverage for watershed level)*
		periphyton
		other:
Benthos		
sampling gear		collect by hand, dipnet, kick net (1 meter); 500-600 micron mesh
habitat selection		multihabitat, woody debris, richest habitat
subsample size		300 count
taxonomy		family and species
Fish		
sampling gear		backpack and boat electrofishers, Rotenone, seine; 1/8" and 1/4" mesh
habitat selection		multihabitat
sample processing		length measurement and anomalies
subsample		none
taxonomy		species
Habitat assessments		visual based; performed with bioassessments (habitat reference conditions found in WQS, LAC 33:IX.1113.B.12.)
Quality assurance program elements		standard operating procedures and quality assurance plan

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
	✓	other: nonparametric analysis
Multimetric thresholds		
transforming metrics into unitless scores		cumulative distribution function, North Carolina Biotic Index (NCBI), EPT, fish richness metrics (USEPA 1989)
defining impairment in a multimetric index		cumulative distribution function, NCBI, EPT, fish richness metrics (USEPA 1989)*
Evaluation of performance characteristics		repeat sampling
		precision
Not currently evaluated		sensitivity
		bias
		accuracy
Biological data		
Storage		spreadsheets and paper files
Retrieval and analysis		SAS and Excel

*LDEQ has used biological indices and matrices for evaluating wadeable streams in several ecoregions and for determining appropriate reference sites. These indices and matrices have not been adopted into the water quality standards and are not used to assess impairment for 305(b) or regulatory purposes.

MAINE



Contact Information

Susan P. Davies, Program Manager, Biologist III
Maine Department of Environmental Protection (MDEP)
SHS 17 ■ Augusta, ME 04333
Phone 207/287-7778 ■ Fax 207/287-7191
email: susan.p.davies@state.me.us
MDEP Biomonitoring Program website: http://www.state.me.us/dep/blwq/biohompg.htm
For General Information, contact: BioME@state.me.us

Program Description

Biological monitoring is a primary method used by the State of Maine to assess water quality. The Biological Monitoring Program is one of five Sections within the Division of Environmental Assessment. All field, analytical and statistical methods, including the resultant numeric biocriteria have been designed, developed and tested by the MDEP Biomonitoring Program staff and a consulting biostatistician (Dr. Francis Drummond, University of Maine, Orono, Maine). Water quality standards in current use in Maine, including tiered aquatic life uses and statutory definitions of biological terms, were drafted by the Biomonitoring Program and other staff of the Division of Environmental Assessment.

The State of Maine began the process of biological criteria development by incorporating explicit narrative standards for aquatic life uses in the state water quality classification law. Each of three classes, ranging from "natural" (Class A) to minimum state standards (Class C), contains specific language that defines the allowable biological response, taking into consideration other designated uses, and expectations of community response to human activities allowed in that class. The benthic macroinvertebrate community is assessed to determine attainment of standards.

Maine's numeric biological criteria rely on a three stage decision process. The first stage is a linear discriminant model, utilizing nine metrics to assign an initial classification probability for an unknown site. The second stage linear discriminant model uses 17 additional metrics and indicator taxa, along with probabilities derived in the first stage model, to compute final probabilities of group membership. The output is expressed as a probability of group membership for each of the four water quality classes. The highest class attained, with at least 60% probability, is used as the final model outcome. The third stage uses expert biologist's judgement to make a final decision about attainment, based on the outcome of the linear discriminant analysis, with adjustments for any known sampling errors, unexplained community structure anomalies or atypical conditions surrounding the sampling event.

The regulatory authority for the Department's numeric biological criteria is derived from the tiered aquatic life use designations that are explicitly defined in the water quality standards law (MRSA Title 38 Article 4-A § 464-465). The Department has draft rules in support of the numeric biocriteria protocol and is expected to go to rule-making as soon as a needed electronic database upgrade is completed. The Biological Monitoring Program provides water quality information for a wide array of programs and initiatives including:

- evaluation of water quality classification attainment and 303(d) listing;
- evaluation of impacts downstream of discharges;
- general, long-term ambient monitoring and trend assessment;
- evaluation of the effects of management activities
- evaluation of the effects of nonpoint source impacts;
- evaluation of impacts from diffuse toxic contamination through the Surface Water Ambient Toxics Program (MDEP 1993)
- evaluation of the impacts of hydropower activities in fulfillment of requirements for the Clean Water Act SEC. 401 water quality certification process.

In addition, the Program is refining methods and criteria to better assess aquatic biological impacts of poor land use practices on stream and wetland systems.

MDEP is funded to do a pilot project using the EPA Stressor Identification protocol applied to an intensively surveyed 303(d) listed urban watershed. To facilitate the development of TMDLs, findings from the SI procedure will be used to better target the assessment approach for a set of five other similarly impacted urban streams.

Documentation and Further Information

State of Maine 305(b) Report, Summer 2000

Biomonitoring Retrospective: Fifteen Year Summary for Maine Rivers and Streams, December 1999: http://www.state.me.us/dep/blwq/docmonitoring/biological/biorep2000.htm

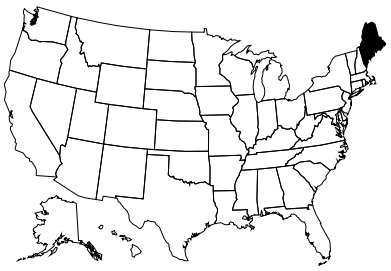
S.P. Davies & L. Tsomides, (1997) "*Methods for Biological Sampling and Analysis of Maine's Inland Waters*", MDEP, revised June 1997: http://www.state.me.us/dep/blwq/docmonitoring/finlmeth.pdf

Relevant biomonitoring materials can be accessed online: http://www.state.me.us/dep/blwq/

MAINE

Contact Information

Susan P. Davies, Program Manager, Biologist III
Maine Department of Environmental Protection (MDEP)
SHS 17 ■ Augusta, ME 04333
Phone 207/287-7778 ■ Fax 207/287-7191
email: susan.p.davies@state.me.us
For General Information, contact: BioME@state.me.us

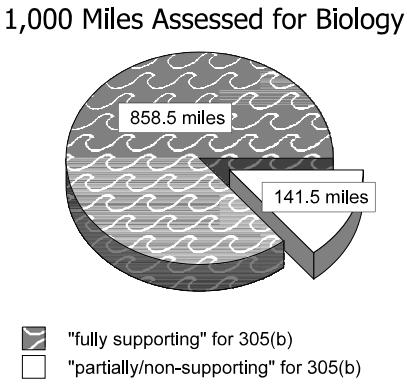


Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
	✓	other: hydropower dam licensing, uncontrolled hazardous waste site monitoring
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
	✓	fixed station (i.e., water quality monitoring stations) *(specific river basins or watersheds)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(5 yr rotation, specific river basins or watersheds)*
	✓	other: hydropower dam licensing, uncontrolled hazardous waste site monitoring

Stream Miles

Total miles *(determined using state based local GIS coverage)*	**31,672**
Total perennial miles	23,879
Total miles assessed for biology	**1,000***
fully supporting for 305(b)	858.5
partially/non-supporting for 305(b)	141.5
listed for 303(d)	141.5
number of sites sampled *(on an annual basis)*	40
number of miles assessed per site	~5



*These miles are based on the last five years of monitoring. Stream and river miles are combined, with streams accounting for roughly 80% of the total miles assessed. For program-wide estimation purposes, miles are estimated assuming that each monitored station assesses about 5 miles of river or stream, though this number does vary. The last few years, up to 55 sites have been sampled, but 40 is the average number.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class system (AA, A, B, C)	
ALU designations in state water quality standards*	Four designations based on a gradient of biological condition: AA- "as naturally occurs", natural flow regime; A- "as naturally occurs", hydro allowed; B- "no detrimental change"; C- "maintain structure and function, support for salmonids"	
Narrative Biocriteria in WQS	Procedures used to support narrative biocriteria located in MDEP WQS.	
Numeric Biocriteria in WQS	under development – Draft numeric biocriteria rule in internal agency review, due for promulgation in 2002. (A probabilistic model - linear discriminant analysis - designed using expert judgment and statistical analysis is currently used to determine attainment of conditions described in aquatic life standards. Numeric biocriteria have been used to implement agency policy since 1990.)	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management *(pertains to "small" watersheds)*
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Many examples of this have been documented in case studies provided in "Biomonitoring Retrospective: Fifteen year summary for Maine rivers and streams" available in .pdf on website: http://www.state.me.us/dep/blwq/docmonitoring/biological/biorep2000.htm	

*Tiered aquatic life uses in Maine Water Quality standards are consistent with the condition gradient describing other applicable WQ standards (dissolved oxygen, bacteria, toxics) for each class.

Reference Site/Condition Development

Number of reference sites	**370 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	Minimally disturbed reference site standards are defined by the following criteria – Based on ArcView GIS coverages; by percent of watershed upstream of the sampled station: >90% forested; <5% active logging; <1% cropland, residential or urban.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
	✓	gradient response
	✓	professional judgment
	✓	other: minimally disturbed**
Stream stratification within regional reference conditions		ecoregions (or some aggregate)
		elevation
		stream type
	✓	multivariate grouping *(4 multivariate groups)*
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
	✓	reference sites/condition referenced in water quality standards *(State of Maine. 1985. Maine Laws Ch. 698 §15 - in part. An Act to Amend the Classification System for Maine Waters)*
	✓	some reference sites represent acceptable human-induced conditions

**Minimally disturbed characterization is one component of established reference conditions; they are also divided into different classes and groups with different biological attributes. Maine has a range of streams, from pristine to severely degraded.

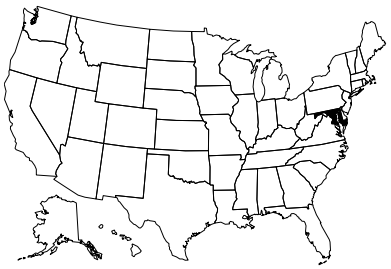
Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - watershed level and broad coverage)*
		fish
	✓	periphyton *(<100 samples/year; single season, multiple sites - broad coverage)*
		other:
Benthos		
sampling gear		rock baskets (500-600 micron mesh)
habitat selection		riffle/run (cobble), artificial substrate
subsample size		entire sample *(if >500 organisms, subsamples are taken proportionately at 25% of sample, then adjusted back to whole sample counts)*
taxonomy		genus, species *(identified to lowest possible level; adjusted to genus in database)*
Periphyton		
sampling gear		**natural substrate**: brushing/scraping device (razor, toothbrush, etc.) **artificial substrate**: periphytometer
habitat selection		open canopy in riffle/run
sample processing		chlorophyll *a*/ phaeophytin; biomass; taxonomic identification
taxonomy		all algae; genus level; species level
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings, training for biologists, sorting proficiency checks, taxonomic proficiency checks, specimen archive

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(multiple computed metrics are used as input variables in probabilistic model)*
	✓	disturbance gradients
		other:
Multivariate thresholds		
defining impairment in a multivariate index		Probabilistic model using *a priori* sites defined by expert judgement
Evaluation of performance characteristics	✓	repeat sampling *(long-term annual monitoring sites)*
	✓	precision *(percent accuracy compared to a priori class)*
		sensitivity
	✓	bias *(in relation to stream size, latitude/longitude, velocity, eco-region)*
	✓	accuracy *(percent accuracy compared to a priori class; a priori reference sites compared to land use - selected reference sites)*
Biological data		
Storage		STORET; Oracle/Visual Basic relational database (with linkage to ARCINFO spatial database with point coverage for all monitoring stations)
Retrieval and analysis		Core linear discriminant models statistical routines are run and reported from within the Oracle database; spatial analysis in ArcView and ARCINFO; routine queries run in MS Access, Systat or Excel

MARYLAND



Contact Information

Paul Kazyak, Monitoring and Non-Tidal Assessment Division Director
Maryland Department of Natural Resources (MD DNR)
Tawes State Office Bldg., C-2 ■ Annapolis, MD 21401
Phone 410/260-8607 ■ Fax 410/260-8620
email: pkazyak@dnr.state.md.us
MD DNR Maryland Streams homepage: http://www.dnr.state.md.us/streams/index.html

Richard Eskin, PhD, Deputy Director - Technical and Regulatory Services Administration
Maryland Department of the Environment (MDE)
1800 Washington Blvd. ■ Baltimore, MD 21230
Phone 410/537-3000 ■ Fax 410/631-3998
email: reskin@mde.state.md.us
website: http://www.mde.state.md.us/

Program Description

The Maryland Biological Stream Survey (MBSS) is a program of the Maryland Department of Natural Resources (MD DNR) and is intended to provide statistically unbiased estimates of the condition of first through third-order (wadeable) non-tidal streams and rivers of Maryland on a local (e.g., drainage basin or county) as well as a statewide scale. The survey is based on a probabilistic stream sampling approach where random selections are made from all streams in the state that can physically be sampled. The approach supports statistically valid population estimation of variables of interest (e.g., largemouth bass densities, miles of streams with degraded physical habitat, miles of streams with poor Index of Biotic Integrity scores, etc.). When repeated, the Survey will also provide a basis for assessing future changes in ecological condition of flowing waters of the state. At present, plans are to repeat the Survey at regular intervals and expand the approach to larger streams and tidal creeks.

Benthic macroinvertebrates and water quality samples are collected during the spring index period from March through early May, while fish, herpetofauna, *in situ* stream chemistry, and physical habitat sampling are conducted during the low flow period in the summer, from June through September.

Data collected from each sample site are used to develop statewide and basin-specific estimates of totals, means (or averages), proportions, and percentiles for the parameters of interest. The amount of variability (or margin of error) associated with any estimate of a total, mean, proportion, or percentile is determined by calculating a standard error, a statistic that measures the reliability of an estimate. A standard error also provides a statistical basis for deciding if the observed changes in any parameter of interest over time or space are significantly different or simply due to chance alone.

Documentation and Further Information

2000 Maryland Section 305(b) Water Quality Report, with *Appendix E, Assessment Methodology*:
http://dnrweb.dnr.state.md.us/download/bays/MD2000_305b.pdf

DRAFT 2002 Integrated 303(d) List: http://www.mde.state.md.us/tmdl/2002_303dlist/index.html

From the Mountains to the Sea: The State of Maryland's Freshwater Streams, December 1999:
http://www.dnr.state.md.us/streams/pubs/md-streams.pdf

Maryland Biological Stream Survey (MBSS) Sampling Manual, February 2000:
http://www.dnr.state.md.us/streams/pubs/2000samp_manual.pdf

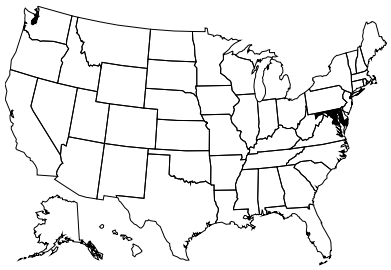
MBSS Laboratory Methods for Benthic Macroinvertebrate Processing and Taxonomy, November 2000:
http://www.dnr.state.md.us/streams/pubs/ea00-6_lab_man.pdf

Refinement and Validation of a Fish Index of Biotic Integrity (IBI) for Maryland Streams, October 2000:
http://www.dnr.state.md.us/streams/pubs/ea00-2_fibi.pdf

Development of a Benthic Index of Biological Integrity for Maryland Streams, December 1998:
http://www.dnr.state.md.us/streams/pubs/1998_Benthic%20IBI.pdf

For more documents and publications, go to: http://www.dnr.state.md.us/streams/mbss/mbss_pubs.html or
http://www.dnr.state.md.us/streams/pubs/pub_list.html

MARYLAND



Contact Information

Paul Kazyak, Monitoring and Non-Tidal Assessment Division Director
Maryland Department of Natural Resources (MD DNR)
Tawes State Office Bldg., C-2 ■ Annapolis, MD 21401
Phone 410/260-8607 ■ Fax 410/260-8620
email: pkazyak@dnr.state.md.us

Richard Eskin, PhD, Deputy Director - Technical and Regulatory Services Administration
Maryland Department of the Environment (MDE)
1800 Washington Blvd. ■ Baltimore, MD 21230
Phone 410/537-3000 ■ Fax 410/631-3998
email: reskin@mde.state.md.us

Programmatic Elements

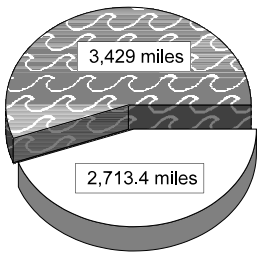
Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs *(LIMITED)*
	✓	ALU determinations/ambient monitoring *(LIMITED)*
	UD	promulgated into state water quality standards as biocriteria *(through MDE)*
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions *(LIMITED)*
	✓	TMDL assessment and monitoring *(MDE using MBSS data)*
	✓	other: target restoration costs and locations; areas for preservation; track trends in stream conditions; identify relationships between stressors and biota; predict future conditions based on land use changes
Applicable monitoring designs*	✓	targeted *(small portion - special projects and specific river basins or watersheds)*
	✓	fixed station (i.e., water quality monitoring stations) *(sentinel site network, best of the best streams in the state, comprehensive use throughout jurisdiction)*
	✓	probabilistic by stream order/catchment area *(comprehensive use throughout jurisdiction)*
	✓	probabilistic by ecoregion, or statewide *(comprehensive use throughout jurisdiction)*
	✓	rotating basin *(comprehensive use throughout jurisdiction)*
		other:

*The largest portion of sampling effort is for probabilistic sampling with watershed as primary strata.

Stream Miles

Total miles *(determined using National Hydrography Database)*	**17,000**
Total perennial miles	12,343
Total miles assessed for biology**	**6,142**
fully supporting for 305(b)	3,429.0
partially/non-supporting for 305(b)	2,713.4
listed for 303(d)**	178 actual listings
number of sites sampled *(from 1995-1997)*	1,000
number of miles assessed per site	–

6,142 Miles Assessed for Biology



"fully supporting" for 305(b)
"partially/non-supporting" for 305(b)

**The miles listed above were extracted from Maryland's 2000 305(b) Report, which stated, "The assessment of non-tidal rivers and streams is based on monitoring data, including ambient water quality monitoring programs and other water quality data collected by [various agencies and programs]." The above miles are categorized as "monitored" in the 2000 305(b). However, the MBSS method only applies to *wadeable* nontidal streams, thus some portion of the total assessed stream and river miles listed above were not assessed using this method. The 178 sites listed for 303(d) were pulled from the DRAFT 2002 303(d) Report. These miles do not include streams larger than 4th order or with tidal flow.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis		Single Aquatic Life Use, Fishery Based Uses, Warm Water vs. Cold Water
ALU designations in state water quality standards		Seven uses: I: support of fish & aquatic life and recreation; I-P: adds drinking water supply to Use I; II: shellfish harvesting; III: natural trout; III-P: adds drinking water supply; IV: recreational trout (put and take); IV-P: adds drinking water.
Narrative Biocriteria in WQS		Narrative regulations and formal/informal numeric procedures specifically addressing biocriteria applications are under development.
Numeric Biocriteria in WQS		none - documented quantitative method applied
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges *(RARELY)*
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU		Threatened and Endangered species listings are being revised based on MBSS fish population data; cost estimates for habitat restoration in MD streams are being finalized in support of Chesapeake Bay 2000 Agreement action items; MBSS data integral to developing restoration priority ranking for MD watersheds; also used by The Nature Conservancy to develop highest priority watersheds for land acquisition and other preservation activities

Reference Site/Condition Development

Number of reference sites		**152 total**
Reference site determinations		site-specific
		paired watersheds
		regional (aggregate of sites)
		professional judgment
	✓	other: use combination of *a priori* physical and chemical criteria applied to randomly selected sites - these represent the best remaining sites in Maryland
Reference site criteria		Must meet *a priori* chemical and physical criteria (criteria found in MBSS IBI documents for fish and benthos)
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: reference sites stratified by stream order
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

Field and Lab Methods

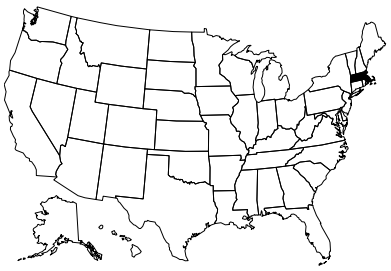
Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - watershed level)*
	✓	fish *(100-500 samples/year; single season, multiple sites - watershed level)*
		periphyton
	✓	other: macrophytes and amphibians/reptiles (*presence/absence only) (100-500 samples/year; single season, multiple sites - watershed level*)
Benthos		
sampling gear		D-frame; 500-600 micron mesh
habitat selection		multihabitat, focus on most productive habitat - riffles
subsample size		100 count
taxonomy		genus (family level taxonomy for volunteer Stream Waders Program)
Fish		
sampling gear		backpack electrofisher, barge shocker sometimes used on larger streams, herpetile search also conducted by hand; 1/4" mesh
habitat selection		whatever is in the 75 meter segment
sample processing		length measurement and biomass – batch (gamefish only); anomalies (unusual types or prevalence noted)
subsample		none
taxonomy		species
Habitat assessments		visual based, quantitative measurements, buffer width and vegetation size category, linear and areal extent of eroded banks; performed with bioassessments
Quality assurance program elements		standard operating procedures; quality assurance plan; periodic meetings/ training for biologists; sorting and taxonomic proficiency checks; specimen archival; double entry of data; range checks; peer review of reports; certification program for bioassessment

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
	✓	disturbance gradients
	✓	other: various, depending on needs
Multimetric thresholds*		
transforming metrics into unitless scores		50th percentile of reference population
defining impairment in a multimetric index		10th percentile used as threshold between metric scores of 3 and 1; confidence intervals used to evaluate sample results for attainment decisions
Multivariate thresholds		
defining impairment in a multivariate index		For development of IBI; not current analysis
Evaluation of performance characteristics	✓	repeat sampling *(see IBI documents plus interim biocriteria document produced by MDE)*
	✓	precision *(replicate sample/same team, same reach)*
	✓	sensitivity *(classification efficiency)*
		bias
	✓	accuracy *(classification efficiency)*
	✓	other: re-sort in laboratory
Biological data		
Storage		MS Access, SAS primarily, but also use spreadsheets for some applications (data dictionaries are produced for external users - see MBSS publications page)
Retrieval and analysis		SAS, Excel, Quattro pro, ARC View

*Fish and Benthic IBIs are also combined into a "Combined Biological Index."

MASSACHUSETTS



Contact Information

Arthur S. Johnson, Environmental Monitoring Coordinator
Massachusetts Department of Environmental Protection (MADEP)
627 Main Street ■ Worcester, MA 01608
Phone 508/767-2873 ■ Fax 508/791-4131
email: arthur.johnson@state.ma.us
website: http://www.state.ma.us/dep/

Program Description

Biological monitoring techniques are an important component of the watershed-based surface water quality monitoring and assessment program administered by the Massachusetts Department of Environmental Protection (MADEP). The goals of this program are to assess whether the surface waters of Massachusetts are of sufficient quality and quantity to support their multiple uses, and to report those findings in watershed assessment reports, the 305(b) Summary of Water Quality Report and the 303(d) List of Impaired Waters. Monitoring is also used to identify causes and sources of water use impairments as the first step toward developing water quality and quantity management strategies.

MADEP biologists assess the condition of resident macroinvertebrate, fish and algal communities in streams to provide a direct measure of the ecological response to the cumulative effects of pollutant loadings and habitat degradation. These bioassessments, coupled with water quality data and other relevant information, form the basis for determining the aquatic life use-support status, as defined in the *Massachusetts Surface Water Quality Standards*.

Rapid bioassessment protocols (RBPs), based on those developed by the USEPA, are used to monitor the integrity of the benthic macroinvertebrate community. A targeted sampling design is employed whereby sites are selected for upstream/downstream comparisons, comparisons against a regional or surrogate reference, or for long-term trend monitoring. Based on scoring of several metrics, four categories of impairment are discerned by the RBP analysis (non-impaired, slightly impaired, moderately impaired, and severely impaired). Approximately 50-75 sites are assessed each year in accordance with a rotating watershed monitoring scheme.

The analysis of the structure of the finfish community as a measure of biological integrity is another component of the water quality monitoring program. MADEP utilizes a standardized method based on RBP V (USEPA 1989) to improve data comparability among wadeable sampling sites. The fish collection procedures involve sampling habitats in relative proportion to their local availability. A representative 100-meter stream reach is selected to include the primary physical habitat characteristics of the stream (i.e., riffle, run, and pool habitats). Electrofishing is the preferred method for obtaining a representative sample of the fish community at each sampling site. Fish (except young-of-the-year) collected within the study reach are identified to species, counted, and examined for external anomalies, (i.e., deformities, eroded fins, lesions, and tumors). Aquatic life use-support status is derived from a knowledge of the environmental requirements (e.g., water temperature and clarity, dissolved oxygen content) and relative tolerance to water pollution of the species collected.

Algae represent a third community that may be assessed. The analysis of the attached algae or periphyton community in shallow streams, or the phytoplankton in deeper rivers and lakes employs an indicator species approach whereby inferences on water quality conditions are drawn from an understanding of the environmental preferences and tolerances of the species present. Because the algal community typically exhibits dramatic temporal shifts in species composition throughout a single growing season, results from a single sampling event are generally not indicative of historical conditions. For this reason the information gained from the algal community assessment is more useful as a supplement to the assessments of other communities that serve to integrate conditions over a longer time period.

In addition to the community analyses described above, MADEP also collects some fish to be assayed for the presence of toxic contaminants in their tissues. The goal of this monitoring element is primarily to provide data for the assessment of the risk to human consumers associated with the consumption of freshwater finfish. In the past fish collection efforts were generally restricted to waterbodies where wastewater discharge data or previous water quality studies indicated potential toxic contamination problems. More recently, concerns about mercury contamination from both local and far-field sources have led to a broader survey of waterbodies throughout Massachusetts. In both cases, nonetheless, the analyses have been restricted to edible fish fillets.

Documentation and Further Information

Commonwealth of Massachusetts Summary of Water Quality 2000

Massachusetts Surface Water Quality Standards, May 1997: http://www.state.ma.us/dep/bwp/iww/files/314004.pdf

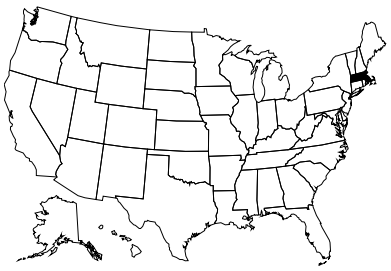
For a list of online resources, go to: http://www.state.ma.us/dep/brp/wm/wmpubs.htm#other

Jessup, B.K., J. Gerritsen, M.T. Barbour, and R. Haynes. 2001. *Analysis and Interpretation of Pilot Study Data as an Initial Step in the Development of Biological Criteria for Streams and Small Rivers in Massachusetts*. Prepared by Tetra Tech, Inc., for Massachusetts Department of Environmental Protection, Worcester, MA.

MASSACHUSETTS

Contact Information

Arthur S. Johnson, Environmental Monitoring Coordinator
Massachusetts Department of Environmental Protection (MADEP)
627 Main Street ■ Worcester, MA 01608
Phone 508/767-2873 ■ Fax 508/791-4131
email: arthur.johnson@state.ma.us



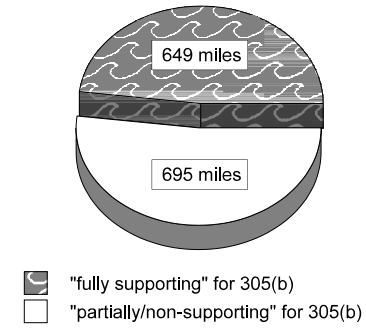
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
		monitoring the effectiveness of BMPs
	✓	ALU determinations, ambient monitoring
		promulgated into state water quality standards as biocriteria
		support of antidegradation
	✓	evaluation of discharge permit conditions
		TMDL assessment and monitoring
	✓	other: development of numeric biocriteria
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(specific river basins or watersheds)*
		fixed station (i.e., water quality monitoring stations)
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(specific river basins or watersheds)*
		other:

Stream Miles

Total miles *(determined using a state based program)*	**8,229**
Total perennial miles	7,133
Total miles assessed for biology	**1,344**
fully supporting for 305(b)	649
partially/non-supporting for 305(b)	695
listed for 303(d)	695
number of sites sampled *(on an annual basis)**	~100
number of miles assessed per site*	site specific

1,344 Miles Assessed for Biology



*The number of sites sampled varies annually, as does the number of miles assessed per site.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Warm water vs. Cold water	
ALU designations in state water quality standards	Three designations: 1. General Aquatic Life Support 2. Cold Water/Warm Water Fishery 3. Shellfish Harvesting	
Narrative Biocriteria in WQS	none - General aquatic life statement found in WQS; informal process in place to translate RBP metrics to level of use support.	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
		cause and effect determinations
	✓	permitted discharges
		monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Information discussed in water quality assessment reports along with recommendations for management, restoration and further monitoring.	

Reference Site/Condition Development

Number of reference sites	**5 - 10 total** *(on an annual basis)**	
Reference site determinations	✓	site-specific
	✓	paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	Least impacted by known point discharges; least impacted by riparian zone land uses; habitat qualities comparable to test sites. For regional reference sites MADEP attempts to locate the least-disturbed sites by conducting extensive reconnaissance throughout the watershed and selecting sites that do not appear to have point or nonpoint sources of pollution upstream from them. Reference sites that represent the various sub-ecoregions that exist in Massachusetts are gradually being identified. This process is not yet complete, however.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: MADEP is working on identifying reference sites to represent various sub-ecoregions
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

*MADEP does not have a fixed set of reference stations situated throughout the state. Rather, during the rotating basin schedule MADEP reconnaissances new reference sites depending upon where the sampling will take place. Therefore the number of reference sites may vary from year to year.

Field and Lab Methods

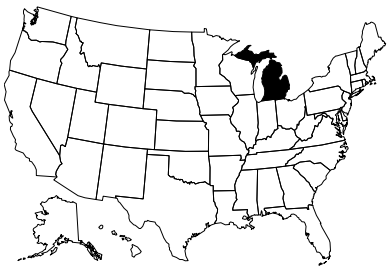
Assemblages assessed	✓	benthos *(<100 samples/year; single season, multiple sites - watershed level)*
	✓	fish *(<100 samples/year; single season, multiple sites - watershed level*)
	✓	periphyton *(<100 samples/year; single season, multiple sites - some at watershed level)*
	✓	other: macrophytes *(<100 samples/year; single season, multiple sites - not at watershed level)*
Benthos		
sampling gear		multi-plate, rock baskets, collect by hand, single-pole kick-net (45 cm, rectangular, 500-600 micron mesh)
habitat selection		riffle/run (cobble)
subsample size		100 count
taxonomy		combination--genus, species
Fish		
sampling gear		backpack electrofisher, boat electrofisher, seine; 1/8", 3/16" and 1/4" mesh
habitat selection		multihabitat
sample processing		length measurement, biomass - individual, anomalies
subsample		all species, 25 individuals of each
taxonomy		sub-species
Periphyton		
sampling gear		**natural substrate**: suction device, brushing/scraping device (razor, toothbrush, etc.), collect by hand; **artificial substrate**: microslides or other suitable substratum
habitat selection		richest habitat, riffle/run (cobble), multihabitat, artificial substrate
sample processing		chlorophyll *a*/ phaeophytin, biomass, taxonomic identification
taxonomy		genus level for soft-bodied algae when possible; diatoms are not cleared
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures; quality assurance plan; periodic meetings, training for biologists; limited taxonomic proficiency checks; specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds*		
transforming metrics into unitless scores		Follow 1989 EPA RBP guidelines (Figure 6.3-4)
defining impairment in a multimetric index		Follow 1989 EPA RBP guidelines: anything <83% of reference is impaired/impacted
Evaluation of performance characteristics		repeat sampling
	✓	precision *(duplicate sampling)*
		sensitivity
		bias
		accuracy
Biological data		
Storage		MS Access 2000
Retrieval and analysis		MS Access 2000 - benthos database customized from EDAS

*Everything is determined relative to the reference sites; however some parts of this have been refined, including the similarity index thresholds, and MADEP hopes to use biocriteria data to further modify thresholds. MADEP has also evaluated a model community at order level as a substitute for similarity indices (see Novak & Bode, 1992).

MICHIGAN



Contact Information

William Creal, Environmental Manager
Michigan Department of Environmental Quality (MDEQ)
P.O. Box 30273 ■ Lansing, MI 48909
Phone 517/335-4181 ■ Fax 517/241-8133
email: crealw@michigan.gov
MDEQ Water homepage: http://www.michigan.gov/deq/1,1607,7-135-3313---,00.html

Program Description

In 1997, the Michigan Department of Environmental Quality (MDEQ) completed a report entitled, *A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters* (Strategy). This Strategy describes the monitoring activities necessary for a comprehensive assessment of water quality in Michigan's surface waters. One component of the Strategy is expanded and improved monitoring of biological integrity and physical habitat.

This program element includes all monitoring conducted for fish and benthic invertebrate community structure, nuisance aquatic plants, algae, and slimes, and assessment of physical habitat. The MDEQ's goal in conducting watershed surveys is to assess 80 percent of the stream and river miles in Michigan over a five-year period.

Enhanced biological integrity and physical habitat monitoring is consistent with existing MDEQ programs and activities. MDEQ uses the existing five-year basin units defined by the NPDES permitting program, which includes 45 watershed units based on drainage to the four Great Lakes. Monitoring activities in each watershed include not only biological integrity, but also fish and wildlife contaminant studies, water chemistry, and sediment chemistry. Integrating the enhanced biological monitoring with the other activities, within the framework of the five-year permitting cycle, will ensure that the monitoring is closely linked with other MDEQ programs and contributes to resource management decisions. Specific objectives of biological integrity and physical habitat monitoring are to:

1. Determine whether waters of the state are attaining standards for aquatic life.
2. Assess the biological integrity of the waters of the state.
3. Determine the extent to which sedimentation in surface waters is impacting indigenous aquatic life.
4. Determine whether the biological integrity of surface waters is changing with time.
5. Assess the effectiveness of BMPs and other restoration efforts in protecting and/or restoring biological integrity and physical habitat.
6. Evaluate the overall effectiveness of MDEQ programs in protecting the biological integrity of surface waters.
7. Identify waters that are high quality, as well as those that are not meeting standards.
8. Identify the waters of the state that are impacted by nuisance aquatic plants, algae, and bacterial slimes.

Rapid, qualitative biological assessments of wadeable streams and rivers are conducted using the Great Lakes and Environmental Assessment Section Procedure 51, which compares fish and benthic invertebrate communities at a site to the communities that are expected at an un-impacted, or reference, site. This is a key tool used by MDEQ to determine whether waterbodies are attaining Michigan WQS. Because Procedure 51 is meant to be a qualitative, rapid assessment tool, the MDEQ established a contract with the Great Lakes Environmental Center to develop a statistically valid sample design and procedure for detection of trends using benthic macroinvertebrates. This project is scheduled for completion in January 2003.

All biological community data are entered into MDEQ's MS Access database. Biological and habitat data collected as part of the five-year watershed surveys are summarized in watershed reports. The list of these reports is stored in a database that will be accessible to the public via the MDEQ Surface Water Quality Division's website.

Documentation and Further Information

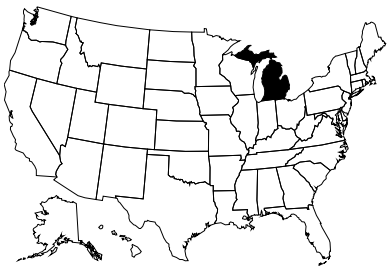
Michigan Water Quality Report (Year 2000 305(b) Report):
http://www.michigan.gov/deq/1,1607,7-135-3313_3686_3728-12711--,00.html

CWA Section 303(d) List: Michigan Submittal for Year 2002:
http://www.deq.state.mi.us/documents/deq-swq-gleas-303_d_Rpt2002b.pdf

Michigan's WQS, revised April 1999: http://www.deq.state.mi.us/documents/deq-swq-gleas-305b2002Appl.doc

MDEQ Biosurveys website:
http://www.michigan.gov/deq/0,1607,7-135-3313_3686_3728-32369--,00.html

MICHIGAN



Contact Information

William Creal, Environmental Manager
Michigan Department of Environmental Quality (MDEQ)
P.O. Box 30273 ■ Lansing, MI 48909
Phone 517/335-4181 ■ Fax 517/241-8133
email: crealw@michigan.gov

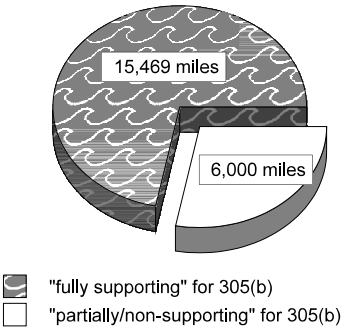
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
		fixed station (i.e., water quality monitoring stations)
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(specific river basins or watersheds and comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles *(determined using RF3)*	**49,141**
Total perennial miles	27,873
Total miles assessed for biology	**21,469**
fully supporting for 305(b)	15,469
partially/non-supporting for 305(b)	6,000
listed for 303(d)	2,600
number of sites sampled	3,500
number of miles assessed per site	–

21,469 Miles Assessed for Biology



Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Warm Water vs. Cold Water	
ALU designations in state water quality standards	Three designations: coldwater fisheries, warmwater fisheries, and other indigenous aquatic life and wildlife (per Rule 100 of Michigan's WQS). Coldwater fishery includes any of the following: trout, salmon, whitefish, cisco. Warmwater fishery includes fish species that thrive in relatively warmwater, including any of the following: bass, pike, walleye, panfish.	
Narrative Biocriteria in WQS	none*	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	TMDL listing and delisting decisions	

*Michigan does not have narrative biocriteria, per se. However, MI does have tiered ALU designations and numeric procedures (the Gleas Procedure #51) to implement WQS, evaluate nonpoint source impacts, and assess designated uses. According to MDEQ's *Qualitative and Biological Biological Survey Protocols for Wadeable Streams and Rivers* (Procedure #51), "The development of these biological and habitat survey protocols was a result of the increasing demand for a more vigorous and standardized evaluation of nonpoint source impacts. The nature and diversity of the causes of nonpoint pollution created a need for greater refinement and sophistication of the Surface Water Quality Division's standard biological survey procedures in order to assess the degree and causes of these biological impacts."

Reference Site/Condition Development

Number of reference sites	**200 total**	
Reference site determinations	✓	site-specific
		paired watersheds
		regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria	excellent biota present	
Characterization of reference sites within a regional context *Not applicable*		historical conditions
		least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

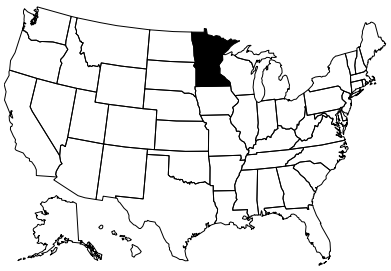
Field and Lab Methods

Assemblages assessed	✓	benthos *(>500 samples/year; single season, multiple sites - watershed level)*
	✓	fish *(<100 samples/year; single season, multiple sites - watershed level)*
		periphyton
		other:
Benthos		
sampling gear		D-frame and dipnet; 800-900 micron mesh
habitat selection		multihabitat
subsample size		100 count
taxonomy		combination - family, genus
Fish		
sampling gear		backpack electrofisher and pram unit (tote barge)
habitat selection		multihabitat
sample processing		length measurement and anomalies
subsample		none
taxonomy		species
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		Two standard deviations from excellent condition
defining impairment in a multimetric index		Two standard deviations from excellent condition
Evaluation of performance characteristics	✓	repeat sampling
	✓	precision *(repeat sampling by teams during round robins over the years)*
		sensitivity
		bias
		accuracy
Biological data		
Storage		MS Access database, spreadsheets
Retrieval and analysis		SAS, Systat and Statistica

MINNESOTA



Contact Information

Scott Niemela, Research Scientist
Minnesota Pollution Control Agency (MPCA)
520 Lafayette Road ■ St. Paul, MN 55155
Phone 651/296-8878 ■ Fax 651/297-8324
email: scott.niemela@pca.state.mn.us
MPCA Water homepage: http://www.pca.state.mn.us/water/index.html

Program Description

The Minnesota Pollution Control Agency (MPCA) Biological Assessment Unit, located in the Environmental Standards and Analysis Section, performs many functions integral to water quality decision-making. Among these, the Unit:

- Develops biological measures of ecological integrity for streams and wetlands.
- Collects and analyzes biological monitoring data.
- Builds a biological monitoring system that includes streams in the 10 major river basins.
- Lays the groundwork for the development of biological indicators for lakes and large rivers.
- Determines biological impairments of rivers and streams for use in TMDL studies
- Coordinates creation of TMDL listing.

Documentation and Further Information

2000 Minnesota Water Quality: Surface Water Section, Years 1998 - 1999 305(b) Report: http://www.pca.state.mn.us/publications/reports/305bfinalreport-2000.pdf

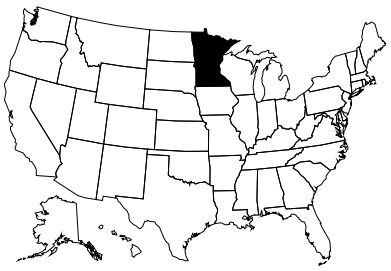
Stream Assessment Methods for Use Support: http://www.pca.state.mn.us/water/basins/method98.pdf

MPCA Water Quality Criteria - Aquatic Life Use Support in Rivers and Streams: http://www.pca.state.mn.us/water/basins/rivkey98.pdf

Minnesota Lake Water Quality Assessment Data: 2000: http://www.pca.state.mn.us/water/pubs/lwqar.pdf

MPCA Environmental Outcomes Division website: http://www.pca.state.mn.us/about/eod.html

MINNESOTA



Contact Information

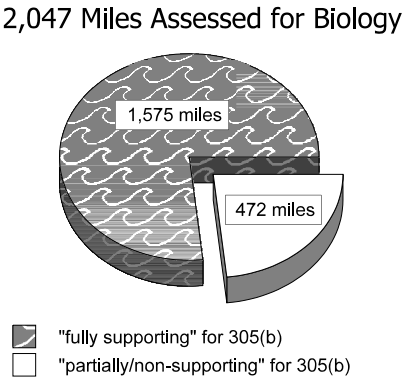
Scott Niemela, Research Scientist
Minnesota Pollution Control Agency (MPCA)
520 Lafayette Road ■ St. Paul, MN 55155
Phone 651/296-8878 ■ Fax 651/297-8324
email: scott.niemela@pca.state.mn.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
		monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(in specific river basins or watersheds for biocriteria development, problem investigation, and effectiveness monitoring)*
		fixed station (i.e., water quality monitoring stations)
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(in specific river basins or watersheds for condition monitoring and biocriteria development)*
	✓	other: probabilistic by major basin

Stream Miles

Total miles *(determined using National Hydrography Database)*	**91,944**
Total perennial miles	32,985
Total miles assessed for biology*	2,047
fully supporting for 305(b)	1,575
partially/non-supporting for 305(b)	472
listed for 303(d)	785
number of sites sampled *(on an annual basis)*	100
number of miles assessed per site	depends on segment length



*The discrepancy between 305(b) and 303(d) miles is due to a change in methods related to the threshold level of impairment. The numbers for 303(d) reflect the information from the latest proposed 303(d) list using the new threshold levels. The 305(b) miles will reflect the old threshold levels until the next 305(b) assessments occur.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class System (1,2,3), Fishery Based Uses and Warm Water vs. Cold Water	
ALU designations in state water quality standards	Aquatic life and recreation, Class 2. 4 subclasses: 2A, cold water (salmonid) fishery; 2B cool & warm water fishery; 2C, "indigenous" fishery; 2D, wetlands	
Narrative Biocriteria in WQS	Numeric procedures to implement narrative biocriteria are in separate Guidance documents, not part of the water quality standards.	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
		cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Bioassessment information is being used in the TMDL process and to support decisions regarding permitted discharges.	

Reference Site/Condition Development

Number of reference sites	**35 total**	
Reference site determinations*		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	Reference sites are defined as minimally disturbed reaches/areas within a specific geographic region, within a given aquatic classification framework. The criteria used to define reference sites are based on biology, landuse, and habitat and are adjusted by region (basin, ecoregion, etc).	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
	✓	other:**
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
	✓	stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: At this time MPCA is using major river basin as a framework. This could change once a statewide database is developed.
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

*Candidate reference sites are initially selected using GIS coverages including landuse, point source, ditching, and feedlot. After the biological sampling has occurred, reference sites are chosen using the biological, habitat, and GIS based information.

**There are regions within Minnesota where *minimally impacted* reference sites will eventually be identified. MPCA has not had the opportunity to develop biological criteria for these areas yet, but is planning to do so within the next five to ten years.

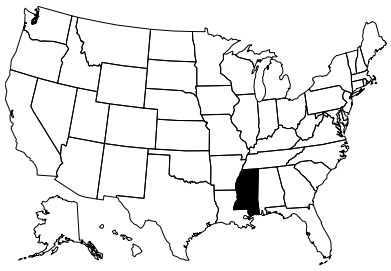
Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - watershed level)*
	✓	fish *(100-500 samples/year; single season, multiple sites - watershed level)*
		periphyton
	✓	other: macrophytes *(<100 samples/year; single season multiple sites – not at watershed level)*
Benthos		
sampling gear		D-frame; 500-600 micron mesh
habitat selection		multihabitat
subsample size		300 count
taxonomy		genus
Fish		
sampling gear		backpack and boat electrofishers, and pram unit (tote barge)
habitat selection		multihabitat
sample processing		length measurement, biomass - batch and anomalies
subsample		none
taxonomy		species
Habitat assessments		quantitative measurements; performed with bioassessments
Quality assurance program elements		standard operating procedures, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
	✓	disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		95th percentile of all sites
defining impairment in a multimetric index		The percentile of the reference population will vary by major basin because of wide variability between basins regarding the level of human disturbance.
Evaluation of performance characteristics	✓	repeat sampling *(10% of all sites are repeated during a season)*
	✓	precision (*A multiyear study, currently 5 years long, is being conducted to evaluate the precision of IBI scores over a long term period. This work is taking place at reference sites and degraded sites - ten sites total.)*
	✓	sensitivity *(sensitivity has been examined by evaluating IBI scores against gradients of disturbance)*
		bias
	✓	accuracy *(accuracy has been informally examined by comparison of IBI scores to expected results from a landuse/habitat rating score)*
Biological data		
Storage		database (details not provided)
Retrieval and analysis		Systat

MISSISSIPPI



Contact Information

Randy Reed, Chief, Water Quality Assessment Branch
Mississippi Department of Environmental Quality (MDEQ)
P.O. Box 10385 ■ Jackson, MS 39289-0385
Phone 601/961-5158 ■ Fax 601/961-5357
email: randy_reed@deq.state.ms.us
MDEQ homepage:
http://www.deq.state.ms.us

Program Description

The Mississippi Department of Environmental Quality (MDEQ) has a Surface Water Monitoring Program (SWMP), which:

- Meets the requirements of Section 106 of CWA,
- Monitors, assesses and reports overall status and trends of surface water quality state-wide,
- Identifies impaired waterbodies and determines causes and sources of impairment,
- Determines effectiveness and supports monitoring and assessment activities of other Surface Water Division (SWD) Programs,
- Addresses surface water quality issues and economic development interests of public concern, and
- Determines better ways of monitoring and assessing surface waters.

Biological data collection, assessment and reporting are an integral component of MDEQ's SWMP and have been for many years. In addition, biological data are a primary assessment component of MDEQ's 305(b) and 303(d) reporting processes. Specifically, macroinvertebrate assessment results are used in the process of determining aquatic life use support and for identifying impaired waterbodies. Macroinvertebrate data are also used to complement other environmental data throughout the TMDL process, including stressor identification and TMDL implementation monitoring. A probabilistic survey design is planned for incorporation into MDEQ's ongoing ambient monitoring network in the future. This approach is intended to produce a more accurate, scientifically defensible and comprehensive assessment of biological condition throughout the state. This will result in collection of biological data at a combination of fixed and random stations each year in conjunction with MS DEQ's Basin Management Approach.

In 2001, MDEQ redesigned its biological monitoring and assessment program to include more rigorous training; field sampling; laboratory sorting, subsampling, and taxonomy; analytical methods; and documentation. It included a comprehensive QA Project Plan with detailed standard operating procedures (SOPs), revision of data entry and database management procedures, and documentation of data quality characteristics throughout the entire assessment process. Approximately 450 wadeable stream sites were sampled statewide with the exception of the MS River Alluvial Plain during a winter index period for benthic macroinvertebrates, physical habitat quality, substrate particle size distribution, and selected field and analytical chemistry. Using GIS, the drainage area for the each site was delineated and land use characterized. For five bioregions, reference conditions were developed based on the concept of "best attainable" conditions, and a multimetric index of biological integrity calibrated, the Mississippi Benthic Index of Stream Quality (M-BISQ).

Documentation and Further Information

State of Mississippi Water Quality Assessment 2002 Section 305(b) Report, Big Black River Basin Supplement: http://www.deq.state.ms.us Click: OPC then Surface Water then 305(b)

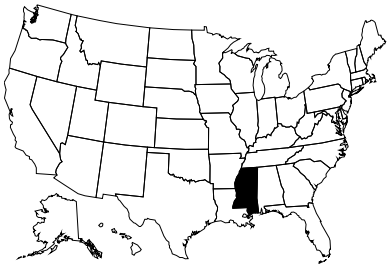
State of Mississippi 2002 List of Waterbodies, 303(d) Report: http://www.deq.state.ms.us Click: TMDLs

State of Mississippi Water Quality Criteria for Intrastate, Interstate and Coastal Waters, October 2002: http://www.deq.state.ms.us Click: MDEQ Regulations then By Type then Water then WPC-1

Quality Assurance Project Plan for 303(d) List Assessment and Calibration of the Index of Biological Integrity for Wadeable Streams in Mississippi.

Development and Application of the Mississippi Benthic Index of Stream Quality (M-BISQ).

MISSISSIPPI



Contact Information

Randy Reed, Chief, Water Quality Assessment Branch
Mississippi Department of Environmental Quality (MDEQ)
P.O. Box 10385 ■ Jackson, MS 39289-0385
Phone 601/961-5158 ■ Fax 601/961-5357
email: randy_reed@deq.state.ms.us

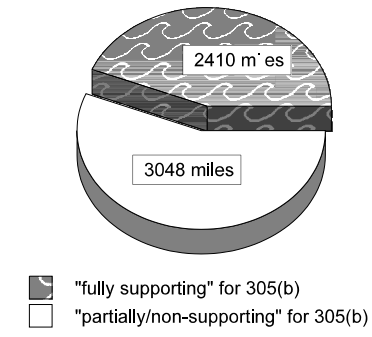
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles *(determined using RF3)*	**84,003**
Total perennial miles	26,454
Total miles assessed for biology	**5,458**
fully attaining ALUS for 305(b)	2,410
not fully attaining ALUS for 305(b)	3,048
listed for 303(d)	3,048
number of sites sampled	455
number of miles assessed per site	~12

5,458 Miles Assessed for Biology



*MDEQ implemented a new biological assessment program (started in fall, 2001). Miles assessed for biology and 305(b)/303(d) numbers reflect this change and vary significantly from previous assessments.

NOTE: All information contained in this summary refers to procedures adopted under the *new* bioassessment program.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Single Aquatic Life Use	
ALU designations in state water quality standards	One designation: Fish and Wildlife (biological data are only assessed for fish and wildlife classification)	
Narrative Biocriteria in WQS	Presently, there are no written informal/formal numeric procedures to support narrative biocriteria decisions. Available procedures support a general aquatic life standard.	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	none	

Reference Site/Condition Development

Number of reference sites	**83 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria	Surrounding landuse, physical habitat, substrate particle size, water chemistry, biology, and historical information.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions		ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: bioregion
Additional information	✓	reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

Field and Lab Methods

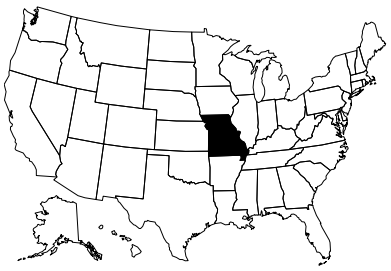
Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - broad coverage)*
		fish
		periphyton
		other:
Benthos		
sampling gear		D-frame net (800 x 900 micron mesh) for wadeable streams
habitat selection		multihabitat
subsample size		200 count
taxonomy		genus
Habitat assessments		visual based habitat assessment and modified Wolman Pebble Count; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, field and laboratory performance audits, sorting and taxonomic proficiency checks, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
	✓	multivariate analysis*
	✓	biological metrics *(aggregate metrics into an index)*
	✓	disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		95th percentile of all sites
defining impairment in a multimetric index		25th percentile of reference condition
Evaluation of performance characteristics**	✓	repeat sampling *(different team, same reach; same team, adjacent reach)*
	✓	precision *(repeat & duplicate field samples, repeat sorting, taxonomic & data checks)*
	✓	sensitivity *(disturbance gradient for reference & degraded streams)*
	✓	bias *(repeat, duplicate samples)*
	✓	accuracy (discrimination efficiency)
Biological data		
Storage		EDAS
Retrieval and analysis		Systat, Statistica and EDAS

***** Multivariate analysis is being used to *develop* the new index, but the subsequent analysis of biological data will be multimetric.
**Additional evaluation procedures of performance characteristics include: field (biological, habitat and chemistry repeats), lab (pickate rechecks, QC checks), taxonomy (two taxonomists and a third party for precision; reference collection), data entry QC, and metric calculation QC checks.

MISSOURI



Contact Information

Randy Sarver, Aquatic Bioassessment Unit Supervisor
Missouri Department of Natural Resources (MDNR)
P.O. Box 176 ■ Jefferson City, MO 65102
Phone 573/526-3365 ■ Fax 573/526-3350
email: nrsarvr@mail.dnr.state.mo.us
website: http://www.dnr.state.mo.us/water.htm

Steve Fischer, Fisheries Research Biologist
Missouri Department of Conservation (MDC)
1110 South College Avenue ■ Columbia, MO 65201
Phone 573/882-9880 x3271 ■ Fax 573/882-4517
email: fischsa@mail.conservation.state.mo.us
website: http://www.conservation.state.mo.us/

Program Description

The overall aquatic biological assessment program for Missouri streams and wadeable rivers is a multi-agency collaborative effort between the Missouri Department of Conservation (MDC), the Missouri Department of Natural Resources (MDNR), The University of Missouri-Columbia, and the USEPA. The overall program involves a Resource Assessment and Monitoring Program, biological criteria development, monitoring of targeted sites to determine compliance with the designated use of aquatic life protection in the standards, monitoring for 303(d) purposes, and the development of a stream classification system framework.

The Resource Assessment and Monitoring Program is committed to sampling 120 sites per year beginning in 2002. These sites are a combination of targeted reference sites and randomly selected sites. The MDC is responsible for fish sampling, physical habitat assessment, and water quality contaminant sampling (to be analyzed by the USEPA). The MDNR is responsible for sampling macroinvertebrates at 30% of the sites. For the remainder of the sites, samples are collected by MDC and analyzed by the University of Missouri-Columbia. The Resource Assessment and Monitoring Program operates on a five year cycle with statewide random sites collected for one year and random sites in priority watersheds collected for four years. Data will be used to report on the status of Missouri's streams and wadeable rivers.

The MDNR initiated biological criteria development for wadeable, perennial streams in 1992. Numeric biocriteria for one trophic level (macroinvertebrate communities) were completed in February 2002. This effort also involved the cooperation of the University of Missouri-Columbia, School of Natural Resources and the Missouri Resource Assessment Partnership. Future biological criteria efforts will add an additional trophic level (fish communities) to wadeable, perennial streams and will initiate a low level effort to develop numeric criteria for other size ranges of streams and rivers. The numeric criteria and associated components have been used to evaluate compliance with the designated use of aquatic life protection as well as in the assessment of biological communities for 303(d) purposes.

The Missouri Resource Assessment Partnership is an interagency partnership that provides expertise in geographic information systems, remote sensing, and natural resource management. Since 1997, the Missouri Resource Assessment Partnership has been in the process of developing a hierarchical classification framework for Missouri's stream resources. This framework is expected to provide the foundation for biological study designs in the Resource Assessment and Monitoring Program, biological criteria, and targeted studies concerning the designated use of aquatic life protection and 303(d) purposes.

Documentation and Further Information

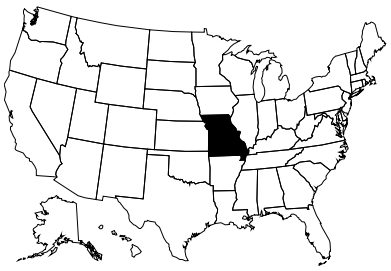
Methodology for the 2002 303(d) list, 1998 303(d) list, and Missouri's Water Quality Standards and criteria are all available on the MDNR Water Pollution Control Program homepage: http://www.dnr.state.mo.us/deq/wpcp/homewpcp.htm

Fischer, S.A. 2002. *Resource Assessment and Monitoring Program: Standard Operating Procedures - fish sampling*. Missouri Department of Conservation, Columbia, MO.

Sarver, R., S. Harlan, C. Rabeni, and S. Sowa. 2001. *Draft Report - Biological Criteria for Wadeable/Perennial Streams of Missouri*. Prepared by Missouri Department of Natural Resources, Air and Land Protection Division, Environmental Services Program.

Also available through MDNR: *Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure* (2001); *Stream Habitat Assessment Project Procedure* (2000); Macroinvertebrate Levels of Taxonomy SOP/FSS/209 (1998); *Biological Criteria for Streams of Missouri* - A Final Report to the MO Department of Natural Resources, University of Missouri, Cooperative Fish and Wildlife Unit; *Quality Control Procedures for Data Processing* (2001) MDNR/WQMS/214.

MISSOURI



Contact Information

Randy Sarver, Aquatic Bioassessment Unit Supervisor
Missouri Department of Natural Resources (MDNR)
P.O. Box 176 ■ Jefferson City, MO 65102
Phone 573/526-3365 ■ Fax 573/526-3350
email: nrsarvr@mail.dnr.state.mo.us

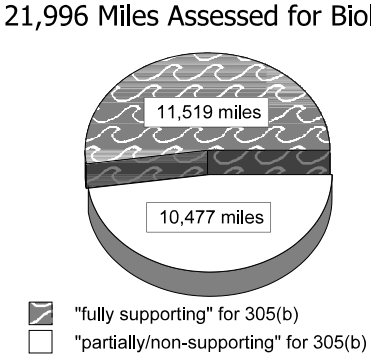
Steve Fischer, Fisheries Research Biologist
Missouri Department of Conservation (MDC)
1110 South College Avenue ■ Columbia, MO 65201
Phone 573/882-9880 x3271 ■ Fax 573/882-4517
email: fischsa@mail.conservation.state.mo.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
	✓	evaluation of discharge permit conditions *(MDNR only)*
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(comprehensive use throughout jurisdiction by MDNR)*
		fixed station (i.e., water quality monitoring stations)
	✓	probabilistic by stream order/catchment area *(comprehensive use throughout jurisdiction and in specific river basins or watersheds by MDC)*
	✓	probabilistic by ecoregion, or statewide *(comprehensive use throughout jurisdiction and in specific river basins or watersheds by MDC)*
	✓	rotating basin *(used in specific rivers basins or watersheds by MDNR)*
	✓	other: reference site monitoring

Stream Miles

Total miles *(estimated using National Hydrography Database)*	**52,194**
Total perennial miles	22,194
Total miles assessed for biology*	**21,996**
fully supporting for 305(b)	11,519
partially/non-supporting for 305(b)	10,477
listed for 303(d)	n/a
number of sites sampled *(on an annual basis)*	200
number of miles assessed per site	site specific *(MDC)* 0.25 *(MDNR)*



*Miles assessed for aquatic life as reported in Missouri's draft 2002 305(b) Water Quality Report are based on biological, chemical, physical and toxicological data. The status and number of stream miles assessed exclusively for biology is not readily available.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Warm Water vs. Cold Water	
ALU designations in state water quality standards	Four designations: General Warm Water Aquatic Life, Limited Warm Water Aquatic Life, Cool Water Fisheries, and Cold Water Fisheries	
Narrative Biocriteria in WQS	Procedures used to support narrative biocriteria located in SOPs and draft biocriteria document for wadeable/perennial streams housed at MDNR/Air and Land Protection Division, Environmental Services Program	
Numeric Biocriteria in WQS	under development (Numeric biocriteria for macroinvertebrate communities in wadeable, perennial streams will be completed sometime in 2002. These criteria are intended for inclusion in the water quality standards during the next triennial WQS review.)	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
		monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	none	

Reference Site/Condition Development

Number of reference sites	**62 total**	
Reference site determinations	✓	site-specific *(MDC)*
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment *(MDC)*
	✓	other: Missouri Ecologic Drainage Units/VST layer *(MDC)*
Reference site criteria	Representative of ecoregion and stream size, and in natural condition with respect to habitat, water quality, biological integrity and diversity, watershed land use and riparian conditions Disturbed habitat = <75% comparable to reference *(MDNR)* MDC uses R-EMAP terminology: perennial flow, relatively high heterogeneity of substrate materials, natural channel morphology, natural hydrograph, natural water color	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
	✓	other: minimally disturbed in the Ozarks
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
	✓	stream type *(MDNR)*
		multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: MDC is attempting to put reference sites into each of Missouri's 17 Ecologic Drainage Units.
Additional information	✓	reference sites linked to ALU
	✓	reference sites/condition referenced in water quality standards *(Sarver et al. 2001)*
	✓	some reference sites represent acceptable human-induced conditions

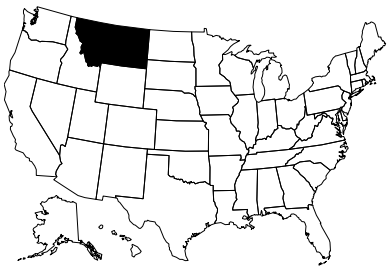
Field and Lab Methods

Assemblages assessed	✓	benthos *(100 - 500 samples per year; single season, multiple sites - broad coverage by MDC; multiple seasons, multiple sites - broad coverage for watershed level by MDNR)*
	✓	fish *(100 - 500 samples per year; single season, multiple sites - broad coverage by MDC only)*
		periphyton
		other:
Benthos		
sampling gear		kick net, 500 micron mesh nitex bag
habitat selection		multihabitat
subsample size		900 for glide/pool streams, 1200 for riffle/pool streams
taxonomy		genus, species
Fish		
sampling gear		backpack electrofisher, pram unit (tote barge), and seines; 3/16" mesh for 12' net and 1/4" mesh for 30' net
habitat selection		multihabitat
sample processing		biomass - batch
subsample		batch
taxonomy		species
Habitat assessments		visual based, quantitative measurements *(MDC)*, stream width and discharge *(MDNR)*; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival, MDNR data entry QC, certification program for bioassessment within MDC

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		25th percentile of reference population *(MDNR)*; some based on log 10 mean wetted width, mean proportion of reference sites, or specific percentiles *(MDC)*
defining impairment in a multimetric index		cumulative score equivalent to 81% of reference condition *(MDNR)*
Multivariate thresholds		
defining impairment in a multivariate index		significant departure from mean of reference population *(MDC)*, threshold not used by MDNR for criteria but as supporting information only
Evaluation of performance characteristics	✓	repeat sampling *(multiple seasons and years by MDNR, annual revisits by MDC)*
	✓	precision *(10% duplicates within reach by MDNR)*
	✓	sensitivity *(evaluated in MDNR pilot project)*
	✓	bias *(MDNR eliminated redundant metrics during pilot project, multiple techniques used by MDC)*
		accuracy
Biological data		
Storage		STORET *(MDC)*, MS Access
Retrieval and analysis		SAS *(MDC)*, Programming in Visual Basics for MS Access and Sigmastat *(MDNR)*

MONTANA



Contact Information

Rosie Sada de Suplee, Aquatic Microbiologist
Montana Department of Environmental Quality (DEQ)
1520 East 6th Avenue ■ Helena, MT 59620
Phone 406/444-6764 ■ Fax 406/444-6836
email: rsada@state.mt.us
DEQ Water Quality Monitoring and Assessment homepage:
http://www.deq.state.mt.us/wqinfo/MDM/WQMonitoring_Assessment.asp

Randy Apfelbeck, Water Quality Specialist
Montana Department of Environmental Quality (DEQ)
2209 Phoenix Avenue ■ Helena, MT 59601
Phone 406/444-2709 ■ Fax 406/444-5275
email: rapfelbeck@state.mt.us
DEQ Water Quality Information homepage: http://www.deq.state.mt.us/wqinfo/Index.asp

Program Description

The Montana Department of Environmental Quality (DEQ) strongly encourages the use of biological data for making ALUS determinations (more than 90% of MT's 303(d) assessments include biological data). It is very difficult to acquire sufficient credible data in Montana without having biological data; thus the incorporation of bioassessment in DEQ's monitoring program is very important.

DEQ is in the second year of collecting macroinvertebrate and periphyton data from fixed station sites that are located on major streams throughout Montana. The primary objective is to determine status and trends. In 2002, the Department initiated an effort to develop vegetation assessment tools for assessing the biological conditions of riparian areas and wetlands and is also looking at amphibians. In the past, wetland macroinvertebrate and diatom communities have been assessed.

DEQ collaborates with a number of agencies and organizations. The Montana Bureau of Land Management has helped fund DEQ's statewide biological monitoring efforts. USGS is collecting chemistry data at most fixed station sites. The Department is also working closely with the wetlands program, universities and the Montana Natural Heritage Program to assess riparian zones. For 303(d) purposes DEQ has collaborated with conservation districts, the Natural Resource Conservation Service, USFS, and USEPA, among others.

In 2000 DEQ developed a new listing methodology that strongly encourages the use of biological data to assess waters for 303(d) purposes. The Department was required to use this methodology for all waters that were previously listed as impaired, but were unfortunately not required to use the new listing methodology for streams that were previously listed as fully supporting ALU. Montana DEQ is also currently forming workgroups to begin the process of developing a state-wide water quality database that can be accessed by federal and state agencies in Montana.

Some challenges include achieving access to private lands and assessing prairie streams that are located in eastern Montana. In the future DEQ intends to develop and implement a random study design to assess the biological condition of smaller order streams.

Documentation and Further Information

Year 2001 305(b) Report Database and Year 2000 303(d) List Database:
http://nris.state.mt.us/scripts/esrimap.dll?name=TMDL&Cmd=INST

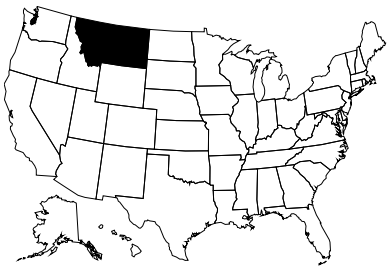
DRAFT 2002 Montana 303(d) List: http://nris.state.mt.us/scripts/esrimap.dll?name=TMDL2002&Cmd=INST

Montana's *Water Quality Standards and Classifications*: http://www.deq.state.mt.us/wqinfo/Standards/Index.asp

Water Quality Monitoring Standard Operating Procedures: http://www.deq.state.mt.us/ppa/mdm/SOP/sop.asp

Montana Natural Heritage Program homepage: http://nhp.nris.state.mt.us/

MONTANA



Contact Information

Rosie Sada de Suplee, Aquatic Microbiologist
Montana Department of Environmental Quality (DEQ)
1520 East 6th Avenue ■ Helena, MT 59620
Phone 406/444-6764 ■ Fax 406/444-6836
email: rsada@state.mt.us

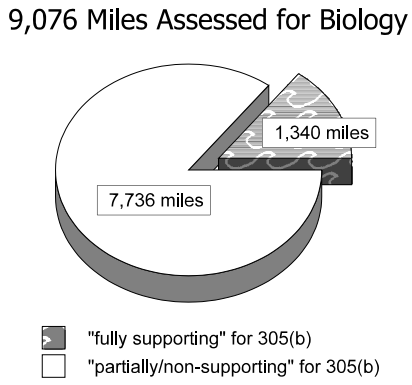
Randy Apfelbeck, Water Quality Specialist
Montana Department of Environmental Quality (DEQ)
2209 Phoenix Avenue ■ Helena, MT 59601
Phone 406/444-2709 ■ Fax 406/444-5275
email: rapfelbeck@state.mt.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	UD	promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive throughout jurisdiction)*
	✓	probabilistic by stream order/catchment area *(special projects only)*
	✓	probabilistic by ecoregion, or statewide *(special projects only)*
		rotating basin
		other:

Stream Miles

Total miles *(determined using RF3)*	**176,750**
Total perennial miles	53,221
Total miles assessed for biology*	**9,076**
fully supporting for 305(b)**	1,340
partially/non-supporting for 305(b)**	7,736
listed for 303(d)	7,736
number of sites sampled *(USGS sites)*	~40
number of miles assessed per site	–



*MT DEQ collects biological data as part of a joint project with USGS to assess 38 sites that are located near the mouth of major streams and rivers. Aside from this, Montana does not have a state biological monitoring program but it is currently under development.

**71% of the waters that were assessed as fully supporting ALU used biological data; 94% of the waters where ALUS was determined to be impaired used biological data.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class System (A,B,C), Warm Water vs. Cold Water	
ALU designations in state water quality standards	Although there are 9 classifications (A, B, C and subdivided), Class A-Closed is suitable for growth and propagation of fishes and associated aquatic life (among other uses) and Classes A-1, B-1, B-2, B-3, C-1 AND C-2 must have water quality suitable for growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers (among other uses).	
Narrative Biocriteria in WQS	under development (Brief biocriteria language without formal numeric translation mechanism located in WQS. Informal numeric procedures located in guidance document for 303(d) listing purposes complying with WQS.)	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
		permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	TMDL targets	

Reference Site/Condition Development

Number of reference sites	**~50 total (potential reference sites)***	
Reference site determinations	✓	site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	specific criteria under development; currently using best professional judgment to determine "least impaired" considering geomorphology, habitat, landuse, biology, and chemistry	
Characterization of reference sites within a regional context	✓	historical conditions
	✓	least disturbed sites
		gradient response
	✓	professional judgment
	✓	other: some sites are minimally disturbed**
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
	✓	elevation
	✓	stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

*In 2001, Montana DEQ began the process of locating reference sites using GIS and sampled ~30 potential reference sites using EMAP methods. A similar effort was made in 1990 when ~38 sites were sampled. In total, Montana has assessed ~50 potential reference sites.

**Montana's regional reference sites are characterized as least disturbed. These sites are used to describe the best potential for a stream given the historical land use. However, many least disturbed reference sites are actually *minimally* disturbed, especially those sites that are located in the Rocky Mountain Ecoregion. In this case the best potential for a stream is near natural condition. These streams are often located in roadless areas, wilderness areas or National Parks.

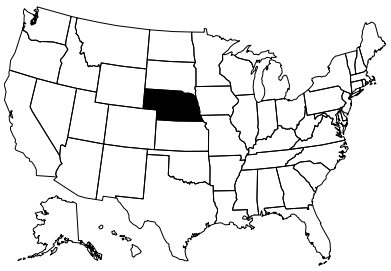
Field and Lab Methods

Assemblages assessed	✓	benthos *(100 - 500 samples per year; single season, multiple sites - broad coverage)*
	✓	fish *(<100 samples per year; single season, multiple sites - broad coverage)*
	✓	periphyton *(100 - 500 samples per year; single season, multiple sites - broad coverage)*
	✓	other: macrophytes *(<100 samples per year; single season, multiple sites - watershed level)*
Benthos		
sampling gear		Hess, D-frame, kick net (1m); 500 - 600 and >800 micron mesh sizes
habitat selection		richest habitat, riffle/run (cobble), multihabitat, woody debris
subsample size		300-500 count
taxonomy		combination - lowest feasible
Fish		
sampling gear		backpack and boat electrofishers, seine; 1/4" mesh
habitat selection		multihabitat
sample processing		length measurement, anomalies
subsample		none
taxonomy		species
Periphyton		
sampling gear		**natural substrate**: suction device, brushing/scraping device
habitat selection		riffle/run (cobble), multihabitat
sample processing		chlorophyll *a* / phaeophytin, biomass, taxonomic identification
taxonomy		diatoms (mainly species level), all algae (genus and species)
Habitat assessments		visual based, quantitative measurements, hydrogeomorphology, pebble counts; performed with and independent of bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index and return single metrics)*
	✓	disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		cumulative distribution function
defining impairment in a multimetric index		75% of reference condition
Multivariate thresholds		
defining impairment in a multivariate index		significant departure from mean of reference population
Evaluation of performance characteristics	✓	repeat sampling *(duplicates)*
	✓	precision *(splits with USGS and EMAP for bioassessments)*
		sensitivity
	✓	bias *(comparison of different methods)*
		accuracy
Biological data		
Storage		developing use of MS Access and Excel
Retrieval and analysis		Systat, Statmost

NEBRASKA



Contact Information

Ken Bazata, Program Specialist - Surface Water Section
Nebraska Department of Environmental Quality (NDEQ)
1200 "N" Street, Suite 400 ■ Lincoln, NE 68509-8922
Phone 402/471-2192■ Fax 402/471-2909
email: ken.bazata@ndeq.state.ne.us
website: www.ndeq.state.ne.us

Program Description

Nebraska's biological monitoring program was started in 1985 with semi-quantitative methods for collecting fish and macroinvertebrates. The original purpose was to determine naturally occurring biological delineations within the state and to classify streams based on biological characteristics. In 1997, collection methods were changed to the REMAP methodology because the Nebraska Department of Environmental Quality (NDEQ) felt that more quantitative approaches were needed to summarize the data.

NDEQ's program for adapting the metrics to the standards and fine tuning the metrics has been slowed by data management and computer programming problems. NDEQ has a small staff and time constraints have affected this program. NDEQ is experiencing problems with the reference site concept. Since many of the streams have a "sameness" throughout a large area of the state, Nebraska lacks solid reference sites for the ecoregions and stream classes. Except for a few places, it seems most streams are heavily affected by agricultural use. NDEQ has a lot of data, but is having trouble analyzing it.

Due to concerns about the accuracy of the existing biological indices, NDEQ has chosen to reassess past biological data and redefine its indices. Five streams are currently listed on Nebraska's 303(d) list due to biodiversity impacts. Only about 20% of Nebraska's total stream miles are currently assessed for biology in the 305(b) report. These streams are known to be fully supporting (17%) or not supporting (3%).

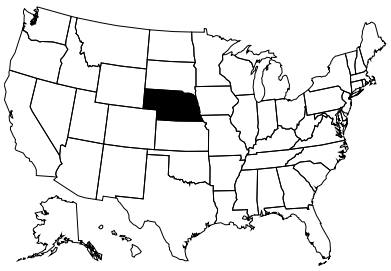
Nebraska agrees with the reference site concept but needs to determine if appropriate reference sites exist in Nebraska. NDEQ is currently evaluating macroinvertebrate and fish data to locate both excellent and severely impaired sites in order to determine the appropriate habitat conditions that correspond to both extremes. Reference site criteria have not yet been finalized.

Documentation and Further Information

Nebraska DRAFT 2000 305(b) report

DRAFT 2002 303(d) report, 2001, *Comprehensive Study of Water Quality Monitoring*, and Title 117 - Nebraska's Surface Water Quality Standards are available online at http://www.ndeq.state.ne.us

NEBRASKA



Contact Information

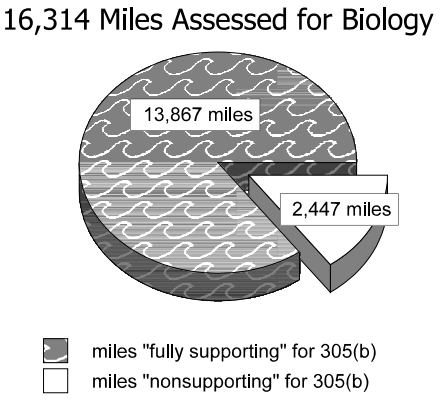
Ken Bazata, Program Specialist - Surface Water Section
Nebraska Department of Environmental Quality (NDEQ)
1200 "N" Street, Suite 400 ■ Lincoln, NE 68509-8922
Phone 402/471-2192 ■ Fax 402/471-2909
email: ken.bazata@ndeq.state.ne.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
		TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) (*specific river basins or watersheds*)
	✓	fixed station (i.e., water quality monitoring stations) (*comprehensive use throughout jurisdiction*)
		probabilistic by stream order/catchment area
	✓	probabilistic by ecoregion, or statewide (*comprehensive use throughout jurisdiction*)
	✓	rotating basin (*comprehensive use throughout jurisdiction*)
		other:

Stream Miles

Total miles *(determined using RF3)*	**81,573**
Total perennial miles	16,090
Total miles assessed for biology*	**16,314**
fully supporting for 305(b)	13,867
non-supporting for 305(b)	2,447
listed for 303(d)	0
number of sites sampled *(on an annual basis)*	40
number of miles assessed per site	site specific



*The 16,314 stream miles assessed for biology are the streams known to be only very high fully supporting (13,867) and very low non-supporting (2,447).

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class system (A, B, C), Fishery Based Uses, Warm Water vs. Cold Water	
ALU designations in state water quality standards	Four designations: Warmwater A, Warmwater B, Coldwater A, Coldwater B	
Narrative Biocriteria in WQS	Procedures used to support narrative biocriteria located in various reports, e.g., biological classification, 305(b), bioassessment procedures	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
		permitted discharges
		monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	none	

Reference Site/Condition Development*

Number of reference sites	**38 total**	
Reference site determinations	✓	site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference Site Criteria	No waste water treatment plants, other point sources, or concentrated animal feeding operations (CAFOs); good instream habitat, riparian habitat, land use and cover, physical and chemical parameters, biological metrics, and faunal assemblages; no altered hydrologic regimes; representativeness. At a minumum, sites need to be in the top 10 to 20 percent of all sites sampled in the ecoregion, with little disturbance and no spills or discharges within sites area.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
	✓	other: regionally representative, reasonably attainable
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate) *(there are three ecoregions and six strata with roughly five reference sites in each)*
		elevation
	✓	stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

*Reference site criteria have not been finalized. These responses are based on NDEQ's current efforts to evaluate reference sites and condition.

Field and Lab Methods

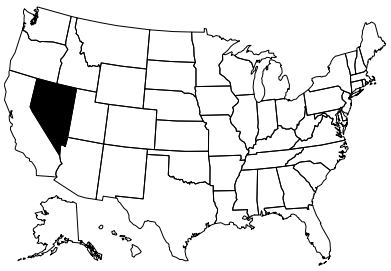
Assemblages assessed	✓	benthos *(<100 samples/year, single season, multiple sites - broad coverage)*
	✓	fish *(<100 samples/year, single season, multiple sites - broad coverage)*
		periphyton
		other:
Benthos		
sampling gear		surber, multiplate, collect by hand, D-frame, dipnet; 200 - 400 micron mesh
habitat selection		multihabitat, artificial substrate, woody debris
subsample size		300 count, entire sample
taxonomy		genus, species
Fish		
sampling gear		backpack electrofisher, boat electrofisher, pram unit (tote barge), seine; 1/4" mesh
habitat selection		pool/glide, riffle/run (cobble), multihabitat
sample processing		length measurement (gamefish only), anomalies
subsample		batch
taxonomy		species
Habitat assessments		visual based, quantitative measurements; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, taxonomic proficiency checks and specimen archival

Data Analysis and Interpretation*

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		95th percentile of reference population, dependent upon approach
defining impairment in a multimetric index		25th percentile of reference population
Evaluation of performance characteristics	✓	repeat sampling *(revisit sites)*
		precision
		sensitivity
		bias
		accuracy
Biological data		
Storage		STORET, Excel and MS Access spreadsheets
Retrieval and analysis		SAS, Minitab

*****NDEQ is testing different indices for validity and, as mentioned earlier, is still exploring reference criteria. Responses are based on NDEQ's current evaluation efforts, which include several changes in the way past biological data were evaluated. Data analysis procedures may change before metrics, indices, and reference sites are finalized.

NEVADA



Contact Information

Karen Vargas, Bioassessment Coordinator/Environmental Scientist II
Nevada Division of Environmental Protection (NDEP)
123 West Nye Lane, Suite 138 ■ Carson City, NV 89706-0851
Phone 775/687-9444 ■ Fax 775/687-5856
email: kvargas@ndep.state.nv.us
NDEP Bureau of Water Quality Planning homepage: http://ndep.state.nv.us/bwqp/

Program Description

Nevada began its Bioassessment Program in the year 2000 and has continued to collect biological information on an annual basis. Although the program is in its infancy, the State plans to continue collecting biological data for ambient monitoring and to assist in defining reference conditions and sites. There are seven primary water basins in Nevada and the State has collected biological data annually on four of these basins covering approximately 600 river miles. It is expected the State will continue to collect at these river basins, in addition to new basins and several lakes, until a valid biological baseline has been established over the next four to five years. After such time, the State is expected to switch to an alternating site or basin ambient bioassessment monitoring program.

The program primarily consists of macroinvertebrate collection, physical habitat evaluations, and physical measurements of slope, velocity, flow, dissolved oxygen, specific conductivity, pH, temperature, substrate composition, canopy cover, and width and depth of the sampling area. Periphyton, plankton, and/or chlorophyll sampling is conducted when necessary to assist in defining problem areas. Water chemistry data is collected at sites where the water chemistry is currently unknown. The data will eventually be used in 305(b) and 303(d) reports in addition to basin assessments of stream health. Some NPDES dischargers in the State are voluntarily collecting macroinvertebrates to assess impact to the aquatic environment.

Reference site criteria are currently being defined based on available information. The State expects to use chemical data, habitat assessments, physical measurements, professional knowledge and degrees of human impact to define the conditions and sites. Where reference sites are unavailable, the State expects to use modeling and/or least disturbed sites to evaluate conditions. It is anticipated to take several years for reference sites to be selected.

An independent biological laboratory conducts identification of macroinvertebrates. QA/QC of macroinvertebrate identification consists of approximately 15% of the samples being analyzed by two distinct biological laboratories. Data collected will be stored annually in the Ecological Data Application System (EDAS). Analysis and evaluation of the bioassessment data will be developed as the program progresses and based on the most accurate methods. Reference sites, where appropriate, will be used as a baseline for analysis.

Nevada recently hosted its first bioassessment conference in the State. The conference resulted in the formation of a State Bioassessment Committee consisting of agencies, tribes, and industry. The primary goal of the committee is to evaluate and coordinate protocols, methodologies and sampling in the State. Nevada also participates in the National Aquatic Life Use (ALUS) work group based out of USEPA Headquarters in Washington, D.C. The State is also planning to host an Arid West Aquatic Life Use Workgroup in conjunction with other arid states, tribal entities and USEPA in the next year.

Documentation and Further Information

Nevada's 305(b) report, September 2000: http://ndep.state.nv.us/bwqp/305b1998.pdf

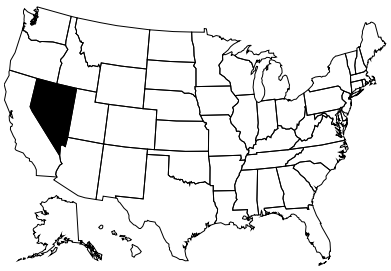
DRAFT Nevada's 2002 303(d) Impaired Waters List, June 2002: http://ndep.state.nv.us/bwqp/303list.pdf

Nevada's 1998 303(d) List, April 1998: http://ndep.state.nv.us/bwqp/nv303d98.pdf

Draft Continuing Planning Process, December 2001: http://ndep.state.nv.us/bwqp/cppdraft.pdf

Water Quality Standards, narrative and numeric: http://ndep.state.nv.us/bwqp/stdsw.htm

NEVADA



Contact Information

Karen Vargas, Bioassessment Coordinator/Environmental Scientist II
Nevada Division of Environmental Protection (NDEP)
123 West Nye Lane, Suite 138 ■ Carson City, NV 89706-0851
Phone 775/687-9444 ■ Fax 775/687-5856
email: kvargas@ndep.state.nv.us

Programmatic Elements

Uses of bioassessment within overall water quality program*	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
	✓	other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects, specific river basins or watersheds, and comprehensive use throughout jurisdiction)*
	✓	fixed station *(i.e., water quality monitoring stations) (special projects, specific river basins or watersheds, and comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(specific river basins or watersheds and comprehensive use throughout jurisdiction)*
		other:

*Bioassessment information will eventually be used in 303(d) and 305(b) reports.

Stream Miles

Total miles *(determined using River Reaches and calculated using GIS coverages.)*	**143,578**
Total perennial miles	14,988
Total miles assessed for biology**	**602**
fully supporting for 305(b)	0
partially/non-supporting for 305(b)	0
listed for 303(d)	0
number of sites sampled	50-60
number of miles assessed per site	–

**602 miles were assessed per year for 2000 and 2001 by the state (NDEP) and 97 miles were also assessed by others (Dischargers). The state estimates 900 river miles to be assessed in 2002. Since mileage is estimated and Nevada's 2001 data set has not been analyzed, the State has not used biology for 305(b)/303(d); therefore "0" is reported. However, it will be used in the future.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class System (A,B,C), Fishery Based Uses and Warm Water vs. Cold Water	
ALU designations in state water quality standards	Propagation of aquatic life and the levels of warm water and cold water fisheries.	
Narrative Biocriteria in WQS	under development	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
		permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Truckee River Restoration projects include the lahontan cutthroat trout.	

Reference Site/Condition Development*

Number of reference sites	**0 total**	
Reference site determinations	✓	site-specific
	✓	paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	This is under development. NDEP expects to use chemical, habitat, physical measurements and least human impact. Where reference sites are unavailable modeling and/or metrics will be used to evaluate conditions.	
Characterization of reference sites within a regional context	✓	historical conditions
	✓	least disturbed sites
		gradient response
	✓	professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
	✓	elevation
	✓	stream type
	✓	multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions *(for fishery based uses)*

*Nevada is in the process of developing reference sites. This section has been completed based on the criteria that will be considered during development.

Field and Lab Methods

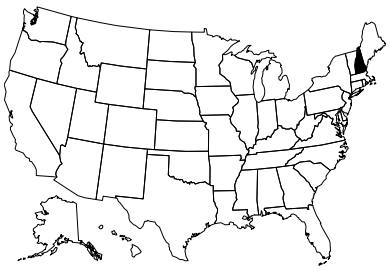
Assemblages assessed	✓	benthos *(<100 samples/year, single season, multiple sites - broad coverage)*
		fish
	UD	periphyton *(<100 samples/year, single season, multiple sites - watershed level)*
		other:
Benthos		
sampling gear	kick net (1 m); 500-600 micron mesh	
habitat selection	riffle/run (cobble) *(when unavailable, use vegetation and sediment)*	
subsample size	500 count	
taxonomy	combination--family, genus, species	
Periphyton		
sampling gear	**natural substrate**: brushing/scraping device (razor, toothbrush, etc.) Periphyton will be routinely collected and analyzed by a professional lab beginning in 2002. Chlorophyll analysis is performed at some stations.	
habitat selection	n/a	
sample processing	chlorophyll *a*/ phaeophytin and taxonomic identification	
taxonomy	genus level for soft-bodied algae when possible; diatoms are not cleared	
Habitat assessments	quantitative measurements (some sites) and visual based; performed with bioassessments; riffle slope, flow, average width and depth of flow, riffle velocity, canopy cover, some vegetation (grass, scrubs, trees) coverage along riparian zone, reach length, conductivity, temperature and dissolved oxygen	
Quality assurance program elements	Quality assurance program elements are currently being developed (i.e., standard operating procedures, quality assurance plan, taxonomic proficiency checks, specimen archival).	

Data Analysis and Interpretation*

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
	✓	multivariate analysis
	UD	biological metrics *(NDEP has not yet developed metrics but analysis tools and methods will be developed based on the most accurate method)*
	✓	disturbance gradients
		other:
Evaluation of performance characteristics	✓	repeat sampling *(ideally, 5 years worth of data will be collected at each site to determine the variability)*
		precision
		sensitivity
		bias
		accuracy
Biological data		
Storage	EDAS (being developed)	
Retrieval and analysis	EDAS (being developed)	

*Analysis tools and methods will be developed more fully in the future.

NEW HAMPSHIRE



Contact Information

David Neils, Biomonitoring Program Coordinator
New Hampshire Department of Environmental Services (NHDES)
6 Hazen Drive ■ Concord, NH 03302-0095
Phone 603/271-8865 ■ Fax 603/271-7894
email: dneils@des.state.nh.us
NHDES Watershed Management Bureau, *Biomonitoring Program*:
http://www.des.state.nh.us/wmb/biomonitoring/

Program Description

The New Hampshire Department of Environmental Services (NHDES) has been gathering biological data in wadeable streams and rivers since 1995. The primary goal of this effort is the development of numeric biological criteria in support of the current narrative standard. Biological communities assessed for this purpose are fish and macroinvertebrates. Since the program's inception, the protocols for collecting data have remained fairly consistent. The fish are collected with a backpack electro-shocker for 150 meters, with efforts to include all habitats typical of the stream type. Macroinvertebrate sampling is done by rock baskets deployed for 8 weeks and retrieved in the fall. A visual habitat assessment is also conducted at each station using USEPA's Rapid Bioassessment Protocols for high or low gradient streams, whichever is appropriate.

Since the program's beginnings, over 200 stations have been assessed. These stations are captured in an ArcView coverage that includes watershed delineations specific to the biological sampling station. Efforts are currently underway to determine the degree of human activity in each of the watersheds by evaluating parameters such as land use, population, hazardous waste sites and road density. This type of scoring will help to determine reference quality/least impacted sites.

The Biomonitoring Program is also investigating the need to classify the wadeable streams in New Hampshire. The state is small but very diverse, with low coastal systems and high mountainous regions. It is not yet clear whether it will be necessary to establish unique biological criteria for different regions of the state.

In the past, biomonitoring information has been used for 305(b) reporting and also for 303(d) listing. The Watershed Management Bureau, which is responsible for producing these reports, is currently evaluating the assessment and listing methodologies, using USEPA's CALM guidance. In 2002-2003 the Biomonitoring Program will be testing a probabilistic sampling design for site selection. This type of sampling will allow for greater confidence in statements of statewide water quality, and continue to provide useful data for biocriteria development.

Information about New Hampshire's Biomonitoring Program, including sampling protocols, can be found at http://www.des.state.nh.us/wmb/biomonitoring/.

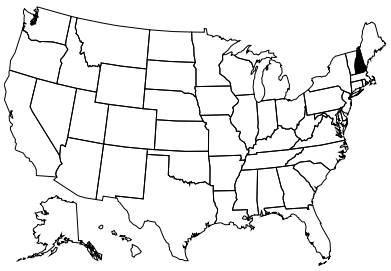
Documentation and Further Information

State of New Hampshire 2000 Section 305(b) Water Quality Report:
http://www.des.state.nh.us/wmb/2000-305b.pdf

NHDES Biomonitoring Program Protocols, January 2002:
http://www.des.state.nh.us/wmb/biomonitoring/protocols.pdf

New Hampshire Biomonitoring Program general information: http://www.des.state.nh.us/wmb/biomonitoring/sites

NEW HAMPSHIRE



Contact Information

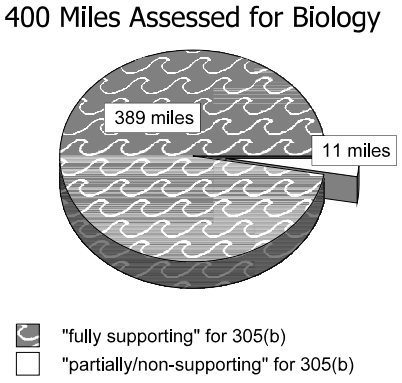
David Neils, Biomonitoring Program Coordinator
New Hampshire Department of Environmental Services (NHDES)
6 Hazen Drive ■ Concord, NH 03302-0095
Phone 603/271-8865 ■ Fax 603/271-7894
email: dneils@des.state.nh.us

Programmatic Elements

Use of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
	✓	evaluation of discharge permit conditions
		TMDL assessment and monitoring
	✓	other: Ecological Risk Assessments
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects and specific river basins or watersheds)*
	✓	fixed station (i.e., water quality monitoring stations) *(special projects only)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
		rotating basin
		other:

Stream Miles

Total miles *(State based determination)*	**10,881**
Total perennial miles	8,636
Total miles assessed for biology	**400**
fully supporting for 305(b)	389
partially/non-supporting for 305(b)	11
listed for 303(d)	0
number of sites sampled *(on an annual basis)*	130
number of miles assessed per site*	~3



*NHDES will be doing random sampling in the future. For now, 150 meters are assessed and extrapolated to a broader area, roughly three miles per site, though this number does vary.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class system (A, B, C)	
ALU designations in state water quality standards	One designation: Fishable	
Narrative Biocriteria in WQS	There aren't any written formal/informal numeric procedures to support narrative biocriteria decisions yet because they are very subjective. Presently, data is being analyzed using New York's metrics.	
Numeric Biocriteria in WQS	under development	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
		cause and effect determinations
	✓	permitted discharges
		monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	none	

Reference Site/Condition Development

Number of reference sites	**40 total**	
Reference site determinations	✓	site-specific
		paired watersheds
		regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	Generally use best professional judgment. Least disturbed sites are determined following some stratification of characteristics (ArcView coverage, hazardous waste sites, etc.) – it is very visual.	
Characterization of reference sites within a regional context *Not applicable**		historical conditions
		least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions *Not applicable**		ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

*Regional reference sites not used.

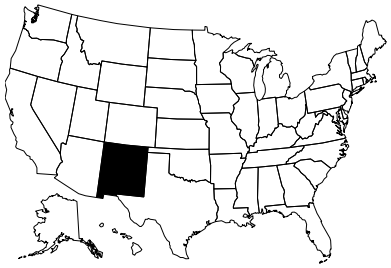
Field and Lab Methods

Assemblages assessed	✓	benthos *(<100 samples/year; single season, multiple sites - broad coverage)*
	✓	fish *(<100 samples/year; single season, multiple sites - broad coverage)*
		periphyton
	✓	other: amphibians/reptiles *(<100 samples/year; single season, multiple sites - broad coverage)*
Benthos		
sampling gear		D-frame, kick net (1 meter), multiplate, rock baskets; 500-600 micron mesh
habitat selection		multihabitat, artificial substrate
subsample size		100 count
taxonomy		genus, lowest reasonable taxa
Fish		
sampling gear		backpack electrofisher
habitat selection		multihabitat
sample processing		anomalies
subsample		none
taxonomy		species
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures; quality assurance plan; periodic meetings, training for biologists; sorting and taxonomic proficiency checks; specimen archival; certification program for bioassessment (Biologists must have a certificate of completion of USFWS Electrofishing Course)

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(return single metrics - use endpoint for each single metric)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		under development - Presently, only the raw score is tracked – there is no scale of comparison with the reference site yet.
Evaluation of performance characteristics		repeat sampling
		precision
Information not provided		sensitivity
		bias
		accuracy
Biological data		
Storage		EDAS
Retrieval and analysis		EDAS

NEW MEXICO



Contact Information

Seva J. Joseph, Environmental Specialist
New Mexico Environment Department (NMED)
1190 Saint Francis Drive ■ Santa Fe, NM 87502-0110
Phone 505/827-0573 ■ Fax 505/827-0160
email: seva_joseph@nmenv.state.nm.us
NMED Surface Water Quality Bureau: http://www.nmenv.state.nm.us/swqb/swqb.html

Program Description

Starting in 1998 the New Mexico Environment Department's (NMED) Surface Water Quality Bureau (SWQB) had a goal of monitoring all watersheds in the state on a 5-year cycle. NMED has recently begun to survey fish populations to supplement the data from the NM Department of Game and Fish. NMED uses RBP collection methods and is currently working on assessment methods suitable for the depauperate fish population of New Mexico. The SWQB coordinates with the NM Department of Game and Fish to obtain the most current fishery assessments in the watersheds.

The benefits of this approach are:

- It provides a systematic, detailed review of water quality data and allows for a more efficient use of valuable monitoring resources;
- It provides information at a scale where implementation of corrective activities is feasible;
- With an established order of rotation and predictable sampling in each basin, it is easier to coordinate efforts with other programs and water quality entities, and program efficiency is enhanced and the basis for management decisions is improved.

Documentation and Further Information

Water Quality and Water Pollution Control in New Mexico, 2000 305(b):
http://www.nmenv.state.nm.us/swqb/305b_2000.html

State of New Mexico Standards for Interstate and Intrastate Surface Waters, December 16, 2001:
http://www.nmenv.state.nm.us/NMED_regs/swqb/20_6_4_nmac.html

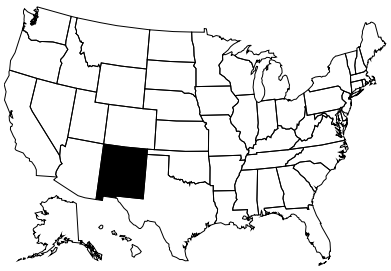
Surface Water Quality Bureau Library: http://www.nmenv.state.nm.us/swqb/links.html#WPS_Library

For a list of and links to *Reports and Publications*, go to:
http://www.nmenv.state.nm.us/gwb/Technical%20resources/TSS.html#Reports

For a *Table of Contents* containing ALL Technical Reports and other information, go to:
http://www.nmenv.state.nm.us/gwb/Technical%20resources/TSS.html

For a list of and links to *Biological Databases*, go to:
http://www.nmenv.state.nm.us/gwb/Technical%20resources/TSS.html#Biological

NEW MEXICO



Contact Information

Seva J. Joseph, Environmental Specialist
New Mexico Environment Department (NMED)
1190 Saint Francis Drive ■ Santa Fe, NM 87502-0110
Phone 505/827-0573 ■ Fax 505/827-0160
email: seva_joseph@nmenv.state.nm.us

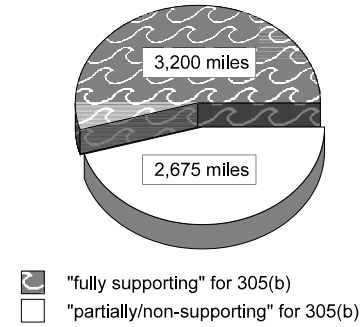
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
	✓	probabilistic by ecoregion, or statewide *(special projects only)*
	✓	rotating basin *(comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles *(State based determination)*	**110,741**
Total perennial miles	8,682
Total miles assessed for biology	**5,875**
fully supporting for 305(b)	3,200
partially/non-supporting for 305(b)*	2,675
listed for 303(d)*	–
number of sites sampled *(on an annual basis)*	30
number of miles assessed per site	–

5,875 Miles Assessed for Biology



*A total of 3,080 miles are partially/non-supporting when miles with "impacts observed" are included. NMED is currently working on a 303(d) list.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis		Fishery Based Uses and Warm Water vs. Cold Water
ALU designations in state water quality standards		Five designations: Coldwater Fishery, High Quality Coldwater Fishery, Limited Warmwater Fishery, Marginal Coldwater Fishery, and Warmwater Fishery
Narrative Biocriteria in WQS		none
Numeric Biocriteria in WQS		none
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
		permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU		none

Reference Site/Condition Development

Number of reference sites		**200 total**
Reference site determinations		site-specific
		paired watersheds
		regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria		The least disturbed sites are picked according to best professional judgment (based on chemistry, quantitative habitat measurements, visual indicators, etc). There are plans to shift to RIVPACS as biocriteria are developed during the next few years.
Characterization of reference sites within a regional context *Not applicable*		historical conditions
		least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions		ecoregions (or some aggregate)
	✓	elevation *(preliminary ecoregions are based on elevation and other habitat parameters)*
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

Field and Lab Methods

Assemblages assessed	✓	benthos *(30 samples/year; single season, multiple sites - watershed level)*
	✓	fish *(30 samples/year; single season, multiple sites - watershed level)*
	✓	periphyton* *(9 samples/year; single observation, limited sampling)*
	✓	other: phytoplankton *(9 samples/year; single observation, limited sampling)*
Benthos		
sampling gear		Hess, D-frame, kick net (1 meter); 500-600 micron mesh
habitat selection		riffle/run (cobble)
subsample size		300 count
taxonomy		combination (it depends on the family--some to genus, some to species level)
Fish		
sampling gear		backpack and bank electrofisher; 1/4" mesh
habitat selection		multihabitat
sample processing		length measurement and anomalies
subsample		batch
taxonomy		species
Periphyton*		
sampling gear		**natural substrate:** collect by hand; **artificial substrate:** periphytometer
habitat selection		richest habitat and multihabitat
sample processing		taxonomic identification
taxonomy		diatoms only
Habitat assessments**		visual based, hydrogeomorphology; and the RBP assessment is conducted with the bioassessment. NMDE may also conduct a Rosgen type hydrogeomorphological assessment, including pebble counts, independently of the bioassessment.
Quality assurance program elements		standard operating procedures, quality assurance plan, sorting proficiency checks and specimen archival

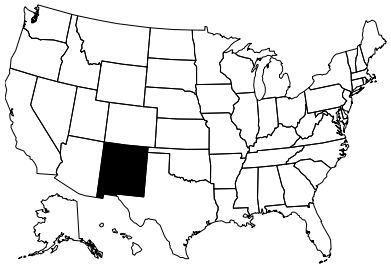
*Periphyton is collected primarily from lakes. It is only collected from streams in response to a specific problem or when looking at a certain impairment – sampling is very minimal (<10).

**Up to this point bioassessments have been conducted as described in the EPA's RBP. These methods are just now starting to be refined for regional applicability.

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		95th percentile of reference population
defining impairment in a multimetric index		95th percentile of reference population
Evaluation of performance characteristics		repeat sampling
		precision
Not currently evaluated		sensitivity
		bias
		accuracy
Biological data		
Storage		Just recently started using MS Access. All historic data (1977 - 1999) are in STORET
Retrieval and analysis		In the process of moving from STORET to MS Access; some data are also in Excel

NEW MEXICO



Contact Information

Seva J. Joseph, Environmental Specialist
New Mexico Environment Department (NMED)
1190 Saint Francis Drive ■ Santa Fe, NM 87502-0110
Phone 505/827-0573 ■ Fax 505/827-0160
email: seva_joseph@nmenv.state.nm.us
NMED Surface Water Quality Bureau: http://www.nmenv.state.nm.us/swqb/swqb.html

Program Description

Starting in 1998 the New Mexico Environment Department's (NMED) Surface Water Quality Bureau (SWQB) had a goal of monitoring all watersheds in the state on a 5-year cycle. NMED has recently begun to survey fish populations to supplement the data from the NM Department of Game and Fish. NMED uses RBP collection methods and is currently working on assessment methods suitable for the depauperate fish population of New Mexico. The SWQB coordinates with the NM Department of Game and Fish to obtain the most current fishery assessments in the watersheds.

The benefits of this approach are:

- It provides a systematic, detailed review of water quality data and allows for a more efficient use of valuable monitoring resources;
- It provides information at a scale where implementation of corrective activities is feasible;
- With an established order of rotation and predictable sampling in each basin, it is easier to coordinate efforts with other programs and water quality entities, and program efficiency is enhanced and the basis for management decisions is improved.

Documentation and Further Information

Water Quality and Water Pollution Control in New Mexico, 2000 305(b):
http://www.nmenv.state.nm.us/swqb/305b_2000.html

State of New Mexico Standards for Interstate and Intrastate Surface Waters, December 16, 2001:
http://www.nmenv.state.nm.us/NMED_regs/swqb/20_6_4_nmac.html

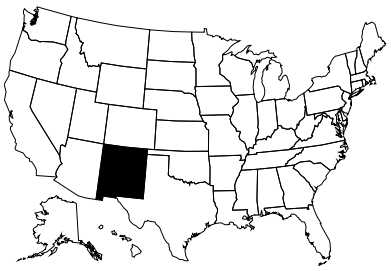
Surface Water Quality Bureau Library: http://www.nmenv.state.nm.us/swqb/links.html#WPS_Library

For a list of and links to *Reports and Publications*, go to:
http://www.nmenv.state.nm.us/gwb/Technical%20resources/TSS.html#Reports

For a *Table of Contents* containing ALL Technical Reports and other information, go to:
http://www.nmenv.state.nm.us/gwb/Technical%20resources/TSS.html

For a list of and links to *Biological Databases*, go to:
http://www.nmenv.state.nm.us/gwb/Technical%20resources/TSS.html#Biological

NEW MEXICO



Contact Information

Seva J. Joseph, Environmental Specialist
New Mexico Environment Department (NMED)
1190 Saint Francis Drive ■ Santa Fe, NM 87502-0110
Phone 505/827-0573 ■ Fax 505/827-0160
email: seva_joseph@nmenv.state.nm.us

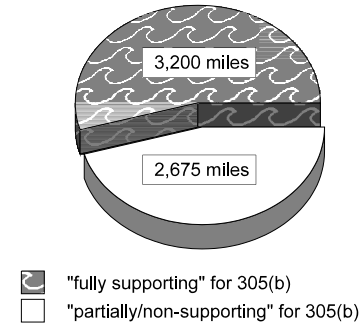
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
	✓	probabilistic by ecoregion, or statewide *(special projects only)*
	✓	rotating basin *(comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles *(State based determination)*	**110,741**
Total perennial miles	8,682
Total miles assessed for biology	**5,875**
fully supporting for 305(b)	3,200
partially/non-supporting for 305(b)*	2,675
listed for 303(d)*	–
number of sites sampled *(on an annual basis)*	30
number of miles assessed per site	–

5,875 Miles Assessed for Biology



*A total of 3,080 miles are partially/non-supporting when miles with "impacts observed" are included. NMED is currently working on a 303(d) list.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis		Fishery Based Uses and Warm Water vs. Cold Water
ALU designations in state water quality standards		Five designations: Coldwater Fishery, High Quality Coldwater Fishery, Limited Warmwater Fishery, Marginal Coldwater Fishery, and Warmwater Fishery
Narrative Biocriteria in WQS		none
Numeric Biocriteria in WQS		none
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
		permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU		none

Reference Site/Condition Development

Number of reference sites		**200 total**
Reference site determinations		site-specific
		paired watersheds
		regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria		The least disturbed sites are picked according to best professional judgment (based on chemistry, quantitative habitat measurements, visual indicators, etc). There are plans to shift to RIVPACS as biocriteria are developed during the next few years.
Characterization of reference sites within a regional context *Not applicable*		historical conditions
		least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions		ecoregions (or some aggregate)
	✓	elevation *(preliminary ecoregions are based on elevation and other habitat parameters)*
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

Field and Lab Methods

Assemblages assessed	✓	benthos *(30 samples/year; single season, multiple sites - watershed level)*
	✓	fish *(30 samples/year; single season, multiple sites - watershed level)*
	✓	periphyton* *(9 samples/year; single observation, limited sampling)*
	✓	other: phytoplankton *(9 samples/year; single observation, limited sampling)*
Benthos		
sampling gear		Hess, D-frame, kick net (1 meter); 500-600 micron mesh
habitat selection		riffle/run (cobble)
subsample size		300 count
taxonomy		combination (it depends on the family--some to genus, some to species level)
Fish		
sampling gear		backpack and bank electrofisher; 1/4" mesh
habitat selection		multihabitat
sample processing		length measurement and anomalies
subsample		batch
taxonomy		species
Periphyton*		
sampling gear		**natural substrate:** collect by hand; **artificial substrate:** periphytometer
habitat selection		richest habitat and multihabitat
sample processing		taxonomic identification
taxonomy		diatoms only
Habitat assessments**		visual based, hydrogeomorphology; and the RBP assessment is conducted with the bioassessment. NMDE may also conduct a Rosgen type hydrogeomorphological assessment, including pebble counts, independently of the bioassessment.
Quality assurance program elements		standard operating procedures, quality assurance plan, sorting proficiency checks and specimen archival

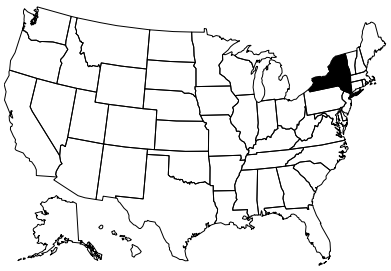
*Periphyton is collected primarily from lakes. It is only collected from streams in response to a specific problem or when looking at a certain impairment – sampling is very minimal (<10).

**Up to this point bioassessments have been conducted as described in the EPA's RBP. These methods are just now starting to be refined for regional applicability.

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		95th percentile of reference population
defining impairment in a multimetric index		95th percentile of reference population
Evaluation of performance characteristics		repeat sampling
		precision
Not currently evaluated		sensitivity
		bias
		accuracy
Biological data		
Storage		Just recently started using MS Access. All historic data (1977 - 1999) are in STORET
Retrieval and analysis		In the process of moving from STORET to MS Access; some data are also in Excel

NEW YORK



Contact Information

Robert W. Bode, Research Scientist III
New York State Department of Environmental Conservation (NYSDEC)
625 Broadway ■ Albany, NY 12233-3502
Phone 518/285-5682 ■ Fax 518/285-5601
email: rwbode@gw.dec.state.ny.us
NYSDEC homepage: www.dec.state.ny.us/website/dow/index.html

Program Description

The Stream Biomonitoring Unit of the New York State Department of Environmental Conservation (NYSDEC) was formed in 1972. The primary objective of the Unit is to assess the water quality of streams and rivers in New York State using aquatic invertebrate communities. Secondary objectives include taxonomic investigations, invertebrate tissue analysis, and public outreach. The unit presently consists of five biologists: Robert Bode, Margaret Novak, Lawrence Abele, Diana Heitzman, and Alexander Smith.

The Stream Biomonitoring Unit is part of the ambient surface water monitoring team at NYSDEC. Water quality is assessed to determine the level of designated use support and the primary factors causing the impacts. In addition to community assessments, invertebrates are collected for tissue analysis to determine if elevated levels exist for metals, pesticides, PCBs, or PAHs. Biological monitoring using benthic invertebrate communities is the primary monitoring tool for the initial screening phase within the watersheds, providing a coverage of 150-200 streams each year. Additionally, biomonitoring is used to conduct multi-site intensive surveys on approximately 10 streams each year to provide baseline data and trend monitoring data or to trackdown sources of xenobiotic substances.

Assessments based on macroinvertebrate sampling are used extensively in 305(b) reports and the Priority Water List, and to a lesser extent in 303(d) reports. Assessments generally do not directly address the designated uses of drinking, swimming, or fishing, contained in the State water quality standards, although they provide sound basis for determination of aquatic life support (reported in 305b) and relate secondarily to the designated use of fish propagation and survival. Biocriteria are addressed by the Biological Impairment Criteria, which are used to define impairment by exceedances of metrics measured upstream and downstream of a discharge. The primary assessment method using benthic macroinvertebrates is based on a multimetric scale divided into four levels of impairment, ranging from non-impacted to severely impacted. Although nearly all the collection of biological data remains within the Unit, many studies are conducted in cooperation with other New York State agencies (NYS Museum), federal agencies (USGS, USEPA), neighboring states (Vermont, Massachusetts, New Jersey), and non-governmental organizations (Hudson Basin River Watch, Trout Unlimited, Nature Conservancy).

Accomplishments

- publication of a manual for the identification of larvae of Chironomidae (1980)
- development of methods for the Rapid Biological Assessment of streams (1983)
- establishment of biological impairment criteria (1990)
- publication of Percent Model Affinity, a community analysis technique (1992)
- documentation of 20-year trends in water quality in New York State (1993)
- development of Impact Source Determination, a pollution identification method (1995)

Future program directions and challenges

- continuing long-term trend monitoring
- providing maximum biomonitoring coverage of streams in New York State
- integrating more assessments with diatom and fish data
- developing invertebrate identification aids using digital photography and the NYSDEC website
- capturing biodiversity information outside of the subsampling process

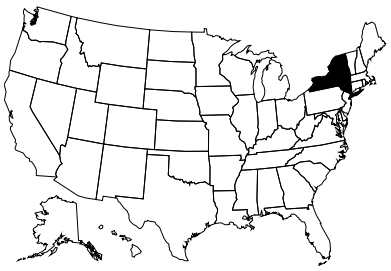
Documentation and Further Information

New York State Water Quality 2000, 305(b) Report, October 2000: http://www.dec.state.ny.us/website/dow/305b00.pdf

Draft 2002 Section 303(d) list: http://www.dec.state.ny.us/website/dow/303dcalm.pdf

Bode, R. W., M.A. Novak, and L.E. Abele, 1996. Quality assurance work plan for biological stream monitoring in New York State. New York State Department of Environmental Conservation Technical Report, 89 pages.

NEW YORK



Contact Information

Robert W. Bode, Research Scientist III
New York State Department of Environmental Conservation (NYSDEC)
625 Broadway ■ Albany, NY 12233-3502
Phone 518/285-5682 ■ Fax 518/285-5601
email: rwbode@gw.dec.state.ny.us

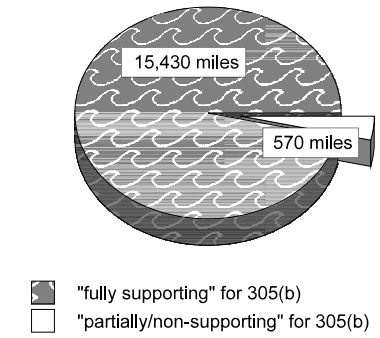
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
		TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
	✓	probabilistic by stream order/catchment area *(special projects only)*
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles *(determined using a state based program)*	**52,337**
Total perennial miles	46,266
Total miles assessed for biology*	**16,000**
fully supporting for 305(b)	15,430
partially/non-supporting for 305(b)	570
listed for 303(d)	484
number of sites sampled	800
number of miles assessed per site	20

16,000 Miles Assessed for Biology



*These numbers represent primarily stream miles (roughly 85-90%), but there are some river miles included due to program overlap in metrics, etc. It would be very difficult to separate the data for these two waterbody types. Also, there is a discrepancy between 305(b) partially/non-supporting and 303(d) stream miles because the 1998 303(d) list did not include all impaired waters, just impaired waters suitable for TMDLs. Also, the 305(b) and 303(d) lists, up until now, have been developed independent of each other.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Fishery Based Uses	
ALU designations in state water quality standards	One designation: Fish propagation and survival	
Narrative Biocriteria in WQS	none - New York does have *biological impairment criteria* (see footnote), but these are not found in the water quality standards.	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
		permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to their designated ALU	none	

Reference Site/Condition Development

Number of reference sites	**not applicable***	
Reference site determinations	✓	site-specific
		paired watersheds
		regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria	For application of biological impairment criteria, reference sites are control sites located upstream of a suspected source of impairment.	
Characterization of reference sites within a regional context *Not applicable**		historical conditions
		least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions *Not applicable**		ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
		some reference sites represent acceptable human-induced conditions

*Reference sites are used in the following manner only: NYSDEC's reference sites are merely site-specific "control" sites, used strictly used for rating the water quality near a suspected source of impairment. This is done by collecting water samples at the source of impairment and upstream of the source, and then *biological impairment criteria* are applied for rating purposes. For example, if more than eight species are lost between the two samples, then the impairment criteria have been exceeded and the stream section would be considered significantly impaired. Thus the biological impairment criteria define how much change is allowed from upstream to downstream.

Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - watershed level)*
	✓	fish *(<100 samples/year; single season, multiple sites - not at watershed level)*
	✓	periphyton *(<100 samples/year; single season, multiple sites - not at watershed level)*
		other:
Benthos		
sampling gear		multiplate, Ponar grab sampler, dipnet; >800 micron mesh
habitat selection		riffle/run (cobble)
subsample size		100 count
taxonomy		genus, species, combination
Fish		
sampling gear		backpack electrofisher, 1/4" mesh
habitat selection		pool/glide, riffle/run (cobble)
sample processing		counts only
subsample		100 count
taxonomy		species
Periphyton		
sampling gear		**natural substrate**: suction device, brushing/scraping device (razor, toothbrush, etc.), from macrophyte surfaces; **artificial substrate**: collect by hand (multihabitat) using a knife blade and eyedropper
habitat selection		multihabitat
sample processing		taxonomic identification
taxonomy		diatoms only, species
Habitat assessments		quantitative measurements; performed with bioassessments
Quality assurance program elements		standard operating procedures; quality assurance plan; periodic meetings, training for biologists; sorting proficiency checks; taxonomic proficiency checks; specimen archival

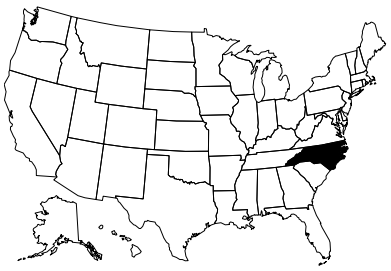
*Water quality assessments using benthos are based on a multimetric scale divided into 4 levels of impairment ranging from non-impacted to severely impacted (see below). NYSDEC's bioassessment program had periphyton monitoring capabilities in 1999 and 2000, but this has since been dropped and it is not clear if the sampling will be continued. Fish sampling is conducted by another Division within NYSDEC for a limited number of sites per year.

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index and return single metrics)*
		disturbance gradients
	✓	other: Impact Source Determination using cluster analysis
Multimetric thresholds		
transforming metrics into unitless scores		transformed into 4 impact categories, using approximately 25th, 50th, and 75th percentiles of database
defining impairment in a multimetric index		transformed into 4 impact categories using approximately 25th, 50th, and 75th percentiles**
Evaluation of performance characteristics	✓	repeat sampling *(sampling same site in different flow regime years)*
	✓	precision *(QA checks on subsampling)*
	✓	sensitivity *(comparisons with diatom sampling, fish sampling)*
	✓	bias *(replicate sampling to test for sampler differences)*
	✓	accuracy *(comparisons with toxicity testing, chemical sampling)*
Biological data		
Storage		data are entered in Excel spreadsheets, then transferred to FoxPro
Retrieval and analysis		In-house programs in FoxPro

**The impairment threshold is not defined using reference sites. Instead, NYSDEC creates impact categories using all of the data from the sites: everything >75th percentile is considered non-impacted/good.

NORTH CAROLINA



Contact Information

Trish MacPherson, Environmental Biology Supervisor II
North Carolina Department of Environmental and Natural Resources (NCDENR)
1621 Mail Service Center ■ Raleigh, NC 27699-1621
Phone 919/733-6946 ■ Fax 919/733-9959
email: trish.macpherson@ncmail.net
NC Environmental Sciences Branch homepage: http://www.esb.enr.state.nc.us/

Program Description

Benthic Macroinvertebrates
The Biological Assessment Unit of NCDENR uses aquatic macroinvertebrates as one type of indicator of biological integrity in streams and rivers. A swamp-sampling method is under development with sampling occurring in winter/early spring. North Carolina biologists first began collecting data in the late 1970s, and began using consistent sampling in 1983. Collection methods include a standard qualitative method (applicable for most between-site and/or between-date comparisons and used for all evaluations of impaired streams - those on the state 303(d) list), and the EPT method (an abbreviated version of the regular qualitative technique used to quickly determine between-site differences in water quality). Benthic samples are processed on site at each location. Another collection method is used for swamp streams. The boat sampling technique for nonwadeable freshwater rivers is an adaptation of the standard qualitative method.

Bioclassification criteria have been developed that are based on the number of intolerant EPT taxa present and the relative pollution tolerance of each taxa, as summarized in a Biotic Index for standard evaluation (EPT uses taxa richness only). Stream and river reaches are then given a final bioclassification of either Excellent, Good, Good/Fair, Fair or Poor. These bioclassifications, which have been developed for major ecoregions, are used to assess the various impacts of both point source discharges and nonpoint source runoff.

Beginning in 1991, the benthos summer sampling effort was directed toward specific river basins in given years based on the NPDES permitting schedule. This basin-wide monitoring is generally conducted three years prior to the year of permit renewal for the basin. This allows biological data to be incorporated in basin assessment, and subsequently into the management plan for each basin. Benthos data, by sub-basin, is incorporated into an Environmental Sciences Branch assessment report that also includes a review of pertinent data and information from other sources.

Between 110 and 130 wadeable sites are sampled for benthos each year during basinwide monitoring, and additional sites are sampled for special studies. The resulting information is used to document both spatial and temporal changes in water quality and to complement water chemistry analyses, fish community data, and habitat evaluations. In addition to assessing the effects of water pollution, biological information is also used to define High Quality or Outstanding Resource Waters, support enforcement of stream standards, and measure improvements associated with management actions. The results of biological investigations have been an integral part of North Carolina's basinwide monitoring program. Benthos data is the primary source for use support determinations.

Fish Community
To the public, the condition of the fishery is one of the most meaningful indicators of ecological integrity. Fish occupy the upper levels of the aquatic food web and are both directly and indirectly affected by chemical and physical changes in the environment. The Biological Assessment Unit employs a standard method for assessing streams' biological integrity by examining the structure and health of fish communities. This assessment incorporates information about species richness and composition, trophic composition, fish abundance, and fish condition. Criteria for the 12 metrics used in the North Carolina Index of Biological Integrity (NCIBI) are based on reference site data collected from groupings of river basins with similar fauna. The reference site sampling began in 1999, and fish community samples are now given a bioclassification similar to the benthos sites. Approximately 90 basinwide fish sites are sampled annually. Fish community data are used in the same ways as benthos data.

Use Support
North Carolina has moved toward assessing use support for each use class. Benthos and fish data are used for the evaluation of aquatic life standards. Biological data are typically given more weight than chemical data for use support. Sites with data from more than one trophic level are evaluated on a site specific basis for use support.

Documentation and Further Information

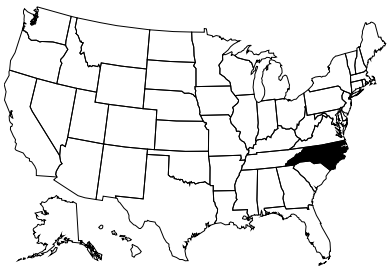
North Carolina 2000 305(b) Report: http://h2o.enr.state.nc.us/bepu/download.html

SOPs Biological Monitoring, Stream Fish Community Assessment & Fish Tissue: http://www.esb.enr.state.nc.us/BAUwww/IBI%20Methods%202001.pdf

SOPs for Benthic Macroinvertebrates: http://www.esb.enr.state.nc.us/BAUwww/benthossop.pdf

Benthic Macroinvertebrate Sampling and Narrative Criteria: http://www.esb.enr.state.nc.us/BAUwww/benthosdata.pdf

NORTH CAROLINA



Contact Information

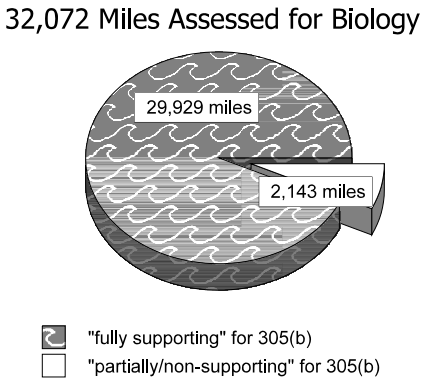
Trish MacPherson, Environmental Biology Supervisor II
North Carolina Department of Environmental and Natural Resources (NCDENR)
1621 Mail Service Center ■ Raleigh, NC 27699-1621
Phone 919/733-6946 ■ Fax 919/733-9959
email: trish.macpherson@ncmail.net

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
	✓	other: 303(d) listing
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles *(State based determinations)*	**37,672**
Total perennial miles	–
Total miles assessed for biology*	**32,072**
fully supporting for 305(b)	29,929
partially/non-supporting for 305(b)	2,143
listed for 303(d)	2,143
number of sites sampled *(on an annual basis)***	350
number of miles assessed per site	91.6



*Presently, biological sites are not separated from chemical for reporting purposes. However, Aquatic Life usages will be based primarily on biological assessment in the future. The 303(d) list is due before all assessments were completed (roughly 99% of partially/non supporting waters for 305(b) list). Thus, the number of miles assessed using biological data can't be confirmed because so many sources of information are used to make use support assessments. It can be assumed that using the current methodology of breaking out use support ratings by category (i.e., aquatic life), all the waters assessed in this category could be added up into miles. However, this method has only been applied to 6 of the 17 basins in North Carolina. NCDENR may have these numbers in the next few years.

**Best professional estimate of the number of sites sampled since the program's inception is 5000 benthos, 600 fish and 4000 phytoplankton samples (this is very good coverage of sites within river basins for mainstem and major tributaries).

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis		Class System (A,B,C)
ALU designations in state water quality standards		"Aquatic life propagation and maintenance of biological integrity..." applies as a best usage for Class C and Class WS-I waters.
Narrative Biocriteria in WQS		Procedures used to support narrative biocriteria located in SOPs for biological assessment
Numeric Biocriteria in WQS		none (Located in SOPs for biological assessment but not in water quality standards.)
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU		Biological data have been used to pinpoint degraded areas and to validate improvement after management activities have been completed.

Reference Site/Condition Development

Number of reference sites		**300 total**
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria		Must achieve an excellent bioclassification or meet certain land use criteria (percent forest, no major dischargers, etc). Benthos reference sites: EPT criteria and biotic index criteria; fish reference sites: IBI criteria.
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
	✓	elevation
	✓	stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

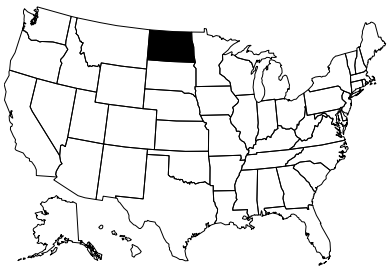
Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; multiple seasons, multiple sites – broad coverage for watershed level)*
	✓	fish *(<100 samples/year; multiple seasons, multiple sites – broad coverage for watershed level)*
	✓	periphyton, *(<100 samples/year; single observation, limited sampling)*
	✓	other: phytoplankton *(>500 samples/year; multiple seasons, multiple sites – broad coverage for watershed level)* and macrophytes *(<100 samples/year; single observation, limited sampling*)
Benthos		
sampling gear		collect by hand, sandbag, fine-mesh samplers made with net between PVC pipe joins, dipnet, kick net (1 meter); 200-400 micron mesh
habitat selection		multihabitat
subsample size		entire sample, aimed at >10 organisms/taxon (from qualitative field picking)
taxonomy		genus, species
Fish		
sampling gear		backpack electrofisher, boat electrofisher, seine; 1/8" mesh
habitat selection		multihabitat
sample processing		length measurement, anomalies
subsample		none
taxonomy		species, subspecies
Periphyton		
sampling gear		**natural substrate**: brushing/scraping device (razor, toothbrush, etc.), collect by hand; **artificial substrate**: collect by hand, bring rock back to lab
habitat selection		richest habitat
sample processing		taxonomic identification
taxonomy		diatoms only, species level
Habitat assessments		visual based, performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, taxonomic proficiency checks, specimen archival, certification program for bioassessment

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index and return single metrics - use endpoint for each single metric)*
	✓	disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		reference data set used to set bounds for metrics - percent will vary with metric
defining impairment in a multimetric index		reference data set used to set bounds for metrics - percent will vary with metric
Evaluation of performance characteristics	✓	repeat sampling *(seasonal, multiyear data)*
	✓	precision *(to look for subtle differences in water quality)*
	✓	sensitivity *(different teams sample the same site)*
	✓	bias *(overlap sites with different crews)*
	✓	accuracy *(compare bioassessments with chemical & toxicity data)*
Biological data		
Storage		Fourth Dimension used for benthos data, MS Access used for fish and phytoplankton data
Retrieval and analysis		In house database

NORTH DAKOTA



Contact Information

Michael J. Ell, Environmental Scientist
North Dakota Department of Health (NDHD)
1200 Missouri Avenue, P.O. Box 5520 ■ Bismarck, ND 58506
Phone 701/328-5214 ■ Fax 701/328-5200
email: mell@state.nd.us
NDHD Division of Water Quality homepage: http://www.health.state.nd.us/ndhd/environ/wq/

Program Description

The primary goal of North Dakota's biological monitoring and assessment program is to develop a set of scientifically defensible ecological indicators that can be used to assess the extent to which the state's rivers and streams are meeting their designated aquatic life uses. Once developed, these indicators can also be used to set restoration goals when developing total maximum daily loads (TMDLs) and/or Section 319 nonpoint source pollution project implementation plans.

The North Dakota Department of Health (NDHD) initiated its biological monitoring and assessment program in 1993 and 1994 as part of an interagency project to develop a multimetric index of biological integrity (IBI) for fish in the Lake Agassiz Plain ecoregion, Red River of the North Basin. In addition to the Department of Health, other agencies involved in the project were the Minnesota Pollution Control Agency, Minnesota Department of Natural Resources, EPA Region V, and the USGS – Red River National Water Quality Assessment (NAWQA) project team. The project resulted in a 12 metric IBI for fish which distinguished among headwater, moderate, and large sized rivers.

Since 1995, NDHD has conducted biological monitoring in each of the state's four major river basins. The Department's biological monitoring and assessment efforts continued in the Red River of the North Basin in 1995 and 1996. In addition to fish, the Department began sampling macroinvertebrates in 1995. In 1997 and 1998, monitoring and assessment efforts were expanded to the Souris River and James River basins, respectively, and in 1999 and 2000 the Department sampled the Missouri River Basin. In addition to fish and macroinvertebrate samples collected at each site, NDHD also conducted a habitat assessment following EPA's Rapid Bioassessment Protocol.

Preliminary multimetric IBIs have been developed for fish and macroinvertebrates in the Red River Basin and for fish in the Souris River Basin. These IBIs have been used to assess aquatic life use support for the 2000 Section 305(b) report. As these IBIs are refined and as additional IBIs are developed for the remaining river basins, it is the Department's intent to include these biological assessments in future Section 305(b) reports as well as in the development of Section 303(d) TMDL lists.

NDHD is currently collaborating with North Dakota State University and EPA Region VIII in a two year pilot project to evaluate the response of the benthic periphyton community to varying summer growing season nutrient levels with the goal of developing regional nutrient criteria. Based on the results of this pilot project, NDHD may include periphyton in future biological monitoring and assessment activities, especially in relation to nutrient enrichment and eutrophication.

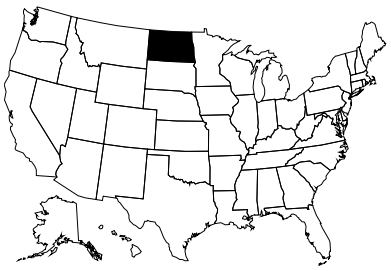
The Department is also a collaborator with EPA in the EMAP Western Pilot Project. The EMAP Western Pilot is currently in the third year of a four year project. By collaborating in this 12 state project, the Department hopes to integrate EMAP sampling design as well as EMAP sampling protocols into future biological monitoring and assessment projects. When NDHD's commitment to this project is completed in 2004, it's the Department's plan to begin its rotating basin monitoring program with the Red River Basin.

Documentation and Further Information

North Dakota Water Quality Assessment 1998 - 1999, 2000 305(b) Report:
http://www.health.state.nd.us/ndhd/environ/wq/2000_305b/2000_305b.pdf

For links to numerous NDHD surface water quality/management publications, including *Standards of Quality for Waters of the State, Chapter 33-16-02* and *North Dakota Unified Watershed Assessment, FY1999*, go to:
http://www.health.state.nd.us/ndhd/environ/wq/

NORTH DAKOTA



Contact Information

Michael J. Ell, Environmental Scientist
North Dakota Department of Health (NDHD)
1200 Missouri Avenue, P.O. Box 5520 ■ Bismarck, ND 58506
Phone 701/328-5214 ■ Fax 701/328-5200
email: mell@state.nd.us

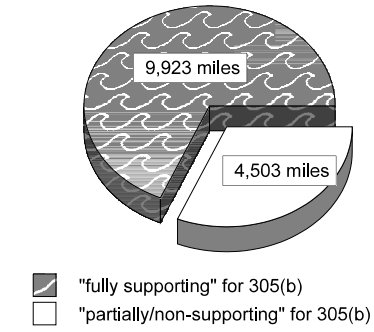
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
		fixed station (i.e., water quality monitoring stations)
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(specific river basins or watersheds)*
		other:

Stream Miles

Total miles *(determined using RF3)*	**54,427**
Total perennial miles	unknown
Total miles assessed for biology*	**14,426**
fully supporting for 305(b)	9,923
partially/non-supporting for 305(b)	4,503
listed for 303(d)	–
number of sites sampled *(on an annual basis)***	150
number of miles assessed per site	–

14,426 Miles Assessed for Biology



*Both stream and river miles were assessed for biological, chemical and physical effects. As reported in ND's 2000 305(b) report, approximately 68.8 percent (9,923 miles) of rivers and streams assessed for this report fully support the beneficial use designated as aquatic life. The remaining 31.2 percent of rivers and streams (4,503 miles) either partially supporting or did not support their aquatic life uses.

**According to ND's 2000 305(b) report, "In 1997, 1998, and 1999, the department focused its intensive basin survey efforts on the Souris River Basin, the James River Basin, and the Lake Sakakawea subbasin, respectively. In addition to chemical monitoring, biological monitoring was conducted at approximately 50 sites in each basin each year."

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Single Aquatic Life Use	
ALU designations in state water quality standards	North Dakota has several classes described (Class I, Ia, II, and III) but the ALU is basically the same for all classes.	
Narrative Biocriteria in WQS	A narrative biological goal is contained in ND's water quality standards. There are no formal/informal numeric procedures used to support narrative biocriteria.	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
		permitted discharges
		monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Nonpoint source project implementation plans	

Reference Site/Condition Development

Number of reference sites	**~75 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria	Reference sites are the best sites of the whole population sampled, determined by habitat condition of sites and fish IBI.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
	✓	stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: river basin
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

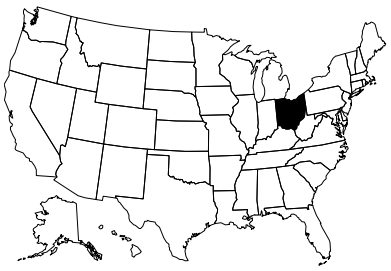
Field and Lab Methods

Assemblages assessed	✓	benthos *(100 - 500 samples/year; single season, multiple sites - watershed level)*
	✓	fish *(<100 samples/year; single season, multiple sites - watershed level)*
	✓	periphyton *(<100 samples/year; multiple seasons, multiple sites - broad coverage for watershed level)*
		other:
Benthos		
sampling gear	D-frame; 500-600 micron mesh	
habitat selection	multihabitat	
subsample size	300 count	
taxonomy	lowest practical, usually genus	
Fish		
sampling gear	boat and longline electrofishers, pram unit (tote barge)	
habitat selection	multihabitat	
sample processing	length measurement, biomass - batch, anomalies	
subsample	none	
taxonomy	species	
Periphyton		
sampling gear	**natural substrate**: suction device	
habitat selection	riffle/run (cobble)	
sample processing	taxonomic identification	
taxonomy	diatoms only	
Habitat assessments	visual based and hydrogeomorphology; performed with bioassessments	
Quality assurance program elements	standard operating procedures, quality assurance plan and specimen archival	

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(multimetric index under development)*
	✓	disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores	95th percentile of all sites	
defining impairment in a multimetric index	"power analysis"	
Evaluation of performance characteristics	✓	repeat sampling *(replicate sampling within and among years)*
		precision
		sensitivity
		bias
		accuracy
Biological data		
Storage	Fish and habitat assessment data are in an MS Access 97 database maintained by the Department. Macroinvertebrate data are in EDAS.	
Retrieval and analysis	Macroinvertebrate data are analyzed by EDAS, and plots generated by SAS. Fish data are analyzed with queries developed in-house.	

OHIO



Contact Information

Jeffrey E. DeShon, Acting Manager - Ecological Assessment Section
Ohio Environmental Protection Agency (OHEPA)
4675 Homer Ohio Lane ■ Graveport, OH 43125
Phone 614/836-8780 ■ Fax 614/836-8795
email: jeff.deshon@epa.state.oh.us
OHEPA Division of Surface Water,Statewide Biological and Water Quality Monitoring and Assessment homepage: http://www.epa.state.oh.us/dsw/bioassess/ohstrat.html

Program Description

The Ohio EPA has been sampling biological communities in Ohio streams and rivers with standardized sampling protocols since the mid 1970s. Biological criteria was incorporated into the Ohio water quality standards (WQS; Ohio Administrative Code 3745-1) regulations in February 1990 (effective May 1990). These criteria consist of numeric values for the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), both of which are based on fish assemblage data, and the Invertebrate Community Index (ICI), which is based on macroinvertebrate assemblage data. Criteria for each index are specified for each of Ohio's five ecoregions (as described by Omernik 1987), and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the existing chemical and whole effluent toxicity evaluation methods and criteria, figure prominently in the monitoring and assessment of Ohio's surface water resources.

Ohio EPA employs biological, chemical, and physical monitoring and assessment techniques in biosurveys in order to meet three major objectives: 1) determine the extent to which use designations assigned in the Ohio WQS are either attained or not attained; 2) determine if use designations assigned to a given waterbody are appropriate and attainable; 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 best management practices. Biosurvey data are processed, evaluated, and synthesized in a biological and water quality report. Each biological and water quality study contains a summary of major findings and recommendations for revisions to WQS, future monitoring needs, or other actions that may be needed to resolve existing impairment of designated uses. While the principal focus of a biosurvey is on the status of aquatic life uses, the status of other uses such as recreation and water supply, as well as human health concerns, are also addressed.

Documentation and Further Information

Year 2000 Ohio Water Resource Inventory, 305(b) Report: http://www.epa.state.oh.us/dsw/documents/Ohio305B2000.pdf

FWPCA Section 303(d) TMDL Priority List for FFY 1999-2000: http://www.epa.state.oh.us/dsw/tmdl/303dnotc.html

The State of the Aquatic Ecosystem: Ohio Rivers and Streams, 1998 Status: http://www.epa.state.oh.us/dsw/documents/fs8mas98.pdf

The Role of Biological Criteria in Water Quality Monitoring, Assessment, and Regulation, 1995: http://www.epa.state.oh.us/dsw/documents/instbusl.pdf

Using Biological Criteria to Validate Applications of Water Quality Criteria: Dissolved and Total Recoverable Metals, February 1997: http://www.epa.state.oh.us/dsw/documents/gli_bio.pdf

Rankin, E.T. 1989. *The qualitative habitat evaluation index (QHEI): rationale, methods, and application*. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

Biological and Water Quality Reports, list of documents: http://www.epa.state.oh.us/dsw/document_index/psdindx.html

Biocriteria manuals are currently only available as hard copies upon emailed or written request. Information on obtaining copies can be found at http://www.epa.state.oh.us/dsw/document_index/printdoc.html. The biocriteria manuals are titled as follows:

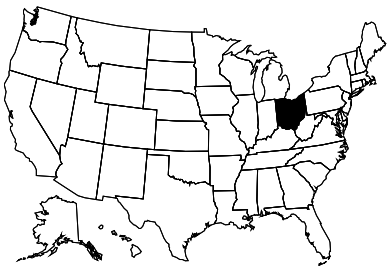
Ohio Environmental Protection Agency. 1987a. *Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment*. Division of Water Quality Monitoring & Assessment, Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1987b. *Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters*. Division of Water Quality Monitoring & Assessment, Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989b. *Addendum to Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters*. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989c. *Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities*. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

OHIO



Contact Information

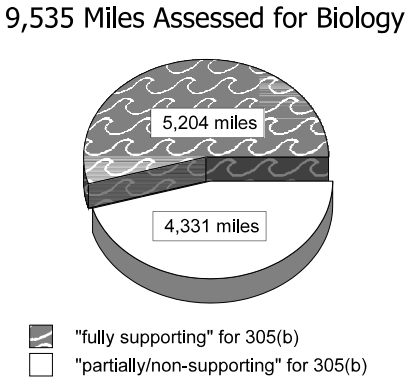
Jeffrey E. DeShon, Acting Manager - Ecological Assessment Section
Ohio Environmental Protection Agency (OHEPA)
4675 Homer Ohio Lane ■ Graveport, OH 43125
Phone 614/836-8780 ■ Fax 614/836-8795
email: jeff.deshon@epa.state.oh.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALUS determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects, specific river basins or watersheds, and comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(specific river basins or watersheds)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(special projects, specific river basins or watersheds, and comprehensive use throughout jurisdiction)*
	✓	other: geometric design *(specific river basins or watersheds and comprehensive use throughout jurisdiction)*

Stream Miles

Total miles *(based on the USEPA RF3 map of perennial stream miles as determined for Ohio)*	**29,113**
Total perennial miles	29,113
Total miles assessed for biology	**9,535**
fully supporting for 305(b)	5,204
partially/non-supporting for 305(b)	4,331
listed for 303(d)*	2,052
number of sites sampled *(1999-2000)*	1,100
number of miles assessed per site *(1999-2000)*	2.5



*The 2,052 miles are from Ohio's 1998 303(d) list, which is based on the 1996 305(b) statistics and includes data collected through 1994. OHEPA has recently taken a different approach to assessment and listing that will be reflected in upcoming 303(d) listings. The Agency now discourages the use of attainment statistics based on monitored stream miles in favor of a watershed level approach that provides an indication of the attainment status of watersheds in total (in essence, a measure of square miles of watersheds fully, partially, or not supporting ALU).

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis		Class System (A,B,C) - Tiered
ALU designations in state water quality standards		Seven designations: Warmwater Habitat, Exceptional Warmwater Habitat, Coldwater Habitat, Modified Warmwater Habitat, Seasonal Salmonid, Limited Warmwater Habitat (being phased out), Limited Resource Water
Narrative Biocriteria in WQS		Procedures used to support narrative biocriteria located in Ohio WQS, http://www.epa.state.oh.us/dsw/rules/3745-1.html
Numeric Biocriteria in WQS		Also found in Ohio WQS, see above link
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU		There are many instances where bioassessments documented before and after conditions based on POTW improvements. Biosurvey data and biocriteria thresholds are the primary arbiters in the determination of aquatic life use attainment status; results are used to determine 305(b) aquatic life use attainment statistics and to drive the 303(d) listing/delisting and TMDL development process.

Reference Site/Condition Development

Number of reference sites		**500 total** (including modified reference sites)
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria*		Representative of best watershed conditions within an ecoregion given the background activities prevalent in society.
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
	✓	reference sites/condition referenced in water quality standards *(listed in Biocriteria Manuals, which are referenced in WQS)*
	✓	some reference sites represent acceptable human-induced conditions

*All reference sites were originally screened to eliminate sites with evidence of substantial human disturbance. This was accomplished by examining maps of human population density and current and past land uses, compiling a watershed disturbance ranking, and noting the size and location of point source discharges. Additional site-specific factors considered in the selection of a reference site included (1) the amount, if any, of stream channel modification, (2) the condition of the vegetative riparian buffer zone, (3) water volume, (4) channel morphology characteristics, (5) substrate character and condition, (6) presence of obvious color/odor problems, (7) amount of instream woody debris, and (8) the general representativeness of the site within the ecoregion.

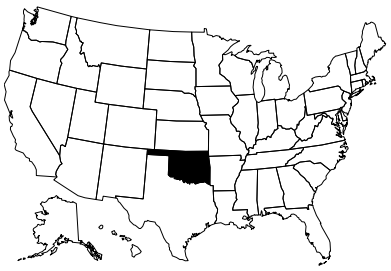
Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - broad coverage)*
	✓	fish *(100-500 samples/year; single season, multiple sites - broad coverage)*
		periphyton
		other:
Benthos		
sampling gear		collect by hand, multiplate: 200-400 micron mesh
habitat selection		multihabitat and artificial substrate
subsample size		entire sample (presort with subsampling)
taxonomy		combination (lowest practical with current knowledge)
Fish		
sampling gear		backpack electrofisher (in small streams only), boat electrofisher, pram unit (tote barge), and longline method using electrofishing unit and 100 meter line
habitat selection		multihabitat
sample processing		biomass - individual and batch, anomalies
subsample		batch (for weight only)
taxonomy		species
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, taxonomic proficiency checks, specimen archival, and a certification program for bioassessment has been developed for the OHEPA Voluntary Action Program (i.e., Brownfields Redevelopment)

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		95th percentile of reference population
defining impairment in a multimetric index		25th percentile of reference population (ecoregion Warmwater Habitat and Modified Warmwater Habitat); 75th percentile of reference population (statewide Exceptional Warmwater Habitat); EPA RBP Guidelines
Evaluation of performance characteristics	✓	repeat sampling *(many sites - including reference sites - with multiple-year collections to track temporal variability)*
	✓	precision *(multiple samples occasionally collected from the same site on the same date, especially at potential litigation sites)*
	✓	sensitivity *(studies have been done to determine the possible range of variation in index scores at a given sampling location on a given sampling date)*
		bias
		accuracy
Biological data		
Storage		In initial stages of modernization and migration to MS Access
Retrieval and analysis		Custom programs to calculate indices, other summarized data, 305(b) statistics, etc.

OKLAHOMA



Contact Information

Charles Potts, Senior Environmental Specialist
Oklahoma Water Resources Board (OWRB)
3800 North Classen ■ Oklahoma City, OK 73118
Phone 405/530-8800 ■ Fax 405/530-8900
email: capotts@owrb.state.ok.us
OWRB homepage: http://www.owrb.state.ok.us/

Program Description

The Oklahoma Water Resources Board (OWRB) has many monitoring programs. In 1998, the State Legislature directed the OWRB to oversee certain state water quality monitoring activities to determine compliance with Oklahoma's Water Quality Standards (OWQS). Specifically, the OWRB was charged with coordinating all monitoring under a standing cooperative agreement with the USGS, conducting a Comprehensive Beneficial Use Monitoring Program (BUMP), and developing Use Support Assessment Protocols (USAPS) to ensure the consistent data interpretation of beneficial use support. The overall goal of BUMP is to document beneficial use impairments, identify impairment sources (if possible), detect water quality trends, provide needed information for the OWQS and facilitate the prioritization of pollution control activities. River and stream monitoring is one of five key elements of BUMP.

So far, OWRB's biological monitoring is related only to special projects, such as biocriteria development or the occasional fish tissue study. However, BUMP is a developing program and there is intent to expand biological monitoring in the near future. Presently, there are fixed and rotating stations at which chemistry and flow information may be collected. The OWRB is currently monitoring almost 200 sites on a monthly basis. These sites are segregated into two discrete types of monitoring activities. The first monitoring activity is focuses on fixed station monitoring on rivers and streams. In general, at least one sample station is located in each of 67 watersheds. Following consultation with other appropriate state environmental agencies, the OWRB originally identified 84 fixed sites; that number has now grown to 100. The second component of river and stream monitoring focuses on water quality sampling stations whose location will rotate on an annual basis. Stations and identified monitoring parameters were based upon Oklahoma's 303(d) list and the monitoring requirements of other state environmental agencies. Monitoring parameters are specific for each stream segment.

Oklahoma DEQ's fish monitoring program has been discontinued but provided a wealth of information concerning statewide fish distribution. Improvements in Oklahoma's water quality monitoring programs are being developed and implemented in order to provide more consistent and reliable information related to the condition of aquatic resources (including quality habitat alteration, and impacts of polluted runoff and point source discharges). Unfortunately, much of the monitoring information in Oklahoma is fragmentary and incompatible because it is collected through programs that are designed and conducted for differing objectives.

Documentation and Further Information

The State of Oklahoma Water Quality Assessment Report, 2000 Edition, November 2000:
http://www.deq.state.ok.us/WQDnew/305b_303d/2000_305b_Report_Final.pdf

Status of Water Quality Monitoring in Oklahoma, 2000 Final Report to the Oklahoma Legislature:
www.owrb.state.ok.us/reports/OkWqStatus2000.pdf

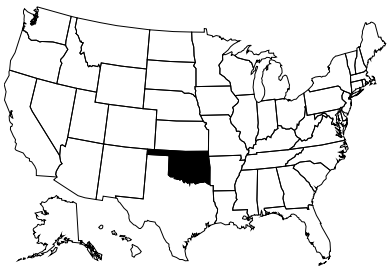
Oklahoma Water Resources Board, Chapter 46 of Implementation of Oklahoma's WQS, effective August 2001:
http://www.owrb.state.ok.us/rules/Chap46.pdf

SOP for Field Sampling Efforts of the OK Water Resources Board Beneficial Use Monitoring Program, June 2001:
http://www.owrb.state.ok.us/reports/BUMP_SOPFY-01.pdf

Oklahoma's Nonpoint Source Management Program and Nonpoint Source Assessment Report, FINAL DRAFT:
http://www.okcc.state.ok.us/Divisions/Water_Quality/Reports/REPORT078.pdf

Conduct your own "Biological Monitoring" search for additional documents using: http://www.soonersearch.odl.state.ok.us/

OKLAHOMA



Contact Information

Charles Potts, Senior Environmental Specialist
Oklahoma Water Resources Board (OWRB)
3800 North Classen ■ Oklahoma City, OK 73118
Phone 405/530-8800 ■ Fax 405/530-8900
email: capotts@owrb.state.ok.us

Programmatic Elements

Uses of bioassessment within overall water quality program*		problem identification (screening)
		nonpoint source assessments
		monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
		TMDL assessment and monitoring
		other:
Applicable monitoring designs		targeted (i.e., sites selected for specific purpose)
		fixed station (i.e., water quality monitoring stations)
		probabilistic by stream order/catchment area
	✓	probabilistic by ecoregion, or statewide *(comprehensive use throughout jurisdiction)*
		rotating basin
		other:

*Several possibilities exist, but currently only use-support decisions and use assignments are done with bioassessments.

Stream Miles

Total miles *(State based determination - waterbody identifications)*	**78,778**
Total perennial miles	22,386
Total miles assessed for biology	**13,313**
fully supporting for 305(b)**	–
partially/non-supporting for 305(b)**	–
listed for 303(d)**	–
number of sites sampled	3,391
number of miles assessed per site	~4 (site specific)

**Much of Oklahoma's efforts are still in the development stages. The new 305(b) and 303(d) are not complete and there have been significant changes in protocol since last completed; thus the data from past reports are no longer relevant. The new 305(b) and 303(d) reports should be complete sometime in 2002.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	ALU subcategories	
ALU designations in state water quality standards	Habitat Limited Aquatic Community (least restrictive), Warm Water A.C., Cool Water A.C. (most restrictive), Trout Fishery (anti-degradation limitation)	
Narrative Biocriteria in WQS	Formal/informal numeric procedures used to support narrative biocriteria exist for specific ecoregions only.	
Numeric Biocriteria in WQS	Only for specific ecoregions; biological use-support thresholds found in 785:46-15 (WQS implementation).	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
		cause and effect determinations
		permitted discharges
		monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	none	

Reference Site/Condition Development

Number of reference sites	**66 - 132 total** (will increase as number of ecoregions are completed)	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
		professional judgment
	✓	other: least impacted, no point sources
Reference site criteria	Reference sites are defined by the least impacted version of a stream type in a particular ecoregion. Specific criteria is under development.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
	✓	stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

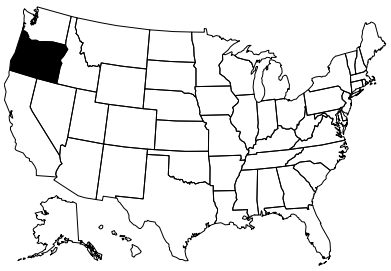
Field and Lab Methods

Assemblages assessed	✓	benthos *(<100 samples/year; single observation, limited sampling*)
	✓	fish *(<100 samples/year; single observation, limited sampling*)
		periphyton
		other:
Benthos		
sampling gear		dipnet, kick net (1 meter); 500-600 micron mesh
habitat selection		riffle/run (cobble) and woody debris
subsample size		100 count
taxonomy		genus
Fish		
sampling gear		backpack electrofisher, seine; 1/4" mesh
habitat selection		all habitats contained within the "representative" reach of 200 - 400 meters
sample processing		anomalies and taxonomic identification
subsample		none
taxonomy		species
Habitat assessments		quantitative measurements; performed independent of bioassessments (see *Oklahoma Water Resource Board Technical Report 99-3* for more information)
Quality assurance program elements		standard operating procedures, quality assurance plan, taxonomic proficiency checks and specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		cumulative distribution function (ecoregion dependent)
defining impairment in a multimetric index		cumulative distribution function (ecoregion dependent)
Evaluation of performance characteristics	✓	repeat sampling *(site validation collections and habitat assessments)*
		precision
		sensitivity
		bias
		accuracy
Biological data		
Storage		MS Access and/or Excel formats
Retrieval and analysis		application dependent, spreadsheet driven (no large statistical treatment yet); in the process of pulling existing data from other agencies to help develop a program

OREGON



Contact Information

Rick Hafele, Manager - Biomonitoring Section
Oregon Department of Environmental Quality (ORDEQ)
2020 SW 4th Avenue, Suite 400 ■ Portland, OR 97201
Phone 503/229-5349 ■ Fax 503/229-6957
email: hafele.rick@deq.state.or.us
ORDEQ Water Quality Program homepage: http://www.deq.state.or.us/wq/

Program Description

Oregon DEQ (ORDEQ) has a history of using biological data in water quality assessments. Since the early 1990's the biomonitoring program has grown from two full time staff to nine current permanent staff, and over 15 during the summer field season. The principle objectives of the biomonitoring program are to:

- Assess the status of stream conditions and fish and macroinvertebrate assemblages across the state,
- Identify trends in stream conditions and biological assemblages,
- Identify the primary chemical and physical parameters impairing biological assemblages,
- Assess the effectiveness of restoration projects and management activities designed to improve stream conditions, and
- Help standardize protocols for biological assessments throughout the state and region

Increased concern over nonpoint sources of pollution and the listing of numerous salmon species as threatened or endangered has focused more attention on the importance of biological information in the State. In 1991 Oregon DEQ adopted narrative biocriteria into state water quality standards. ORDEQ is currently developing numeric biocriteria and expects to have numeric standards adopted by 2004.

Most biological data are collected using a probabilistic sampling design. A reference site network is also being developed and sampled. ORDEQ has worked closely with EPA and other state agencies in developing its monitoring strategy. Over 400 sites have been sampled for biological, chemical and physical parameters (approximately 150 sites per year). Currently biological data are incorporated into the State's 305(b) report and 303(d) list. Other biological data are used in NPDES permit assessments, CWA Section 401 permit applications, and beneficial use assessments.

Maintaining a commitment to long-term funding is one of the primary challenges of any state monitoring effort. Data management and data quality are also key issues that require ongoing efforts to maintain an effective program. Finally, integrating biological data into the overall water quality program (i.e. TMDLs) is an ongoing challenge and an area for improvement in the future. To view current ORDEQ biomonitoring technical reports, go to: http://www.deq.state.or.us/lab/Biomon/bio_rpt.htm

Documentation and Further Information

Oregon's 2000 Water Quality Status Assessment Report, Section 305(b) Report:
http://www.deq.state.or.us/wq/305bRpt/305bReport00a.pdf

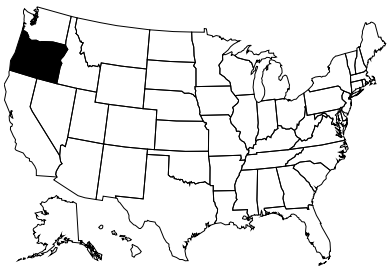
ORDEQ Water Quality Limited Streams 303(d) List information (including Listing Criteria, etc.):
http://www.deq.state.or.us/wq/303dlist/303dpage.htm

Oregon Water Quality Standards homepage: http://www.deq.state.or.us/wq/standards/wqstdshome.htm

Quality Assurance Guidelines:
http://www.deq.state.or.us/lab/qa/NPDES%20and%20WPCF%20Self-Monitoring%20Laboratories.pdf

Mrazik, S. 1999. *Reference site selection: a six step approach for selecting reference sites for biomonitoring and stream evaluation studies*. Oregon Department of Environmental Quality, Biomonitoring Section.

OREGON



Contact Information

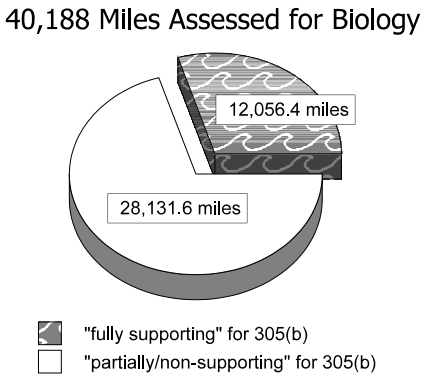
Rick Hafele, Manager - Biomonitoring Section
Oregon Department of Environmental Quality (ORDEQ)
2020 SW 4th Avenue, Suite 400 ■ Portland, OR 97201
Phone 503/229-5349 ■ Fax 503/229-6957
email: hafele.rick@deq.state.or.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
	✓	other: 401 permits and restoration effectiveness monitoring
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
		fixed station (i.e., water quality monitoring stations)
	✓	probabilistic by stream order/catchment area *(specific river basins or watersheds)*
	✓	probabilistic by ecoregion, or statewide *(comprehensive use throughout jurisdiction)*
		rotating basin
		other:

Stream Miles

Total miles *(determined using RF3 and National Hydrography Database)*	**114,823**
Total perennial miles	51,695
Total miles assessed for biology*	**40,188**
fully supporting for 305(b)	12,056.4
partially/non-supporting for 305(b)	28,131.6
listed for 303(d)**	unknown
number of sites sampled *(on an annual basis)****	150+
number of miles assessed per site	–



*Most of the biological monitoring is based on a probabilistic sampling design in order to calculate the total stream miles represented by the data.

**ORDEQ is in the process of drafting a new 303(d) list (as of March 2002). If ORDEQ were to provide data based on past 303(d) lists, the number of miles listed would be considerably smaller than the 28,131 miles that are "partially/non-supporting" for 305(b) because 303(d) lists are *not* based on a probabilistic sampling design.

***Over 400 total sites have been sampled.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Fishery Based Uses	
ALU designations in state water quality standards	Four designations: Salmonid Passage; Salmonid rearing; Salmonid spawning; Protection of resident fish and aquatic life	
Narrative Biocriteria in WQS	applied using a numeric approach found in 303(d) listing criteria, http://www.deq.state.or.us/wq/303dlist/303dpage.htm	
Numeric Biocriteria in WQS	under development	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	The best example is a stream restoration project in Eastern Oregon that is trying to restore habitat and water quality to support salmonid spawning and rearing. Bioassessment data have been an ongoing part of this project's evaluation.	

Reference Site/Condition Development

Number of reference sites	**200 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
	✓	other: see criteria below
Reference site criteria	Reference sites must fall into the lowest level of human disturbance based on a set of GIS information and field results including land use, road density and habitat (GIS data and best professional judgment are used to identify 5th field watersheds with minimal human disturbance). Once potential watersheds have been identified, stream monitoring sites are randomly selected from within those watersheds. Field reconnaissance confirms if they are suitable reference sites.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
	✓	other: minimally disturbed*
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
	✓	elevation
	✓	stream type
	✓	multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: gradient; latitude and longitude; conductivity; watershed area
Additional information		reference sites linked to ALU
	✓	reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

*Oregon has three classes of reference sites: A - Sites with no human disturbance. These sites represent "natural" conditions and are generally found in wilderness areas or very remote regions of the state, B - Sites with minimal human disturbance. These sites represent conditions expected to occur without or with very minimal human activity, and C - Sites with human disturbance that measurably alters stream conditions. These are the best available (least disturbed) sites.

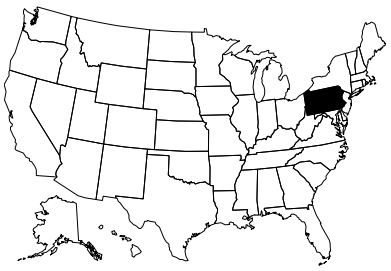
Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - broad coverage)*
	✓	fish *(100-500 samples/year; single season, multiple sites - broad coverage)*
	✓	periphyton *(<100 samples/year; single season, multiple sites - watershed level) NOTE: ORDEQ samples periphyton for some projects, but not at the majority of sites.*
	✓	other: amphibians and reptiles *(100-500 samples/year; single season, multiple sites - broad coverage)*
Benthos		
sampling gear		D-frame; 500-600 micron mesh
habitat selection		riffle/run (cobble)
subsample size		500 count
taxonomy		combination - typically genus/species. A regional (multistate) taxonomy workgroup meets to set taxonomic level standards.
Fish/Amphibians		
sampling gear		backpack electrofisher
habitat selection		multihabitat
sample processing		length measurement and anomalies
subsample		none
taxonomy		species
Periphyton		
sampling gear		**natural substrate**: brushing/scraping device (razor/toothbrush, etc.)
habitat selection		riffle/run (cobble)
sample processing		taxonomic identification
taxonomy		all algae
Habitat assessments		quantitative measurements; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, and specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
	✓	disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		25th percentile of reference population
defining impairment in a multimetric index		Cumulative distribution function
Multivariate thresholds		
defining impairment in a multivariate index		Significant departure from mean of reference population
Evaluation of performance characteristics	✓	repeat sampling *(a minimum of 10% of sites are sampled twice each field season)*
	✓	precision *(Signal-to-noise analysis)*
	✓	sensitivity *(Multivariate model sensitivity checked by rerunning model on subset of reference sites)*
		bias
		accuracy
Biological data		
Storage		Data are stored in an agency database using MS Access. Macroinvertebrate data are also being stored in a regional database (multi-agency and multi-state).
Retrieval and analysis		SAS and Statistica

PENNSYLVANIA



Contact Information

Daniel Bogar, Water Pollution Biologist II
Pennsylvania Department of Environmental Protection (PA DEP)
P.O. Box 8467 ■ Harrisburg, PA 17105-8467
Phone 717/787-9637 ■ Fax 717/772-3249
email: dbogar@state.pa.us
PA DEP Office of Water Management homepage:
http://www.dep.state.pa.us/dep/deputate/watermgt/watermgt.htm

Program Description

The basics of Pennsylvania's current water quality monitoring program began in the late 1960s and has included elements of bioassessment in some form since its inception. The primary objectives of the water quality monitoring program are to define surface water quality status and trends and to evaluate compliance with discharge permit limits.

The State of Pennsylvania uses biological assessments in several program areas. The Statewide Surface Water Assessment Program (SSWAP), started in 1997, was developed to assess all 83,000 miles of streams in the state. The first comprehensive statewide assessment is scheduled for completion by 2007. After five seasons, approximately two thirds of Pennsylvania's surface waters have been assessed. Assessments are based on an evaluation of the instream habitat and macroinvertebrate community composition. All assessed streams are determined to be either impaired or unimpaired and a source and cause is listed for the former. These data are compiled into an MS Access database and GIS stream layer that is updated yearly and submitted to USEPA as part of the 305(b) report. Impaired reaches are placed on the 303(d) list and scheduled for follow-up TMDLs. Due to increasing complexities in the TMDL program, the assessment field methodology will be refined and enhanced in order to satisfy data needs for TMDL development.

Pennsylvania's Antidegradation Program also uses biological assessments based on a modified version of USEPA's Rapid Bioassessment Protocols (RBP) methodology to define aquatic life use designations of candidate streams. Biological samples are collected, subsampled, identified, and selected metrics are generated and analyzed. Candidate streams are compared to reference streams to determine if they qualify for designation as High Quality or Exceptional Value Waters. To alleviate the problem of site-specific reference site variability, staff biologists are currently working to develop a set of regionalized Reference Condition scores that can be compared to candidate streams.

Biological assessments are also an important component of the Surface Water Quality Monitoring Network (WQN). Biological samples are collected at 26 fixed stations three times per year (spring, summer, and fall) and once a year (summer) at 123 additional stations using the same RBP methodology referenced above. These data, in conjunction with bimonthly water chemistry samples, are used to monitor long-term trends in water quality on the major streams in the Commonwealth.

Fish are collected at approximately 35 WQN stations each year. Fillets from these fish are analyzed for contaminants such as heavy metals and pesticides. This tissue analysis is used to generate consumption advisories for fish living in any contaminated surface waters.

In order to more effectively meet its water quality objectives, Pennsylvania has fostered several cooperative bioassessment partnerships. Through contracts with the PA DEP, the Pennsylvania Fish and Boat Commission (PFBC), Susquehanna River Basin Commission (SRBC), and Interstate Commission on the Potomac River Basin (ICPRB) assist with SSWAP assessments. The Department plans to contract with the USGS to collect WQN samples. There are also cooperative efforts with citizen monitoring groups for water quality monitoring data collection and 305(b) reporting purposes.

While Pennsylvania's bioassessment efforts have increased in recent years (Statewide Surface Waters Assessment program), additional bioassessment challenges are being tackled. Department biologists are currently working to develop fish-based bioassessment methodologies for larger streams, refine lake assessments for 303(d) reporting purposes, and bioassessments of specialized habitats; such as limestone, glide/pool dominated, and non-wadeable waters.

Documentation and Further Information

Commonwealth of Pennsylvania 2000 Water Quality Assessment 305(b) Report:
http://www.dep.state.pa.us/dep/deputate/watermgt/Wqp/WQStandards/305_wq2000_narr.htm

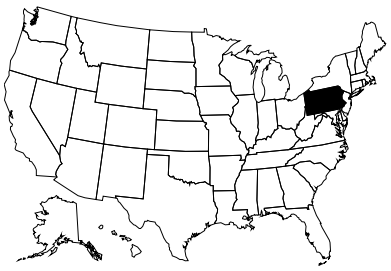
Commonwealth of Pennsylvania 2001 305(b) UPDATE:
http://www.dep.state.pa.us/dep/deputate/watermgt/Wqp/WQStandards/305_wq2001_narr.htm

DRAFT 2002 Section 303(d) Report, List of Impaired Waterbodies, June 2002:
http://www.dep.state.pa.us/dep/deputate/watermgt/Wqp/WQStandards/303d-Report.htm

Pennsylvania's Surface Water Quality Monitoring Network (WQN), revised 2001:
http://www.dep.state.pa.us/dep/deputate/watermgt/wqp/wqstandards/Facts/BK0636-1.pdf

Water Quality Assessment and Standards Fact Sheets:
http://www.dep.state.pa.us/dep/deputate/watermgt/wqp/wqstandards/Facts/Pubs-c.htm

PENNSYLVANIA



Contact Information

Daniel Bogar, Water Pollution Biologist II
Pennsylvania Department of Environmental Protection (PA DEP)
P.O. Box 8467 ■ Harrisburg, PA 17105-8467
Phone 717/787-9637 ■ Fax 717/772-3249
email: dbogar@state.pa.us

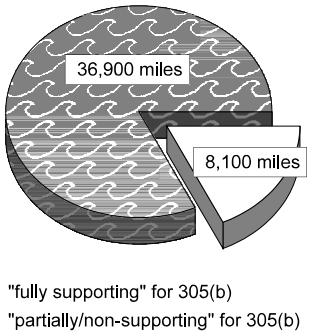
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(special projects only)*
		other:

Stream Miles

Total miles *(determined using 1/24,000 scale streams GIS coverage)*	**83,000**
Total perennial miles	–
Total miles assessed for biology	**45,000**
fully supporting for 305(b)	36,900
partially/non-supporting for 305(b)	8,100
listed for 303(d)	8,100
number of sites sampled	7,435
number of miles assessed per site*	–

45,000 Miles Assessed for Biology



*Stations are placed at the mouths of major tributaries and on mainstems; towns are bracketed (upstream/downstream) depending on landuse observed while in field.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Fishery Based Uses	
ALU designations in state water quality standards	Four designations: Cold water fishes, Warm water fishes, Migratory fishes, Trout stocking	
Narrative Biocriteria in WQS	none - Antidegradation protocols used to support general aquatic life standard are under development, not statutory - found in Chapter 93 of Statutory Code.	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	none	

Reference Site/Condition Development

Number of reference sites	**~100 total**	
Reference site determinations		site-specific
	✓	paired watersheds
	✓	regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria	Based on stream classification in the antidegradation program, land use, and habitat: primarily forested, no water quality criteria violations, excellent habitat, and minimal siltation.	
Characterization of reference sites within a regional context		historical conditions
		least disturbed sites
		gradient response
		professional judgment
	✓	other: minimally disturbed
Stream stratification within regional reference conditions		ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: drainage area, land use, use designations, gradient, size and other regionalization other than ecoregion
Additional information	✓	reference sites linked to ALU
		reference sites/condition referenced in water quality standards
		some reference sites represent acceptable human-induced conditions

Field and Lab Methods

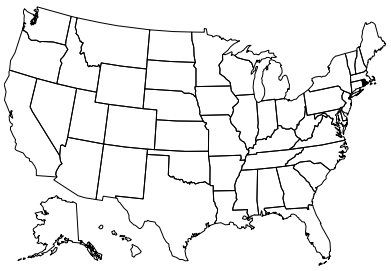
Assemblages assessed	✓	benthos *(100-500 samples/year; multiple seasons, multiple sites - broad coverage for watershed level)*
	✓	fish* *(<100 samples/year; single season, multiple sites - not at watershed level)*
		periphyton
	✓	other: phytoplankton *(<100 samples/year; single season, multiple sites - not at watershed level)*
Benthos		
sampling gear		multiplate, D-frame and kick net (1 meter); >800 micron mesh
habitat selection		riffle/run (cobble)
subsample size		100 count
taxonomy		genus
Fish*		
sampling gear		backpack and boat electrofishers
habitat selection		multihabitat
sample processing		length measurement and anomalies
subsample		none
taxonomy		species
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, taxonomic proficiency checks, specimen archival

*Pennsylvania Fish & Boat Commission provides fish data to PA DEP. For more information, contact Rick Spear, PA Fish & Boat Commission, 450 Robinson Lane, Bellefonte, PA 16823, Phone: 814/359-5233, e-mail: rspear@state.pa.us.

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(return single metrics - use endpoint for each single metric)*
	✓	disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		Still in the process of evaluating the best approach (considering 75th and 95th percentile of reference population and cumulative distribution function)
defining impairment in a multimetric index		Still in the process of evaluating the best approach (considering 75th and 95th percentile of reference population and cumulative distribution function)
Multivariate thresholds		
defining impairment in a multivariate index		In the process of evaluating the best approach
Evaluation of performance characteristics	✓	repeat sampling *(two or three separate samples in the same riffle)*
		precision
		sensitivity
		bias
		accuracy
Biological data		
Storage		MS Access
Retrieval and analysis		SAS

RHODE ISLAND



Contact Information

Robert Richardson, Senior Environmental Scientist
Rhode Island Department of Environmental Management (RIDEM)
235 Promenade Street ■ Providence, RI 02908-5767
Phone 401/222-4700 x7240 ■ Fax 401/222-3564
email: rrichard@doa.state.ri.us
RIDEM Office of Water Resources homepage:
http://www.state.ri.us/dem/programs/benviron/water/index.htm

Program Description

The importance of biological assessments in the evaluation of water quality has long been recognized in Rhode Island. Biological assessments are used to supplement physical and chemical water quality monitoring data. More specifically, the biological data can be used to identify long-term trends in water quality which reflect water pollution abatement efforts and/or needs. The Rhode Island Department of Environmental Management (RIDEM), Office of Water Resources (OWR) has two types of biological monitoring programs. Multiple plate artificial substrates have been used to evaluate the biological community in deep rivers since 1974. In addition, EPA's Rapid Bioassessment Protocol (RBP) (USEPA 1989) has been used since 1991 for the assessment of the biological integrity of various shallow river sites in the state.

Artificial Substrate Monitoring
The Fullner multiple-plate artificial substrate with 14 plates has been used by the Office of Water Resources for over 20 years to assess instream biological communities. Stations selected for this biological monitoring include those used for USGS trend chemical sampling to more closely relate chemical and biological data. This method has the advantage of providing a uniform sampling habitat for each station, thus reducing the problem caused by varying types of river bottom and depth. Macroinvertebrates collected on the artificial substrates are classified according to their tolerance of pollutants.

Rapid Bioassessment Protocol Monitoring
RBP monitoring involves an integrated assessment, comparing habitat (physical structure, flow regime) and biological measures with defined reference site conditions. Since 1992, a network of 45 stream riffle-area sites have been surveyed by Roger Williams University in cooperation with and contracted by RIDEM. Each site is visited during the spring-summer season and macroinvertebrates are sampled (minimum 100 organisms per site visit where feasible). Data are analyzed using RBP I and II protocols, which include varying degrees of field and laboratory organism identification.

The streams sampled within the state range from first order to fifth order. Eight of the streams are considered to be first order, eighteen second order, twelve third order, four fourth order and three are of the fifth order. Lower order streams are quite dependent upon the immediate characteristics of the watershed. In other words, runoff is a direct-affect component versus one of many components within a higher order stream. It is important to note that the 1993, 1995 and 1997 sampling events took place during drought conditions, which may have resulted in fewer riffles, lower dilution and lack of runoff. This probably affected the types of organisms collected and resulted in an altered picture of the stations based from that seen in other years. This information was taken into account during the evaluation of the biological assessments.

Initial bioassessment work involved establishing and field testing the RBPs in Rhode Island streams and rivers. In addition, refinement of the protocol over the past 4 years has established the presence of two sub-ecoregions within the state: coastal areas and inland areas. Incorporation of the presence of these two sub-ecoregions into selection of reference sites and application of the protocols will continue. The habitat/physical parameters and biological metrics of each station were compared to those of the selected reference station and given an overall bioassessment score.

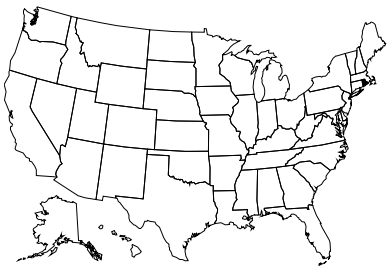
Documentation and Further Information

The State of the State's Waters Rhode Island Section 305(b) Report, September 2000:
http://www.state.ri.us/dem/pubs/305b/index.htm

State of Rhode Island 2000 303(d) List of Impaired Waters, November 2000: http://www.state.ri.us/dem/pubs/303d/303d00.pdf

Water Quality Regulations (including WQS), amended June 2000:
http://www.state.ri.us/dem/pubs/regs/REGS/WATER/h20qlty.pdf

RHODE ISLAND



Contact Information

Robert Richardson, Senior Environmental Scientist
Rhode Island Department of Environmental Management (RIDEM)
235 Promenade Street ■ Providence, RI 02908-5767
Phone 401/222-4700 x7240 ■ Fax 401/222-3564
email: rrichard@doa.state.ri.us

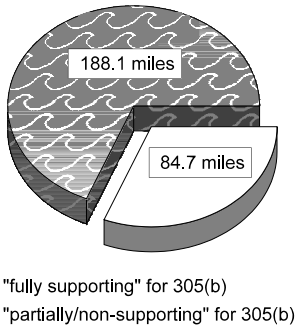
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(specific river basins or watersheds and comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(specific river basins or watersheds and comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
	✓	probabilistic by ecoregion, or statewide *(comprehensive use throughout jurisdiction)*
		rotating basin
		other:

Stream Miles

Total miles *(determined using state based GIS coverage)*	**1,498**
Total perennial miles	979
Total miles assessed for biology*	**272.8**
fully supporting for 305(b)*	188.1
partially/non-supporting for 305(b)*	84.7
listed for 303(d)*	78.5
number of sites sampled *(on an annual basis)***	~62
number of miles assessed per site	site specific

272.8 Miles Assessed for Biology



*These numbers represent the miles assessed for ALUS using biology or a combination of biological and chemical data. The miles listed for 303(d) were taken from the RI draft 2002 303(d) list for biodiversity impairments.

**Roughly 62 sites are monitored on an annual basis, though this number does vary (10 = artificial substrate; 45 - 50 = RBP). Fifty-five additional sites were sampled in 2000 as part of a random sampling design for the EPA.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis		Single Aquatic Life Use and Class System (A,B,C)
ALU designations in state water quality standards		One designation: fish and wildlife habitat
Narrative Biocriteria in WQS		No formal/informal numeric procedures are used to support narrative biocriteria; however, there is a qualitative and/or narrative scale of condition.
Numeric Biocriteria in WQS		none
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU		Super-fund sites and Rhode Island Pollutant Elimination Discharge System (RIPDES) permit toxic elimination

Reference Site/Condition Development

Number of reference sites		**2 total**
Reference site determinations	✓	site-specific
		paired watersheds
		regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria		Minimally impaired/disturbed (best reference site in New England) – natural conditions, bank erosion, land use, etc. High Quality unimpaired condition for RBP or site-specific for special site studies.
Characterization of reference sites within a regional context	✓	historical conditions
		least disturbed sites
		gradient response
		professional judgment
	✓	other: minimally disturbed*
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
		reference sites/condition referenced in water quality standards
		some reference sites represent acceptable human-induced conditions

*Rhode Island's reference sites are considered minimally disturbed. The Wood River reference site (most widely used) will likely remain minimally disturbed because its watershed is largely contained within State Park boundaries. RI allows for about a 20% variation from that target for compliance. However, special watershed projects may be asking an upstream or downstream question and, therefore, may be required to find a least disturbed site within the unique segment for comparison.

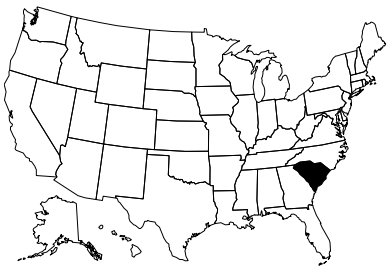
Field and Lab Methods

Assemblages assessed	✓	benthos *(<100 samples/year; single season, multiple sites - broad coverage)*
	✓	fish *(sampled once in conjunction with USEPA: < 100 samples; single observation)*
		periphyton
	✓	other: macrophytes *(<100 samples/year; single season, multiple sites - broad coverage)*
Benthos		
sampling gear		collect by hand, multiplate, D-frame; 200-400 micron mesh
habitat selection		riffle/run (cobble), artificial substrate
subsample size		100 count
taxonomy		combination
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, periodic meetings and training for biologists, taxonomic proficiency checks, and specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		25th percentile of reference population
defining impairment in a multimetric index		75th percentile of reference population - standard random sampling design, EPT index, RBPs
Evaluation of performance characteristics	✓	repeat sampling
		precision
		sensitivity
	✓	bias
		accuracy
Biological data		
Storage		databases, spreadsheets
Retrieval and analysis		EDAS

SOUTH CAROLINA



Contact Information

James Glover, PhD, Aquatic Biologist
South Carolina Department of Health and Environmental Control (SC DHEC)
2600 Bull Street ■ Columbia, SC 29201
Phone 803/898-4081 ■ Fax 803/898-4200
email: GloverJB@columb32.DHEC.state.sc.us
SC DHEC Bureau of Water homepage: http://www.scdhec.net/water/

Program Description

Biologists at the South Carolina Department of Health and Environmental Control use aquatic macroinvertebrates as bioindicators to make assessments of water quality. The program began in the early 1970s with the first technical report printed in 1972. Currently, flowing streams and rivers are the primary waterbodies that are assessed. South Carolina's monitoring efforts can be divided into two categories: ambient monitoring and special studies. Both fixed sites and randomly selected sites are chosen each year for the ambient monitoring work. Fixed sites are sampled once every five years on a rotating basin schedule. Special studies usually involve a point source discharge or a nonpoint source perturbation such as a logging operation. Upstream and downstream sites are selected for sampling when conducting special studies. Agency staff may carry out the special studies or they may be required by the industry as part of a permit or consent order. In the latter case, state certified consultants conduct the studies with the resulting reports reviewed by agency scientists.

South Carolina's program is modeled after that of North Carolina's, which was developed in the 1970s and 1980s. A timed qualitative multihabitat approach is taken for sampling macroinvertebrates. Organisms are picked in the field and returned to the laboratory for identification to the lowest practical taxonomic level – usually genus or species. Two metrics are calculated to produce an assessment: the EPT Index, and the NC Biotic Index. These two metrics are standardized on a scale of 1 to 5 and averaged to produce a final score. The Bioclassification of the stream is based on this score. The numeric criteria developed in SC are dependant on the ecoregion within which the stream is located. There are separate criteria for the mountains, piedmont, and coastal plain regions of the state. For special studies, impact is determined by the change in the bioclassification score from the upstream control site to the downstream test site. A rigorous quality control/quality assurance program has been developed and implemented for sampling, identification of organisms, and data entry.

Documentation and Further Information

The 2002 Section 305(b) Water Quality Assessment Report for South Carolina, March 2000: http://www.scdhec.net/eqc/water/pubs/305b.pdf

State of South Carolina 303(d) List for 2000, EPA approved in May 2000: http://www.scdhec.net/eqc/water/pubs/303d2000.pdf (for the DRAFT 2002 303(d) List and 1998 303(d) List, go to http://www.scdhec.net/eqc/water/html/tmdl.html#303d)

The Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. 2001. SC DHEC.

State of South Carolina Monitoring Strategy for Calendar Year 2002, January 2002: http://www.scdhec.net/eqc/water/pubs/strategy.pdf

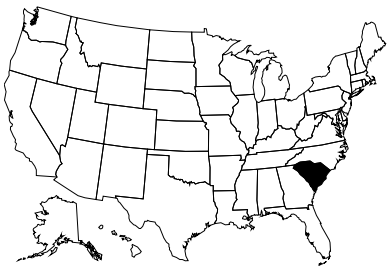
Antidegradation Implementation for Water Quality in South Carolina, July 1998: http://www.scdhec.net/eqc/water/pubs/antideg.pdf

Watershed Water Quality Management Strategy Program Description: http://www.scdhec.net/water/shed/prog.html

For a list of and links to additional SC DHEC *Bureau of Water* water quality publications, go to http://www.scdhec.net/eqc/admin/html/eqcpubs.html#wqreports

DRAFT July 1998. *Standard Operating Procedures and Quality Control Procedures for Macroinvertebrate Sampling*. Technical Report No. 004-98. Prepared by South Carolina Bureau of Water, Division of Water Monitoring, Assessment and Protection, Aquatic Biology Section.

SOUTH CAROLINA



Contact Information

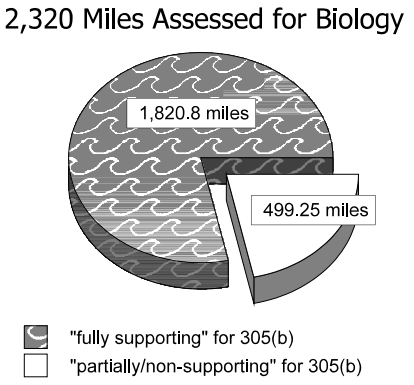
James Glover, PhD, Aquatic Biologist
South Carolina Department of Health and Environmental Control (SC DHEC)
2600 Bull Street ■ Columbia, SC 29201
Phone 803/898-4081 ■ Fax 803/898-4200
email: GloverJB@columb32.DHEC.state.sc.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
	✓	probabilistic by stream order/catchment area *(comprehensive use throughout jurisdiction)*
	✓	probabilistic by ecoregion, or statewide *(comprehensive use throughout jurisdiction)*
	✓	rotating basin *(specific river basins or watersheds)*
		other:

Stream Miles

Total miles *(determined using RF3)*	**35,461**
Total perennial miles	25,729
Total miles assessed for biology*	**2,320**
fully supporting for 305(b)	1,820.8
partially/non-supporting for 305(b)	499.25
listed for 303(d)	499.25
number of sites sampled *(on an annual basis)*	80
number of miles assessed per site	–



*These miles, listed in the 2000 205(b) report, were assessed based on a combination of physical/chemical **and** biological/habitat data. The following subset of the 2,320 total combined miles contains stream miles assessed based **solely** on biological/habitat: 678.6 total miles assessed, 563.98 miles "fully supporting" for 305(b), and 114.6 miles "partially/non-supporting" for 305(b) and listed for 303(d).

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class System (A,B,C) and Warm Water vs. Cold Water	
ALU designations in state water quality standards	Three designations: Freshwater, Trout - 3 types, Saltwater	
Narrative Biocriteria in WQS	Procedures used to support narrative biocriteria are not included in SC water quality standards, but are available in the monitoring program SOP.	
Numeric Biocriteria in WQS	none (South Carolina has limited numeric biociteria/indices used to evaluate ALU, which are not included in state water quality standards – see monitoring program SOP.)	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Biocriteria can affect permitting decisions if a watershed is listed on the 303(d) list for biological impacts.	

Reference Site/Condition Development

Number of reference sites	**30 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria	The best sites are selected from a habitat and organismal point of view. Faunal characteristics and land use data from GIS are also considered (see newly-amended R.61-68.F.I.d. for more information).	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
	✓	stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
	✓	reference sites/condition referenced in water quality standards *(found in R61-68.F.I.d.)*
	✓	some reference sites represent acceptable human-induced conditions

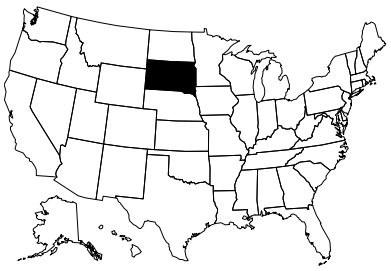
Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; multiple seasons, multiple sites – broad coverage for watershed level)*
		fish
		periphyton
		other:
Benthos		
sampling gear		collect by hand, brass sieve, D-frame, kick net (1 meter); 500-600 micron mesh
habitat selection		multihabitat
subsample size		entire sample
taxonomy		combination and species when possible
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, taxonomic and sampling proficiency checks, specimen archival, data entry checks, certification program for bioassessment

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		cumulative distribution function
defining impairment in a multimetric index		cumulative distribution function - follow guidelines outlined in following document: Lenat. 1993. *A biotic index for the southeastern United States, derivation and list of tolerance values, with criteria for assigning water quality ratings*. Journal of the North American Benthological Society. 12:279-290
Evaluation of performance characteristics		repeat sampling
	✓	precision *(replicate sampling of same stream, 10% each year)*
		sensitivity
		bias
	✓	accuracy *(compare faunal results with land use data and discharge presence or absence)*
Biological data		
Storage		MS FoxPro for Windows and Excel
Retrieval and analysis		FoxPro

SOUTH DAKOTA



Contact Information

Gene Stueven, Environmental Senior Scientist
South Dakota Department of Environment and Natural Resources (SD DENR)
Joe Foss Buildings 523 East Capitol ■ Pierre, SD 57501
Phone 605/773-4254 ■ Fax 605/773-4068
email: gene.stueven@state.sd.us
SD DENR Surface Water Quality website:
http://www.state.sd.us/denr/DES/Surfacewater/surfwprg.htm

Program Description

Currently, the South Dakota Department of Environment and Natural Resources (SD DENR) Water Resources Assistance Program (WRAP) collects biological data in addition to chemical and physical parameters for TMDL assessments. These bioassessments are useful in determining the impact of contaminants as well as detecting chronic water quality impairments that may not be discovered by ambient chemical and physical grab samples. Of the 9,937 total stream miles, approximately 4 miles have been biologically assessed (60 sites assessed; 150 meters per site). SD DENR has not yet established biological criteria for use in water quality standards.

The Water Resource Assistance Program evaluates benthic macroinvertebrate community structure in streams using both the EMAP protocol and USEPA's Rapid Bioassessment Protocols (RBPs) in conjunction with assessments of stream habitats. All biological samples are identified to the lowest possible level of taxonomic resolution. Biological data are entered into the STORET database and are summarized using multimetric indices and descriptive statistics. SD DENR intends to use the biological data to identify potential reference sites for determining the condition of water quality and the integrity of the biological community. WRAP is beginning to sample periphyton communities to determine if they are a better biological indicator of water quality.

Documentation and Further Information

Stueven, E., A. Wittmuss, and R.L. Smith. 2000. *Standard Operating Procedures for Field Samplers. Revision 4.0, January 2000*. South Dakota Department of Environment and Natural Resources, Water Resource Assistance Program. Pierre, SD.

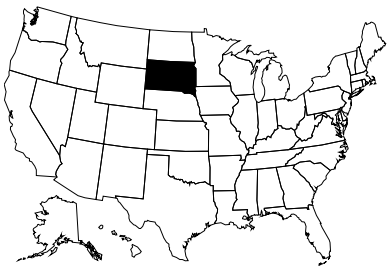
Ecoregion Targeting of Impaired Lakes in South Dakota (May 2000)

The 2000 South Dakota Report to Congress, 305(b) Water Quality Assessment, http://www.state.sd.us/denr/Documents/SD_2000_305b.pdf

The 1998 South Dakota 303(d) Waterbody List and Supporting Documentation, http://www.state.sd.us/denr/303(d)/98sd303d.pdf

South Dakota Surface Water Quality Standards, http://legis.state.sd.us/rules/rules/7451.htm

SOUTH DAKOTA



Contact Information

Gene Stueven, Environmental Senior Scientist
South Dakota Department of Environment and Natural Resources (SD DENR)
Joe Foss Buildings 523 East Capitol ■ Pierre, SD 57501
Phone 605/773-4254 ■ Fax 605/773-4068
email: gene.stueven@state.sd.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects, specific river basins or watersheds)*
		fixed station (i.e., water quality monitoring stations)
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
		rotating basin
		other:

Stream Miles

Total miles *(determined using RF3, National Hydrography Database, and state based determination)*	**9,937**
Total perennial miles	1,932
Total miles assessed for biology*	**3.73**
fully supporting for 305(b)	n/a
partially/non-supporting for 305(b)	n/a
listed for 303(d)	n/a
number of sites sampled *(on an annual basis)*	~60
number of miles assessed per site	~.093 *(150 meters)*

*South Dakota reports only chemical data in 305(b) reports and 303(d) listings. Currently, biological data is only collected during TMDL assessments. South Dakota's DENR plans to use the biological data to locate reference sites and conditions based on ecoregions as well as to establish biocriteria.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis		Warm Water vs. Cold Water
ALU designations in state water quality standards		Five designations: Cold Water Permanent, Cold Water Marginal, Warm Water Permanent, Warm Water Semi-Permanent, Warm Water Marginal
Narrative Biocriteria in WQS		No formal/informal numeric procedures exist to support narrative biocriteria
Numeric Biocriteria in WQS		none
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
		cause and effect determinations
		permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU		none

Reference Site/Condition Development*

Number of reference sites		**~31 total**
Reference site determinations *Under development*		site-specific
		paired watersheds
		regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria		Under development. Criteria used for defining reference sites include: EMAP protocol, habitat, chemical, and aquatic life.
Characterization of reference sites within a regional context *Under development*		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions *Under development*	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information *Under development*		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

*The responses above characterize how reference sites will most likely be determined in the future. Twenty-seven sites have been assessed in South Dakota as reference for the EMAP data set. South Dakota's DENR samples ~4 sites as reference and will be working on establishing formal reference sites and criteria for streams and rivers. Lake reference sites and criteria have already been developed.

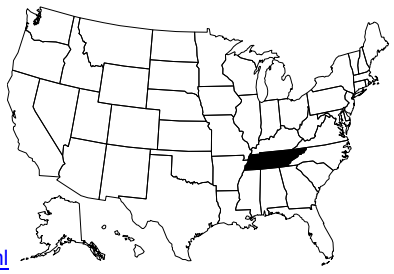
Field and Lab Methods

Assemblages assessed	✓	benthos *(100 - 500 samples/year; single season, multiple sites - not at watershed level)*
		fish
	✓	periphyton *(<100 samples/year; single season, multiple sites - not at watershed level)*
		other:
Benthos		
sampling gear		D-frame, multiplate, rock baskets; 500 - 600 micron mesh
habitat selection		multihabitat
subsample size		300 count
taxonomy		combination
Periphyton		
sampling gear		**natural substrate**: brushing/scraping device (razor, toothbrush, etc.) **artificial substrate**: microslides or other suitable substratum
habitat selection		multihabitat
sample processing		chlorophyll *a* / phaeophytin, taxonomic identification
taxonomy		species level
Habitat assessments		visual based, quantitative measurements, hydrogeomorphology; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, taxonomic proficiency checks, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(multimetric index under development)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		25th percentile of reference population, natural breaks
defining impairment in a multimetric index		25th percentile of reference population
Evaluation of performance characteristics		repeat sampling
		precision
Not currently evaluated		sensitivity
		bias
		accuracy
Biological data		
Storage		STORET
Retrieval and analysis		Statistica, EDAS

TENNESSEE



Contact Information

Gregory M. Denton, Manager - Planning and Standards
Tennessee Department of Environment & Conservation (TDEC)
7th Floor L&C Annex, 401 Church Street ■ Nashville, TN 37243-1534
Phone 615/532-0699 ■ Fax 615/532-0046
email: gregory.denton@state.tn.us
TDEC Division of Water Pollution Control: http://www.state.tn.us/environment/wpc/index.html

Program Description

The Tennessee Department of Environment and Conservation's (TDEC) Division of Water Pollution Control (WPC), has an extensive bioassessment program. Benthic macroinvertebrate surveys are one of the primary tools used in assessing surface waters in the state. Biological data are instrumental in determining use-support and generating both the 305(b) and 303(d) reports. In-stream macroinvertebrate monitoring is included in many NPDES permits. Bioassessments are also used in the anti-degradation evaluation process. Biological data are used to measure improvements in water quality resulting from clean-up and habitat restoration efforts. Over 2,100 macroinvertebrate surveys have been conducted by TDEC since 1996.

TDEC has eight field offices each with at least two benthic biologist positions. In addition, there is a central laboratory facility in the Department of Health with seven aquatic biologists under contract to TDEC. These nine offices conduct the majority of macroinvertebrate stream surveys. Data from other agencies including the Tennessee Valley Authority (TVA), US Army Corps of Engineers (USACE), and USGS are also incorporated into the program.

In 1995, TDEC initiated an ecoregion delineation project resulting in the identification of 25 ecological subregions. Ninety-eight reference streams were targeted for monitoring. The macroinvertebrate community in these streams was sampled seasonally for three years and on a five-year cycle by watershed starting in 1999. These data were used to develop regional numeric biocriteria that have been proposed for inclusion in the 2002 triennial review of water quality standards. The proposed numeric criteria are already being used to help interpret narrative criteria. In addition, reference stream data were used to develop guidelines for biological reconnaissance as a screening tool during watershed assessments.

Future goals of the bioassessment program include:

- Continue to monitor ecoregional reference streams and locate additional streams to further refine biocriteria and better identify reference condition.
- Conduct additional bioassessments as means to increase TDEC's percentage of assessed streams for national reporting purposes.
- Develop a macroinvertebrate tolerance index specific to Tennessee.
- Develop biocriteria for large rivers, wetlands and reservoirs.
- Continue to use benthic data as a measure of improvement in water quality.

Documentation and Further Information

Arnwine, D.H. and G. M. Denton. 2001. *Development of Regionally-Based Interpretations of Tennessee's Existing Biological Integrity Criteria*. Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Nashville. TN

Arnwine D.H. and G. M. Denton. 2001. *Habitat of Least Impacted Streams in Tennessee*, Tennessee Department of Environment and Conservation, Division of Water Pollution Control, Nashville, TN

Arnwine, D.H., J.I. Broach, L.K. Cartwright and G.M. Denton. 2000. *Tennessee Ecoregion Project*. Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Nashville, TN.

Denton, G.M., A.D. Vann, and S.H. Wang. 2000.*The status of Water Quality in Tennessee: Year 2000 305(b) Report*. Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Nashville, TN.

Griffith, G.E., J.M. Omernik and S. Azevedo. 1997. *Ecoregions of Tennessee*. EPA/600/R-97/022. NHREEL, Western Ecological Division, U.S. Environmental Protection Agency, Corvalis, Oregon.

Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys. 2002. Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Nashville. TN.

DRAFT Year 2002 303(d) List, July 2002: http://www.state.tn.us/environment/wpc/2002303ddraft.pdf

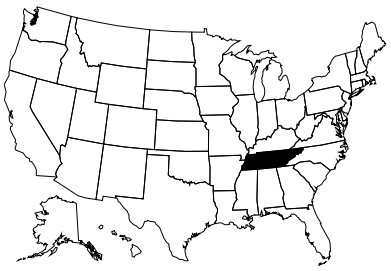
TDEC General Water Quality Criteria, rev. October 1999: http://www.state.tn.us/sos/rules/1200/1200-04/1200-04-03.pdf

TDEC Use Classifications for Surface Waters, rev. October 1999: http://www.state.tn.us/sos/rules/1200/1200-04/1200-04-04.pdf

2001 Triennial Review of Water Quality Standards, Staff Proposal: http://www.state.tn.us/environment/wpc/tr_wqs.pdf

Other TDEC publications, including 305(b) reports, can be found online at: http://www.state.tn.us/environment/wpc/publicat.htm

TENNESSEE



Contact Information

Gregory M. Denton, Manager - Planning and Standards
Tennessee Department of Environment & Conservation (TDEC)
7th Floor L&C Annex, 401 Church Street ■ Nashville, TN 37243-1534
Phone 615/532-0699 ■ Fax 615/532-0046
email: gregory.denton@state.tn.us

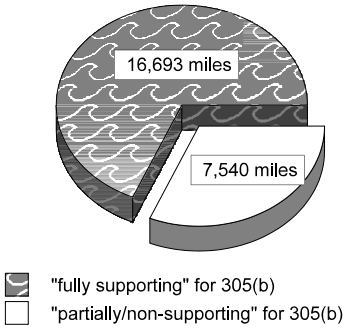
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
	✓	probabilistic by ecoregion, or statewide *(special projects only)*
	✓	rotating basin *(comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles *(Determined using RF3)*	**60,187**
Total perennial miles	–
Total miles assessed for biology	**24,233**
fully supporting for 305(b)	16,693
partially/non-supporting for 305(b)*	7,540
listed for 303(d)*	14,333
number of sites sampled	2,202
number of miles assessed per site	–

24,233 Miles Assessed for Biology



*The stream miles "partially/non-supporting" for 305(b) are significantly less than the stream miles listed for 303(d) because the last 303(d) list was revised in 1998 while the 305(b) reflects assessments through 2000. The 2002 draft 303(d) and 305(b) reports are in agreement.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Single Aquatic Life Use	
ALU designations in state water quality standards	One designation: Fish and Aquatic Life	
Narrative Biocriteria in WQS	Formal/informal numeric procedures used to support narrative biocriteria are found in the *Development of Regionally-Based Numeric Interpretations of Tennessee's Narrative Biological Integrity Criterion* (see documentation).	
Numeric Biocriteria in WQS	under development (Tennessee water quality standards will be changed in 2002 to reflect proposed numeric criteria for 15 bioregions. Numeric biocriteria, proposed for inclusion in the new WQS are as follows, "Multimetric index using 7 metrics - TR, EPT, %EPT, %OC, NCBI, %DOM and % Clingers*. Scoring criteria is based on 25% of reference condition. Reference condition is based on ecoregion reference data at the 90th percentile. Ecoregions have been grouped into 15 bioregions. Expected index score is calibrated to each bioregion and by season where appropriate.")	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Nonpoint source section, field offices - office by office use, not systematic/statewide use	

*TR = total richness; EPT = Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies); OC = Orthocladiinae of Chironomidae; NCBI = North Carolina Biotic Index; DOM = dominant taxa.

Reference Site/Condition Development

Number of reference sites	**98 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria	Reference database of chemical, habitat and biometrics based on monitoring of regional reference sites since 1996. Reference sites must fall within 90th percentile for chemical, biological and habitat parameters compared to existing reference database. Disturbed sites are those under 75% comparable to reference condition for biological and habitat, above the 90th percentile (reference) for nutrients (and show impaired biology), or exceed numeric criteria for other specified parameters.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
	UD	reference sites/condition referenced in water quality standards *(WQS under revision)*
	✓	some reference sites represent acceptable human-induced conditions

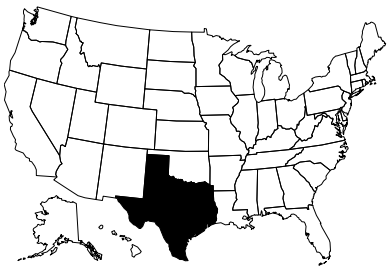
Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - watershed level)*
		fish
		periphyton
		other:
Benthos		
sampling gear		dipnet and kick net (1 meter); 500 - 600 micron mesh
habitat selection		riffle/run used for biocriteria in high gradient streams; rooted bank used for biocriteria in low gradient streams (Note that four jab multihabitat bioreconnaissances are used for general water quality assessments, not comparable to biocriteria)
subsample size		200 count
taxonomy		genus
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		90th or 10th percentile of reference population depending on direction of metric
defining impairment in a multimetric index		25% of 90th (or 10th) percentile of reference population
Multivariate thresholds		
defining impairment in a multivariate index		Used for development of initial criteria, not for current assessments
Evaluation of performance characteristics	✓	repeat sampling *(replicate samples at 10% of reference sites by different teams)*
	✓	precision *(two samples collected at 10% of sites by two teams)*
	✓	sensitivity *(standard level of identification, compare metric scores to known impacts)*
	✓	bias *(compared different sample/habitat types)*
	✓	accuracy *(10% of samples QC for taxonomy and sorting efficiency)*
Biological data		
Storage		MS Access; semi-quantitative samples (taxa lists and metric scores) are stored in EDAS database and bioreconnaissance results are stored in Water Quality Database (taxa lists are in paper files). The eventual goal is for data to be sent to STORET. Assessment results are stored in an Assessment Database.
Retrieval and analysis		EDAS, Statview, and multivariate statistical package

TEXAS



Contact Information

Charles Bayer, Aquatic Scientist
Texas Commission on Environmental Quality (TCEQ)*
P.O. Box 13087 ■ Austin, Texas 78711-3087
Phone 512/239-4583 ■ Fax 512/239-4420
email: cbayer@tnrcc.state.tx.us
website: http://www.tceq.state.tx.us/

Roy Kleinsasser, River Studies Program Leader
Texas Parks and Wildlife Department (TPWD)
505 Staples Road ■ San Marcos, TX 78666
Phone 512/353-3480
email: leroy.kleinsasser@tpwd.state.tx.us
website: http://www.tpwd.state.tx.us

Program Description

Since the late 1980s, biological assessments have been employed for use attainability analyses (UAAs) and the development of an index of biological integrity (IBI) for rivers and streams. A tidal streams IBI is in the preliminary stages of development. Recently, a new emphasis has been placed on bioassessments relative to 303(d) listed waterbodies. For the most part, the new data have not been fully evaluated and work is continuing to expand in this area. Also, for the first time, the draft 2002 Water Quality Inventory includes bioassessments to determine the support of aquatic life uses.

The Texas Parks and Wildlife Department (TPWD) has been a major provider of fish community data for many of the UAAs and the development of the IBI. Other providers include various river authorities in the state.

***NOTE: On September 1, 2002, the Texas Natural Resources Conservation Commission (TNRCC) formally changed its name and began doing business as the Texas Commission on Environmental Quality (TCEQ).**

Documentation and Further Information

Draft 2002 Texas Water Quality Monitoring and Assessment Report (Integrated 305(b) report and 303(d) list):
http://www.tnrcc.state.tx.us/water/quality/02_twqmar/index.html

Texas Water Quality Inventory (SFR-050/00), includes *Volume I: Surface Water, Groundwater and Finished Drinking Water Assessments and Water Quality Management Programs:*
http://www.tnrcc.state.tx.us/admin/topdoc/sfr/050_00/050_00.html#1

Revisions to the Texas Surface Water Quality Standards and Implementation Procedures:
http://www.tnrcc.state.tx.us/permitting/waterperm/wqstand/revisions.html

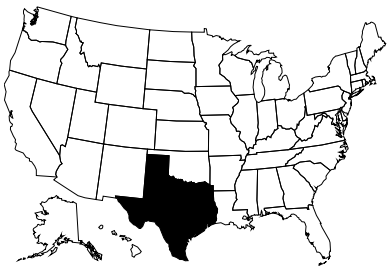
Surface Water Quality Monitoring Procedures Manual (Chapter 7: Biological Sampling Procedures and Chapter 8: Stream Habitat Assessment Procedures), August 1999, GI-252:
http://www.tnrcc.state.tx.us/admin/topdoc/gi/252.html

Monitoring and Receiving Water Assessment Procedures Manuals:
http://www.tnrcc.state.tx.us/water/quality/data/wqm/index.html#manuals

Surface Water Quality Monitoring Program information:
http://www.tnrcc.state.tx.us/water/quality/data/wqm/index.html

Leppo, E.W., M.T. Barbour, and J. Gerritsen. 2001. *An evaluation of the stream habitat assessment approach used by TNRCC*. Prepared for: Texas Natural Resource and Conservation Commission, Austin, Texas and USEPA Region 6, Dallas, Texas.

TEXAS



Contact Information

Charles Bayer, Aquatic Scientist
Texas Commission on Environmental Quality (TCEQ)
P.O. Box 13087 ■ Austin, Texas 78711-3087
Phone 512/239-4583 ■ Fax 512/239-4420
email: cbayer@tnrcc.state.tx.us

Roy Kleinsasser, River Studies Program Leader
Texas Parks and Wildlife Department (TPWD)
505 Staples Road ■ San Marcos, TX 78666
Phone 512/353-3480
email: leroy.kleinsasser@tpwd.state.tx.us

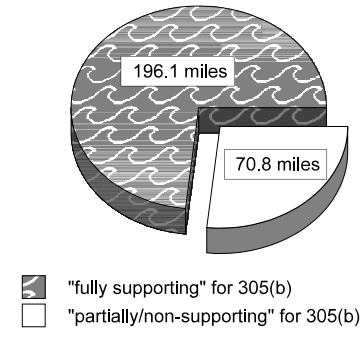
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
		nonpoint source assessments
		monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
		support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects, specific river basins or watersheds, and comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(specific river basins or watersheds and comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
	✓	probabilistic by ecoregion, or statewide *(special projects only)*
		rotating basin
		other:

Stream Miles

Total miles *(State based determination)*	**191,228**
Total perennial miles	40,194
Total miles assessed for biology*	**266.9**
fully supporting for 305(b)	196.1
partially/non-supporting for 305(b)	70.8
listed for 303(d)	–
number of sites sampled *(on an annual basis)**	30
number of miles assessed per site	–

266.9 Miles Assessed for Biology



*68,611.78 total miles were surveyed and 63,102.68 total miles were assessed. Of these, 266.9 miles were assessed using biology. 30 sites were surveyed and 16 sites were assessed.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class System (A,B,C)	
ALU designations in state water quality standards	Five designations: Exceptional, High, Intermediate, Limited, and Oyster waters	
Narrative Biocriteria in WQS	Procedures used to support narrative biocriteria located in the *Water Quality Standards Implementation Procedures Receiving Water Assessment Procedures Manual* (see documentation)	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Trinity River Segment 0805 was elevated from a limited aquatic life use to a high aquatic life use designation. EPA Region 6 considers Texas' high and exceptional aquatic life use designations as meeting the 101(a) goals of the Clean Water Act.	

Reference Site/Condition Development

Number of reference sites	**72 total**	
Reference site determinations	✓	site-specific
	✓	paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	no point source discharge, land use patterns, limited human impact, least disturbed sites determined using best professional judgment	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

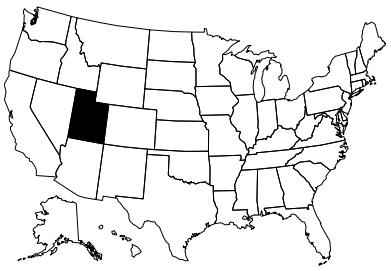
Field and Lab Methods

Assemblages assessed	✓	benthos *(<100 samples/year; multiple seasons, multiple sites – broad coverage for watershed level)*
	✓	fish *(<100 samples/year; multiple seasons, multiple sites – broad coverage for watershed level)*
		periphyton
		other:
Benthos		
sampling gear		surber, multiplate, lopping shears for collecting woody debris, D-frame, kick net; 500-600 micron mesh
habitat selection		riffle/run (cobble), artificial substrate and woody debris
subsample size		100 count and entire sample
taxonomy		combination
Fish		
sampling gear		backpack and boat electrofisher, trawl and gill net (particularly for tidal streams), seine; 1/8", 3/16" and 1/4" mesh
habitat selection		multihabitat
sample processing		length measurement, batch, anomalies
subsample		none
taxonomy		species
Habitat assessments		quantitative measurements; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, taxonomic proficiency checks, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		95th percentile of reference population
defining impairment in a multimetric index		50th percentile of reference population (follow EPA RBP guidelines)
Evaluation of performance characteristics		repeat sampling
		precision
Not currently evaluated		sensitivity
		bias
		accuracy
Biological data		
Storage		TCEQ's TRACS database and hard copies; STORET is under development
Retrieval and analysis		At this time, the hard copies are primarily used for evaluation of biological data. Spreadsheets are also used.

UTAH



Contact Information

Thomas W. Toole, Environmental Scientist
Richard Denton, Manager
Utah Department of Environmental Quality (UDEQ)
288 N. 1460 W., P.O. Box 144870 ■ Salt Lake City, UT 84114-4870
Phone 801/538-6146 ■ Fax 801/538-6016
email: ttoole@utah.gov and rdenton@utah.gov
UDEQ Division of Water Quality homepage: http://waterquality.utah.gov/

Program Description

Prior to 2001, The Utah Division of Water Quality (DWQ) Biological Assessment program was limited to benthic macroinvertebrate data collected at 18 long-term monitoring sites. They have been sampled since 1978 with the exception of about five years in which the allocation of the 18 samples were used to supplement water chemistry and physical data collected in the five-year basin rotation monitoring plan. These samples were collected to ascertain long-term water quality and to be used in determining trends. In addition, benthic macroinvertebrate samples were collected at 16 Nonpoint Source Project sites to assess the effects of BMP implementation. These data have been incorporated into several NPS reports to determine what improvements in water quality have occurred. Data collected from the 18 long-term monitoring sites and the NPS projects have been used in making beneficial use assessments (305(b)) and listing waters on the 303(d) list.

In 2001, the DWQ reviewed its bio-monitoring program and decided that a major effort was needed to improve and develop new components of its water quality assessment program. During this review, an inventory of benthic macroinvertebrate data collected by DWQ, the U.S. Bureau of Land Management (BLM), and the U.S. Forest Service (USFS) was completed. Upon completion of this review, the DWQ contacted the BLM and USFS and requested all of the benthic macroinvertebrate data that they had collected from 1990 through 1997 be sent to DWQ for entering into STORED. These data, along with DWQ's, were entered into STORET. Data collected since 1997 have been stored electronically and a program to electronically transfer these data into STORET is being developed. These data will be evaluated as to their usefulness in establishing reference sites and the development of metrics to be used in assessing beneficial use support.

In 2001, the DWQ negotiated an agreement to complete the E-MAP sampling for EPA within the State. Experience obtained from this work would allow environmental scientists (field and staff) to learn and evaluate the methods used in the E-MAP protocol. This experience could then be used to develop a bioassessment protocol for assessing waters within the State.

Concurrent with doing the E-MAP work, the Division decided to commit additional resources to develop reference sites for bioassess-ment work. It was decided that the DWQ would select and try to sample up to 60 potential reference sites during the next 2-3 years. Water chemistry, fish, benthic macroinvertebrate, periphyton, and physical habitat data will be collected at these sites. The selection of sites were based upon the different ecoregions within the state and the need for low elevation, low-gradient stream reference sites.

DWQ is also assisting the EPA Corvallis Lab in reviewing and selecting reference sites that were initially selected using GIS techniques. Approximately 100 sites were initially selected and the number has been reduced to 20 sites. The DWQ is assisting in sampling these sites. Information obtained from this program will be evaluated and possibly incorporated into the Division's bio-assessment program.

The DWQ has committed to developing a set of reference sites and metrics that can be used to ensure that the waters of the State are assessed in a scientifically sound and standard method. Work is also going on to evaluate other assessment methods such as RIVPACS in assessing beneficial use support.

Documentation and Further Information

Utah Water Quality Assessment Report to Congress, September 2000 and Year 2000 Water Quality Inventory, 305(b) Assessment: http://www.waterquality.utah.gov/2000_305b_fact.pdf

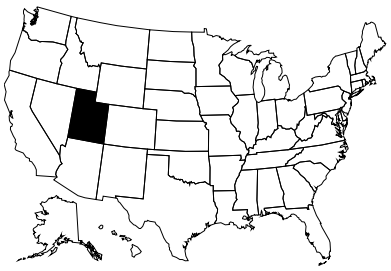
Utah Division of Water Quality's 2000 Water Quality Monitoring Program::
http://www.waterquality.utah.gov/monitoring/complete_monitor_plan_2000.pdf

Utah's 2000 303(d) List of Waters, October 2000: http://www.waterquality.utah.gov/documents/approved_2000_303d.pdf

DRAFT, Utah's 2002 303(d) List of Waters: http://www.waterquality.utah.gov/documents/2002303dinternet.pdf

Quality Assurance and Standard Operating Procedures Manual. Utah Department of Environmental Quality, Division of Water Quality. 1993. Utah Department of Environmental Quality, Salt Lake City, UT.

UTAH



Contact Information

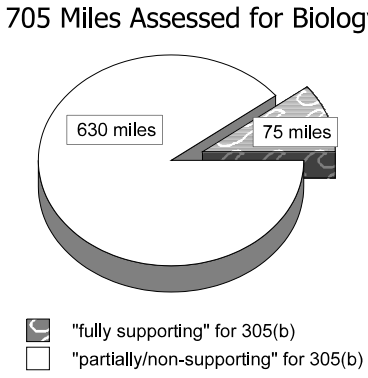
Thomas W. Toole, Environmental Scientist
Richard Denton, Manager
Utah Department of Environmental Quality (UDEQ)
288 N. 1460 W., P.O. Box 144870 ■ Salt Lake City, UT 84114-4870
Phone 801/538-6859 or -6055 ■ Fax 801/538-6016
email: ttoole@deq.state.ut.us and rdenton@deq.state.ut.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects, specific river basins or watersheds and comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(special projects, specific river basins or watersheds and comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(specific river basins or watersheds and comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles *(determined using the National Hydrography database and state based determination)*	**85,916**
Total perennial miles	14,000+
Total miles assessed for biology*	**705**
fully supporting for 305(b)	75
partially/non-supporting for 305(b)	630
listed for 303(d)	300
number of sites sampled *(on an annual basis)*	~56
number of miles assessed per site	12.6



*Biological data were used along with water chemistry data to assess the above listed miles. The biological assessment was done using benthic macroinvertebrates and used a weight-of-evidence assessment because reference sites were not used. Diversity indices, the Biotic Condition Index, and the number of sediment and nutrient tolerant taxa were used to determine beneficial use support when the pollution indicator value for total phosphorus was exceeded.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class System (A,B,C)	
ALU designations in state water quality standards	Five designations*	
Narrative Biocriteria in WQS	none - Procedures used to support general aquatic life statement in WQS are not standardized, but are primarily based on best professional judgment using some metrics.	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
		cause and effect determinations
		permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Used primarily in assessing 319 nonpoint source projects including assessment, implementation of BMPs, and evaluation of water quality	

*The designations are as follows: 3A - cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food web. 3B - warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food web. 3C - Nongame fish and other aquatic life including the necessary aquatic organisms in their food chain. 3D - Waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain. 3E - Severely habitat-limited waters.

Reference Site/Condition Development**

Number of reference sites	**not applicable**	
Reference site determinations		site-specific
		paired watersheds
		regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria		
Characterization of reference sites within a regional context		historical conditions
		least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions		ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
		some reference sites represent acceptable human-induced conditions

**Utah is currently working with the EMAP to develop reference sites.

Field and Lab Methods

Assemblages assessed	✓	benthos *(<100 samples/year; multiple seasons, multiple sites – broad coverage for watershed level)*
		fish
	UD	periphyton *(A periphyton program is under development and will be used primarily in nutrient-impacted streams. Dr. Sam Rushforth, at Utah Valley State College, is assisting in the development of this program.)*
		other:
Benthos		
sampling gear	rock baskets and Hess; 200-400 micron mesh	
habitat selection	riffle/run (cobble) and artificial substrate	
subsample size	300 count	
taxonomy	combination	
Habitat assessments	quantitative measurements, and a few nonpoint source project sites have pebble counts, channel profiles and riparian condition evaluated on a very limited basis; performed with bioassessments	
Quality assurance program elements	standard operating procedures and quality assurance plan	

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(return single metrics - use endpoint for each single metric)*
		disturbance gradients
	✓	other: some tolerance information is used in the evaluation
Multimetric thresholds*		
transforming metrics into unitless scores	BCI Methods described by USFS are used to differentiate higher quality waters, less discriminating in impaired waters.	
Evaluation of performance* characteristics		repeat sampling
		precision
Not currently evaluated		sensitivity
		bias
		accuracy
Biological data**		
Storage	Data are currently being loaded into STORET	
Retrieval and analysis	SAS (metrics are calculated by the contracting laboratory using spreadsheets or another computer program–language not known)	

*EPA is currently having a contractor review benthic macroinvertebrate data to determine what metrics might apply to various regions of the State. Any metrics presently being used are those produced by the contracting laboratory and best professional judgement is used in the interpretation. No metric sensitivity analyses, regional biases, or other evaluations have been done to this point.

**EPA's Assessment Database is being used to store and retrieve assessment information for Utah's 305(b) report. Some indexing of waterbodies still needs to be done, but this should be completed during fiscal year 2002.

VERMONT

Contact Information

Doug Burnham, Biomonitoring and Aquatic Studies Section Chief
Vermont Department of Environmental Conservation (VTDEC)
103 South Main Street-10N ■ Waterbury, VT 05671
Phone 802/241-3784 ■ Fax 802/241-3008
email: dougb@dec.anr.state.vt.us
VTDEC Water Quality Division website: http://www.anr.state.vt.us/dec/waterq/wqdhome.htm

Program Description

The Water Quality Division of the Vermont Department of Environmental Conservation (VTDEC) has been conducting aquatic biological health assessments since the early 1970's. In 1982, the Biomonitoring and Aquatic Studies Section (BASS) was created with a focus on river and stream biological monitoring. BASS is currently staffed by five full-time aquatic biologists who participate in VTDEC water quality management programs at all levels. This "top to bottom" involvement by biologists has been critical to the extensive acceptance and use of biological assessment data within a wide variety of Departmental programs. The primary objectives of ambient monitoring activities are: 1) monitor long-term trends in water quality as revealed in changes over time to ambient aquatic biological communities; 2) evaluate potential impacts from point and nonpoint permitted direct and indirect discharges, development projects, nonpoint sources, and spills on aquatic biological communities; 3) establish a reference database that would facilitate the generation of Vermont-specific biological criteria for water quality classification and use attainment determinations; 4) support VTDEC permitting and water quality management programs requiring biological assessment data; 5) conduct special studies to assess emerging water quality and environmental management issues. Further information about VTDEC BASS is available at: http://www.anr.state.vt.us/dec/waterq/bass.htm.

Since 1985, the Department has used standardized methods for sampling fish and macroinvertebrate communities, evaluating physical habitat, processing samples, and analyzing and evaluating data. The program has led to the development of two Vermont-specific fish community Indexes of Biotic Integrity (IBI) and selected macroinvertebrate metrics. Guidelines have been developed for determining water quality classification attainment by using both macroinvertebrate community biological integrity metrics and the fish community IBI. Approximately 75-125 sites per year are assessed using fish and/or macroinvertebrate assemblages. Alkalinity, pH, conductivity, temperature and such measurements as substrate composition (pebble counts), embeddedness, canopy cover, percent and type of periphyton cover, and approximate velocity are routinely monitored. From 1985 to 2001, approximately 1,500 stream assessments were completed using macroinvertebrate and/or fish from more than 900 wadeable stream reaches. This monitoring effort is subject to a USEPA-approved quality assurance project plan. Data from the project are summarized and stored in an electronic database.

Biological data are used extensively to determine aquatic life use support and impairment. A significant proportion of Vermont's 303(d) list is made up of reaches with impaired aquatic life use determined through bioassessment. The development of biological criteria supported by the Vermont Water Quality Standards has provided a vehicle for enforceable implementation of biocriteria. Biological assessment data are used extensively in virtually all VTDEC water quality management programs, including RCRA, NPDES, CERCLA, watershed planning, 401 certification, aquatic nuisance control permitting, and 305(b). In addition to wadeable stream monitoring, BASS conducts a variety of special studies and assessment in other aquatic habitats, and is in the process of evaluating biocriteria for vernal pools and ponded waters.

VTDEC participates in collaborations with other agencies and organizations including: USEPA; USFWS; USFS; USGS; academic institutions; neighboring states; private consultants; special interest groups; and volunteer monitors. Staff also participate in public outreach activities as resources allow.

Biological criteria are the current performance standards for a large number of 303(d) waterbodies throughout the state. Future demand for biological assessments from VTDEC management programs will increase as the 303(d)/TMDL process advances and watershed planning initiatives expand statewide. The greatest challenge facing the biomonitoring program will be maintaining adequate staff resources to continue assessing 303(d) restoration management actions, providing support to watershed plan development, and providing support to various management programs within VTDEC and the Agency of Natural Resources.

Documentation and Further Information

Vermont 2000 Water Quality and Assessment, 305(b) Report

Vermont Water Quality Methodology, April 2001

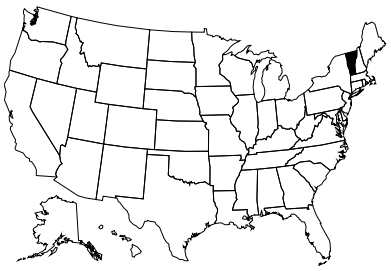
Wadeable Stream Biocriteria Development for Fish and Macroinvertebrate Assemblages in Vermont Streams and Rivers

July 2, 2000 Vermont Water Quality Standards: http://www.state.vt.us/wtrboard/july2000wqs.htm

Fish Sampling and Metrics homepage: http://www.anr.state.vt.us/dec/waterq/bassfish.htm

Macroinvertebrate Sampling, Processing and Metrics homepage: http://www.anr.state.vt.us/dec/waterq/bassmacro.htm

VERMONT



Contact Information

Doug Burnham, Biomonitoring and Aquatic Studies Section Chief
Vermont Department of Environmental Conservation (VTDEC)
103 South Main Street-10N ■ Waterbury, VT 05671
Phone 802/241-3784 ■ Fax 802/241-3008
email: dougb@dec.anr.state.vt.us

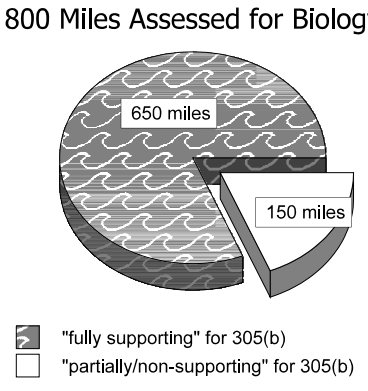
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
	✓	other: bioassessments used for all aquatic life use support evaluations
Applicable monitoring designs*	✓	targeted (i.e., sites selected for specific purpose) *(comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
	✓	probabilistic by stream order/catchment area *(special projects only)*
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(specific river basins or watersheds)*
		other:

*The majority of biological sampling conducted by VTDEC is targeted and in the context of rotating basin elements. Fixed station and special projects are also significant elements. Some monitoring required by discharge permits or basin plans related to TMDL's is done by consultants. Consultants generating biological monitoring data for aquatic life use support determinations consistent with Vermont Water Quality Standards or for compliance with discharge permit limitations are required to meet QA/QC requirements and submit to QA oversight by VTDEC biologists.

Stream Miles

Total miles *(State based determination)*	**7,099**
Total perennial miles	7,099
Total miles assessed for biology*	**~800**
fully supporting for 305(b)	~650
partially/non-supporting for 305(b)	~150
listed for 303(d)	~150
number of sites sampled *(total number with available biological monitoring data)*	1,193
number of miles assessed per site	–



*The latest 305(b) report was used to estimate some of these numbers. 305(b) reports total stream miles assessed by "evaluation" and "monitoring". The majority of VTDEC sites that are "monitored" are monitored for biology. The total miles reported as assessed in the last "statewide" assessment report in 2000 was 5,261, with 4,411 miles "evaluated" and 850 miles "monitored". Roughly 800 of the 850 miles "monitored" were monitored using biology (similarly with use support categories).

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class System (A,B,C)	
ALU designations in state water quality standards	Three designations related to changes from reference condition: minimal, minor, and moderate change from the reference condition.	
Narrative Biocriteria in WQS	VTDEC procedures used to support narrative biocriteria are independent of WQS.	
Numeric Biocriteria in WQS	none (Numeric biocriteria are currently found in VTDEC procedural documents.)	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Used extensively throughout management programs including: NPDES, 305(b), 303(d), basin planning, point and nonpoint source management, aquatic nuisance control, RCRA, CERCLA.	

Reference Site/Condition Development

Number of reference sites	**150 total**	
Reference site determinations	✓	site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	Reference sites are defined using the best professional judgment of biologists based on the level of human activity and potential for that activity to affect the aquatic resource. There are no quantitative criteria, but general considerations may include: very good riparian condition at site; predominantly forested watershed; outside the influence of assessed activity; least disturbed condition.	
Characterization of reference sites within a regional context	✓	historical conditions
		least disturbed sites
		gradient response
	✓	professional judgment
	✓	other: minimally disturbed*
Stream stratification within regional reference conditions		ecoregions (or some aggregate)
		elevation
	✓	stream type
	✓	multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
	✓	reference sites/condition referenced in water quality standards
		some reference sites represent acceptable human-induced conditions

*This language is included in the definition of reference condition in the Vermont Water Quality Standards, effective July 2, 2000.

Field and Lab Methods

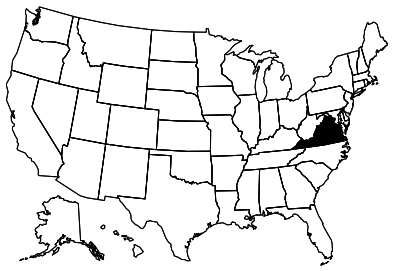
Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - broad coverage)*
	✓	fish *(<100 samples/year; single season, multiple sites - broad coverage)*
	✓	periphyton *(Periphyton and algae in rivers and streams are sampled qualitatively for descriptive purposes only. Some indirect discharge permits require quantitative periphyton and macroinvertebrate sampling with artificial substrates in order to determine compliance with permit conditions. Compliance criteria are independent of WQS.)*
Benthos		
sampling gear		rock baskets, kick net (18x9 rectangular net, 500 micron mesh)
habitat selection		riffle/run (cobble) and woody debris (varies according to stream category)
subsample size		must be minimum 300 animals AND 25% of sample.
taxonomy		lowest possible taxon - genus, species and combination (specified level in SOPs and C185)
Fish		
sampling gear		backpack electrofisher
habitat selection		multihabitat
sample processing		length measurement and anomalies
subsample		none
taxonomy		species
Habitat assessments		visual based and hydrogeomorphology - performed with and independent of bioassessments; pebble counts currently implemented quite extensively in conjunction with bioassessments
Quality assurance program elements		standard operating procedures; quality assurance plan; periodic meetings and training for biologists; sorting and taxonomic proficiency checks; specimen archival; sending voucher specimens to experts for identification confirmation

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index and return single metrics - use endpoint for each single metric)*
		disturbance gradients
		other:
Multimetric thresholds*		
transforming metrics into unitless scores		Combination of reference distribution, impaired site distribution, and best professional judgement; do not use unitless scores.
defining impairment in a multimetric index		Cumulative distribution function
Multivariate thresholds*		
defining impairment in a multivariate index		Significant departure from mean of reference population
Evaluation of performance characteristics	✓	repeat sampling *(long term fixed station sampling)*
	✓	precision *(field replication)*
		sensitivity
		bias
	✓	accuracy *(sample processing and analysis QA)*
Biological data		
Storage		Data are stored and managed in MS Access data base. Various programs used to analyze sub-sets include: Excel, Sigma-Plot/Stat and PC-ORD
Retrieval and analysis		MS Access database calculates metrics and generates event summary reports. Data can be moved from Access to other programs for project-specific analyses. Commonly used programs include: Excel, Sigma-Plot/Stat, PC-ORD

*Benthos data are used to generate individual metrics, which are considered individually. Fish assemblage data are used to generate metrics for a multimetric Index of Biotic Integrity. Water Quality Standard thresholds (deviations from the reference condition) are based on BPJ evaluations of metric distribution patterns in both reference and non-reference sites.

VIRGINIA



Contact Information

Alex M. Barron, Environmental Program Planner
Virginia Department of Environmental Quality (DEQ)
P.O. Box 10009 ■ Richmond, VA 23240
Phone 804/698-4119 ■ Fax 804/698-4116
email: ambarron@deq.state.va.us
DEQ Water Programs homepage: http://www.deq.state.va.us/water/

Program Description

The Virginia Department of Environmental Quality (DEQ) Biological Monitoring Program (BMP) utilizes the study of bottom dwelling macroinvertebrate communities to determine overall water quality. Changes in water quality generally alter the kinds and numbers of these animals living in streams or other waterbodies. Like physical and chemical water quality monitoring data, biological monitoring data are used to assess water quality for support of aquatic life designated use and the Clean Water Act "fishable and swimmable" goals.

The BMP is composed of 150 to 170 stations that are examined annually during the spring and fall. Qualitative and semiquantitative biological monitoring has been conducted by the agency since the early 1970s. The USEPA Rapid Bioassessment Protocol (RBP) II was employed beginning in the fall of 1990 to utilize standardized and repeatable methodology. The RBPs produce water quality ratings of nonimpaired, slightly impaired, moderately impaired and severely impaired instead of the former ratings of good, fair and poor.

Currently, there are approximately 70 organizations throughout the Commonwealth with active citizen water quality monitoring programs. Biological parameters measured by citizen monitors often include benthic macroinvertebrates, fecal coliform bacteria, and/or chlorophyll *a*. A statewide organization, the Izaak Walton League of America Virginia Save Our Streams Program (IWLA VA SOS), took the lead in establishing relations with DEQ and the Department of Conservation and Recreation (DCR) to develop a statewide citizen monitoring program. IWLA VA SOS has a benthic macroinvertebrate citizen monitoring protocol that is widely used by many affiliate organizations. In 2000, VA SOS completed a two-year study, funded by DEQ, evaluating this protocol and developing a new protocol to more closely correlate with professional methods developed by EPA and used by DEQ.

Documentation and Further Information

Water Quality Assessment and Impaired Waters Report (combined 2002 305b and 303d), July 2002:
http://www.deq.state.va.us/water/305b.html

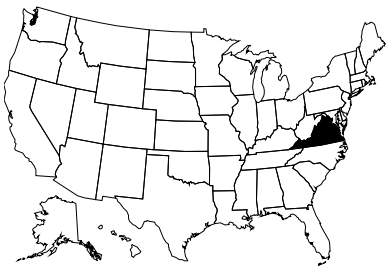
2000 Water Quality Assessment 305(b) Report: http://www.deq.state.va.us/water/00-305b.html

Water Quality Assessment Guidance Manual for 2002, 305(b) and 303(d) reports, July 2002:
http://www.deq.state.va.us/pdf/water/wqassessguide.pdf

2001 Ambient Water Quality Monitoring Plan:
http://www.deq.state.va.us/water/my01rpt.html

Watershed Maps of *Virginia Impaired Water Segments, 303(d) TMDL Priority List*:
http://www.deq.state.va.us/watermaps/

VIRGINIA



Contact Information

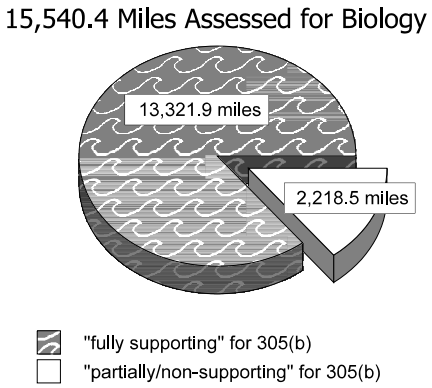
Alex M. Barron, Environmental Program Planner
Virginia Department of Environmental Quality (DEQ)
P.O. Box 10009 ■ Richmond, VA 23240
Phone 804/698-4119 ■ Fax 804/698-4116
email: ambarron@deq.state.va.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
		monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
	✓	probabilistic by ecoregion, or statewide *(comprehensive use throughout jurisdiction)*
		rotating basin
		other:

Stream Miles

Total miles *(determined using the National Hydrography Database)*	**50,329**
Total perennial miles	50,329
Total miles assessed for biology*	**15,540.4**
fully supporting for 305(b)*	13,321.9
partially/non-supporting for 305(b)*	2,218.5
listed for 303(d)*	2,218.5
number of sites sampled *(on an annual basis)**	150 -170
number of miles assessed per site	–



*The numbers listed above were extracted from Virginia's 2002 combined 305(b)/303(d) report and represent stream and river miles assessed (evaluated and monitored) for aquatic life using chemical, physical and biological parameters. However, of the 2,218.5 total miles partially/non-supporting for 305(b), 661.4 miles were determined to be impaired based solely on biological (benthic) data.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Single Aquatic Life Use	
ALU designations in state water quality standards	Three designations (apply to all State waters): recreational uses, e.g., swimming and boating; the propagation and growth of a balanced, indigenous population of aquatic life, including game fish, which might reasonably be expected to inhabit them; and the production of marketable resources, e.g. fish and shellfish.	
Narrative Biocriteria in WQS	none - Virginia has no formal/informal numeric procedures to support general aquatic life statement found in WQS	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria) *Information not provided*		assessment of aquatic resources
		cause and effect determinations
		permitted discharges
		monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Several TMDLs are addressing ALUS restoration because of poor bioassessment scores.	

Reference Site/Condition Development

Number of reference sites	**information not provided**	
Reference site determinations	✓	site-specific
	✓	paired watersheds
		regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	No reference site criteria. Reference sites are defined as best available, least impaired.	
Characterization of reference sites within a regional context *Information not provided*		historical conditions
		least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions *Information not provided*		ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

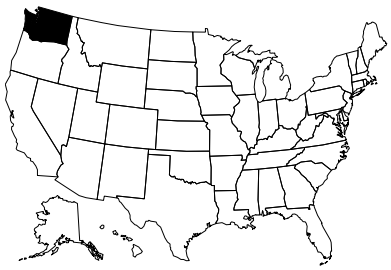
Field and Lab Methods

Assemblages assessed	✓	benthos *(300-400 samples/year; multiple seasons, multiple sites – broad coverage for watershed level)*
		fish
		periphyton
		other:
Benthos		
sampling gear		D-frame, kick net (1 meter); 500-600 micron mesh
habitat selection		richest habitat and riffle/run (cobble)
subsample size		100 count
taxonomy		family
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
		biological metrics
		disturbance gradients
		other:
Evaluation of performance characteristics		repeat sampling
		precision
Information not provided		sensitivity
		bias
		accuracy
Biological data		
Storage		EDAS
Retrieval and analysis		EDAS

WASHINGTON



Contact Information

Robert W. Plotnikoff, Freshwater Monitoring Unit Supervisor
Washington State Department of Ecology
P.O. Box 47710, 300 Desmond Drive ■ Olympia, WA 98504-7710
Phone 360/407-6687 ■ Fax 360/407-6884
email: rplo461@ecy.wa.gov
Stream Biological Monitoring website:
http://www.ecy.wa.gov/programs/eap/fw_benth/fwb_intr.html

Program Description

Washington State's Biological Monitoring Program has been operated by the Washington Department of Ecology since 1993. The program has served as a focal point for technical assistance and as a reference for data comparison. Its primary objectives are: 1) to continually describe the spatial and temporal features of biotic communities in wadeable streams, 2) describe and then validate biological expectations for appropriate spatial classifications (e.g., ecoregions), 3) develop guidance and criteria that evaluate human-induced disturbance in biological communities, and 4) expand where biological information is used in water quality and resource management. Although field data collection methodology has remained consistent, data storage and analytical products have improved in their capacity and sophistication.

The Freshwater Monitoring Unit within the Department of Ecology has engaged in biological monitoring activities for more than twelve years and has made its information available online for public use. The primary objectives in continuing to develop this program are to: 1) proceed with calibration of ten biometrics that will be based on reference conditions within each of eight ecoregions, 2) continue assistance in development of RIVPACS (River Invertebrate Prediction and Classification System) models for western and eastern Washington streams with researchers at Utah State University (Dr. C. Hawkins), and 3) locate and visit additional reference sites outside of the ranges currently being monitored.

Interpretive tools developed from these efforts are being placed into the ALUS framework under development by the USEPA (contact Susan Jackson). WA is able to use the knowledge and tools developed through former biological monitoring efforts to create a meaningful matrix of expectations as diagramed by ALUS so that incremental improvements in stream quality, based on biological signatures, can be tracked. The first step toward adoption of biocriteria will be the construction of a guidance that outlines analytical products and biological expectations for streams within each ecoregion of Washington State. Biological evaluation tools such as RIVPACS scores, biometric scores, index scores, and indicator taxa are currently being assembled for inclusion in the guidance.

Biological information is currently being included in the 303(d) listing process to directly evaluate impairment. WA has amassed an adequate data bank for describing reference conditions that serves as an effective and defensible means for comparison. The Freshwater Monitoring Unit issued a report titled "Condition of Freshwaters in Washington State for the Year 2000" that evaluates data from water quality monitoring, biological monitoring, lakes monitoring, and nuisance aquatic plant monitoring. This report was intended as a template for future reviews of environmental information, like the 305(b) report, and will eventually satisfy reporting content of the current required data summaries as well as new guidance like CALM (Consolidated Assessment and Listing Methodology).

Many of the water quality problems of interest to the Department of Ecology's Regional Offices are related to habitat destruction due to human influence. This is one of the areas in which collaborative work with volunteer monitoring groups, local governments, state agencies, tribes, and other federal agencies is promoted.

One important partnership has been with the USEPA and the Environmental Monitoring and Assessment Program (EMAP). The Department of Ecology has engaged both EMAP and R-EMAP (Regional Environmental Monitoring and Assessment Program) since 1994. The acquisition of both knowledge and equipment in operating this program has provided impetus to implement the probabilistic monitoring design in the Ambient River and Stream Water Quality Monitoring Program. WA is working with the Colville Tribe in expanding the description of reference conditions for northeastern Washington and with the Yakima Tribe, county, and federal agencies in evaluating the effects of floodplain gravel mining along the Yakima River. WA is especially encouraged by several volunteer monitoring groups, like Streamkeepers of Clallam County, whose organizers have assembled teams of personnel that generate useful biological, chemical, and flow data.

Documentation and Further Information

2000 Washington State Water Quality Assessment - Section 305(b) Report: http://www.ecy.wa.gov/pubs/0010058.pdf

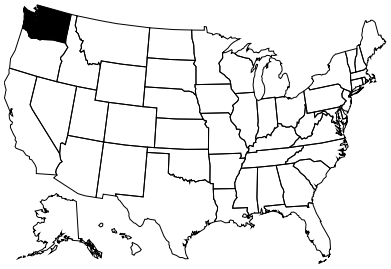
DRAFT 2002 303(d) List of Impaired and Threatened Waters, May 2002:
http://www.ecy.wa.gov/programs/wq/303d/2002-revised/listpolicydraftfinal7.pdf

Condition of Freshwaters in Washington State for the Year 2000: http://www.ecy.wa.gov/pubs/0103025.pdf

Water Quality Standards for Surface Waters of the State of Washington: http://www.ecy.wa.gov/pubs/wac173201a.pdf

For a comprehensive list of Stream Biological Monitoring Publications available online and/or by mail, go to:
http://www.ecy.wa.gov/programs/eap/fw_benth/fwb_pubs.html

WASHINGTON



Contact Information

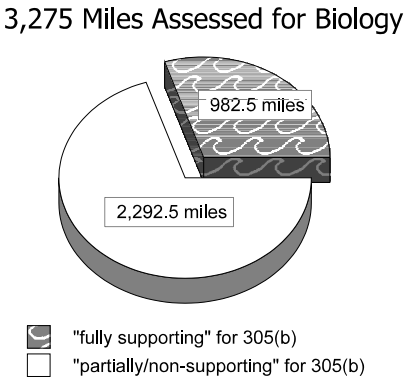
Robert W. Plotnikoff, Freshwater Monitoring Unit Supervisor
Washington State Department of Ecology
P.O. Box 47710, 300 Desmond Drive ■ Olympia, WA 98504-7710
Phone 360/407-6687 ■ Fax 360/407-6884
email: rplo461@ecy.wa.gov

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
		ALU determinations/ambient monitoring
	UD	promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(specific river basins or watersheds)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
	✓	probabilistic by stream order/catchment area *(stream order as subset of ecoregion sampling)*
	✓	probabilistic by ecoregion, or statewide *(special projects and comprehensive use throughout jurisdiction)*
	✓	rotating basin *(specific river basins or watersheds)*
		other:

Stream Miles

Total miles *(State based determination)*	**73,886**
Total perennial miles	39,483
Total miles assessed for biology*	**3,275**
fully supporting for 305(b)**	982.5
partially/non-supporting for 305(b)**	2,292.5
listed for 303(d)	0
number of sites sampled	655
number of miles assessed per site	5



*Approximately 10% of the State's perennial streams are assessed for biology. The 3,275 total miles assessed for biology is an estimate derived from multiplying 655 sites by the 5 miles assessed per site.

**The "fully supporting" and "partially/non-supporting" for 305(b) stream mile estimates are based on an old assessment policy estimation process. WA most recently used EPA's National Hydrography Data Layer to create the stream segment breaks but the new data has not been generated yet.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class System (A,B,C)	
ALU designations in state water quality standards	The Water Class system currently in use contains four categories: Class AA, Class A, Class B, and Class C. Class AA (extraordinary) freshwaters shall markedly and uniformly exceed the requirements for all or substantially all uses. Class A (excellent) freshwaters shall meet or exceed the requirements for all or substantially all uses. Class B (good) freshwaters shall meet or exceed requirements for most uses. Class C (fair) freshwaters shall meet or exceed the requirements of selected and essential uses.	
Narrative Biocriteria in WQS*	under development	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	none	

*Water Classes AA, A, and B include a characteristic use designation called "Wildlife Habitat." This characteristic use designates waters of the state used by, or that directly or indirectly provide food support to fish, other aquatic life, and wildlife for any life history stage or activity. The term "biological assessment" is defined in Washington's water quality standards and is intended to be used to evaluate the condition of "Wildlife Habitat."

Reference Site/Condition Development

Number of reference sites	**187 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	1) Least-disturbed sites that show little or no signs of human impact, 2) Relatively-unimpacted sites that show some signs of historical human influence but are at an advanced successional stage	
Characterization of reference sites within a regional context	✓	historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
	✓	other: minimally disturbed (see "relatively-unimpacted" reference site criteria)
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
	✓	stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

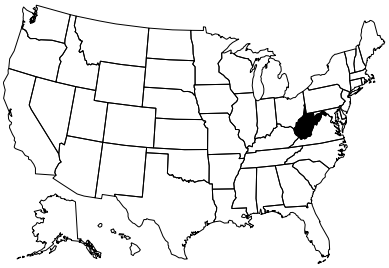
Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - watershed level and broad coverage)*
	✓	fish *(100-500 samples/year; single season, multiple sites - watershed level and broad coverage)*
	✓	periphyton *(<100 samples/year; single season, multiple sites - watershed level and broad coverage)*
	✓	other: macrophytes and waterfowl *(<100 samples/year; single season, multiple sites - watershed level and broad coverage)*
Benthos		
sampling gear		Surber, D-frame; 500-600 micron mesh
habitat selection		riffle/run (cobble); pool habitat may also be assessed if physical and/or chemical degradation has occurred and can be detected through a biotic response
subsample size		500 count
taxonomy		family, genus, and species
Fish		
sampling gear		backpack electrofisher; 7 millimeter mesh
habitat selection		multihabitat
sample processing		length measurement, anomalies
subsample		none - all specimens are examined and counted
taxonomy		species, life stage
Periphyton		
sampling gear		**natural substrate:** brushing/scraping device (razor, toothbrush, etc.); **artificial substrate:** collect by hand
habitat selection		multihabitat
sample processing		taxonomic identification
taxonomy		genus
Habitat assessments		visual based, quantitative measurements and hydrogeomorphology; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
Multimetric thresholds		
transforming metrics into unitless scores		25th percentile of reference population
defining impairment in a multimetric index		25th percentile of reference population
Multivariate thresholds		
defining impairment in a multivariate index		Significant departure from mean of reference population
Evaluation of performance characteristics	✓	repeat sampling *(multi-year sampling at gradient of sites)*
	✓	precision *(multi-year sampling at reference sites)*
		sensitivity
		bias
		accuracy
Biological data		
Storage		All biological (including habitat and chemistry) information is stored in MS Access
Retrieval and analysis		SAS, Systat, CANOCO, Primer, Cornell Ecology Programs, and Calibrate

WEST VIRGINIA



Contact Information

John Wirts, Program Manager
West Virginia Department of Environmental Protection (WV DEP)
1201 Greenbrier Street ■ Charleston, WV 25311
Phone 304/558-2108 ■ Fax 304/558-2780
email: jwirts@mail.dep.state.wv.us
WV DEP Division of Water Resources homepage: http://www.dep.state.wv.us/item.cfm?ssid=11

Dan Cincotta, Fisheries Biologist
West Virginia Division of Natural Resources (WV DNR)
P.O. Box 67 ■ Elkins, WV 26241
Phone 304/637-0245 ■ Fax 304/637-0250
email: dcincotta@dnr.state.wv.us
WV DNR Wildlife Resources Section homepage: http://www.dnr.state.wv.us/wvwildlife/default.htm

Program Description

The West Virginia Department of Environmental Protection (WV DEP) implemented the Watershed Assessment Program in 1996. This program was designed to systematically measure the water quality and biological health of the state's rivers and streams. The program has four major components: 1) Random or Probabilistic Sampling; 2) Pre-TMDL sampling; 3) Ambient WQ Monitoring; and 4) "Regular Assessments."

Benthic macroinvertebrates are collected at the "random sites," regular WAP (Watershed Assessment Program) sites, and selected Pre-TMDL sites. The program utilizes a rectangular dip net, compositing samples from two square meters and identifying a 200 organism sub-sample. WV DEP identified the "bugs" in-house to family level the first three years of the program. In 1999, WV DEP contracted out the identification work and switched to genus level identification. In 2000, a macroinvertebrate index was developed for West Virginia with support from EPA's biocriteria development program. This index provides a means to establish an impairment threshold that is based on a set of minimally disturbed reference sites.

The "Regular Assessments" were the majority of WV DEP's workload in the program's first year and continue to be a major portion of efforts. These consisted of sampling as many streams as possible (considering personnel limitations) in watersheds that were scheduled for assessment according to a 5 year cycle (5-7 watersheds per year). These assessments included the collection of water quality, habitat and macroinvertebrate data. All streams previously listed as impaired were targeted for assessment, as were a portion of all "unassessed" and "partially impaired" streams.

In 1997, the Watershed Assessment Program added a probabilistic sampling component. The first 5-year cycle was completed in 2001. The first cycle consisted of sampling 30-35 sites in each of the major watersheds (8-digit HUCs) in the state, sampling all sites in a watershed in a single year. The next 5 year cycle begins in 2002 and will have a different sampling strategy. The same effort, 150 sites, will be spread across the state each year instead of just the 5-7 watersheds being assessed that year. This will allow a summary of the condition of the state's streams to be completed every year instead of having to wait for the end of the 5-year cycle. This strategy also eliminates the problem of comparing watersheds sampled in different years that may have had drastically different climactic conditions (i.e. drought versus flood).

Periphyton will be collected at all of the random sites starting in 2002. The results of these collections will hopefully aid in the development of nutrient criteria. Streams with known eutrification problems and some of WV DEP's established reference sites may be sampled as well.

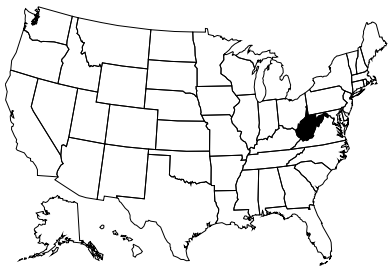
The Division of Natural Resources (DNR) is the fish and game agency of West Virginia. As part of its duties, statewide fishery surveys are conducted annually to monitor game and nongame fish populations. These surveys are not probability based as they are usually performed on target streams with ongoing programs (e.g., stockings) or due to crisis management reasons. The WV DNR has no regulatory authority relative to the state's water quality standards, but we are sometimes involved in a fish advisory capacity. The WV DNR is developing a fish Index of Biotic Integrity via a cooperative agreement with the USEPA. The IBI is being developed somewhat independently from the WQS that are utilized by WV DEP. Someday it may be used in the 305(b) program by a collaboration of agencies.

Documentation and Further Information

WV DEP Division of Water Resources list of publications, including direct links to *West Virginia Water Quality Status Assessment 305(b) Report 2000* and other 305(b) reports, multiple 303(d) listings, *West Virginia's Monitoring Strategy*, and *A Stream Condition Index for West Virginia Wadeable Streams*, 2000: http://www.dep.state.wv.us/item.cfm?ssid=11&ss1id=192

Smithson, J. 2001. Watershed assessment program. SOP. WV DEP Division of Water Resources.

WEST VIRGINIA



Contact Information

John Wirts, Program Manager
West Virginia Department of Environmental Protection (WV DEP)
1201 Greenbrier Street ■ Charleston, WV 25311
Phone 304/558-2108 ■ Fax 304/558-2780
email: jwirts@mail.dep.state.wv.us

Dan Cincotta, Fisheries Biologist
West Virginia Division of Natural Resources (WV DNR)
P.O. Box 67 ■ Elkins, WV 26241
Phone 304/637-0245 ■ Fax 304/637-0250
email: dcincotta@dnr.state.wv.us

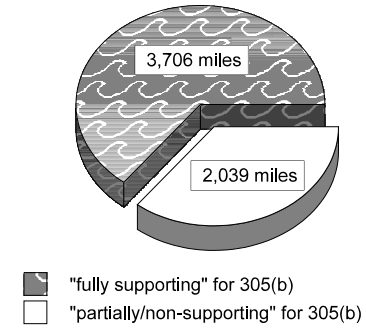
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(comprehensive use throughout jurisdiction)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
	✓	probabilistic by ecoregion, or statewide *(comprehensive use throughout jurisdiction)*
	✓	rotating basin *(comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles *(determined using RF3 augmented with all named streams on 1:24,000 topographic map)*	**32,278**
Total perennial miles	21,114
Total miles assessed for biology	**5,745**
fully supporting for 305(b)	3,706
partially/non-supporting for 305(b)	2,039
listed for 303(d)	1,315
number of sites sampled	60-90
number of miles assessed per site	–

5,745 Miles Assessed for Biology



Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Single Aquatic Life Use	
ALU designations in state water quality standards	Two designations: warmwater and coldwater	
Narrative Biocriteria in WQS	none - Internal program procedures used to support general aquatic life standard	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Watershed restoration action strategies as part of the 319 grant program.	

Reference Site/Condition Development

Number of reference sites	**~105 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	The following selection criteria are used to select reference sites: (* Indicates criterion that can be determined in the field.) 1. D.O. > 5.0mg/l* 2. pH between 6.0 and 9.0* 3. Conductivity < 500 µS /cm* 4. Fecal coliform < 800 colony/100ml 5. No violations of State WQ Standards 6. No obvious sources of nonpoint pollution* 7. Epifaunal substrate / available cover score >10* 8. Channel alteration score >10* 9. Sediment deposition score >10 * 10. Bank vegetative protection score >5* 11. Undisturbed vegetation zone width score >5* 12. Total habitat score > or = 130 points* 13. Evaluation of anthropogenic activities and disturbances* 14. No known point source discharges upstream and within view of assessment site (completed after 1-13 are met)	
Characterization of reference sites within a regional context		historical conditions
		least disturbed sites
		gradient response
		professional judgment
	✓	other: minimally disturbed**
Stream stratification within a regional reference conditions		ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
	✓	jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions *(minimal)*

**WV reference sites are best described as *minimally disturbed* sites. They have to meet each of the 14 criteria mentioned above; thus there are some areas with no sites that WV DEP is comfortable calling reference.

Field and Lab Methods

Assemblages assessed	✓	benthos *(>500 samples/year, single season, multiple sites - watershed level)*
	✓	fish* *(<100 samples/year; single observation, limited sampling)*
		periphyton
		other:
Benthos		
sampling gear		D-frame, dipnet, collect by hand; 500-600 micron mesh
habitat selection		riffle/run (cobble)
subsample size		200 count
taxonomy		family, genus
Fish*		
sampling gear		seine, backpack and boat electrofishers, electric seine; 1/8" and 3/16" mesh
habitat selection		multihabitat
sample processing		length measurement, biomass - individual
subsample		none
taxonomy		species
Habitat assessments		visual based, quantitative measurements, riffle stability index; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings, training for biologists, sorting proficiency checks, sorting and taxonomic proficiency checks, specimen archival

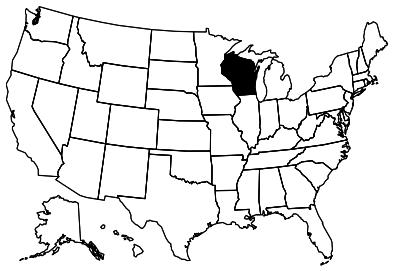
*West Virginia Division of Natural Resources is the fish and game agency of West Virginia. WV DNR duties include statewide annual fishery surveys to monitor game and nongame fish populations. These surveys are not probability based as they are ususally performed on target streams due to ongoing programs (eg. stockings) or crisis management reasons. The WV DNR has no regulatory authority relative to the state's water quality standards, but are sometimes involved in a fish advisory capacity. The WV DNR is developing a fish Index of Biotic Integrity via a cooperative agreement with the USEPA. It is being developed somewhat independently from the quality standards that are utilized by WV DEP, and may someday be used in the 305(b) program by a collaboration of agencies.

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		95th percentile of total population
defining impairment in a multimetric index		5th percentile of reference sites
Evaluation of performance characteristics*	✓	repeat sampling
	✓	precision
	✓	sensitivity
	✓	bias
	✓	accuracy
Biological data		
Storage		WAPBAS (similar to EDAS)
Retrieval and analysis		WAPBAS (similar to EDAS)

*Described in *A Stream Condition Index for West Virginia Wadeable Streams* (see documentation and further information)

WISCONSIN



Contact Information

Mike Talbot, Chief - Monitoring Section, Bureau of Fisheries and Habitat Protection
Bob Masnado, Chief - Water Quality Standards Section, Bureau of Watershed Management
Wisconsin Department of Natural Resources (WDNR)
P.O. Box 7921 ■ Madison, Wisconsin 53707
Phone 608/266-0832 ■ Fax 608/266-2244
Phone 608/267-7662 ■ Fax 608/267-2800
email: talbom@dnr.state.wi.us and masnar@dnr.state.wi.us
WI DNR Division of Water homepage: http://www.dnr.state.wi.us/environmentprotect/water.html

Program Description

Historically, much of the water resource assessment work done by the Wisconsin Department of Natural Resources (WDNR) has focused on the evaluation of degraded watersheds or water resources with high public profile. As a result, there is a lack of data on the overall quality of Wisconsin's water resources. In addition, monitoring techniques often varied among assessment sites and over time thus making it difficult to compare data across the state or from different time periods. To address these concerns, WDNR initiated a new program in 1999, called Baseline Monitoring. Standardized assessment techniques for aquatic habitat, macroinvertebrates and fish have been developed and are being applied throughout the state. The elements of this new program are contained in a draft report on Wisconsin's Surface Water Monitoring Strategy.

The overall goals of the baseline monitoring strategy are to answer the following questions:

1. What are the use expectations for Wisconsin's water resources?
2. Are the state's waters meeting their use potential?
3. What factors are preventing the state's water resources from meeting their potential?
4. What are the statewide status and trends in the quality of Wisconsin's surface waters?

To achieve the goals of the program, the following specific set of monitoring objectives were established:

- Determine the designated attainable uses of each waterbody. Stream and lake habitat information and fisheries data collected during baseline assessments will be compared with biological criteria obtained from "least-impacted" regional reference waters to determine the water's use classification.
- Determine the level of use attainment of each waterbody. Stream habitat and fisheries data collected during baseline assessment monitoring will allow the WDNR to determine if designated uses are being attained. More emphasis is being placed on biological monitoring to determine if designated uses are being met.
- Determine why some waterbodies are not attaining their designated uses. Physical, chemical and biological data collected during baseline assessment monitoring will provide at least some of the information required to achieve this objective.

For stream biological monitoring, WDNR collects information on riparian and in-stream habitat data, aquatic insects and fish species. The aquatic insects are identified and the numbers of fish are determined using standardized collection protocols. Lake monitoring involves collecting trophic state data and fish community data using the standardized protocols.

WDNR will begin using a stratified-random sampling approach to achieve adequate coverage of the state's 55,000 miles of streams. This sampling design allows the WDNR to sample a variety of streams and lakes across the state and also provides the Department with the ability to evaluate the quality of water resources that have not been sampled. The WDNR collects over 400 aquatic invertebrate samples per year. However, under the baseline monitoring that was initiated last year, the WDNR is now annually assessing about 600 stream sites. In the future, maps showing the location of biological sampling sites will be available.

Documentation and Further Information

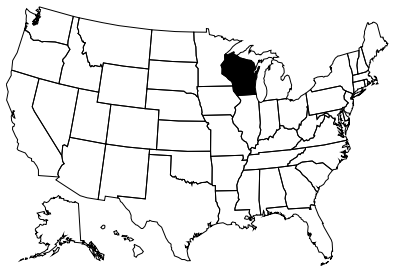
Wisconsin Water Quality Report to Congress, 2000 305(b): http://www.dnr.state.wi.us/org/water/wm/watersummary/WQ.pdf

Wisconsin's Unified Watershed Assessment: http://www.dnr.state.wi.us/org/water/wm/watersummary/uwa/index.htm#intro

Water Quality Standards for Wisconsin Surface Waters, revised February 1998:
http://www.legis.state.wi.us/rsb/code/nr/nr102.pdf

Wisconsin DNR Fisheries and Habitat Biological Database: http://infotrek.er.usgs.gov/wdnr_bio/

WISCONSIN



Contact Information

Mike Talbot, Chief - Monitoring Section, Bureau of Fisheries and Habitat Protection
Bob Masnado, Chief - Water Quality Standards Section, Bureau of Watershed Management
Wisconsin Department of Natural Resources (WDNR)
P.O. Box 7921 ■ Madison, Wisconsin 53707
Phone 608/266-0832 ■ Fax 608/266-2244
Phone 608/267-7662 ■ Fax 608/267-2800
email: talbom@dnr.state.wi.us and masnar@dnr.state.wi.us

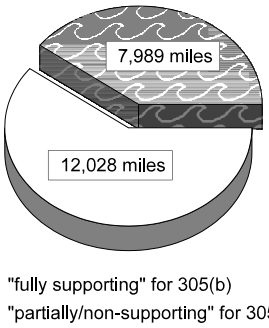
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
	✓	other: fishery assessments, FERC re-licensing, decisions, etc.
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
	✓	fixed station (i.e., water quality monitoring stations) *(specific river basins or watersheds)*
		probabilistic by stream order/catchment area
	✓	probabilistic by ecoregion, or statewide *(comprehensive use throughout jurisdiction)*
		rotating basin
		other:

Stream Miles

Total miles*	**55,000**
Total perennial miles	32,000
Total miles assessed for biology**	**24,422**
fully supporting for 305(b)	7,989
partially/non-supporting for 305(b)	12,028
listed for 303(d)	–
number of sites sampled *(on an annual basis)*	600
number of miles assessed per site**	5

24,422 Miles Assessed for Biology



*Surface water resources for Wisconsin have been quantified using GIS. A 1:24,000 scale hydrography GIS database was developed by digitizing surface waters shown on USGS 7.5 minute quadrangle maps.

**The miles assessed for biology include fish consumption and aquatic life use. Of the 12,394 miles fully supporting for 305(b), 4,405 miles are threatened. Each site sampled represents 5 miles of stream for baseline surveys, based on research conducted by WDNR.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Fishery Based Uses and Warm Water vs. Coldwater	
ALU designations in state water quality standards	Five designations: 1) Coldwater – Salmonids & some sculpin species, 2) Warm Water Fish & Aquatic Life – game fish and some important forage species, 3) Warm Water Forage Fish – forage fish communities intolerant to low dissolved oxygen, 4) Limited Forage Fish – forage fish communities tolerant of low dissolved oxygen, 5) Limited Aquatic Life – communities with non-fish species (invertebrates, etc.) that are tolerant of low dissolved oxygen.	
Narrative Biocriteria in WQS	Wisconsin does not have narrative biocriteria per se. It does have narrative criteria that are applied to protect against harm to human, wildlife and fish and aquatic life communities. Please see below.*	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Wisconsin's bioassessment program is still evolving, but has been used regularly to make water quality management decisions that range from fishery management issues (bag limits, habitat restoration projects) to FERC license operating conditions to assessing potential vs. actual fish & aquatic life uses of surface waters.	

*__Acute Narrative Criterion__: NR 102.04(1)(d) (d) Substances in concentrations or combinations which are toxic or harmful to humans shall not be present in amounts found to be of public health significance, nor shall substances be present in amounts which are acutely harmful to animal, plant or aquatic life.
__Chronic Narrative Criterion__: NR 102.04(4)(d) (d) Other substances. Unauthorized concentrations of substances are not permitted that alone or in combination with other materials present are toxic to fish or other aquatic life. Surface waters shall meet the acute and chronic criteria as set forth in or developed pursuant to ss. NR 105.05 and 105.06. Surface waters shall meet the criteria which correspond to the appropriate fish and aquatic life subcategory for the surface water, except as provided in s. NR 104.02(3).

Reference Site/Condition Development

Number of reference sites	**100 total**	
Reference site determinations	✓	site-specific
		paired watershed
	✓	regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria	Reference sites are defined by 1) BPJ using biota, 2) Upper quartile of biota index scores within two years, and 3) will eventually be supplemented with *a priori* land use. Also, a fish IBI is currently used, and habitat, water chemistry and macroinvertebrates will be incorporated within two years.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
	✓	professional judgment
	✓	other: will eventually use *a priori* GIS land use data
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
	✓	stream type *(temperature, gradient, stream order)*
		multivariate grouping
		jurisdictional (i.e., statewide)
	✓	other: will assess strata with multivariate analysis
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

Field and Lab Methods

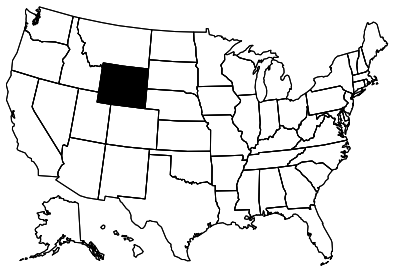
Assemblages assessed	✓	benthos *(>500 samples/year; single season, multiple sites - broad coverage)*
	✓	fish *(>500 samples/year; single season, multiple sites - broad coverage)*
	✓	periphyton *(<100 samples/year; single observation, limited sampling)*
		other:
Benthos		
sampling gear		Surber, Hess, D-frame (all limited use); 500 - 600 micron mesh
habitat selection		riffle/run (cobble)
subsample size		minimum of 125, but typically 200 - 300 organisms
taxonomy		lowest taxa-level possible - usually genus, sometimes combination
Fish		
sampling gear		backpack and boat electrofisher, pram unit (tote barge); 1/4" mesh
habitat selection		multihabitat
sample processing		length measurement, biomass- individual (gamefish), biomass- batch (non-game), anomalies
subsample		selected species
taxonomy		species
Periphyton		
sampling gear		**natural substrate**: brushing/scraping device (razor, toothbrush, etc.) **artificial substrate**: rock, rip-rap, bridge concrete
habitat selection		richest habitat
sample processing		chlorophyll *a/* phaeophytin and taxonomic identification
taxonomy		diatoms only
Habitat assessments		quantitative measurements; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings, training for biologists, sorting and taxonomic proficiency checks, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)**
	✓	disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		25th percentile of reference population
defining impairment in a multimetric index		25th percentile of reference population
Evaluation of performance characteristics	✓	repeat sampling
	✓	precision *(repeat sampling of assessment sites is conducted)*
	✓	sensitivity *(multiple streams along various stressor gradients have been assessed to document metric sensitivity to the stressor of concern)*
	✓	bias *(Stream habitat assessment crews assess the same site to document crew experience bias. Least-impacted streams of differing size/stream order are sampled to document macroinvertebrate metric bias among streams of varying order)*
	✓	accuracy *(multiple least-impacted streams are sampled to document metric accuracy)*
Biological data		
Storage		A database has been developed in concert with USGS. It is not currently compatible with STORET. The database can be viewed at: http://www.infotrek.er.usgs.gov/wdnr_bio/
Retrieval and analysis		SAS, Systat, and Statistica. Also, an ORACLE-based data management system is being developed to store data and provide routine report summaries and metric calculations.

*Multimetric indexes for habitat and fish have been developed, and a multimetric index for macroinvertebrates is being developed.

WYOMING



Contact Information

Jeremy ZumBerge, Monitoring Program Supervisor
Wyoming Department of Environmental Quality (WYDEQ)
1043 Coffeen Avenue, Suite D ■ Sheridan, WY 82801
Phone 307/672-6457 ■ Fax 307/674-6050
email: jzumbe@state.wy.us
WYDEQ Water Quality Division website: http://deq.state.wy.us/wqd/index.asp?pageid=5

Program Description

The primary objective of bioassessments conducted by the Wyoming Department of Environmental Quality (WYDEQ) is to assess the support of aquatic life for 303(d) listing and 305(b) reporting, using macroinvertebrates as the primary indicator. The program has been in existence since 1993, when it was initiated in the form of the Reference Stream Project (RSP). The primary goal of the RSP was to collect baseline biological data at least-impacted (reference) streams in each ecoregion of Wyoming as a benchmark for assessing biological and water quality conditions of other streams across the State. In 1998, the focus shifted from collecting reference stream data to using RSP data as a benchmark to assess biological conditions of other Wyoming streams as part of the Beneficial Use Reconnaissance Program (BURP). BURP uses a comprehensive approach (chemical, physical, and biological components) to assess water quality conditions of Wyoming streams. Today, the RSP is still ongoing, but at a much smaller scale.

Several other organizations have been or will be important sources of bioassessment data in Wyoming. The Wyoming Association of Conservation Districts (WACD) has been very involved in collecting biological data at streams across Wyoming. With proper guidance, local Conservation Districts (CDs) can elect to assume some of WYDEQ's bioassessment responsibilities, with the data being used for 303(d) and 305(b). Many CDs have welcomed the opportunity to collect bioassessment data.

The USGS also has been a very important source of biological data. Wyoming has contracted the USGS-Wyoming District to carry out the Environmental Monitoring and Assessment Program (EMAP) monitoring in Wyoming. Approximately 50 randomly selected sites will be assessed over the four year contract, with the end goal being an unbiased estimate of water quality conditions in the State. The USGS also conducted an assessment of the Yellowstone River Basin of Wyoming and Montana as part of the National Water-Quality Assessment Program (NAWQA). The considerable amount of biological data generated from these studies is being evaluated for comparability with WYDEQ data to explore the usefulness of these data for 305(b) purposes. In addition, joint-funding agreements are in place with the USGS that allow for enhanced biological monitoring of streams in areas affected by coal bed methane development.

The Wyoming Game and Fish Department (WGFD) is an important source of fish data. WYDEQ has chosen not to sample fish communities as part of bioassessments, but uses WGFD data for determining support of fisheries uses, as well as in classifying streams for assignment of uses and designating appropriate water quality standards associated with those uses.

Wyoming has made significant strides in recent years in the development of multimetric biocriteria. Work will continue toward refining the existing numeric criteria and narrative aquatic life standard, and toward the eventual implementation of numeric aquatic life standards. Implementation of numeric standards is sure to be a challenging effort. The physical heterogeneity of Wyoming (e.g., climate, landscape, land use, and geology) poses significant scientific challenges. Political considerations are also likely to pose challenges.

Currently, WY is exploring the use of predictive models for assessing biological conditions of streams, as well as the addition of periphyton as an additional biological indicator to supplement macroinvertebrate data and WGFD fish data used in bioassessments. Periphyton samples have been collected at a limited number of long-term reference stations in the past, and the use of periphyton data will expand in coming years.

Documentation and Further Information

Wyoming's 2000 305(b) State Water Quality Assessment Report and *2000 303(d) Report*:
http://deq.state.wy.us/wqd/watershed/01452-doc.pdf

Wyoming Surface Water Quality Standards: http://deq.state.wy.us/wqd/index.asp?pageid=52#Stand

Manual of SOPs for Sample Collection and Analysis: http://deq.state.wy.us/wqd/watershed/10574-doc.pdf

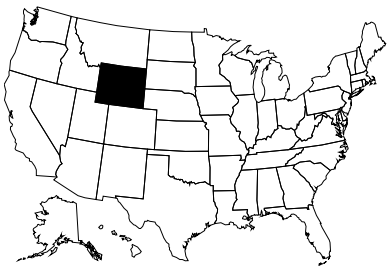
WYDEQ Water Quality Division Five-Year Comprehensive Monitoring Plan, 2001 Update, October 2001:
http://deq.state.wy.us/wqd/watershed/12806-doc.pdf

Jessup, B.K. and J.B. Stribling. 2000. *Testing the Wyoming stream integrity index*. Prepared by Tetra Tech, Inc., Owings Mills, Maryland, for USEPA Region 8, Denver, CO.

Gerritsen, J; Jessup, B.K.; King, K.; Smith, J. and Stribling, J.B. 2000. *Development of Biological Criteria for Wyoming Streams and their Use in the TMDL Process.* Prepared by Tetra Tech, Inc., Owings Mills, Maryland, for USEPA Region 8, Denver, CO.

Data can be found online at http://wy.water.usgs.gov/ and http://www.wrds.uwyo.edu/

WYOMING



Contact Information

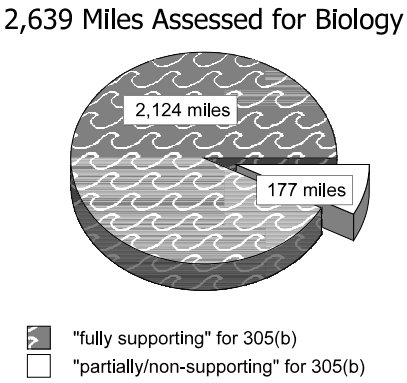
Jeremy ZumBerge, Monitoring Program Supervisor
Wyoming Department of Environmental Quality (WYDEQ)
1043 Coffeen Avenue, Suite D ■ Sheridan, WY 82801
Phone 307/672-6457 ■ Fax 307/674-6050
email: jzumbe@state.wy.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
	✓	other: UAAs and site-specific standards
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(specific river basins or watersheds)*
	✓	fixed station (i.e., water quality monitoring stations) *(specific river basins or watersheds)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(specific river basins or watersheds)*
		other:

Stream Miles

Total miles *(determined using RF3, 2000 and National Hydrography Datatbase, 2001)*	**113,422**
Total perennial miles	32,520
Total miles assessed for biology*	**2,639**
fully supporting for 305(b)	2,124
partially/non-supporting for 305(b)	177
listed for 303(d)	177
extent fully supporting, but threatened	388
number of sites sampled	700+
number of miles assessed per site	3.25



*Since a Weight-of-Evidence approach is used in use support decisions, the numbers provided reflect waterbody reach extent where some type of biological data were used in the assessment.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class System (A,B,C), Fishery Based Uses and Warm Water vs. Cold Water	
ALU designations in state water quality standards	Game Fish (Warm Water and Cold Water Game Fish), Non-game Fish and Aquatic Life Other than Fish	
Narrative Biocriteria in WQS	Formal/informal numeric procedures exist to support ALU decisions.	
Numeric Biocriteria in WQS	under development (Numeric biocriteria are in use but are still being refined and are not yet incorporated in WY's water quality standards.)	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
		permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Trend analysis in watershed improvement projects and following degradation resulting from construction projects and spills.	

Reference Site/Condition Development

Number of reference sites	**140** based on field investigation checklist **90** based on quantitative physical and chemical filters	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment *(Best Professional Judgment based on landscape and field investigation coupled with select water chemical and physical filters)*
		other:
Reference site criteria	Site is identified by the field investigation to be "reference quality" based on analysis of a 27 item checklist of reach and watershed characteristics plus select ecoregion specific quantitative physical and chemical filters.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
	✓	professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites – not at watershed level)*
		fish
	UD	periphyton
		other:
Benthos		
sampling gear		Surber, dipnet; 500-600 micron mesh
habitat selection		riffle/run (cobble)
subsample size		500 count
taxonomy		combination--genus, species
Periphyton		
sampling gear		**natural substrate:** brushing/scraping device (razor, toothbrush, etc.)
habitat selection		riffle/run (cobble)
sample processing		WYDEQ's periphyton program is under development. Samples have been collected, but analysis protocols are yet to be developed.
taxonomy		under development
Habitat assessments		visual based, quantitative measurements, hydrogeomorphology, pebble counts (Wolman), streambank stability (Bauer and Burton - EPA910/R-93-017), pool quality (Bauer and Burton); performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, taxonomic proficiency checks, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
	UD	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		95th percentile of reference population
defining impairment in a multimetric index		25th percentile of reference population
Evaluation of performance characteristics	✓	repeat sampling *(select sites are sampled annually to document annual variability)*
	✓	precision *(side-by-side sampling at 10% of stations; Data Quality Objectives for density and number of taxa)*
		sensitivity
		bias
		accuracy
Biological data		
Storage		STORET, EDAS, and internal spreadsheets
Retrieval and analysis		EDAS

AMERICAN SAMOA

Contact Information

Edna Buchan, Water Program Manager
American Samoa Environmental Protection Agency (ASEPA)
Executive Office Building ■ Pago Pago, American Samoa 96799
Phone 684/633-2304 ■ Fax 684/633-5801
email: ednabuchan@hotmail.com
website: http://www.asg-gov.com/agencies/epa.asg.htm

Program Description

American (Amerika) Samoa is a group of six Polynesian islands in the South Pacific. Located fourteen degrees below the equator, it is the United States' southern-most territory.

The American Samoa Environmental Protection Agency (ASEPA) develops and implements programs that protect environmental and public health from harmful impacts on air and water quality. USEPA works in partnership with ASEPA and provides funding and technical assistance to carry out environmental programs. ASEPA activities include water quality monitoring, inspecting facilities and new developments for compliance with environmental regulations, preparing responses to hazardous material releases, advocating practices that decrease and prevent pollution, and educating the public on environmental issues and practices.

American Samoa does not have a biological assessment program in place, and has no immediate plans for implementing a bioassessment program. The American Samoa Water Quality Standards contain no numeric biocriteria. Wording in standards that states that Fresh Surface Water and Wetlands "shall be protected to support the propagation of indigenous aquatic and terrestrial life" may be considered narrative criteria.

Documentation and Further Information

Personal communication (email), Edna Buchan, 11/26/2001.

THIS PAGE INTENTIONALLY LEFT BLANK

Commonwealth of Northern Mariana Islands (CNMI)

Contact Information

Peter C. Houk, Marine Biologist
CNMI Division of Environmental Quality (DEQ)
P.O. Box 501304 ■ Saipan, MP 96950
Phone 670/664-8505 ■ Fax 670/664-8540
email: peter.houk@saipan.com
website: http://www.deq.gov.mp/

Program Description

NOTE: Since few freshwater sources exist on the islands, all information in this program summary refers to CNMI's marine environments (CNMI has only two or three, very small, perennial streams. CNMI's dynamic tropical marine system requires different approaches and techniques than are used by the states to develop biocriteria.)

The objective of CNMI's Marine Monitoring Program is to monitor CNMI's reefs, lagoon, and reef flats with regards to benthic communities, macroinvertebrate and fish abundances, and water quality. In addition, CNMI has a biodiversity list of all organisms encountered in CNMI and a reference collection. CNMI Water Quality Standards clearly state that benthic communities can not be altered due to a discharge (Section 7.12 (d)). Any significant changes would be changes from 1) previous conditions at the same site or 2) changes from a similar reference site. The goal is to gather as much baseline data in as many different areas as possible to use for comparisons. Last year, a "State of the Reef Report" was completed which comprises all of the results from monitoring efforts.

In 2001, the focus was on assessments of nearshore coral reef systems surrounding Saipan and Rota. The 2000/2001 *State of the Reef Reports* were produced summarizing past and present coral reef data for Saipan and Rota. Though it would be impossible to survey the entire coral reef system around CNMI with current resources, there are approximately 20 sites established for intensive data collection on a yearly basis. The goal is to continue to enhance CNMI's interagency marine monitoring group composed of Coastal Resources Management, Division of Fish and Wildlife, and Division of Environmental Quality. Assessments of existing and additional sites on Rota, Saipan, Tinian, and other Northern Islands will be conducted and included in the next Reef Report (2002). Data will be used for future assessments of natural disasters, potential anthropogenic disturbances/development, and overall biological health.

In 2002, the entire Saipan Lagoon, covering several watersheds, will also be surveyed to assess and understand how upland runoff (nonpoint source pollution) may be affecting this valuable resource. The entire lagoon will be divided into habitats and quantitative and qualitative data from each habitat will be gathered. Once completed, existing aerial photographs will be scanned and remote sensing techniques will delineate the habitats found. The end result will be used to examine correlations between water quality, drainage areas, other areas of concern, and the lagoon habitat. This project is also required by the Army Corps of Engineers in order to proceed with a master drainage plan for areas associated with Saipan's Lagoon. Lagoon survey work is currently a joint project between NOAA's Coastal Resource Management Program and DEQ. Hopefully, the Division of Fish and Wildlife will be involved in this project in 2002 as well.

CNMI's reef monitoring program is based on site selection. Sites that have "concerns" or "disturbances" are selected, as well as several reference sites. There are many more habitats in the nearshore coral reef communities around CNMI than are found in the Saipan Lagoon, hence the difference in methods. Also, weather conditions prohibit surveys on windward sides of the islands most of the year. All of this data is very useful for understanding baseline water quality conditions, and these data are used for assessment when and if projects are proposed that involve a discharge.

CNMI's program can not follow the same type of biocriteria monitoring program implemented in any of the U.S. states. There is a very dynamic tropical marine system surrounding CNMI which warrants the use of techniques different than those used by our State counterparts.

Documentation and Further Information

Commonwealth of Northern Mariana Islands Water Quality Assessment Report 305(b), April 2000

Commonwealth of Northern Mariana Islands Water Quality Assessment Report 305(b), 2002
(Interested parties can contact Peter Houk, CNMI DEQ, or EPA Region 9 for a copy of either report)

CNMI *State of the Reef Report*, 2000

CNMI *Nonpoint Source and Marine Monitoring Program* information: http://www.deq.gov.mp/NPS/default.htm

Commonwealth of Northern Mariana Islands

Contact Information

Peter C. Houk, Marine Biologist
CNMI Division of Environmental Quality (DEQ)
P.O. Box 501304 ■ Saipan, MP 96950
Phone 670/664-8505 ■ Fax 670/664-8540
email: peter.houk@saipan.com

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
		TMDL assessment and monitoring
	✓	other: public information and awareness
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
	✓	fixed station (i.e., water quality monitoring stations) *(comprehensive use throughout jurisdiction)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
		rotating basin
		other:

Stream Miles* (pertains to coral reef monitoring)

Total miles	**–**
Total perennial miles	–
Total miles assessed for biology	**n/a**
fully supporting for 305(b)	n/a
partially/non-supporting for 305(b)	n/a
listed for 303(d)	n/a
number of sites sampled on the reef *(on an annual basis)*	20
number of miles assessed per site	site specific

*The above section is not applicable to CNMI's monitoring program since no stream monitoring is conducted. For lagoon surveys, CNMI plans to intensively survey and create habitat maps for the entire Saipan Lagoon system. This covers several watersheds. CNMI's outer reef monitoring program is based on site selection - sites that have "concerns" or "disturbances," as well as several reference sites. There are many more habitats in the nearshore coral reef communities around CNMI than are found in the Saipan Lagoon, hence the difference in methods. Also, weather conditions prohibit surveys on windward sides of the islands most of the year. All of these data are very useful for understanding baseline water quality conditions, and these data are used for assessment when and if projects are proposed that involve a discharge.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class System (A,B,C)	
ALU designations in state water quality standards	AA - top quality marine, A - marine non-recreational 1 - surface water (runoff mainly, no rivers) highest quality, 2 - surface water non-recreational	
Narrative Biocriteria in WQS	Formal/informal numeric procedures used to support narrative biocriteria are determined by the best available data.	
Numeric Biocriteria in WQS	none (Numeric biocriteria are located in yearly reports on monitoring activities. Each site differs with respect to benthic communities and CNMI's WQS uses the term "shall not differ substantially from those where similar conditions exist.")	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
		cause and effect determinations
		permitted discharges
		monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	A ponding basin was established on Rota Island in response to CNMI DEQ's monitoring results. There are also other small projects similar to this. DEQ is collecting baseline data with the intention of using it to assess BMPs and aid future decision-making.	

Reference Site/Condition Development

Number of reference sites	**5 total**	
Reference site determinations	✓	site-specific
		paired watersheds
		regional (aggregate of sites)
	✓	professional judgment
	✓	other: based on benthic community composition
Reference site criteria	Reference sites are chosen based on similar geological/physical features (slope, substrate, etc.). They are sites similar in community composition that are not subjected to the discharge in question. There are usually several on each island in CNMI.	
Characterization of reference sites within a regional context *Not applicable**		historical conditions
		least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions *Not applicable*		ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU *(in some cases)*
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions *(in some cases)*

*Characterization of reference sites does not apply because CNMI uses a degree of community change based on reference versus test sites.

Field and Lab Methods*

Assemblages assessed	✓	benthos *(<100 samples/year; single season, multiple sites - broad coverage)*
	✓	fish *(<100 samples/year; single season, multiple sites - broad coverage)*
		periphyton
	✓	other: waterfowl *(100-500 samples/year; multiple seasons, multiple sites - broad coverage for watershed level)*
Benthos*		
sampling gear		Transect lines, underwater photo equipment, hammer, measuring tapes, diving gear, underwater slates/pencils
taxonomy		genus and species
Fish*		
sampling gear		speargun, reference books
taxonomy		species
Habitat assessments		quantitative measurements, benthic coverage estimates of major benthos, basic water quality parameter measurements, abundances of fish and macroinvertebrates, and biodiversity of all organisms present; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, and specimen archival

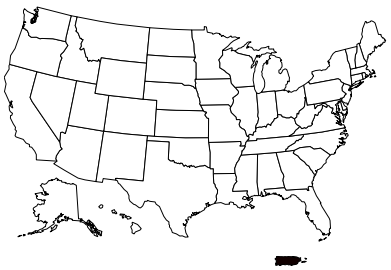
*Following is a summary of biological sampling methods used in the reef – see CNMI's *State of the Reef Report* for details

- Three 50 meter transect lines are secured parallel to the shoreline (laid end-to-end, 150m total length), and marked with a sediment trap holder and re-bar driven securely into the reef.
- For benthics, an underwater camera is used to take still photographs of .5-m quadrats placed at all even numbers along the transect line. For each photo the bottom right corner of the quadrat is aligned with the corresponding transect line distance.
- Coral communities are examined using the point-quarter method described by Randall et al., (1988). A dive knife is haphazardly tossed 16 times along the three transects. For each toss the distance to the nearest living coral colony is noted for each of four quadrants, as well as the diameter and taxonomic name.
- Fish abundance is determined by a single observer swimming along the transect lines recording data. Counts of all fishes within 5 meters of each side of the transect line are recorded. Fishes are identified to the family level.
- All macroinvertebrates within 2 meters of each side of the transect line are counted. These data were presented as abundances per (100-m^2) of reef on each of three transects. Macroinvertebrates are either identified to genus or grouped by life form, depending on abundances.
- Sediment traps provide sedimentation rate data from sites where sedimentation is a concern.
- Water samples are taken for chemistry.

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis
		biological metrics
		disturbance gradients
	✓	other: distribution analysis and cluster analysis
Multivariate thresholds		
defining impairment in a multivariate index		5^{th} percentile of reference population (Pvalue of .05 is cut off)
Evaluation of performance characteristics	✓	repeat sampling
		precision
		sensitivity
		bias
		accuracy
Biological data		
Storage		MS Access, Excel, Word, Arcview GIS and Photo documentation
Retrieval and analysis		Excel

PUERTO RICO and the U.S. VIRGIN ISLANDS



Contact Information

James Kurtenbach, Aquatic Biologist
USEPA - Region II, Division of Environmental Monitoring and Assessment
2890 Woodbridge Avenue, Bldg. 209 ■ Edison, NJ 08837
Phone 732/321-6695 ■ Fax 732/321-6616
email: kurtenbach.james@epa.gov

Program Description

Puerto Rico is presently evaluating Rapid Bioassessment Protocols (RBPs) for mountain streams. According to the Water Monitoring Plan for fiscal year 2002, the Puerto Rico Environmental Quality Board (PREQB), in coordination with EPA Region II, will continue to work on the development of biological indicators for stream monitoring. PREQB is responsible for current monitoring activities which include ambient water quality monitoring, intensive water quality studies, and 305(b) reporting. The 2000 Cycle 305(b) Report doesn't include any biological information (aside from limited wetland loss data). The EPA (ORD Coastal 2000 Program) conducted an EMAP study on the estuaries of Puerto Rico, which included benthic macroinvertebrate sampling.

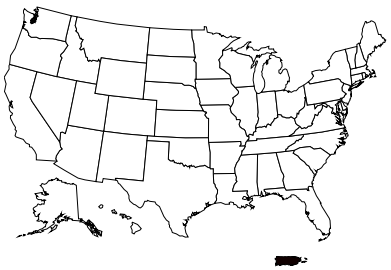
The *U.S. Virgin Islands 2000 Water Quality Assessment* reported that there are "no perennial streams on any of the islands; intermittent streams can only be seen after heavy rainfall. The absence of large freshwater resources and perennial streams means that *guts* (watercourses) form the basis for watershed management in the territory." Also, the Virgin Islands primarily assess coastal waters and estuaries, but "no monitoring for biological effects is conducted for lack of baseline standards for Virgin Islands conditions. According to the Virgin Islands multi-year monitoring strategy, the Department of Planning and Natural Resources (DPNR) will explore options for implementing a biological component of the Ambient Monitoring Program. This may include developing a partnership with NOAA or another agency with similar monitoring objectives."

Documentation and Further Information

Goals and Progress of Statewide Water Quality Management Planning: Puerto Rico 1998-1999, 2000 Cycle 305(b) Report. Puerto Rico Environmental Quality Board. November 2000.

2000 Water Quality Assessment for the United States Virgin Islands, 2000 305(b) Report. Department of Planning and Natural Resources, Division of Environmental Protection (DPNR/DEP). April 2001.

PUERTO RICO and the U.S. VIRGIN ISLANDS



Contact Information

James Kurtenbach, Aquatic Biologist
USEPA - Region II, Division of Environmental Monitoring and Assessment
2890 Woodbridge Avenue, Bldg. 209 ■ Edison, NJ 08837
Phone 732/321-6695 ■ Fax 732/321-6616
email: kurtenbach.james@epa.gov

Programmatic Elements

Uses of bioassessment within overall water quality program *Not currently used*		problem identification (screening)
		nonpoint source assessments
		monitoring the effectiveness of BMPs
		ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
		TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
	✓	fixed station (i.e., water quality monitoring stations) *(special projects only)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
		rotating basin
		other:

Stream Miles

NOTE: *These stream and river miles apply only to Puerto Rico. The U.S. Virgin Islands reports no stream miles.*

Total miles *(determined using RF3)*	**5,394.2**
Total perennial miles	–
Total miles assessed for biology*	**0**
fully supporting for 305(b)	n/a
partially/non-supporting for 305(b)	n/a
listed for 303(d)	n/a
number of sites sampled	n/a
number of miles assessed per site	n/a

*Specific biological studies have been conducted, but there are no ongoing projects. However, Puerto Rico does conduct other regular chemical and physical monitoring. According to PR's 2000 305(b) report, during the 1998 - 1999 monitoring cycle there were 5,394 total assessed miles; 4,297 evaluated segments; and 1,096 monitored segments. Of the 1,096.7 river miles monitored for Aquatic Life Use, 222.4 miles were determined to be fully supporting, 16.8 miles were partially supporting, and 857.5 miles were non-supporting.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Class System (A,B,C)	
ALU designations in state water quality standards	Standards list definitions for the following: pelagic and planktonic species, propagation and preservation of desirable species.	
Narrative Biocriteria in WQS	none (Puerto Rico and the U.S. Virgin Islands have no biocriteria. According to Puerto Rico's 2000 305(b) report, there were expectations of achieving/developing some, but no monitoring strategy has been submitted as of yet.)	
Numeric Biocriteria in WQS	none	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria) *Not currently used*		assessment of aquatic resources
		cause and effect determinations
		permitted discharges
		monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	none	

Reference Site/Condition Development*

Number of reference sites	**none**	
Reference site determinations		site-specific
		paired watersheds
		regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria		
Characterization of reference sites within a regional context		historical conditions
		least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions		ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
		some reference sites represent acceptable human-induced conditions

*This section is not applicable – no biological monitoring is conducted in Puerto Rico or the U.S. Virgin Islands, thus neither territory has reference sites.

Field and Lab Methods*

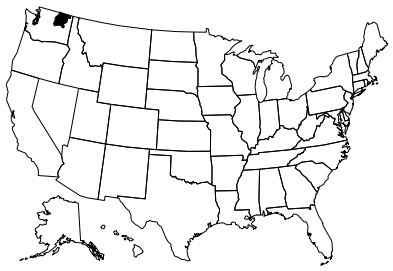
Assemblages assessed	☐	benthos
	☐	fish
	☐	periphyton
	☐	other:
Habitat assessments	not applicable	
Quality assurance program elements	not applicable	

Data Analysis and Interpretation*

Data analysis tools and methods	☐	summary tables, illustrative graphs
	☐	parametric ANOVAs
	☐	multivariate analysis
	☐	biological metrics
	☐	disturbance gradients
	☐	other:
Evaluation of performance characteristics	☐	repeat sampling
	☐	precision
	☐	sensitivity
	☐	bias
	☐	accuracy
Biological data		
Storage	not applicable	
Retrieval and analysis	not applicable	

*These sections are not applicable since no biological monitoring is conducted in Puerto Rico or the U.S. Virgin Islands.

CONFEDERATED TRIBES OF THE COLVILLE RESERVATION



Contact Information

Gary Passmore, Office of Environmental Trust
Confederated Tribes of the Colville Reservation
P.O. Box 150 ■ Nespelem, WA 99155
Phone 509/634-2200 ■ Fax 509/634-4116
email: gary.passmore@colvilletribes.com
website: http://www.colvilletribes.com/

Program Description

The Colville Indian Reservation land base covers 1.4 million acres or 2,100 square acres located in North Central Washington, primarily in Okanogan and Ferry counties. The Reservation consists of tribally owned lands held in federal trust status for the Confederated Tribes, land owned by individual Colville tribal members (most of which is held in federal trust status), and land owned by others (described as fee property and taxable by counties). Colville Reservation lands are diverse with natural resources including standing timber, streams, rivers, lakes, minerals, varied terrain, native plants and wildlife.

Although the Confederated Tribes of the Colville Reservation do have federally approved water quality standards, the Tribes' Office of Environmental Trust doesn't use biological assessment methods as a means to assess water quality. In 2001, the Tribes gave permission to the State of Washington Department of Ecology to conduct some biological assessments on the reservation, but the results of those surveys are not yet complete. The primary obstacle to conducting bioassessment has been cost. The water quality monitoring program is reevaluated every year, and it is possible the Tribes may implement biological monitoring in the future.

Documentation and Further Information

Personal Communication (email), Gary Passmore, 11/28/2001.

THIS PAGE INTENTIONALLY LEFT BLANK

NEZ PERCE TRIBE

Contact Information

Ann Storrar, Water Planner
Nez Perce Tribe Department of Natural Resources
P.O. Box 365 ■ Lapwai, Idaho 83540
Phone 208/843-7368 ■ Fax 208/843-7371
email: anns@nezperce.org
website: http://www.nezperce.org/

Program Description

The Nez Perce Reservation is located in North Central Idaho. The Tribal Department of Natural Resources consists of the Land Services, Cultural Resources, Wildlife Resources, Forest Resources, Water Resources, and Environmental Restoration and Waste Management Programs. These programs focus on delivering resource management services on the Reservation and participating in the planning and decisions of land management activities affecting the Nez Perce Treaty area. The programs provide protection of reserved treaty-rights in all areas to their best abilities. Department administration is structured to facilitate an interdisciplinary approach in meeting these needs.

Currently the Tribe is collecting baseline chemical and physical habitat data on Reservation waterbodies and will, eventually, be establishing its own water quality standards for the reservation area. The Nez Perce Tribe may soon promulgate the standards USEPA is developing for Indian country, with the idea of refining them from narrative standards to both chemical and biological criteria. The Tribe has used the State of Idaho Beneficial Use Assessment Procedure (BURP) for reservation water bodies in 1997, 1998 and 1999 and would like to adopt its own protocols for beneficial use assessment.

The Tribe recently obtained funds to begin the EMAP bioassessment procedure for the reservation. This will be accomplished through participation in the EMAP Western Pilot and methods will be developed based on EMAP protocols.

Documentation and Further Information

Personal Communication (email), Ann Storrar, 10/01/2001.

THIS PAGE INTENTIONALLY LEFT BLANK

ONEIDA NATION OF WISCONSIN

Contact Information

James L. Snitgen, Water Resources Team Leader
Oneida Nation of Wisconsin, Environmental, Health and Safety Department
P.O. Box 365, 3759 W. Mason Street ■ Oneida, WI 54155
Phone 920/497-5812 ■ Fax 920/496-7883
email: jsnitgen@oneidanation.org
website: http://www.oneidanation.org

Program Description

Objectives
The Oneida Tribe's current and future uses of information gathered using bioassessment include protection, restoration, assessing impacts, monitoring changes, as well as driving policy and promoting knowledge and appreciation of aquatic resources.

Background
Although there had been some invertebrate and fish surveys performed on the Reservation over the last twenty years or so, the development of a formal biological monitoring program was initiated in 2000. Tri-annual fishery surveys at established monitoring sites have been performed since 1997. In 1999, the Tribe began sampling invertebrate communities and immediately began using the findings as tools. An onsite aquatic invertebrate taxonomy laboratory was also established in 1999 and equipped with scopes, literature, drying oven, hood, etc. In 2000, qualitative sampling of invertebrates was performed at five stream sites and a quantitative study of one lake was initiated to determine the effectiveness of BMPs in the surrounding basin. In the meantime, SOPs were developed for qualitative and quantitative methods for lakes and wadeable streams and metrics were researched and tested. Contracts were set up for the picking and sorting of invertebrate samples (UW-Superior) and for toxicity testing (Environmental Consulting and Testing) of certain waterbodies. In 2001, quantitative samples were collected at three stream sites and the lake, as well as three more sites being sampled qualitatively. Stream types have not been formalized, but four reference sites have been established:

1. **Thornberry Creek** (at forest Drive), a first order cold water system, exhibiting "pristine" conditions during 1999 and 2000.
2. **Trout Creek** (at County FF), a 3rd order cold water system, exhibiting "good" to "very good" conditions.
3. **Oneida Creek** (at VanBoxtel Road), a 3rd order cool water system, exhibiting "good" conditions in 2000. A very rare fingernet caddisfly, *Wormaldia moesta*, known to occur only in "small, cold, rapid streams" has been collected at this site.
4. **Duck Creek** (at Seminary Road), a 4th order warm water system, the largest stream on the Reservation. The water quality and invertebrate community represent "good" conditions. The same stream is in "poor" condition before entering the Reservation from the south near the Town of Freedom.

The streams at these sites represent the reference conditions for all stream types on the Reservation. In 2002, qualitative or quantitative sampling will be conducted at approximately 30 invertebrate sites and mid-summer fish IBIs will be conducted at eleven sites.

Setting/Land Use
The entire Reservation, covering approximately 64,500 acres, is in the Southeastern Wisconsin Till Plains ecoregion (Omernick 1987). At this time, the main sources of impairment are sedimentation (construction and agriculture) and nutrients (agriculture, suburban lawns, golf courses). The Reservation straddles the boundary of Brown and Outagamie Counties and includes all or portions of the City of Green Bay, Villages of Ashwaubenon and Howard, and the Towns of Hobart, Oneida and Pittsfield. Eleven additional municipalities rest within the watersheds flowing through the Reservation. All surface waters within the Oneida Reservation drain to the Great Lakes Basin (Lake Michigan). There are four separate surface water drainages, bearing numerous tributaries:
1) Duck Creek River – Fish Creek, Oneida Creek, Trout Creek, Lancaster Brook, Beaver Dam Creek, Silver Creek (*Lower Green Bay Basin*); 2) South Branch of the Suamico River (*Upper Green Bay Basin*); 3) Ashwaubenon Creek – North Branch, South Branch, Hemlock Creeks (*Fox River Basin*); and 4) Dutchman Creek (*Fox River Basin*)

Land use percentages surrounding the sites will be mapped this summer (2002), and the first formal biomonitoring report is being produced.

Metrics and Biocriteria Development
While the Oneida Nation does not have federally approved water quality standards, the Tribe is implementing a water quality program with bioassessment surveys under tribal law. The inclusion of biocriteria into the Tribe's WQS has been delayed due to urgent water resource issues that have come up, rather than lack of information. The appropriate metrics to accurately predict responses in benthic invertebrate communities for the area are fairly well proven at this time. The metrics currently being used (for streams) are the Hilsenhoff Biotic Index (HBI), Taxa Richness, dominance, percent clingers and in some cases Ephemeroptera, Plecoptera and Trichoptera (EPT) and E, P and T taken separately. The most common impacts are due to sedimentation and organic loading. Because of the limited number and type of streams within the Reservation, it is believed that the appropriate reference sites to represent all of the stream types have been selected. A final designation of these has not been made, nor are biocriteria being submitted for inclusion in the WQS until there is a chance to conduct more sampling of test sites to compare with the reference sites.

Documentation and Further Information

Personal communication (letter), James L. Snitgen, 1/2002.

Hard copies of documents including the Oneida Nation's WQS; SOPs for the Qualitative Sampling (#BI002) and Quantitative Sampling (#BI003) of Streams for Benthic Invertebrates; Annual Water Resources Report (future reports will contain fish and macroinvertebrate data)

ONEIDA NATION OF WISCONSIN

Contact Information

James Snitgen, Water Resources Team Leader
Oneida Nation of Wisconsin, Environmental, Health and Safety Department
P.O. Box 365, 3759 W. Mason Street ■ Oneida, WI 54155
Phone 920/497-5812 ■ Fax 920/496-7883
email: jsnitgen@oneidanation.org

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
		evaluation of discharge permit conditions
		TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose)
	✓	fixed station (i.e., water quality monitoring stations)
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
		rotating basin
		other:

Stream Miles

Total miles	**233**
Total perennial miles	–
Total miles assessed for biology	–
fully supporting for 305(b)	n/a
partially/non-supporting for 305(b)	n/a
listed for 303(d)	n/a
number of sites sampled *(in summer 2002)*	41
number of miles assessed per site	~0.02 miles (25 meters)

Aquatic Life Use (ALU) Designations and Decision-Making*

ALU designation basis	Warm Water vs. Cold Water	
ALU designations in state water quality standards	Two designations: cold water ecosystems, warm water ecosystems	
Narrative Biocriteria in WQS	Inclusion of narrative and numeric biocriteria into the Tribe's WQS is under development, as is nutrient criteria. Tribal WQS include biological and water quality language but this does not constitute formal biocriteria.	
Numeric Biocriteria in WQS	see above	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
		permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Macroinvertebrate community data were used to designate one stream as a cold water resource. RBPs were conducted following a stormwater spill.	

*Water quality standards were federally approved in 1996 and then rescinded following a lawsuit.

Reference Site/Condition Development

Number of reference sites	**4 total**	
Reference site determinations		site-specific
		paired watershed
		regional (aggregate of sites)
	✓	professional judgment *(Qualitative data gathered initially on candidate reference sites. Most "pristine" of each stream type used as reference--still in early stages of determining all necessary reference sites)*
		other:
Reference site criteria	water quality, benthic invertebrate community (Hilsenhoff Biotic Index), land use, physical habitat, geomorphology, qualitative benthos investigations	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions		ecoregions (or some aggregate)
		elevation
	✓	stream type *(all within Reservation/all in same ecoregion)*
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	UD	reference sites linked to ALU
	UD	reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

Field and Lab Methods*

Assemblages assessed	✓	benthos *(<100 samples per year; single season, multiple sites - broad coverage)*
	✓	fish *(<100 samples per year; multiple seasons, multiple sites - broad coverage for watershed level)*
		periphyton
		other:
Benthos		
sampling gear		Surber, D-frame, collect by hand; 500 micron mesh
habitat selection		riffle/run (cobble)
subsample size		300 count
taxonomy		species
Fish		
sampling gear		backpack electrofisher; 1/4" mesh
habitat selection		previously established monitoring sites and/or sites suitable for long term monitoring
sample processing		biomass - individual (identify and count)
subsample		none
taxonomy		species
Habitat assessments		visual based, quantitative measurements; performed with bioassessments
Quality assurance program elements		standard operating procedures, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival

*The Oneida Nation has sampled fish for four years and began a macroinvertebrate program in 2001 using the RBP habitat rating score sheet. The Tribe's first herpetile survey is planned for summer 2002 to collect baseline data on two riverways and three wetlands. Oneida also plans to begin using macrophytes as indicators in wetlands.

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index and return single metrics)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		information not provided
defining impairment in a multimetric index		information not provided
Evaluation of performance characteristics	✓	repeat sampling
	✓	precision (replicates)
		sensitivity
		bias
		accuracy
Biological data		
Storage		Macroinvertebrate data in Corel Quattro Pro; fish data in MS Access
Retrieval and analysis		information not provided

PASSAMAQUODDY TRIBE, PLEASANT POINT RESERVATION

Contact Information

Deirdre Whitehead
Passamaquoddy Tribe at Pleasant Point
P.O. Box 343 ■ Perry, Maine 04667
Phone 207/853-2600
email: deirdre@wabanaki.com
website: http://www.wabanaki.com

Program Description

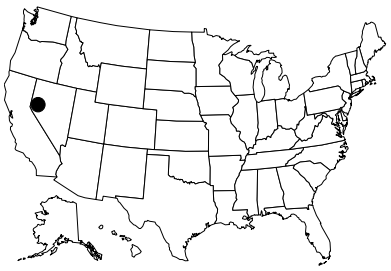
The Passamaquoddy Tribe at Pleasant Point is located in coastal Maine, near the border of New Brunswick. The Tribe's Environmental Department is responsible for the health of the natural resources under Tribal Management. This responsibility begins by assessing and mapping these resources and related risks, then developing programs to insure that these natural resources are protected. While the Passamaquoddy Tribe does not have federally approved water quality standards, it is implementing a water quality program with limited bioassessment surveys under tribal law. Current water quality work includes testing salt water for fecal coliform and phytoplankton in a cooperative arrangement with the Maine Department of Marine Resources (DMR) and the Cobscook Bay Resource Center. This work provides the DMR with information to manage closure of clam flats.

Documentation and Further Information

Personal communication (email), Deirdre Whitehead, 11/30/2001.

THIS PAGE INTENTIONALLY LEFT BLANK

PYRAMID LAKE PAIUTE TRIBE



Contact Information

Dan Mosley, Environmental Specialist
Pyramid Lake Paiute Tribe, Environmental Department
P.O. Box 256 ■ Nixon, NV 89424
Phone 775/574-0101 ■ Fax 775/574-1025
email: dmosley@powernet.net
website: http://plpt.nsn.us/

Program Description

The Pyramid Lake Paiute Tribe's Reservation is located thirty five miles northeast of Reno, Nevada in a remote desert area situated in the counties of Washoe, Lyon, and Storey. The area of the reservation contains 475,000 acres or 742.2 square miles.

The Environmental Department of the Pyramid Lake Paiute Tribe (PLPT) has been conducting bioassessments on waterbodies within the reservation border since 1975. An ecological study on Pyramid Lake was conducted from 1975 through 1977. A comprehensive bioassessment study was conducted on the lower Truckee River during the summer of 1981. In 1989, a regular Rapid Bioassessment (RBA) program was established for the Truckee River, following the first EPA bioassessment training in Reno, Nevada.

PLPT is in the process of establishing standardized protocols for assessing the biological and physical conditions of wadeable streams within the exterior boundaries of the Pyramid Lake Paiute Indian Reservation. The Tribe will use protocols outlined in EPA's Rapid Bioassessment Protocols (USEPA 1989). There are plans to incorporate the bench sheets and protocols as outlined by the California Department of Fish and Game (CA DFG) Water Pollution Control Laboratory in their *California Stream Bioassessment Procedure* (May 1999). These technical documents describe RBA in more detail. Updating and developing aquatic/riparian RBA techniques is an ongoing process.

The PLPT RBA program will ensure that the information generated can be compatible with the National or State EPA bioassessment program, to produce high quality and reliable assessments of stream habitat and water quality. A professional aquatic biologist/entomologist will act as the project team leader, backed by an interdisciplinary team of two to four biologists and/or technicians.

Fish and benthic macroinvertebrates (BMIs) will be identified to the lowest taxonomic level possible (genus/species). The presence or absence of fish and BMIs are proven indicators of an impaired or healthy aquatic system. Bioassessments can be used to detect impairments to aquatic communities from point and nonpoint sources of pollution and for assessing ambient biological condition. The upper third of riffles will be targeted for collecting biological samples because they are the richest habitat for BMIs in wadeable streams. The Tribe's goal is to protect an endangered lake sucker called a "Cui-ui" (*Chasmistes cujus*), and the threatened Lahontan Cutthroat Trout.

In summer 2001, the Tribe initiated a RBA program for springs and wetlands. A wetland specialist will act as team leader, looking at amphibians, wildlife, BMIs, birds, plants, and water chemistry for each waterbody as indicators of an impaired or healthy aquatic system.

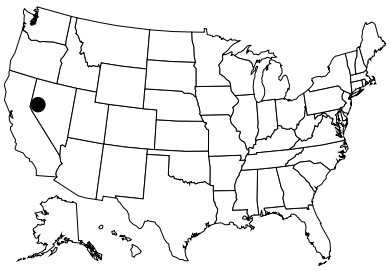
In the future, PLPT plans to explore numeric biocriteria for BMIs on the Truckee River. The Tribe will also begin gathering baseline data on the five streams that surround Pyramid Lake. The Tribe's water quality standards are currently undergoing review by EPA.

Documentation and Further Information

Personal communication (letter), Dan Mosely, 2001.

The following PLPT department homepages are under development (July 2002):
Environmental Department: http://plpt.nsn.us/modules.php?name=Sections&sop=listarticles&secid=21
Water Resources Department: http://plpt.nsn.us/modules.php?name=Sections&sop=listarticles&secid=20

PYRAMID LAKE PAIUTE TRIBE



Contact Information

Dan Mosley, Environmental Specialist
Pyramid Lake Paiute Tribe, Environmental Department
P.O. Box 256 ■ Nixon, NV 89424
Phone 775/574-0101 ■ Fax 775/574-1025
email: dmosley@powernet.net

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	UD	monitoring the effectiveness of BMPs
	UD	ALU determinations/ambient monitoring *(to be developed)*
	UD	promulgated into tribal water quality standards as narrative biocriteria
	UD	support of antidegradation
		evaluation of discharge permit conditions
	UD	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(specific river basins or watersheds)*
	✓	fixed station (i.e., water quality monitoring stations)
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
		rotating basin
		other:

Stream Miles

Total miles	–
Total perennial miles	–
Total miles assessed for biology	**31+**
fully supporting for 305(b)	–
partially/non-supporting for 305(b)	–
listed for 303(d)	–
number of sites sampled*	13 to 15
number of miles assessed per site	–

*Eight to ten sites are sampled on the Truckee River, covering 31 miles. Five sites on five streams surrounding Pyramid Lake are also sampled.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis	Fishery Based Uses	
ALU designations in state water quality standards	under development	
Narrative Biocriteria in WQS	under development (Narrative biocriteria are incorporated into Pyramid Lake's water quality standards, but are currently awaiting approval by EPA Region 9. No formal/informal numeric procedures are used to support narrative biocriteria.)	
Numeric Biocriteria in WQS	under development (The Pyramid Lake Paiute Tribe will be developing "scientifically defensible" numeric biocriteria for the Lower Truckee River over the next several years.)	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	UD	cause and effect determinations
	UD	permitted discharges
	UD	monitoring (e.g., improvements after mitigation)
	UD	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	presently none - to be developed	

Reference Site/Condition Development*

Number of reference sites	**under development**	
Reference site determinations		site-specific
		paired watersheds
		regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	Based on historical data, what the best conditions <u>should be</u> for that site. On Truckee River, the Tribe has been using reference "conditions" based on bioassessment data from 1981 to present.	
Characterization of reference sites within a regional context	✓	historical conditions
		least disturbed sites
		gradient response
	✓	professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
	✓	elevation
	✓	stream type
		multivariate grouping
	✓	jurisdictional *(within Tribe's boundaries)*
		other:
Additional information	UD	reference sites linked to ALU
		reference sites/condition referenced in water quality standards
		some reference sites represent acceptable human-induced conditions

*Reference site use is currently under development.

Field and Lab Methods

Assemblages assessed*	✓	benthos *(<100 samples/year [3 replicates per riffle site]; single season, multiple sites - not at watershed level*)
	✓	fish
	✓	periphyton
		other:
Benthos		
sampling gear		surber (used 1981 through 2000), kicknet (started in 2001) - 9" x 18" rectangle 500 micron mesh
habitat selection		richest habitat - upper third of riffle
subsample size		entire sample
taxonomy		genus and species
Fish		
sampling gear		seine (multiple gill nets), backpack and boat electrofisher
habitat selection		pool/glide
sample processing		length measurement, biomass - individual, anomalies
subsample		study specific
taxonomy		species
Periphyton		
sampling gear		**natural substrate**: brushing/scraping device (razor, toothbrush, etc.) **artificial substrate**: collect by hand
habitat selection		multihabitat
sample processing		chlorophyll *a*/ phaeophytin, biomass, taxonomic identification
taxonomy		all algae; species level; genus level for soft-bodied algae when possible; diatoms are not cleared
Habitat assessments		visual based and quantitative measurements; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologist, sorting and taxonomic proficiency checks, specimen archival

*Tribal Fisheries conducts fish bioassessments and a Tribal Wetlands staff member conducts amphibian biostudies. Periphyton sampling is conducted on tribal land by the Desert Research Institute.

Data Analysis and Interpretation**

Data analysis tools and methods		summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
		biological metrics
		disturbance gradients
		other:
Evaluation of performance characteristics		repeat sampling
		precision
		sensitivity
		bias
		accuracy
Biological data		
Storage		Quattro Pro and paper files
Retrieval and analysis		EDAS (under development)

**Data have not yet been analyzed or evaluated. Pyramid Lake Paiute Tribe is just beginning to sort/identify the 2001 benthic macroinvertebrate collections.

SEMINOLE TRIBE of FLORIDA

Contact Information

Bill Dunson, Environmental Scientist
The Seminole Tribe of Florida, Water Resource Management Department
6300 Stirling Road ■ Hollywood, Florida 33024
Phone 863/902-3200
email: Bdunson@semtribe.com
website: http://www.seminoletribe.com/

Program Description

The reservations that comprise the Seminole Tribe of Florida begin around Tampa and extend into the southern tip of the state. The Tribe's Water Resource Management Department is responsible for protecting the land and water systems within the Reservation while ensuring a sustainable economic and cultural future for the Tribe. USEPA has delegated to the Tribe the authority to implement the Clean Water Act within the Tribe's jurisdiction. As part of that program, the Tribe implemented a sophisticated monitoring program, adopted federally approved water quality standards for the Big Cypress reservation, and is developing standards for the other reservations.

The Tribe has developed other programs, as well, including spill prevention plans for above ground storage tanks and removal programs for underground storage tank facilities. The Tribe actively participates in a number of task forces, working groups, and commissions regarding the restoration of the South Florida ecosystem. The Tribe spends considerable resources supporting the overall design and implementation of South Florida's environmental restoration.

Currently the Tribe does not use biocriteria in any of its water quality monitoring programs. However, the Tribe is involved in a research project conducted by Florida Atlantic University that includes development of biocriteria (primarily for variations in hydroperiod and the effects of restoration), using vegetation and fish as bioindicators.

Documentation and Further Information

Personal communication (email), Bill Dunson, 12/4/2001.

Working Drafts – Bioindicators for wetland change; Presentation on use of data in conducting rapid wetland assessments

THIS PAGE INTENTIONALLY LEFT BLANK

Delaware River Basin Commission (DRBC)

Interstate compact: PA, NJ, NY, DE

Contact Information

Robert L. Limbeck, Watershed Scientist
Edward Santoro, Monitoring Coordinator
Delaware River Basin Commission (DRBC)
P.O. Box 7360 ■ West Trenton, NJ 08628
Phone 609/883-9500 ■ Fax 609/883-9522
email: rlimbeck@drbc.state.nj.us
website: http://www.state.nj.us/drbc/

Program Description

The objectives of the Commission's biological monitoring program are presently focused upon the 200-mile long non-tidal Delaware River corridor:

1. Protection of high quality aquatic life uses in Water Quality Zones 1A through 1E of the Delaware River, from Hancock, New York to Trenton, New Jersey
2. Development of anti-degradation biological criteria based upon existing water quality
3. Definition of longitudinal changes in benthic community structure along the Delaware River corridor, to support decisions to maintain or improve water quality where necessary

DRBC and the National Park Service (NPS) have operated the Scenic Rivers Monitoring Program since the early 1980s. The Commission has never used biological criteria for 305(b) assessments or determinations of impairment, other than reports arising from fish-tissue toxics analysis and inference of aquatic life use attainment based upon water chemistry. Macroinvertebrate biocriteria were developed for DRBC's Special Protection Waters rules issued in 1990, but the criteria were later found to be based upon inconsistent and non-representative methods, and have not been used as envisioned during development of the Commission's anti-degradation policies.

With the launch of DRBC's Lower Delaware Monitoring Program in 1999, declaration of most of the non-tidal Delaware River as Wild and Scenic in 2000, and major efforts to update DRBC's comprehensive plan and water quality standards (applicable to most of the Delaware River), interest in DRBC's biomonitoring program was renewed. Meetings with state and local partners resulted in the decision that the Commission would bear the primary responsibility for biological monitoring of the Delaware River, while each state would regulate and monitor tributaries. With technical support and advice from NJDEP, PADEP, USGS, USEPA Region 3, NPS, and the Academy of Natural Sciences, DRBC set out to define goals, objectives, and methods for improving its biological assessment program for the river.

DRBC investigated large-river bioassessment methods and decided to wait for issuance of EPA's large-rivers guidance before launching large-scale monitoring in difficult habitats such as pools, rapids, and upper-estuarine reaches. In 2001, DRBC initiated an annual benthic survey in 2001 of wadeable riffle, run, and island margin habitats, to develop a benthic index of biological integrity for the non-tidal river. The annual August/September low-flow survey is narrowly defined to eliminate spatial and temporal variability, enabling site-to-site, reach-to-reach, and year-to-year comparison of results. By 2005, DRBC hopes to have enough data to create a low-flow benthic IBI (B-IBI) for wadeable portions of the Delaware River, and to apply the B-IBI to future 305(b) assessments and protection of existing water quality.

The Commission would like to monitor other assemblages in order to gain a more complete picture of the ecological integrity of the Delaware River, and to measure progress toward objectives defined by the Commission's comprehensive plan. DRBC is investigating methods to assess submerged aquatic vegetation, periphyton, fish, mussels, plankton, invasive exotic species, and ecological characterization of over 50 unique microhabitats observed in the river. These investigations have been scheduled on a rotating basis as special studies, though they are not used in use support and/or impairment determinations.

Within the next year, DRBC and the NPS will begin planning for tributary Boundary Control Point biomonitoring. DRBC will establish locations and methods to define existing water quality and create biological targets at each location for antidegradation purposes. With the river survey in progress, this is an appropriate next step in improving biomonitoring coverage and implementing antidegradation policies. DRBC is also moving away from doing taxonomy in-house due to a lack of both time and work space. The identification work from the annual river survey will likely be contracted out sometime in the near future.

Documentation and Further Information

Delaware River & Bay Water Quality Assessment, 2000 305(b) report: http://www.state.nj.us/drbc/2K305b_text.PDF

DRBC Annual Report 2000: http://www.state.nj.us/drbc/ar2000.htm

DRBC Quality Assurance Project Plan 2001 Update: http://www.state.nj.us/drbc/QAplanLDEL01.PDF

DRBC Publications homepage: http://www.state.nj.us/drbc/public.htm

2001 Biomonitoring Work Plan (contains numerous citations, including three reports on DRBC's 3-year bioassessment study, issued by the Academy of Natural Sciences, Patrick Environmental Research Center with recommendations on how best to proceed with update of biocriteria and implementation of antidegradation as mandated in DRBC's Water Quality Standards)

Delaware River Basin Commission (DRBC)

Interstate compact: PA, NJ, NY, DE

Contact Information

Robert L. Limbeck, Watershed Scientist
Edward Santoro, Monitoring Coordinator
Delaware River Basin Commission (DRBC)
PO Box 7360 ■ West Trenton, NJ 08628
Phone 609/883-9500 ■ Fax 609/883-9522
email: rlimbeck@drbc.state.nj.us

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
		monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
		evaluation of discharge permit conditions
		TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects and specific river basins or watersheds)*
	✓	fixed station (i.e., water quality monitoring stations) *(specific river basins or watersheds)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
		rotating basin
		other:

Stream Miles

Total miles* *(total miles of mainstem segment only, not including tributaries; determined using RF3 - Interstate river corridor is well-defined by river reaches, not watershed based)*	**200**
Total perennial miles	unknown
Total miles assessed for biology	**200**
fully supporting for 305(b)**	n/a
partially/non-supporting for 305(b)**	n/a
listed for 303(d)**	n/a
number of sites sampled *(on an annual basis)*	23
number of miles assessed per site***	~8.7

*DRBC is an Interstate Compact encompassing river miles in four states: Pennsylvania, New Jersey, New York and Delaware, and has not determined the number of total stream miles in the Basin. The Delaware River Basin watershed encompasses 13,539 square miles. Bioassessment and biocriteria activities are concentrated on a 200-mile non-tidal segment of the Delaware River and tributary boundary control points.

**Biocriteria are not currently used for the 305(b) report. Biocriteria were developed years ago, but the extent of their application is unknown.

***The number of miles assessed per site (~8.7) is very rough. DRBC's goal is to sample approximately 10 additional sites, thus reducing this number.

Aquatic Life Use (ALU) Designations and Decision-Making*

ALU designation basis	Single Aquatic Life Use and Fishery Based Uses	
ALU designations in state water quality standards	Two designations: The fishery-based designation is general, narrative, and defined by river zone. The single aquatic life use designation is macroinvertebrate criteria within DRBC's Special Protection Waters areas, and is defined for antidegradation purposes.	
Narrative Biocriteria in WQS	See definition of Existing Water Quality in Special Protection Waters (found in the 2001 workplan) for procedures used to support narrative biocriteria.*	
Numeric Biocriteria in WQS	See DRBC's *Administraive Manual – Part III, Water Quality Regulations*, Section 3.10.3 Stream Quality Objectives, Section A. Antidegradation of Waters, Table 1.*	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
		permitted discharges
		monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	DRBC/NPS attempted to use existing criteria to define perceived problem areas. The existing criteria, as defined, could not distinguish anthropogenic versus natural measurable change. Program redesign is necessary.	

*Application of the existing system has been unsuccessful thus far due to the low priority given to biomonitoring. Program redesign recommendations were recently made to improve effectiveness and applicability of the criteria. Criteria for the entire non-tidal river are currently being updated, and a best-habitat based benthic IBI that might eventually be applied to future 305(b) assessments and the protection of existing water quality is under development. Additional data will be required, as well as a clear definition of how the criteria will be applied to the 305(b) process. Separate criteria will be required for the river, the tributaries, and for different levels of application and interpretation.

Reference Site/Condition Development

Number of reference sites	**23 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
		professional judgment
	✓	other: aggregate sites in each river reach were used to define existing water quality for antidegradation purposes.**
Reference site criteria	In known high-quality waters numeric definition of Existing Water Quality provides a reference for comparison. Measurable Change determines departure from the reference condition.	
Characterization of reference sites within a regional context	✓	historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions *UD - tributaries are assessed according to methods used by states to facilitate comparability and data sharing*		ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU *(not well linked)*
	✓	reference sites/condition referenced in water quality standards *(found in water quality standards)*
	✓	some reference sites represent acceptable human-induced conditions *(exceptional water quality was defined under 1980's New York City reservoir operations & dischargers)*

**The program's purpose is to protect the high quality of the river; therefore all sites sampled could be theoretically considered reference sites (the same sites are continually sampled each year and findings are compared to the original samples' data to determine if the quality has changed).

Field and Lab Methods

Assemblages assessed	✓	benthos *(<100 samples/year; single season, multiple sites)*
	✓	fish* *(<100 samples/year; single season, multiple sites)*
		periphyton
	✓	other: macrophytes *(<100 samples/year; single season, multiple sites)*
Benthos		
sampling gear		Surber, Hess, D-frame (500 - 600 micron mesh), BFN = Big-River Frame Net (custom rectangular net, bottom frame area .37 square meters, for Delaware River to 3ft deep, 4 fps, 500 micron mesh)
habitat selection		richest habitat, riffle/run (cobble), multihabitat
subsample size		tributaries - entire sample; river - 200 count
taxonomy		tributaries - family; river - genus
Habitat assessments		visual based, hydrogeomorphology, pebble counts, Pfankuch Flow characterization, Simon Channel Evolution Status; mostly performed with bioassessments, some performed independent of bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival

*Some fish tissue data are collected as part of DRBC's monitoring program, but the work is contracted out to NJDEP and the Academy of Natural Sciences in Philadelphia. DRBC also makes use of PADEP, PA Fish and Boat Commission, and USGS NAWQA study data in water quality assessments.

The Delaware Estuary Program recently assembled an interstate committee to standardize fish advisories in interstate waters. DRBC has had trouble in the past with making use attainment calls based upon state fish advisories. Each state sampled different areas, species, and used different criteria. Conflicts among the different states' data arose when DRBC tried to pull everything together for the Delaware River assessment. DRBC's focus upon interstate coordination and cooperation to improve the process has subsequently increased.

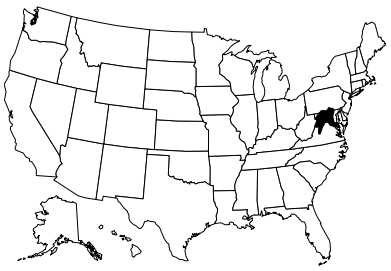
Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(return single metrics - use endpoint for each single metric)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		95th percentile of all sites
Evaluation of performance characteristics**	✓	repeat sampling
	✓	precision
	✓	sensitivity
	✓	bias
	✓	accuracy
Biological data		
Storage		STORET, SAS, MS Access and Excel
Retrieval and analysis		SAS

**See reports issued by the Academy of Natural Sciences (ANS) for an evaluation. ANS identified problems with performance characteristics depending on the level of data interpretation. A redesign of the program is necessary, including refinement of the biocriteria, and field and laboratory practices.

Interstate Commission on the Potomac River Basin (ICPRB)

Interstate compact: VA, WV, MD, PA, DC



Contact Information

James D. Cummins, Associate Director for the Living Resources Section
Interstate Commission on the Potomac River Basin (ICPRB)
6110 Executive Boulevard, Suite 300 ■ Rockville, MD 20852
Phone 301/984-1908 ■ Fax 301/984-5841
email: jcummins@potomac-commission.org
website: http://www.potomacriver.org/

Program Description

ICPRB has no water/land ownership, management or regulatory authority, and therefore has set no water quality standards. However, since the Commission's creation in 1940, ICPRB often assists the basin states (Virginia, Maryland, West Virginia and Pennsylvania), the District of Columbia, and the federal government on such formulations. As part of this assistance, ICPRB conducts stream bioassessments, both fish and benthic, consults with the jurisdictions regarding current and proposed biocriteria and water quality standards, and works with the jurisdictions' data to better understand and characterize the environmental conditions of the Potomac River watershed and associated land usages.

ICPRB is currently working to integrate data from many sources (Virginia, Maryland, West Virginia, Pennsylvania, the District of Columbia, various federal and local governments, and nongovernmental sources) into a single reference watershed analysis. In addition to benthic and fish monitoring in streams and wadeable rivers, ICPRB is doing shad and herring restoration work in non-wadeable rivers. The stream data collected downstream of reservoirs, influences reservoir management decisions. The Commission also analyzes estuary data collected by other entities and works on Chesapeake Bay water quality issues.

Documentation and Further Information

Potomac Basin Water Quality Assessment home (with links to District of Columbia, Maryland, Pennsylvania, Virginia and West Virginia 305(b) and 303(d) information): http://www.potomacriver.org/wqassess.htm

Map of 303(d)-Listed Waters in the Potomac Basin: http://www.potomacriver.org/wq303d.htm

Virginia DEQ Water Quality Assessment Guidance Manual for 2002, 305(b) Water Quality Report and 303(d) Impaired Waters List, amended July 2002: http://www.deq.state.va.us/pdf/water/wqassessguide.pdf

2000 Maryland Section 305(b) Water Quality Report, with *Appendix E, Assessment Methodology*, August 2000: http://dnrweb.dnr.state.md.us/download/bays/MD2000_305b.pdf

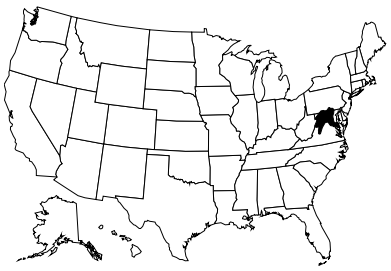
Commonwealth of Pennsylvania 2000 Water Quality Assessment 305(b) Report: http://www.dep.state.pa.us/dep/deputate/watermgt/Wqp/WQStandards/305_wq2000_narr.htm

For a link to *West Virginia Water Quality Status Assessment 2000 305(b) Report for the period 1997-1999,* go to: http://www.dep.state.wv.us/item.cfm?ssid=11&ss1id=192

For a list of ICPRB publications and ordering information, go to: http://www.potomacriver.org/publications.htm

Interstate Commission on the Potomac River Basin (ICPRB)

Interstate compact: VA, WV, MD, PA, DC



Contact Information

James D. Cummins, Associate Director for the Living Resources Section
Interstate Commission on the Potomac River Basin (ICPRB)
6110 Executive Boulevard, Suite 300 ■ Rockville, MD 20852
Phone 301/984-1908 ■ Fax 301/984-5841
email: jcummins@potomac-commission.org

Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects and specific river basins or watersheds)*
		fixed station (i.e., water quality monitoring stations)
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(special projects and specific river basins or watersheds)*
		other:

Stream Miles

Total miles* *(total miles of Potomac River mainstem, not including tributaries)*	**383**
Total perennial miles	–
Total miles assessed for biology**	**n/a**
fully supporting for 305(b)	n/a
partially/non-supporting for 305(b)	n/a
listed for 303(d)	n/a
number of sites sampled*	~1,300
number of miles assessed per site	–

*The Potomac River drainage area includes 14,670 square miles in the following jurisdictions: Maryland, Virginia, West Virginia, Pennsylvania and the District of Columbia.

**ICPRB is not a regulatory authority, but assists the states in the Potomac River Basin (ICPRB doesn't develop own criteria, etc.). The Commission looks at the basin as a whole, across state lines, and thus has no way of producing an accurate estimate of miles assessed. Although ICPRB works with the data from roughly 1,300 sampling stations, sampling is only conducted at several hundred of those stations – these include the samples collected and provided to Pennsylvania's Potomac Watershed Program. The rest of the stations are sampled by various state agencies who supply ICPRB with data to analyze and use for management decisions.

Aquatic Life Use (ALU) Designations and Decision-Making*

ALU designation basis	n/a	
ALU designations in state water quality standards	n/a	
Narrative Biocriteria in WQS	n/a	
Numeric Biocriteria in WQS	n/a	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	n/a	cause and effect determinations
	n/a	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	Not applicable for ICPRB, but member jurisdictions in the Potomac basin use data in various ways.	

*ICPRB does not define aquatic life uses, but uses those designated by member jurisdictions: Virginia, Maryland, West Virginia, Pennsylvania, and the District of Columbia.

Reference Site/Condition Development**

Number of reference sites	**under development**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
		professional judgment
		other:
Reference site criteria	Under development. Each member jurisdiction has its own reference site criteria. ICPRB is working to establish regional reference sites using the "common elements" of the various jurisdictions' habitat evaluations and water quality information. The criteria will be based on water quality data and habitat parameters, and possibly macroinvertebrate data as well. The reference sites will be the least disturbed sites based on these parameters.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
	✓	gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
	✓	jurisdictional (i.e., statewide)
		other:
Additional information	n/a	reference sites linked to ALU
	n/a	reference sites/condition referenced in water quality standards
		some reference sites represent acceptable human-induced conditions

**Reference sites are presently defined by statistical category (example: 95th percentile), but ICPRB would prefer to establish hypothetical reference conditions.

Field and Lab Methods

Assemblages assessed	✓	benthos *(<100 samples/year; multiple seasons, multiple sites – broad coverage for watershed level)*
	✓	fish *(<100 samples/year; multiple seasons, multiple sites – broad coverage for watershed level)*
		periphyton
	✓	other: phytoplankton and zooplankton *(<100 samples/year; multiple seasons, multiple sites – broad coverage for watershed level)*
Benthos		
sampling gear		kick net (1 meter); 200-400 micron mesh
habitat selection		riffle/run (cobble)
subsample size		entire sample
taxonomy		family
Fish		
sampling gear		backpack electrofisher, seine; 1/4" mesh
habitat selection		multihabitat
sample processing		length measurement and anomalies
subsample		selected species, batch
taxonomy		species
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		ICPRB follows QA protocols according to each state's requirements. Elements include periodic meetings and training for biologists, taxonomic proficiency checks, and a certification program for bioassessment.

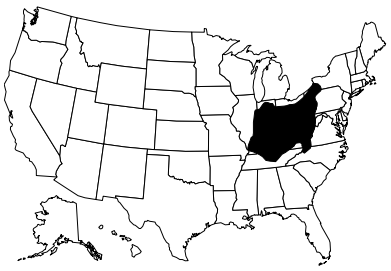
Data Analysis and Interpretation*

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		Current emphasis is on the 95th percentile of all sites (reference and stressed) and a quadrisection of the range. Presently testing various published methods of establishing scoring thresholds in each jurisdiction.
defining impairment in a multimetric index		Consistent thresholds are currently being assembled from impairment criteria applied by member states.
Evaluation of performance characteristics		repeat sampling
		precision
Not currently evaluated		sensitivity
		bias
		accuracy
Biological data		
Storage		Raw data and documentation are obtained from state and federal agencies in varying formats (hardcopy, disc, downloadable ftp files). Data are stored and analyzed using a custom-developed MS Access database similar to EDAS.
Retrieval and analysis		Various statistical software applications are being evaluated; i.e. S-PLUS, Total Access Statistics, et al.

*The objective of the *Basinwide Assessments* program is to integrate and analyze monitoring data from member states' nontidal rivers and streams. While states' data cannot be compared directly, most apply a similar data analysis approach. ICPRB is adapting this analysis framework by selecting and normalizing consistent criteria from the various approaches to define reference and stressed conditions. Invertebrate communities at these sites will be measured and compared. Candidate metrics are also being screened for assessment accuracy and redundancy to select core metrics.

Ohio River Valley Water Sanitation Commission (ORSANCO)

Interstate compact: NY, VA, PA, WV, OH, KY, IN, IL



Contact Information

Erich Emery, Senior Biologist
Ohio River Valley Water Sanitation Commission (ORSANCO)
5735 Kellogg Avenue ■ Cincinnati, OH 45228
Phone 513/231-7719 ■ Fax 513/231-7761
email: emery@orsanco.org
website: http://www.orsanco.org/

Program Description

The strategic objective of ORSANCO's Biological Program is to conduct biological monitoring of the Ohio River in order to determine the extent to which the objective of Article 1 of the Compact "..that the Ohio River be capable of maintaining fish and other aquatic life" is met. Tasks conducted in support of this strategic objective include: 1) Developing techniques for biological monitoring of large rivers in general, and the Ohio River in particular, and 2) Utilizing biological monitoring, assessment, and criteria to characterize the condition of the river. ORSANCO is currently developing numeric biological criteria and plans to integrate biological methods into overall monitoring and assessment efforts.

ORSANCO has been collecting biological data from the Ohio River since 1957 with the initiation of a lockchamber rotenone sampling program, which continues to this day. This method has provided the Commission with a 45-year look at fish community changes within the Ohio River.

ORSANCO is collecting biological data from the Ohio River on behalf of the eight states of the Commission (NY, VA, PA, WV, OH, KY, IN, and IL). These states rely on the Commission to develop appropriate methods, conduct sampling, develop assessment indices and eventually incorporate biological information into all assessment strategies. The states are also relying on ORSANCO to assist them in conducting similar programs on the large Ohio River tributaries within each state.

The Commission uses biological data in a report to each of the states which the states then use for their 305(b) report and 303(d) listings. The Commission is currently in the process of developing numeric biological criteria. Discussions are underway to determine whether the Commission should proceed with referencing biological criteria in Pollution Control Standards for the Ohio River, or incorporating said criteria as 'hard numbers' or codified criteria. ORSANCO will proceed at the recommendation of the states.

ORSANCO is also expanding its programs, including biological efforts, into the tributaries and reaches of the basin. In the very near future, ORSANCO will be working with the states to conduct biological sampling on larger, navigable, tributaries to test methods, develop indices, and eventually expand the coverage of biocriteria. The tributary work will be important in determining how to transition from great rivers to large rivers, in terms of monitoring and assessment, and will enable researchers to make that transition seamlessly.

Documentation and Further Information

ORSANCO 1998 305(b) Fact Sheet for the Ohio River

ORSANCO Water Quality Protection, *Biological Program* homepage: http://www.orsanco.org/watqual/aquatic/biological.htm

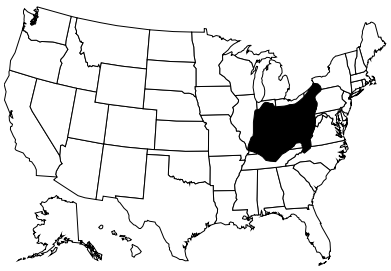
2000 Kentucky Report to Congress on Water Quality, 305(b) report, November 2000: http://water.nr.state.ky.us/wq/305b/2000/2000_305b.htm

1998 Kentucky Report to Congress on Water Quality, 305(b) report, January 1999 (sites sampled by ORSANCO found in *Table 2*): http://water.nr.state.ky.us/305b/

For a list of publications (including QA/QC documents, monitoring and assessment strategies, data summaries, etc.), go to: http://www.orsanco.org/rivinfo/pubs/pubs.htm

Ohio River Valley Water Sanitation Commission (ORSANCO)

Interstate compact: NY, VA, PA, WV, OH, KY, IN, IL



Contact Information

Erich Emery, Senior Biologist
Ohio River Valley Water Sanitation Commission (ORSANCO)
5735 Kellogg Avenue ■ Cincinnati, OH 45228
Phone 513/231-7719 ■ Fax 513/231-7761
email: emery@orsanco.org

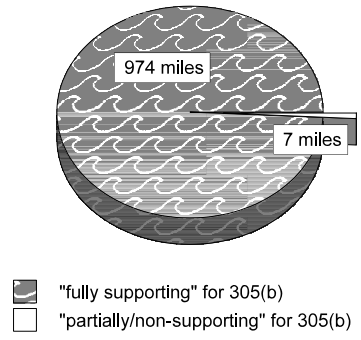
Programmatic Elements

Uses of bioassessment within overall water quality program*	✓	problem identification (screening)
	UD	nonpoint source assessments
	UD	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	UD	support of antidegradation
	UD	evaluation of discharge permit conditions
	UD	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
	✓	fixed station (i.e., water quality monitoring stations) *(special projects only)*
	UD	probabilistic by stream order/catchment area
	UD	probabilistic by ecoregion, or statewide
		rotating basin
		other:

Stream Miles

Total miles *(total miles of mainstem only, not including tributaries)*	**981**
Total perennial miles	–
Total miles assessed for biology*	**981**
fully supporting for 305(b)*	974
partially/non-supporting for 305(b)*	7
listed for 303(d)*	55
number of sites sampled *(on an annual basis)*	>1,000
number of miles assessed per site	0.5

981 Miles Assessed for Biology



*The Ohio River flows through or borders six states: Illinois, Indiana, Kentucky, Ohio, Pennsylvania, and West Virginia. It encompasses 203,940 square miles, but ORSANCO only conducts biological monitoring on the mainstem of the Ohio River, which is 981 miles long. ORSANCO produces a 305(b) report exclusively for the Ohio River, and this document is referenced by different states for use in their own 305(b) reports. Fifty-five Ohio River miles are listed on Kentucky's 303(d) list, but this number is based on a past report and the Kentucky Division of Water feels that there is not enough biological data to delist those miles quite yet.

Aquatic Life Use (ALU) Designations and Decision-Making*

ALU designation basis	Single Aquatic Life Use	
ALU designations in state water quality standards	One designation: Warmwater Aquatic Life – other categories are under development	
Narrative Biocriteria in WQS*	Formal/informal numeric procedures used to support narrative biocriteria are under development.	
Numeric Biocriteria in WQS*	under development (to be included or referenced by standards)	
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
		permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU	This is currently unknown because numeric biocriteria are just being proposed for the water quality standards.	

*ORSANCO's water quality standards are the adopted standards that serve as recommendations to states for incorporation into their own standards. ORSANCO is entering review this year (starting with a fish biocriteria proposal); ALU designations and numeric biocriteria are expected to be completed sometime before 2004.

Reference Site/Condition Development

Number of reference sites	**400 total**	
Reference site determinations	✓	site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	Least impacted sites are sites out of the immediate influence of human impact. Specifically, one kilometer below discharges or major tributaries as well as free from other obvious disturbance. Least impacted sites are used as a surrogate for reference sites.	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)**
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

**Plans are underway to develop a tiered aquatic life use approach with expectations based on river reach (ecoregion surrogate) and habitat type.

Field and Lab Methods

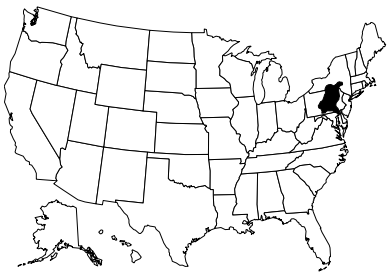
Assemblages assessed	✓	benthos *(100-500 samples/year; multiple seasons, multiple sites – broad coverage for watershed level)*
	✓	fish *(100-500 samples/year; multiple seasons, multiple sites – broad coverage for watershed level)*
		periphyton
		other:
Benthos		
sampling gear	multiplate; standard #30 sieve	
habitat selection	multihabitat	
subsample size	entire sample	
taxonomy	lowest possible level	
Fish		
sampling gear	boat electrofisher; 1/4" mesh	
habitat selection	multihabitat	
sample processing	length measurement, biomass - individual, anomalies	
subsample	none	
taxonomy	species and subspecies	
Habitat assessments	ORSANCO has developed a habitat assessment approach and habitat index for the Ohio River. The index is based on substrate composition (broad categories), depth and cover estimates; these are performed with bioassessments.	
Quality assurance program elements	standard operating procedures, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival. There are plans to develop a certification program for bioassessment.	

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
	✓	parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
	✓	disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores	25^{th} percentile of reference population	
defining impairment in a multimetric index	25^{th} percentile of reference population	
Evaluation of performance characteristics	✓	repeat sampling *(look at site variability)*
		precision
	✓	sensitivity *(look at metrics and index performance)*
		bias
		accuracy
Biological data		
Storage	MS Access	
Retrieval and analysis	Statistica	

Susquehanna River Basin Commission (SRBC)

Interstate compact: NY, PA, MD



Contact Information

Jennifer L. R. Hoffman, Aquatic Ecologist
Susquehanna River Basin Commission (SRBC)
1721 North Front Street ■ Harrisburg, PA 17102
Phone 717/238-0426 ■ Fax 717/238-2436
email: jhoffman@srbc.net
website: http://www.srbc.net/

Program Description

The Susquehanna River Basin Commission (SRBC) is the governing agency established to protect and wisely manage the water resources of the Susquehanna River Basin. The Susquehanna River starts in Cooperstown, NY and flows 444 miles to Havre de Grace, MD, where the river meets the Chesapeake Bay. The watershed encompasses parts of New York, Pennsylvania, and Maryland. Currently, SRBC implements several programs assessing the biological condition of streams and rivers, including the Subbasin Survey and Interstate Water Quality Monitoring Network (ISWQN) Programs.

Six subbasins exist in the Susquehanna River Basin: the Chemung, Upper Susquehanna, Middle Susquehanna, West Branch Susquehanna, Juniata, and Lower Susquehanna. SRBC samples each subbasin on a rotating schedule, assessing each approximately every ten years. The assessment evaluates the chemical, biological, and habitat conditions of streams, identifies major sources of pollution, documents changes in stream quality over time, and identifies areas for more intensive study. This program was initiated in 1982 and was refined in 1998 to include a more intensive second year of sampling to address specific local concerns, such as restoration and protection. Year 1 includes collection of macroinvertebrate samples and physical habitat information using Rapid Bioassessment Protocol (RBP) III, water quality collection, and flow measurement in a single-sampling event during baseflow conditions. Year 2 of the program can include a variety of projects, such as more intensive bimonthly water quality sampling to provide information to watershed groups for protection and restoration efforts. All data collected during SRBC's subbasin surveys are used in reporting to the USEPA under Section 305(b) of the Clean Water Act.

The ISWQN program, initiated in 1986, includes periodic collection of water quality and biological samples, as well as physical habitat assessments of interstate streams. Water quality data are collected quarterly and are used to assess compliance with water quality standards, characterize stream quality and seasonal variations, build a database for assessing water quality trends, and identify areas for restoration and protection. SRBC staff collect macroinvertebrate and physical habitat information annually from 51 sites on interstate streams along the New York-Pennsylvania and Pennsylvania-Maryland borders using RBP III methods. Water samples and flow information are collected at 19 sites quarterly and 30 sites yearly. Water quality data also are used to determine the existence and magnitude of trends for selected parameters. All data collected during SRBC's interstate streams surveys are used in 305(b) reporting to USEPA.

Currently, SRBC is initiating a pilot project to determine proper methods of assessing the biological conditions, using benthic macroinvertebrate populations, of the large rivers in the Susquehanna River Basin. The pilot project will take place on the Susquehanna River between Windsor, NY and Sayre, PA, during late summer 2002. Three separate methodologies will be tested: RBP III, artificial substrate samplers, and a diver operated dome (suction) sampler. A habitat assessment will be performed and water quality samples will also be taken at each site. Data will be used to select and calculate metrics for a benthic Index of Biotic Integrity to assess the biological conditions of the large rivers in the Susquehanna River Basin and will be included in 305(b) reporting.

Documentation and Further Information

2000 Susquehanna River Basin Commission 305(b) Narrative

The 1998 Susquehanna River Basin Water Quality Assessment 305(b) Report: http://www.srbc.net/docs/305bReport_201.pdf

Report Announcement - *2002 Susquehanna River Basin Water Quality Assessment 305(b) Report*, Publication No. 220: http://www.srbc.net/docs/summary_may02.PDF

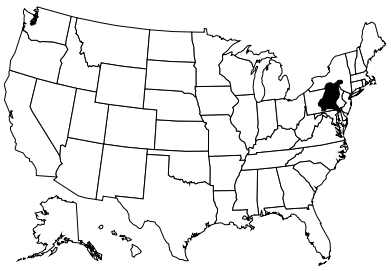
Report Announcement - *Water Quality of Interstate Streams in the Susquehanna River Basin*, Publication No. 211: http://www.srbc.net/pub211summary.pdf

Assessment of Interstate Streams in the Susquehanna River Basin: 1997-1998, Monitoring Report #12, June 1999: http://www.srbc.net/docs/iswq97-98.pdf

Upper Susquehanna Subbasin: A Water Quality and Biological Assessment, 1999: http://www.srbc.net/docs/pub203.pdf

Susquehanna River Basin Commission (SRBC)

Interstate compact: NY, PA, MD



Contact Information

Jennifer L. R. Hoffman, Aquatic Ecologist
Susquehanna River Basin Commission (SRBC)
1721 North Front Street ■ Harrisburg, PA 17102
Phone 717/238-0426 ■ Fax 717/238-2436
email: jhoffman@srbc.net

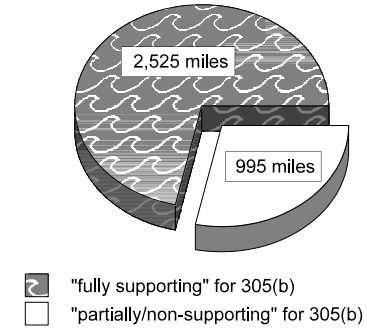
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
		monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
		promulgated into state water quality standards as biocriteria
		support of antidegradation
		evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
		other:
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
	✓	fixed station (i.e., water quality monitoring stations) *(specific river basins or watersheds)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(comprehensive use throughout jurisdiction)*
		other:

Stream Miles

Total miles*	**31,193**
Total perennial miles	–
Total miles assessed for biology	**3,520**
fully supporting for 305(b)**	2,525
partially/non-supporting for 305(b)**	995
listed for 303(d)	n/a
number of sites sampled *(on an annual basis)*	317
number of miles assessed per site	11

3,520 Miles Assessed for Biology



*Stream mile estimate is based on the 1993 EPA document, *Total Waters Estimates for United States Streams and Lakes: Total Waters Database and Reporting Program*. Monitoring Branch Assessment and Watershed Protection Division, Office of Wetlands, Oceans, and Watersheds, Office of Water, Washington, D.C.

**305(b) reporting is for SRBC benefit, USEPA requirements (contracts), and to provide more samples for states to use in their official 305(b) and 303(d) listings.

Aquatic Life Use (ALU) Designations and Decision-Making*

ALU designation basis		
ALU designations in state water quality standards		
Narrative Biocriteria in WQS		
Numeric Biocriteria in WQS		
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)		assessment of aquatic resources
		cause and effect determinations
		permitted discharges
		monitoring (e.g., improvements after mitigation)
		watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU		

*This section is not applicable to SRBC's biological monitoring program. SRBC does not define aquatic life uses, but utilizes those designated by member jurisdictions: Maryland, New York, and Pennsylvania.

Reference Site/Condition Development

Number of reference sites	**total number varies according to project**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria	Habitat disturbance, best available conditions of the biological and chemical components	
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
		gradient response
		professional judgment
		other:
Stream stratification within regional reference conditions	✓	ecoregions (or some aggregate)
		elevation
		stream type
		multivariate grouping
		jurisdictional (i.e., statewide)
		other:
Additional information		reference sites linked to ALU
		reference sites/condition referenced in water quality standards
	✓	some reference sites represent acceptable human-induced conditions

Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - broad coverage)*
		fish
		periphyton
		other:
Benthos		
sampling gear		D-frame, kick net (1 meter); 500-600 micron mesh
habitat selection		riffle/run (cobble)
subsample size		100 count
taxonomy		genus
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings and training for biologists, sorting and taxonomic proficiency checks, specimen archival

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
		multivariate analysis
	✓	biological metrics *(aggregate metrics into an index)*
		disturbance gradients
		other:
Multimetric thresholds		
transforming metrics into unitless scores		varies according to metric used: RBP 1989 methods. Always try to use 6 metrics for each project, but the metrics chosen vary depending on the project
defining impairment in a multimetric index		varies according to metric used: >81% non impaired, though this could vary slightly depending on the project
Evaluation of performance characteristics		repeat sampling
		precision
Not currently evaluated		sensitivity
		bias
		accuracy
Biological data		
Storage		Excel spreadsheets for internal projects; SRBC is currently working on entering data into STORET.
Retrieval and analysis		Excel spreadsheets for internal projects; working on finding a good statistical package that fits needs

4. RELEVANT EXCERPTS FROM WATER QUALITY STANDARDS AND BIOCRITERIA LANGUAGE

This section of the report contains excerpts from the approved water quality standards of states, tribes, territories, and interstate commissions. These excerpts may contain any or all of the following: designated uses as related to aquatic life uses, narrative and/or numeric biocriteria, and any other specific sections that are relevant to the entity's protection and propagation of aquatic life. It is important to note that this chapter is not intended to be a compendium of the entire water quality standard for each state, tribe and territory, but rather to highlight specific language within the standard that describes the use of biology and biological assessments to develop relevant criteria that assess water quality and protect aquatic life.

STATES

Alabama

SOURCE: Alabama Department of Environmental Management, Water Division - Water Quality Program, Chapter 335, Division 6, Volume 1, Chapter 10, Water Quality Criteria: September 7, 2000. http://www.adem.state.al.us/Regulations/Regulations/regulations.htm

335-6-10-.03 Water Use Classifications.

1. Outstanding Alabama Water
3. Swimming and Other Whole Body Water-Contact Sports
5. Fish and Wildlife
6. Limited Warmwater Fishery
7. Agricultural and Industrial Water Supply

335-6-10-.04 Antidegradation Policy.

(1) The purpose and intent of the water quality standards is to conserve the waters of the State of Alabama and to protect, maintain and improve the quality thereof for public water supplies, for the propagation of wildlife, fish and aquatic life, and for domestic, agricultural, industrial, recreational and other legitimate beneficial uses; and to provide for the prevention, abatement and control of new or existing water pollution.

(4) Where high quality waters constitute an outstanding National resource, such as waters of national and state parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.

(5) Developments constituting a new or increased source of thermal pollution shall assure that such release will not impair the propagation of a balanced indigenous population of fish and aquatic life.

335-6-10-.06 Minimum Conditions Applicable to All State Waters. The following minimum conditions are applicable to all State waters, at all places and at all times, regardless of their uses:

(c) State waters shall be free from substances attributable to sewage, industrial wastes or other wastes in concentrations or combinations which are toxic or harmful to human, animal or aquatic life to the extent commensurate with the designated usage of such waters.

335-6-10-.09 Specific Water Quality Criteria.

(1) OUTSTANDING ALABAMA WATER

(a) Best usage of waters: activities consistent with the natural characteristics of the waters.

(b) Conditions related to best usage:

1. High quality waters that constitute an outstanding Alabama resource, such as waters of state parks and wildlife refuges and waters of exceptional recreational or ecological significance, may be considered for classification as an Outstanding Alabama Water (OAW).

(3) SWIMMING AND OTHER WHOLE BODY WATER-CONTACT SPORTS

(b) Conditions related to best usage: ... The quality of waters will also be suitable for the propagation of fish, wildlife and aquatic life. The quality of salt waters and estuarine waters to which this classification is assigned will be suitable for the propagation and harvesting of shrimp and crabs.

(5) FISH AND WILDLIFE

(a) Best usage of waters: fishing, propagation of fish, aquatic life, and wildlife...

(b) Conditions related to best usage: the waters will be suitable for fish, aquatic life and wildlife propagation. The quality of salt and estuarine waters to which this classification is assigned will also be suitable for the propagation of shrimp and crabs.

(e) Specific criteria:

3. Temperature:

(ii) The maximum temperature in streams, lakes, and reservoirs in the Tennessee and Cahaba River Basins, and for that portion of the Tallapoosa River Basin from the tailrace of Thurlow Dam at Tallassee downstream to the junction of the Coosa and Tallapoosa Rivers which has been designated by the Alabama Department of Conservation and Natural Resources as supporting smallmouth bass, sauger, or walleye, shall not exceed 86° F.

(vi) In all waters the normal daily and seasonal temperature variations that were present before the addition of artificial heat shall be maintained, and there shall be no thermal block to the migration of aquatic organisms.

(vii) Thermal permit limitations in NPDES permits may be less stringent than those required by subparagraphs (i)-(iv) hereof when a showing by the discharger has been made pursuant to Section 316 of the Federal Water Pollution Control Act (FWPCA), 33 U.S.C. §1251 et seq. or pursuant to a study of an equal or more stringent nature required by the State of Alabama authorized by Title 22, Section 22-22-9(c), Code of Alabama, 1975, that such limitations will assure the protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife, in and on the body of water to which the discharge is made. Any such demonstration shall take into account the interaction of the thermal discharge component with other pollutants discharged.

4. Dissolved oxygen:

(i) For a diversified warm water biota, including game fish, daily dissolved oxygen concentrations shall not be less than 5 mg/l at all times; except under extreme conditions due to natural causes, it may range between 5 mg/l and 4 mg/l, provided that the water quality is favorable in all other parameters. The normal seasonal and daily fluctuations shall be maintained above these levels. In no event shall the dissolved oxygen level be less than 4 mg/l due to discharges from existing hydroelectric generation impoundments. All new hydroelectric generation impoundments, including addition of new hydroelectric generation units to existing impoundments, shall be designed so that the discharge will contain at least 5 mg/l dissolved oxygen where practicable and technologically possible. The Environmental Protection Agency, in cooperation with the State of Alabama and parties responsible for impoundments, shall develop a program to improve the design of existing facilities.

(iv) In the application of dissolved oxygen criteria referred to above, dissolved oxygen shall be measured at a depth of 5 feet in waters 10 feet or greater in depth; and for those waters less than 10 feet in depth, dissolved oxygen criteria will be applied at mid-depth.

5. Toxic substances attributable to sewage, industrial wastes, or other wastes: only such amounts, whether alone or in combination with other substances, as will not exhibit acute toxicity or chronic toxicity, as demonstrated by effluent toxicity testing or by application of numeric criteria given in Rule 335-6-10-.07, to fish and aquatic life, including shrimp and crabs in estuarine or salt waters or the propagation thereof.

6. Taste, odor, and color-producing substances attributable to sewage, industrial wastes, or other wastes: only such amounts, whether alone or in combination with other substances, as will not exhibit acute toxicity or chronic toxicity, as demonstrated by effluent toxicity testing or by application of numeric criteria given in Rule 335-6-10-.07, to fish and aquatic life, including shrimp and crabs in estuarine and salt waters or adversely affect the propagation thereof; impair the palatability or marketability of fish and wildlife or shrimp and crabs in estuarine and salt waters; or unreasonably affect the aesthetic value of waters for any use under this classification.

(6) LIMITED WARMWATER FISHERY

(a) The (a) The provisions of the Fish and Wildlife water use classification at Rule 335-6-10-.09(5) shall apply to the Limited Warmwater Fishery water use classification, except as noted below. Unless alternative criteria for a given parameter are provided in paragraph (e) below, the applicable Fish and Wildlife criteria at paragraph 10-.09(5)(e) shall apply year-round. At the time the Department proposes to assign the Limited Warmwater Fishery classification to a specific waterbody, the Department may apply criteria from other classifications within this chapter if necessary to protect a documented, legitimate existing use.

(7) AGRICULTURAL AND INDUSTRIAL WATER SUPPLY

(b) Conditions related to best usage:

(i) The waters, except for natural impurities which may be present therein, will be suitable for ... fish survival...

335-6-10-.10 Special Designations.

(1) OUTSTANDING NATIONAL RESOURCE WATER

(a) Designation:

1. High quality waters that constitute an outstanding National resource, such as waters of national and state parks and wildlife refuges and waters of exceptional recreational or ecological significance, may be considered for designation as an Outstanding National Resource Water (ONRW). For waters designated as ONRW, existing water quality shall be maintained and protected.

Alaska

SOURCE: Alaska Administrative Code: Chapter 70, Title 18, amended as of May 27, 1999: http://www.state.ak.us/local/akpages/ENV.CONSERV/title18/70wqs.pdf

18 AAC 70.020. PROTECTED WATER USE CLASSES AND SUBCLASSES; WATER QUALITY CRITERIA; WATER QUALITY STANDARDS TABLE.

(a) Classes and subclasses of use of the state's water protected by criteria set out under (b) of this section are:

(1) fresh water

(A) aquaculture

(C) growth and propagation of fish, shellfish, other aquatic life, and wildlife; and

(2) marine water

(C) growth and propagation of fish, shellfish, other aquatic life, and wildlife; and

(D) harvesting for consumption of raw mollusks or other raw aquatic life.

Arizona

SOURCE: Arizona Administrative Code, Title 18, Environmental Quality, Chapter 11. Department of Environmental Quality, Article 1. Water Quality Standards for Surface Waters, amended effective March 8, 2002: http://www.sosaz.com/public_services/Title_18/18-11.htm

R18-11-101. Definitions

The terms of this Article shall have the following meanings:

7. “Aquatic and wildlife (cold water)” means the use of a surface water by animals, plants, or other cold-water organisms, generally occurring at elevations greater than 5000 feet, for habitation, growth, or propagation.

8. "Aquatic and wildlife (effluent dependent water)" means the use of an effluent dependent water by animals, plants, or other organisms for habitation, growth, or propagation.

9. "Aquatic and wildlife (ephemeral)" means the use of an ephemeral water by animals, plants, or other organisms, excluding fish, for habitation, growth, or propagation.

10. “Aquatic and wildlife (warm water)” means the use of a surface water by animals, plants, or other warm-water organisms, generally occurring at elevations less than 5000 feet, for habitation, growth, or propagation.

22. “Ephemeral water” means a surface water that has a channel that is at all times above the water table and that flows only in direct response to precipitation.

26. "Fish consumption" means the use of a surface water by humans for harvesting aquatic organisms for consumption. Harvestable aquatic organisms include, but are not limited to, fish, clams, turtles, crayfish, and frogs.

44. "Unique water" means a surface water which has been classified as an outstanding state resource water by the Director under R18-11-112.

R18-11-108. Narrative Water Quality Standards

A. A surface water shall be free from pollutants in amounts or combinations that:
   1. Settle to form bottom deposits that inhibit or prohibit the habitation, growth, or propagation of aquatic life or that impair recreational uses;
   5. Are toxic to humans, animals, plants, or other organisms;
   6. Cause the growth of algae or aquatic plants that inhibit or prohibit the habitation, growth, or propagation of other aquatic life or that impair recreational uses;

R18-11-112. Unique Waters

D. The Director may classify a surface water as a unique water upon finding that the surface water is an outstanding state resource water based upon the following criteria:
   a. The surface water is a perennial water;
   b. The surface water is in a free-flowing condition. For purposes of this subsection, “in a free-flowing condition” means that a surface water does not have an impoundment, diversion, channelization, rip-rapping or other bank armor, or another hydrological modification within the reach nominated for unique water classification;
   c. The surface water has good water quality. For purposes of this subsection, “good water quality” means that the surface water has water quality that meets or exceeds applicable surface water quality standards. A surface water that is listed as impaired under § 303(d) of the Clean Water Act [33 U.S.C. § 1313] is ineligible for unique waters classification; and
   d. The surface water meets one or both of the following conditions:
   e. The surface water is of exceptional recreational or ecological significance because of its unique attributes, including but not limited to, attributes related to the geology, flora, fauna, water quality, aesthetic values, or the wilderness characteristics of the surface water.
   f. Threatened or endangered species are known to be associated with the surface water and the existing water quality is essential to the maintenance and propagation of a threatened or endangered species or the surface water provides critical habitat for a threatened or endangered species. Endangered or threatened species are identified in “Endangered and Threatened Wildlife and Plants,” 50 CFR § 17.11 and § 17.12 (revised as of October 1, 2000) which is incorporated by reference and on file with the Department and the Office of the Secretary of State. This incorporation by reference contains no future editions or amendments.

Arkansas

SOURCE: Arkansas Pollution Control and Ecology Commission Regulation 2**,** Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas, October 28, 2002, Chapter 3 Water Body Uses, http://www.adeq.state.ar.us/regs/files/reg02_final_021028.pdf

Section 2.302 Designated Uses
The designated uses are defined as follows:

A. Extraordinary Resource Waters - This beneficial use is a combination of the chemical, physical and biological characteristics of a waterbody and its watershed which is characterized by scenic beauty, aesthetics, scientific values, broad scope recreation potential and intangible social values.

B. Ecologically Sensitive Waterbody - This beneficial use identifies segments known to provide habitat within the existing range of threatened, endangered or endemic species of aquatic or semi-aquatic life forms.

C. Natural and Scenic Waterways - This beneficial use identifies segments which have been legislatively adopted into a state or federal system.

F. Fisheries - This beneficial use provides for the protection and propagation of fish, shellfish and other forms of aquatic life. It is further subdivided into the following subcategories:

(1) Trout - water which is suitable for the growth and survival of trout (Family: Salmonidae).

(2) Lakes and Reservoirs - water which is suitable for the protection and propagation of fish and other forms of aquatic life adapted to impounded waters. Generally characterized by a dominance of sunfishes such as bluegill or similar species, black basses and crappie. May include substantial populations of catfishes such as channel, blue and flathead catfish and commercial fishes including carp, buffalo and suckers. Forage fishes are normally shad or various species of minnows. Unique populations of walleye, striped bass and/or trout may also exist.

(3) Streams - water which is suitable for the protection and propagation of fish and other forms of aquatic life adapted to flowing water systems whether or not the flow is perennial.

(a) Ozark Highlands Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a preponderance of sensitive species and normally dominated by a diverse minnow community followed by sunfishes and darters. The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Duskystripe shiner	Banded sculpin
Northern hogsucker	Ozark madtom
Slender madtom	Southern redbelly dace
"Rock" basses	Whitetail shiner
Rainbow and/or Orangethroat darters	Ozark minnow
Smallmouth bass	

(b) Boston Mountains Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a major proportion of sensitive species; a diverse, often darter-dominated community exists but with nearly equal proportions of minnows and sunfishes. The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Bigeye shiner	Shadow bass
Black redhorse	Wedgespot shiner

Key Species	Indicator Species
Slender madtom	Longnose darter
Longear sunfish	Fantail darter
Greenside darter	
Smallmouth bass	

(c) Arkansas River Valley Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a substantial proportion of sensitive species; a sunfish- and minnow-dominated community exists but with substantial proportions of darters and catfishes (particularly madtoms). The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Bluntnose minnow	Orangespotted sunfish
Golden redhorse	Blacksidedarter
Yellow bullhead	Madtoms
Longear sunfish	
Redfin darter	
Spotted bass	

(d) Ouachita Mountains Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. The fish community is characterized by a major proportion of sensitive species; a minnow-sunfish-dominated community exists, followed by darters. The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Bigeye shiner	Shadow bass
Northern hogsucker	Gravel chub
Freckled madtom	Northern studfish
Longear sunfish	Striped shiner
Orangebelly darter	
Smallmouth bass	

(e) Typical Gulf Coastal Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a limited proportion of sensitive species; sunfishes are distinctly dominant followed by darters and minnows. The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Redfin shiner	Pirate perch
Spotted sucker	Warmouth
Yellow bullhead	Spotted sunfish
Flier	Dusky darter

Key Species	Indicator Species
Slough darter	Creek chubsucker
Grass pickerel	Banded pygmy sunfish

(f) Springwater-influenced Gulf Coastal Ecoregion -Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a substantial proportion of sensitive species; sunfishes normally dominate the community and are followed by darters and minnows. The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Redfin shiner	Pirate perch
Blacktail redhorse	Golden redhorse
Freckled madtom	Spotted bass
Longear sunfish	Scaly sand darter
Creole darter	Striped shiner
Grass pickerel	Banded pygmy sunfish

(g) Least-altered Delta Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by an insignificant proportion of sensitive species; sunfishes are distinctly dominant followed by minnows. The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Ribbon shiner	Pugnose minnow
Smallmouth buffalo	Mosquitofish
Yellow bullhead	Pirate perch
Bluegill	Tadpole madtom
Bluntnose darter	Banded pygmy sunfish
Largemouth bass	

(h) Channel-altered Delta Ecoregion- Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by an absence of sensitive species; sunfishes and minnows dominate the population followed by catfishes. The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Blacktail shiner	Mosquitofish
Drum	Gizzard shad
Carp	Emerald shiner
Channel catfish	
Green sunfish	
Spotted gar	

California*

*This language has not been reviewed for accuracy by state/tribal agency.

SOURCE: California Ocean Plan, Water Quality Control Plan for Ocean Waters of California, State Water Resources Control Resolution No. 90-27, Approval of the Amendment to the Water Quality Control Plan For Ocean Waters of California, effective March 22, 1990.
http://www.epa.gov/ost/standards/wqslibrary

Chapter II WATER QUALITY OBJECTIVES

E. Biological Characteristics

1. Marine communities, including vertebrate, invertebrate, and plant species, shall not be degraded.

Chapter III GENERAL REQUIREMENTS FOR MANAGEMENT OF WASTE* DISCHARGE TO THE OCEAN*

A. Waste management systems that discharge to the ocean must be designed and operated in a manner that will maintain the indigenous marine life and a healthy and diverse marine community.

B. Waste discharged to the ocean must be essentially free of:

2. Settleable material or substances that may form sediments which will degrade benthic communities or other aquatic life.
3. Substances which will accumulate to toxic levels in marine waters, sediments or biota.
4. Substances that significantly decrease the natural light to benthic communities and other marine life.

D. Location of waste discharges must be determined after a detailed assessment of the oceanographic characteristics and current patterns to assure that:

2. Natural water quality conditions are not altered in areas designated as being of special biological significance or areas that existing marine laboratories use as a source of seawater.

Chapter V DISCHARGE PROHIBITIONS

B. Areas of Special Biological Significance--Waste shall not be discharged to areas designated as being of special biological significance. Discharges shall be located a sufficient distance from such designated areas to assure maintenance or natural water quality conditions in these areas.

Region I (North Coast)

Source: Water Quality Control Plan for the North Coast Region, North Coast Regional Water Quality Control Board, Section 6 - Surveillance and Monitoring, Section 6-1.00, amended May 23, 1996. http://www.epa.gov/ost/standards/wqslibrary/ca/ca_9_north_coast.pdf

STATEWIDE MONITORING PROGRAMS

State Mussel Watch Program

The California State Mussel Watch (SMW) Program is a long-term monitoring program administered by the State Water Board. Actual sampling and analysis are performed by the Department of Fish and Game. SMW provides the State Water Board and the six coastal regional water boards with an indication of geographical and temporal (year-to-year) trends in toxic pollutants along the California coast. Mussels (the common bay mussel, Myilus edulis, and the California mussel, M. californianus) have been shown to be efficient bioaccumulators of many toxic substances in their water environment. Further, the sedentary nature of mussels, whether native or transplanted, permits a time integrated sampling of toxic pollutants at one location. The merits of employing mussels as water quality indicators are well established in the scientific literature, previous SMW reports, and other scientific publications. The North Coast Region will continue to participate in existing SMW monitoring and the development of freshwater applications. The North Coast Region has been involved in developing freshwater applications of SMW methodology, using freshwater clams, Corbicula sp. The North Coast Region has required that some discharges be monitored using these techniques. There are current plans to expand the use of these organisms as indicators in sensitive areas. In the North Coast Region sampling under the SMW program has led to the detection and mitigation of controllable releases of toxic substances. Sampling priorities are directed toward areas of immediate concern.

Region II (San Francisco Bay Basin)

Source: Chapter 2, Beneficial Uses, Water Quality Control Plan, Region 2, California Regional Water Quality Control Board, San Francisco Bay Region, June 21, 1995:

http://www.epa.gov/ost/standards/wqslibrary/ca/ca_9_san_francisco.pdf

Definitions of Beneficial Uses
(ASBS) Areas of Special Biological Significance
Areas designated by the State Water Resources Control Board.
These include marine life refuges, ecological reserves, and designated areas where the preservation and enhancement of natural resources requires special protection, in these areas, alteration of natural water quality is undesirable. The areas that have been designated as ASBS in this region are depicted in Figure 2-1. The State Ocean Plan (see Chapter 5) requires wastes to be discharged at a suffitionfor cient distance from these areas to assure maintenance of natural water quality conditions

(COLD) COLD FRESHWATER HABITAT
Uses of water that support cold water ecosysterns,including, but not limited to preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Cold freshwater habitats generally support trout and may support the anadromous salmon and steelhead fisheries as well. Cold water habitats are commonly well-oxygenated. Life within these waters is relatively intolerant to environmental stresses. Often, soft waters feed cold water habitat These waters render fish more susceptible to toxic metals, such as copper, because of their lower buffering capacity.

(EST) ESTUARINE HABITAT
Uses of water that support estuarine ecosysterns, including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds), and the propagation, sustenance, and migration of estuarine organisms.

Estuarine habitat provides an essential and unique habitat that serves to acclimate anadromous fishes (salmon, striped bass) migrating into fresh or marine water conditions. The protection of estuarine habitat is contingent upon (1) the maintenance of adequate Delta outflow to provide mixing and salinity control; and (2) provisions to protect wildlife habitat associated with marshlands and essential to the Bay periphery (i.e., prevention of fill activities). Estuarine habitat is generally associated with moderate seasonal fluctuations in dissolved oxygen, pH, and temperature and with a wide range in turbidity.

(MAR) MARINE HABITAT
Uses of water that support marine ecosysterns, including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

In many cases, the protection of marine habitat will be accomplished by measures that protect wildlife habitat generally, but more stringent criteria may be necessary for waterfowl marshes and other habitat, such as those for shellfish and marine fishes. Some marine habitats, such as important intertidal zones and kelp beds, may require special protection.

(MIGR) FISH MIGRATION
Uses of water that support habitats necessary for migration, acclimatization between fresh water and salt water, and protection of aquatic organisms that are temporary inhabitants of waters within the region.

The water quality provisions acceptable to cold water fish generally protect anadromous fis*h* as well. However, particular attention must be paid to maintaining zones of passage. Any barrier to migration or free movement of migratory fish is harmful. Natural tidal movement in estuaries and unimpeded river flows are necessary to sustain migratory fish and their offspring. A water quality barrier, whether thermal, physical, or chemical, can destroy the integrity of the migration mute and lead to the rapid decline of dependent fisheries. Water quality may vary through a zone of passage as a result of natural or human-induced activities. Fresh water entering estuaries may float on the surface of the denser salt water or hug one shore as a result of density differences related to water temperature, salinity, or suspended matter.

(RARE) PRESERVATION OF RARE AND ENDANGERED SPECIES
Uses of waters that support habitats necessary for the survival and successful maintenance of plant or animal species established under state and/or federal law as rare, threatened, or endangered.

The water quality criteria to be achieved that would encourage development and protection of rare and endangered species should be the same as those for protection of fish and wildlife habitats generally. However, where rare or endangered species exist, special control requirements may be necessary to assure attainment and maintenance of particular quality criteria, which may vary slightly with the environmental needs of each particular species. Criteria for species using areas of special biological significance should likewise be derived from the general criteria for the habitat types involved, with special management diligence given where required.

(SPWN) FISH SPAWNING
Uses of water that support high quality aquatic habitats suitable for reproduction and early deteiopment of fish.

Dissolved oxygen levels in spawning areas should ideally approach saturation levels. Free movement of water is essential to maintain well-oxygenated conditions around eggs deposited in sediments. Water temperature, size distribution and organic content of sediments, water depth, and current velocity are also important determinants of spawning area adequacy.

(WARM) WARM FRESHWATER HABITAT
Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

The warm freshwater habitats supporting bass, bluegill, perch, and other panfish are generally lakes and reservoirs, although some minor streams will serve this purpose where stream flow is sufficient to sustain the fishery. The habitat is also important to a variety of nonfish species, such as flogs, crayfish, and insects, which provide food for fish and small mammals. This habitat is less sensitive to environmental changes, but more diverse than the cold freshwater habitat and natural fluctuations in temperature, dissolved oxygen, pH, and turbidity are usually greater.

WII.D) WILDLIFE HABITAT
Uses of waters that support wildllife habitats, including, but not limited to, the preservation and enhancement of vegetation and prey species used by wildlife, such as waterfowl.

The two most important types of wildlife habitat are riparian and wetland habitats. These habitats can be threatened by development, erosion, and sedimentation, as well as by poor water quality. The water quality requirements of wildlife pertain to the water directly ingested, the aquatic habitat itself, and the effect of water quality on the production of food materials. Waterfowl habitat is particularly sensitive to changes in water quality. Dissolved oxygen, pH, alkalinity, salinity, turbidity, settleable matter, oil, toxicants, and specific disease organisms are water quality characteristics particularly important to waterfowl habitat. Dissolved oxygen is needed in waterfowl habitats to suppress development of botulism organisms; botulism has killed millions of waterfowl. It is particularly important to mainrain adequate circulation and aerobic conditions in shallow fringe areas of ponds or reservoirs where botulism has caused problems.

Region III (Central Coast)
Source: Water Quality Control Plan -Regional Water Quality Control Board 3 (Central Coast), California Regional Water Quality Control Board, Chapter 6: Surveillance And Monitoring, pg. VI-2, September 8, 1991: http://www.epa.gov/ost/standards/wqslibrary/ca/ca_9_wqcp.pdf

III.A.1. TOXIC SUBSTANCE MONITORING
The Toxic Substances Monitoring (TSM) portion of the Primary Network has been integrated with other Primary Network Monitoring. Streams and lakes were ranked according to various criteria established to indicate their importance to the State in terms of water quality. From this process, the water bodies ranked Priority 1, or highest priority, were included in the Primary Network; routine chemical and biological water monitoring is performed by DWR and/or the USGS; and toxic substances monitoring of resident organisms is performed by the Department of Fish and Game. The objectives of the Primary Network TSM program are:

1. To develop statewide baseline data and to demonstrate trends in the occurrence of toxic elements and organic substances in the aquatic biota,

Region IV (Los Angeles)
Source: Water Quality Control Plan Los Angeles - Region Basin Plan for the Coastal Watersheds of Los

Angeles and Ventura Counties, Chapter 6: Surveillance And Monitoring, approved February 23, 1995: http://www.epa.gov/ost/standards/wqslibrary/ca/ca_9_los_angeles.pdf

Biological Criteria
Biological criteria are narrative (and sometimes numeric) expressions that describe the biological integrity of aquatic communities (EPA, 1991). Biological criteria supplement other water quality objectives (physical, chemical, toxicity) by providing a direct measure of aquatic communities at risk from human activities. These criteria can also provide evidence of streams with exceptional water quality. Baseline data must be collected from both reference and impacted streams in the Region. Regular monitoring of these areas can then provide a continual assessment of instream impacts. Over 30 of the 50 states have developed, or are developing, biological criteria programs. Although there is not a current biological criteria program in the Region, Regional Board staff are planning to begin conducting baseline surveys in the coming years. Although **there is not a current** biological criteria program in the Region, Regional Board staff are planning to begin conducting baseline surveys in the coming years.

Colorado

SOURCE: Colorado Department of Public Health and Environment, Department Regulations, Water Quality Control Commission, Surface Water Quality Classifications & Standards, Regulation 31- Basic Standards & Methodologies for Surface Water, amended effective October 30, 2001:
http://www.cdphe.state.co.us/op/regs/100231.pdf and http://www.cdphe.state.co.us/wq/wqhom.html

31.5 DEFINITIONS

(8) "COLD WATER BIOTA" means aquatic life, including trout, normally found in waters where the summer temperature does not often exceed 20° C.

(32)"WARM WATER BIOTA" means aquatic life normally found in waters where the summer temperature frequently exceeds 20° C.

31.11 BASIC STANDARDS APPLICABLE TO SURFACE WATERS OF THE STATE
All surface waters of the state are subject to the following basic standards; however, discharge of substances regulated by permits which are within those permit limitations shall not be a basis for enforcement proceedings under these basic standards:

(1) Except where authorized by permits, BMP's, 401 certifications, or plans of operation approved by the Division or other applicable agencies, state surface waters shall be free from substances attributable to human-caused point source or nonpoint source discharge in amounts, concentrations or combinations which:

(a) for all surface waters of the state except wetlands;
(v) are harmful to the beneficial uses or toxic to humans, animals, plants, or aquatic life; or
(vi) produce a predominance of undesirable aquatic life;

(b) for surface waters in wetlands;
(ii) are toxic to humans, animals, plants, or aquatic life of the wetland.

31.13 STATE USE CLASSIFICATIONS

(c) Aquatic Life
These surface waters presently support aquatic life uses as described below, or such uses may reasonably be expected in the future due to the suitability of present conditions, or the waters are intended to become suitable for such uses as a goal:
(i) Class I - Cold Water Aquatic Life
These are waters that (1) currently are capable of sustaining a wide variety of cold water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions. Waters shall be considered capable of sustaining such biota where physical habitat, water flows or levels, and water quality conditions result in no substantial impairment of the

abundance and diversity of species.

(ii) Class 1 - Warm Water Aquatic Life
These are waters that (1) currently are capable of sustaining a wide variety of warm water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions. Waters shall be considered capable of sustaining such biota where physical habitat, water flows or levels, and water quality conditions result in no substantial impairment of the abundance and diversity of species.

(iii) Class 2- Cold and Warm Water Aquatic Life
These are waters that are not capable of sustaining a wide variety of cold or warm water biota, including sensitive species, due to physical habitat, water flows or levels, or uncorrectable water quality conditions that result in substantial impairment of the abundance and diversity of species.

(e) Wetlands

(v) The Commission may adopt a "wetlands" classification based on the functions of the wetlands in question. Wetland functions that may warrant site-specific protection include ground water recharge or discharge, flood flow alteration, sediment stabilization, sediment or other pollutant retention, nutrient removal or transformation, biological diversity or uniqueness, wildlife diversity or abundance, aquatic life diversity or abundance, and recreation.

Connecticut

SOURCE: Connecticut Water Quality Standards Sections II and III, effective April 9, 1997: http://dep.state.ct.us/wtr/wqsinfo.htm and http://dep.state.ct.us/wtr/wqs.pdf

NARRATIVE BIOCRITERIA

Surface waters and sediments shall be free from chemical constituents in concentrations or combinations which will or can reasonably be expected to result in acute or chronic toxicity to aquatic organisms or impair the biological integrity of aquatic or marine ecosystems outside of any allocated zone of influence or which will or can reasonably be expected to bioconcentrate or bioaccumulate in tissues of fish, shellfish and other aquatic organisms to levels which will impair the health of aquatic organisms or wildlife or result in unacceptable tastes, odors or health risks to human consumers of aquatic life. In determining consistency with this Standard, the Commissioner shall at a minimum consider the specific number criteria listed in Appendix D and any other information she or he deems relevant.

Benthic invertebrate criteria may be utilized where appropriate for assessment of biological integrity of surface waters. The criteria apply to the fauna of erosional or riffle habitats in flowing waters which are not subject to tidal influences.

III. SURFACE WATER CLASSIFICATIONS
INLAND SURFACE WATERS
CLASS AA

Designated Use - Existing or proposed drinking water supply; fish and wildlife habitat; recreational use; agricultural, industrial supply and other purposes, (recreational uses may be restricted).

CRITERIA

Parameter	Standard
13. Benthic Invertebrates which inhabit lotic waters	A wide variety of macroinvertebrate taxa should normally be present and all functional feeding groups should normally be well represented. Presence and productivity of aquatic species is not limited except by natural conditions, permitted flow regulation or irreversible cultural impacts. Water quality shall be sufficient to sustain a diverse macroinvertebrate community of indigenous species. Taxa within the Orders Plecoptera (stoneflies), Ephemeroptera (mayflies), Coleoptera (beetles) and Trichoptera (caddisflies) should be well represented.

INLAND SURFACE WATERS
CLASS A

Designated Uses - Potential drinking water supply; fish and wildlife habitat; recreational use; agricultural, industrial supply and other legitimate uses, including navigation.

CRITERIA

Parameter	Standard
13. Benthic Invertebrates which inhabit lotic waters	A wide variety of macroinvertebrate taxa should normally be present and all functional feeding groups should normally be well represented. Presence and productivity of aquatic species is not limited except by natural conditions, permitted flow regulation or irreversible cultural impacts. Water quality shall be sufficient to sustain a diverse macroinvertebrate community of indigenous species. Taxa within the Orders Plecoptera (stoneflies), Ephemeroptera (mayflies), Coleoptera (beetles) and Trichoptera (caddisflies) should be well represented.

INLAND SURFACE WATERS
CLASS B

Designated Use - Recreational use; fish and wildlife habitat; agricultural and industrial supply and other legitimate uses including navigation.

CRITERIA

Parameter	Standard
13. Benthic Invertebrates which inhabit lotic waters	Water quality shall be sufficient to sustain a diverse macroinvertebrate community of indigenous species. All functional feeding groups and a wide variety of macroinvertebrate taxa shall be present, however one or more may be disproportionate in abundance. Waters which currently support a high quality aquatic community shall be maintained at that high quality. Presence and productivity of taxa within the Orders Plecoptera (stoneflies), Ephemeroptera (mayflies); and pollution intolerant Coleoptera (beetles) and Trichoptera (caddis-flies) may be limited due to cultural activities. Macroinvertebrate communities in waters impaired by cultural activities shall be restored to the extent practical through implementation of the department's procedures for control of pollutant discharges to surface waters and through Best Management Practices for non-point sources of pollution.

INLAND SURFACE WATERS
CLASS C

Present water quality conditions preclude the full attainment of one or more designated uses for Class B waters some or all of the time. One or more Water Quality Criteria for Class B waters are not being consistently achieved. Class C waters may be suitable for certain fish and wildlife habitat, certain recreational activities, industrial use and other legitimate uses, including navigation.

INLAND SURFACE WATERS
CLASS D

Present water quality conditions persistently preclude the attainment of one or more designated uses for Class B waters. One or more Water Quality Criteria for Class B waters are not being achieved most or all of the time. Class D waters may be suitable for bathing or other recreational purposes, certain fish and wildlife habitat, industrial or other legitimate uses, including navigation.

Delaware

SOURCE: State of Delaware Surface Water Quality Standards as amended, August 11, 1999, Department of Natural Resources and Environmental Control: http://www.dnrec.state.de.us/water/wqs1999.pdf

Section 1: Intent

1.1. It is the policy of the Department to maintain within its jurisdiction surface waters of the State of satisfactory quality consistent with public health and public recreation purposes, the propagation and protection of fish and aquatic life, and other beneficial uses of the water.

Section 2: Definitions

Cold water fish use: Protection of fish species (such as from the family Salmonidae) and other flora and fauna indigenous to a cold water habitat.

Fish, aquatic life and wildlife: All animal and plant life found in Delaware, either indigenous or migratory, regardless of life stage or economic importance.

Section 3: Antidegradation Policy

3.1. Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected. Degradation of water quality in such a manner that results in reduced number, quality, or river or stream mileage of existing uses shall be prohibited. Degradation shall be defined for the purposes of this section as a statistically significant reduction, accounting for natural variations, in biological, chemical, or habitat quality as measured or predicted using appropriate assessment protocols.

3.2. Where the quality of the waters exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected. In the case of waters of exceptional recreational or ecological significance, existing quality shall be maintained or enhanced...

3.3. Where high quality waters constitute an outstanding National resource, such as waters of National parks and wildlife refuges, existing quality shall be maintained and protected.

Section 4: General Stream Criteria

4.1. All surface waters of the State (except as detailed in Sections 8 and 12) shall meet the following minimum criteria:

(a) Waters shall be free from substances that are attributable to wastes of industrial, municipal, agricultural or other human-induced origin. Examples include but are not limited to the following:

(iii) Any pollutants, including those of a thermal, toxic, corrosive, bacteriological, radiological, or other nature, that may interfere with attainment and maintenance of designated uses of the water, may impart undesirable odors, tastes, or colors to the water or to aquatic life found therein, may endanger public health, or may result in dominance of nuisance species.

District of Columbia*

*This language has not been reviewed for accuracy by state/tribal agency.

SOURCE: Chapter 11, Water Quality Standards of Title 21 of the District of Columbia Municipal Regulations (Notice of Final Rulemaking, January 21, 2000): http://dchealth.dc.gov/services/administration_offices/environmental/services2/water_division/pdf/WaterQualityStandards.shtm

1101.1 For the purposes of water quality standards, the surface waters of the District shall be classified on the basis of their (i) current uses, and (ii) future uses to which the waters will be restored. The categories of beneficial uses for the surface waters of the District shall be as follows:

Categories of Uses Which Determine Water Quality Standards	Classes of Water
Protection & propagation of fish, shellfish and wildlife	...C...

1102.3 TIER III: Where High Quality Waters constitute an outstanding National resource, such as waters of the National and District parks and wildlife refuges and waters of exceptional recreational or ecological significance, those waters shall be designated Outstanding National Resource Waters (ONRW) and the water quality in the ONRW shall be maintained, protected and designated as below:

(a) New point and nonpoint source discharges, treated or otherwise, shall be prohibited in these segments;

(b) Increases in loadings or new pollutants from existing point and nonpoint source discharges shall be prohibited in these segments;

(c) Short-term degradation of the water quality shall be allowed after opportunity for public participation and addressing their comments, if any. However, all practical means of minimizing such degradation shall be implemented; and

(d) Designation of ONRWs shall be adopted after full satisfaction of the intergovernmental coordination of the District's agencies and public participation.

1102.4 SPECIAL WATERS OF THE DISTRICT OF COLUMBIA (SWDC): Any segment or segments of the surface waters of the District which are of water quality better than needed for the current use or have scenic or aesthetic importance shall be designated as Special Waters of the District of Columbia (SWDC)...

1103 WETLANDS

1103.1 In a wetland, the numerical and the narrative criteria shall be applied to the column of water above the wetland in accordance with the designated use.

1103.2 Wetlands with rooted vascular aquatic vegetation, except those specifically constructed or created as waste water treatment devices and except as provided in D. C. Code subsection 6-923(d) and subsection 6-926(a)(3), shall be protected from significant adverse hydrologic modifications, excessive sedimentation, deposition of toxic substances in toxic amounts, nutrient imbalances, and other adverse anthropogenic impacts.

1104 STANDARDS

1104.1 The surface waters of the District shall be free from substances in amounts or combinations that do any of one the following:

(d) cause injury to, are toxic to, or produce adverse physiological or behavioral changes in humans, plants or animals

(e) Produce undesirable or nuisance aquatic life or result in the dominance of nuisance species; or

(f) Impair the biological community that naturally occurs in the waters or depends on the waters for its survival and propagation

1104.5 Class C streams shall be maintained to support aquatic life and shall not be placed in pipes.

Florida

SOURCE: Florida Administrative Code, Chapter 62-302 Surface Water Quality Standards, effective December 26, 1996: http://www.dep.state.fl.us/water/surfacewater/rules.htm and http://www8.myflorida.com/environment/learn/science/laboratories/index.html

62-302.200 Definitions.

(10)"Exceptional Ecological Significance" shall mean that a water body is a part of an ecosystem of unusual value. The exceptional significance may be in unusual species, productivity, diversity, ecological

relationships, ambient water quality, scientific or educational interest, or in other aspects of the ecosystem's setting or processes.

(15)"Nuisance Species" shall mean species of flora or fauna whose noxious characteristics or presence in sufficient number, biomass, or areal extent may reasonably be expected to prevent, or unreasonably interfere with, a designated use of those waters.

(16)"Nursery Area of Indigenous Aquatic Life" shall mean any bed of the following aquatic plants, either in monoculture or mixed: Halodule wrightii, Halophila spp., Potamogeton spp. (pondweed), Ruppia maritima (widgeon-grass), Sagittaria spp. (arrowhead), Syringodium filiforme (manatee-grass), Thalassia testudinum (turtle grass), or Vallisneria spp. (eel-grass), or any area used by the early-life stages, larvae and post-larvae, of aquatic life during the period of rapid growth and development into the juvenile states.

(17)"Outstanding Florida Waters" shall mean waters designated by the Environmental Regulation Commission as worthy of special protection because of their natural attributes.

(18)"Outstanding National Resource Waters" shall mean waters designated by the Environmental Regulation Commission that are of such exceptional recreational or ecological significance that water quality should be maintained and protected under all circumstances, other than temporary lowering and the lowering allowed under Section 316 of the Federal Clean Water Act.

(22)"Propagation" shall mean reproduction sufficient to maintain the species' role in its respective ecological community.

(24)"Shannon-Weaver Diversity Index" shall mean: negative summation (from i=1 to s) of (n i /N) log 2 (n i /N) where s is the number of species in a sample, N is the total number of individuals in a sample, and n i is the total number of individuals in species i.

(25)"Special Waters" shall mean water bodies designated in accordance with Section 62-302.700, F.A.C., by the Environmental Regulation Commission for inclusion in the Special Waters Category of Outstanding Florida Waters, as contained in Section 62-302.700, F.A.C. A Special Water may include all or part of any water body.

62-302.400 Classification of Surface Waters, Usage, Reclassification, Classified Waters.

(1) All surface waters of the State have been classified according to designated uses as follows:
CLASS III Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife

(4) Water quality classifications are arranged in order of the degree of protection required, with Class I water having generally the most stringent water quality criteria and Class V the least. However, Class I, II, and III surface waters share water quality criteria established to protect recreation and the propagation and maintenance of a healthy, well-balanced population of fish and wildlife.

Excerpt from 62-302.530, Criteria for Surface Water Quality Classifications

Parameter	Units	Class I: Potable Water Supply	Class II: Shellfish Propagation or Harvesting	Class III: Recreation, Propagation and Maintenance of a Health, Well-balanced Population of Fish and Wildlife		Class IV: Agricultural Water Supplies	Class V: Navigation, Utility, and Industrial Use
				Predominantly Fresh Waters	Predominantly Marine Waters		
11) Biological Integrity	Percent reduction of Shannon-Weaver Diversity Index	The Index for benthic macro-invertebrates shall not be reduced less than 75% of background levels measured using organisms retained by a U. S. Standard No. 30 sieve and collected and composited from a minimum of three Hester-Dendy type artificial substrate samplers of 0.10 to 0.15 m2 area each, incubated for a period of four weeks.	The Index for benthic macro-invertebrates shall not be reduced to less than 75% of established background levels as measured using organisms retained by a U. S. Standard No. 30 sieve and collected and composited from a minimum of three natural substrate samples, taken with Ponar type samplers with minimum sampling area of 225 cm2.	The Index for benthic macro-invertebrates shall not be reduced to less than 75% of established background levels as measured using organisms retained by a U. S. Standard No. 30 sieve and collected and composited from a minimum of three Hester-Dendy type artificial substrate samplers of 0.10 to 0.15 m2 area each, incubated for a period of four weeks.	The Index for benthic macro-invertebrates shall not be reduced to less than 75% of established background levels as measured using organisms retained by a U. S. Standard No. 30 sieve and collected and composited from a minimum of three natural substrate samples, taken with Ponar type samplers with minimum sampling area of 225 cm2.		

62-302.800 Site Specific Alternative Criteria.

(2) The affirmative demonstration required by this section shall mean a documented showing that the proposed alternative criteria would exist due to natural background conditions or man-induced conditions which cannot be controlled or abated. Such demonstration shall be based upon relevant factors which include:

(c) A description of the historical and existing biology, including variations, which may be affected by the parameter of concern. Conditions in similar water bodies may be used for comparison.

Georgia

SOURCE: Rules of Georgia Department of Natural Resources, Environmental Protection Division, Chapter 391-3-6, Water Quality Control, revised October 2001:
http://www.dnr.state.ga.us/dnr/environ/rules_files/exist_files/391-3-6.pdf and
http://www.dnr.state.ga.us/dnr/environ

(2) Water Quality Enhancement:

(a) The purposes and intent of the State in establishing Water Quality Standards are to provide enhancement of water quality and prevention of pollution; to protect the public health or welfare in accordance with the public interest for drinking water supplies, conservation of fish, wildlife and other beneficial aquatic life, and agricultural, industrial, recreational, and other reasonable and necessary uses and to maintain and improve the biological integrity of the waters of the State.

391-3-6.03 Water Use Classifications and Water Quality Standards

(3) Definitions:

(b) "Biological integrity" is functionally defined as the condition of the aquatic community inhabiting least impaired waterbodies of a specified habitat measured by community structure and function.

(4) Water Use Classifications. Water use classifications for which the criteria of this Paragraph are applicable are as follows:
   (c) Fishing, Propagation of Fish, Shellfish, Game and Other Aquatic Life
   (d) Wild River
   (e) Scenic River
   (f) Coastal Fishing

(6) Specific Criteria for Classified Water Usage. In addition to the general criteria, the following criteria are deemed necessary and shall be required for the specific water usage as shown:
   (a) Drinking Water Supplies: Those waters approved as a source for public drinking water systems permitted or to be permitted by the Environmental Protection Division. Waters classified for drinking water supplies will also support the fishing use and any other use requiring water of a lower quality.
   (c) Fishing: Propagation of Fish, Shellfish, Game and Other Aquatic Life; secondary contact recreation in and on the water; or for any other use requiring water of a lower quality.
   (d) Wild River: For all waters designated in 391-3-6-.03(13) as “Wild River,” there shall be no alteration of natural water quality from any source.
   (e) Scenic River: For all waters designated in 391-3-6-.03(13) as “Scenic River,” there shall be no alteration of natural water quality from any source.
   (f) Coastal Fishing: This classification will be applicable to specific sites when so designated by the Environmental Protection Division. For waters designated as “Coastal Fishing”, site specific criteria for dissolved oxygen will be assigned and detailed by footnote in Section 391-3-6.03(13), “Specific Water Use Classifications.” All other criteria and uses for the fishing use classification will apply for coastal fishing.

(15) Trout Streams. Streams designated as Primary Trout Waters are waters supporting a self-sustaining population of Rainbow, Brown or Brook Trout. Streams designated as Secondary Trout Streams are those with no evidence of natural trout reproduction, but are capable of supporting trout throughout the year...

Hawai`i

SOURCE: Source: Hawai`i Administrative Rules Title 11, Department of Health Chapter 54, Water Quality Standards, April 17, 2000:
http://www.hawaii.gov/health/rules/11-54.pdf and
http://www.epa.gov/waterscience/standards/wqslibrary/hi/hawaii_9_wqs.pdf

§11-54-01 Definitions. As used in this chapter:

- "Amphidromous" means aquatic life that migrate to and from the sea, but not specifically for reproductive purposes. Amphidromous aquatic life in Hawai‘ian streams are confined to fresh waters as adults, but their larval stages are partially or entirely spent in the ocean as part of the zooplankton.
- "Anchialine pools" means coastal bodies of standing waters that have no surface connections to the ocean but display both tidal fluctuations and salinity ranges characteristic of fresh and brackish waters, indicating the presence of subsurface connections to the watertable and ocean. Anchialine pools are located in porous substrata (recent lava or limestone) and often contain a distinctive assemblage of native aquatic life. Deeper anchialine pools may display salinity stratification, and some shallow pools may contain standing water only on the highest tides.
- "Aquatic life" means "any type or species of mammal, fish, amphibian, reptile, mollusk, crustacean, arthropod, invertebrate, coral, or other animal that inhabits the freshwater or marine environment and includes any part, product, egg, or offspring thereof; or freshwater or marine plants, including, seeds, roots, products, and other parts thereof".
- "Estuaries" means characteristically brackish coastal waters in well-defined basins with a continuous or seasonal surface connection to the ocean that allows entry of marine fauna. Estuaries may be either natural or developed.
- "Introduced aquatic life" means those species of aquatic organisms that are not native to a given area or water body and whose populations were established (deliberately or accidentally) by human activity. "Introduced" organisms are also referred to as "alien" or "exotic".

- "Low wetlands" means freshwater wetlands located below 100 m (330 ft) elevation that may be natural or artificial in origin and are usually found near coasts or in valley termini. Low wetlands are maintained by either stream, well, or ditch influent water, or by exposure of the natural water table. Low wetlands include, but are not limited to, natural lowland marshes, riparian wetlands, littoral zones of standing waters (including lakes, reservoirs, ponds and fishponds) and agricultural wetlands such as taro lo'i.
- "Native aquatic life" means those species or higher taxa of aquatic organisms that occur naturally in a given area or water body and whose populations were not established as a result of human activity.
- "Natural estuaries" means volumes of brackish coastal waters in well-defined basins of natural origin, found mainly at the mouths of streams or rivers. Natural estuaries can be either stream-fed (drowned stream mouths fed by perennial stream runoff) or spring-fed (nearshore basins with subterranean fresh water sources). Stream-fed estuaries serve as important migratory pathways for larval and juvenile amphidromous stream fauna.
- "Natural freshwater lakes" means standing water that is always fresh, in well-defined natural basins, with a surface area usually greater than 0.1 ha (0.25 acres), and in which rooted emergent hydrophytes, if present, occupy no more than 30% of the surface area. Natural freshwater lakes in Hawai‘i occur at high, intermediate, and low elevations. Lowland freshwater lakes characteristically lack a natural oceanic connection (surface or subsurface) of a magnitude sufficient to cause demonstrable tidal fluctuations.

§11-54-03 Classification of water uses.

(a) The following use categories classify inland and marine waters for purposes of applying the standards set forth in this chapter, and for the selection or definition of appropriate quality parameters and uses to be protected in these waters. Storm water discharge into State waters shall be allowed provided it meets the requirements specified in this section and the basic water quality criteria specified in section 11-54-04.

(b) Inland waters.
  (1) Class 1. It is the objective of class 1 waters that these waters remain in their natural state as nearly as possible with an absolute minimum of pollution from any human-caused source. To the extent possible, the wilderness character of these areas shall be protected. Waste discharge into these waters is prohibited. Any conduct which results in a demonstrable increase in levels of point or nonpoint source contamination in class 1 waters is prohibited.
    (a) Class 1.a. The uses to be protected in class 1.a waters are scientific and educational purposes, protection of native breeding stock, baseline references from which human-caused changes can be measured, compatible recreation, aesthetic enjoyment, and other nondegrading uses which are compatible with the protection of the ecosystems associated with waters of this class;
    (b) Class 1.b. The uses to be protected in class 1.b waters are domestic water supplies, food processing, protection of native breeding stock, the support and propagation of aquatic life...

  (2) Class 2. The objective of class 2 waters is to protect their use for recreational purposes, the support and propagation of aquatic life, agricultural and industrial water supplies, shipping, and navigation. The uses to be protected in this class of waters are all uses compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters. These waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control compatible with the criteria established for this class...

(c) Marine waters.
  (1) Class AA. It is the objective of class AA waters that these waters remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions. To the extent practicable, the wilderness character of these areas shall be protected. No zones of mixing shall be permitted in this class:
    (a) Within a defined reef area, in waters of a depth less than 18 meters (ten fathoms); or
    (b) In waters up to a distance of 300 meters (one thousand feet) off shore if there is no defined reef area and if the depth is greater than 18 meters (ten fathoms). The uses to be protected in this class of waters are oceanographic research, the support and propagation of shellfish and other marine life, conservation of coral reefs and wilderness areas, compatible recreation, and aesthetic enjoyment. The classification of any water area as Class AA shall not preclude other uses of the waters compatible with these objectives and in conformance with the criteria applicable to them;

  (2) Class A. It is the objective of class A waters that their use for recreational purposes and aesthetic

enjoyment be protected. Any other use shall be permitted as long as it is compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters. These waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control compatible with the criteria established for this class.

(d) Marine bottom ecosystems.
  (1) Class I. It is the objective of class I marine bottom ecosystems that they remain as nearly as possible in their natural pristine state with an absolute minimum of pollution from any human-induced source. Uses of marine bottom ecosystems in this class are passive human uses without intervention or alteration, allowing the perpetuation and preservation of the marine bottom in a most natural state, such as for nonconsumptive scientific research (demonstration, observation or monitoring only), nonconsumptive education, aesthetic enjoyment, passive activities, and preservation;
  (2) Class II. It is the objective of class II marine bottom ecosystems that their use for protection including propagation of fish, shellfish, and wildlife, and for recreational purposes not be limited in any way. The uses to be protected in this class of marine bottom ecosystems are all uses compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation.

§11-54-05.2 Inland water criteria.

(b) Specific criteria for streams.
  (2) Bottom criteria for streams:
    (e) The director shall prescribe the appropriate parameters, measures, and criteria for monitoring stream bottom biological communities including their habitat, which may be affected by proposed actions. Permanent benchmark stations may be required where necessary for monitoring purposes. The water quality criteria for this subsection shall be deemed to be met if time series surveys of benchmark stations indicate no relative changes in the relevant biological communities, as noted by biological community indicators or by indicator organisms which may be applicable to the specific site.

Idaho

SOURCE: Source: Rules of the Department of Environmental Quality, IDAPA 58.01.02, Water Quality Standards and Wastewater Treatment Requirements, amended April 5, 2000:
http://www2.state.id.us/adm/adminrules/rules/idapa58/0102.pdf and
http://www2.state.id.us/adm/adminrules/rules/idapa58/58index.htm

3. Definitions

04. Beneficial Use. Any of the various uses which may be made of the water of Idaho, including, but not limited to, domestic water supplies, industrial water supplies, agricultural water supplies, navigation, recreation in and on the water, wildlife habitat, and aesthetics. The beneficial use is dependent upon actual use, the ability of the water to support a non-existing use either now or in the future, and its likelihood of being used in a given manner. The use of water for the purpose of wastewater dilution or as a receiving water for a waste treatment facility effluent is not a beneficial use. (8-24-94)

05. Aquatic Species. Any plant or animal that lives at least part of its life in the water column or benthic portion of waters of the state. (8-24-94)

11. Biological Monitoring or Biomonitoring. The use of a biological entity as a detector and its response as a measure to determine environmental conditions. Toxicity tests and biological surveys, including habitat monitoring, are common biomonitoring methods.

23. Desirable Species. Species indigenous to the area or those introduced by the Idaho Department of Fish and Game.

71. Outstanding Resource Water (ORW). A high quality water, such as water of national and state parks and wildlife refuges and water of exceptional recreational or ecological significance, which has been

designated by the legislature and subsequently listed in this chapter. ORW constitutes an outstanding national or state resource that requires protection from point and nonpoint source activities that may lower water quality. (3-20-97)

85. Reference Stream Or Condition. A water body which represents the minimum conditions necessary to fully support the applicable designated beneficial uses as further specified in these rules, or natural conditions with few impacts from human activities and which are representative of the highest level of support attainable in the basin. In highly mineralized areas or in the absence of such reference streams or water bodies, the Director, in consultation with the basin advisory group and the technical advisors to it, may define appropriate hypothetical reference conditions or may use monitoring data specific to the site in question to determine conditions in which the beneficial uses are fully supported.

87. Resident Species. Those species that commonly occur in a site including those that occur only seasonally or intermittently. This includes the species, genera, families, orders, classes, and phyla that: (8-24-94)

a. Are usually present at the site; (8-24-94)
b. Are present only seasonally due to migration; (8-24-94)
c. Are present intermittently because they periodically return or extend their ranges into the site; (8-24-94)
d. Were present at the site in the past but are not currently due to degraded conditions, and are expected to be present at the site when conditions improve; and (8-24-94)
e. Are present in nearby bodies of water but are not currently present at the site due to degraded conditions, and are expected to be present at the site when conditions improve. (8-24-94)

111. Unique Ecological Significance. The attribute of any stream or water body which is inhabited or supports an endangered or threatened species of plant or animal or a species of special concern identified by the Idaho Department of Fish and Game, which provides anadromous fish passage, or which provides spawning or rearing habitat for anadromous or desirable species of lake dwelling fishes.

53. BENEFICIAL USE SUPPORT STATUS.

In determining whether a water body fully supports designated and existing beneficial uses, the Department shall determine whether all of the applicable water quality standards are being achieved, including any criteria developed pursuant to these rules, and whether a healthy, balanced biological community is present. The Department shall utilize biological and aquatic habitat parameters listed below and in the current version of the "Water Body Assessment Guidance", as published by the Idaho Department of Environmental Quality, as a guide to assist in the assessment of beneficial use status. Revisions to this guidance will made after notice and an opportunity for public comment. These parameters are not to be considered or treated as individual water quality criteria or otherwise interpreted or applied as water quality standards. (4-5-00)

01. Aquatic Habitat Parameters. These parameters may include, but are not limited to, stream width, stream depth, stream shade, measurements of sediment impacts, bank stability, water flows, and other physical characteristics of the stream that affect habitat for fish, macroinvertebrates or other aquatic life; and (3-20-97)

02. Biological Parameters. These parameters may include, but are not limited to, evaluation of aquatic macroinvertebrates including Ephemeroptera, Plecoptera and Trichoptera (EPT), Hilsenhoff Biotic Index, measures of functional feeding groups, and the variety and number of fish or other aquatic life to determine biologicalcommunity diversity and functionality.

100. SURFACE WATER USE DESIGNATIONS.

01. Aquatic Life. (7-1-93)

a. Cold water (COLD): water quality appropriate for the protection and maintenance of a viable aquatic life community for cold water species. (4-5-00)
b. Salmonid spawning: waters which provide or could provide a habitat for active self-propagating populations of salmonid fishes. (7-1-93)
c. Seasonal cold water (SC): water quality appropriate for the protection and maintenance of a viable aquatic life community of cool and cold water species, where cold water aquatic life may be absent

during, or tolerant of , seasonally warm temperatures. (4-5-00)

d. Warm water (WARM): water quality appropriate for the protection and maintenance of a viable aquatic life community for warm water species. (4-5-00)
e. Modified (MOD): water quality appropriate for an aquatic life community that is limited due to one (1) or more conditions set forth in 40 CFR 131.10(g) which preclude attainment of reference streams or conditions.

04. Wildlife Habitats. Water quality appropriate for wildlife habitats. This use applies to all surface waters of the state. (4-5-00)

Illinois

SOURCE: Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter I: Pollution Control Board, Part 302 and 303 Water Quality Standards, amended August 26, 1999:
http://www.ipcb.state.il.us/Title_35/Subtitles/C/302.pdf and
http://www.ipcb.state.il.us/Title_35/Subtitles/C/303.pdf

Section 302.102 Allowed Mixing, Mixing Zones and ZIDs

(b) The portion, volume and area of any receiving waters within which mixing is allowed pursuant to subsection (a) shall be limited by the following:
  2) Mixing is not allowed in waters which include a tributary stream entrance if such mixing occludes the tributary mouth or otherwise restricts the movement of aquatic life into or out of the tributary.
  3) Mixing is not allowed in waters containing mussel beds, endangered species habitat, fish spawning areas, areas of important aquatic life habitat, or any other natural features vital to the well being of aquatic life in such a manner that the maintenance of aquatic life in the body of water as a whole would be adversely affected.
  6) Mixing must allow for a zone of passage for aquatic life in which water quality standards are met.

SUBPART E:
Section 302.501 Scope, Applicability, and Definitions

"Resident or indigenous species" means species that currently live a substantial portion of their life cycle, or reproduce, in a given body of water, or that are native species whose historical range includes a given body of water.

"Target species" is a species to be protected by the criterion.

"Target species value" is the criterion value for the target species.

"Trophic level" means a functional classification of taxa within a community that is based on feeding relationships. For example, aquatic green plants and herbivores comprise the first and second trophic levels in a food chain.

SUBPART B: Nonspecific Water Use Designations:
Section 303.204 Secondary Contact and Indigenous Aquatic Life Waters

Waters which are required to meet the secondary contact and indigenous aquatic life standards of Subpart D, Part 302, are not required to meet the general use standards or the public and food processing water supply standards of Subparts B and C, Part 302.

Indiana

SOURCE: Indiana Administrative Code, Title 327 Water Pollution Control Board, Article 2: Water Quality Standards, Updated April 1, 2002: http://www.ai.org/legislative/iac/title327.html

Indiana Water Quality Standards for the Non-Great Lakes Basin Portions of Indiana

327 IAC 2-1-3 Surface water use designations; multiple uses

Sec. 3. (a) The following water uses are designated by the water pollution control board:

(1) Surface waters of the state are designated for full-body contact recreation as provided in section 6(d) of this rule.

(2) All waters, except as described in subdivision (5), will be capable of supporting a well-balanced, warm water aquatic community and, where natural temperatures will permit, will be capable of supporting put-and-take trout fishing. All waters capable of supporting the natural reproduction of trout as of February 17, 1977, shall be so maintained.

(3) All waters which are used for public or industrial water supply must meet the standards for those uses at the points where the water is withdrawn. This use designation and its corresponding water quality standards are not to be construed as imposing a user restriction on those exercising or desiring to exercise the use.

(4) All waters which are used for agricultural purposes must, as a minimum, meet the standards established in section 6(a) of this rule.

(5) All waters in which naturally poor physical characteristics (including lack of sufficient flow), naturally poor chemical quality, or irreversible man-induced conditions, which came into existence prior to January 1, 1983, and having been established by use attainability analysis, public comment period, and hearing may qualify to be classified for limited use and must be evaluated for restoration and upgrading at teach triennial review of this rule. Specific waters of the state designated for limited use are listed in section 11(a) of this rule.

(6) All waters which provide unusual aquatic habitat, which are an integral feature of an area of exceptional natural beauty or character, or which support unique assemblages of aquatic organisms may be classified for exceptional use. Specific waters of the state designated for exceptional use are listed in section 11(b) of this rule.

(b) Where multiple uses have been designated for a body of water, the most protective of all simultaneously applicable standards will apply. *(Water Pollution Control Board; 327 IAC 2-1-3; filed Sep 24, 1987, 3:00 p.m.: 11 IR 580; filed Feb 1, 1990, 4:30 p.m.: 13 IR 1019; filed Jan 14, 1997, 12:00 p.m.: 20 IR 1348)*

327 IAC 2-1-6 Minimum surface water quality standards

Sec. 6. (a) The following are minimum water quality conditions:

(1) All waters at all times and at all places, including the mixing zone, shall meet the minimum conditions of being free from substances, materials, floating debris, oil, or scum attributable to municipal, industrial, agricultural, and other land use practices, or other discharges:

(A) that will settle to form putrescent or otherwise objectionable deposits;

(B) that are in amounts sufficient to be unsightly or deleterious;

(C) that produce color, visible oil sheen, odor, or other conditions in such degree as to create a nuisance;

(D) which are in amounts sufficient to be acutely toxic to, or to otherwise severely injure or kill aquatic life, other animals, plants, or humans:

(i) to assure protection of aquatic life, concentrations of toxic substances shall not exceed the final acute value (FAV = 2 (AAC)) in the undiluted discharge or the acute aquatic criterion (AAC) outside the zone of initial dilution or, if applicable, the zone of discharge-induced mixing:

(AA) for certain substances, the AAC are established and set forth in Table 1 (which table4 incorporates Table 2); and (BB) for substances for which an AAC is not specified in Table 1, or if a different AAC can be scientifically justified based on new toxicological data or site-specific conditions concerning water quality characteristics or species present, an AAC can be calculated by the commissioner using the procedures in section 8.2 of this rule; and

(ii) this clause shall not apply to the chemical control of plants and animals when that control is performed in compliance with approval conditions specified by the Indiana Department of Natural Resources as provided by IC 14-2-1; and

(E) which are in concentrations or combinations that will cause or contribute to the growth of aquatic plants or algae to such degree as to create a nuisance, be unsightly, or otherwise impair the designated uses.

(2) At all times, all waters outside of mixing zones shall be free of substances in concentrations which on the basis of available scientific data are believed to be sufficient to injure, be chronically toxic to, or be carcinogenic, mutagenic, or teratogenic to humans, animals, aquatic life, or plants. To assure protection against the adverse effects identified in this subdivision, the following requirements are established:

The Great Lakes Basin is covered by its own regulation which follows:

327 IAC 2-1.5-5: GLI Water Use Designations

327 IAC 2-1.5-5 Surface water use designations; multiple uses

Sec. 5. (a) The following water uses are designated by the board:

(1) All surface waters of the state within the Great Lakes system are designated for full-body contact recreation.

(2) All surface waters, except as described in subdivision (7), shall be capable of supporting a well-balanced, warm water aquatic community.

(3) Where natural temperatures will permit, surface waters shall be capable of supporting put-and-take trout fishing. All waters capable of supporting the natural reproduction of trout shall be so maintained. The following waters are designated as salmonid waters and shall be capable of supporting a salmonid fishery:
   (A) Trail Creek and its tributaries downstream to Lake Michigan.
   (B) East Branch of the Little Calumet River and its tributaries downstream to Lake Michigan via Burns Ditch.
   (C) Salt Creek above its confluence with the Little Calumet River.
   (D) Kintzele Ditch (Black Ditch) from Beverly Drive downstream to Lake Michigan.
   (E) The Galena River and its tributaries in LaPorte County.
   (F) The St. Joseph River and its tributaries in St. Joseph County from the Twin Branch Dam in Mishawaka downstream to the Indiana/Michigan state line.
   (G) The Indiana portion of the open waters of Lake Michigan.
   (H) Those waters designated by the Indiana department of natural resources for put-and-take trout fishing.

(4) All surface waters used for public water supply are designated as a public water supply. This use designation and its corresponding water quality criteria are not to be construed as imposing a user restriction on those exercising or desiring to exercise the use.

(5) All surface waters used for industrial water supply are designated as an industrial water supply. This use designation and its corresponding water quality criteria are not to be construed as imposing a user restriction on those exercising or desiring to exercise the use.

(6) All surface waters used for agricultural purposes are designated as an agricultural use water.

(7) Limited use waters are designated under section 19(a) of this rule pursuant to section 18 of this rule. All waters that are designated as a limited use water under section 19(a) of this rule must be evaluated for restoration and upgrading at each triennial review of this rule.

(8) Outstanding state resource waters are designated under section 19(b) of this rule pursuant to section 18 of this rule.

(b) Where multiple uses have been designated for a body of water, the most protective of all simultaneously applicable standards will apply. (Water Pollution Control Board; 327 IAC 2-1.5-5; filed Jan 14, 1997, 12:00 p.m.: 20 IR 1369)

327 IAC 2-1.5-8 Minimum surface water quality criteria

Sec. 8. (a) All surface water quality criteria in this section, except those provided in subsection (b)(1), will cease to be applicable when the stream flows are less than the applicable stream design flow for the particular criterion as determined under 327 IAC 5-2-11.4. (b) The following are minimum water quality conditions:

(1) All waters within the Great Lakes system at all times and at all places, including waters within the mixing zone, shall meet the minimum conditions of being free from substances, materials, floating

debris, oil, or scum attributable to municipal, industrial, agricultural, and other land use practices, or other discharges that do any of the following:

(A) Will settle to form putrescent or otherwise objectionable deposits.
(B) Are in amounts sufficient to be unsightly or deleterious.
(C) Produce color, visible oil sheen, odor, or other conditions in such degree as to create a nuisance.
(D) Are in concentrations or combinations that will cause or contribute to the growth of aquatic plants or algae to such degree as to create a nuisance, be unsightly, or otherwise impair the designated uses.
(E) Are in amounts sufficient to be acutely toxic to, or to otherwise severely injure or kill aquatic life, other animals, plants, or humans. To assure protection of aquatic life, the waters shall meet the following requirements:
    (i) Concentrations of toxic substances shall not exceed the CMC outside the zone of initial dilution or the final acute value (FAV = 2 (CMC)) in the undiluted discharge unless, for a discharge to a receiving stream or Lake Michigan, an alternate mixing zone demonstration is conducted and approved in accordance with 327 IAC 5-2-11.4(b)(4), in which case, the CMC shall be met outside the discharge-induced mixing zone:

(2) At all times, all waters outside of the applicable mixing zones determined in accordance with 327 IAC 5-2-11.4(c) through 327 IAC 5-2-11.4(f) shall be free of substances in concentrations, that, on the basis of available scientific data, are believed to be sufficient to injure, be chronically toxic to, or be carcinogenic, mutagenic...

Iowa

SOURCE: Iowa Administrative Code, Environmental Protection Rule 567, Chapter 61, Water Quality Standards, October 18, 2000:
http://www.state.ia.us/government/dnr/organiza/epd/prgrmdsc/wtrqual/spqual.htm
http://www.state.ia.us/epd/prgrmdsc/wtrqual/sum.htm and
http://www.state.ia.us/dnr/organiza/epd/wtrq/wtrqbor.htm

Class "B" Waters: Waters which are designated as Class "B" are to be protected for wildlife, fish, aquatic and semi-aquatic life and secondary contact water uses. Class "B" waters are divided into the following categories:

- Class "B" (CW) (cold water aquatic life): streams or lakes that support trout and associated aquatic communities
- Class "B" (WW) (significant resource warm water): lakes or rivers which support warm water game fish and associated aquatic communities, including sensitive species
- Class "B" (LR) (limited resource warm water): streams which support limited aquatic life populations primarily composed of minnows and other nongame fish species
- Class "B" (LW) (lakes and wetlands): artificial impoundments and natural lakes with lake-like conditions that support warm water game fish and associated aquatic communities

High Quality (HQ) waters: Waters with exceptionally better quality than specified by Iowa water quality criteria and with exceptional recreational and ecological importance. Special protection is warranted to maintain the unusual, unique or outstanding physical, chemical, or biological characteristics that these waters possess.

High Quality Resource (HQR) waters: Waters of substantial recreational or ecological significance that possess unusual, outstanding or unique physical, chemical or biological characteristics that enhance the beneficial uses and warrant special protection.

Kansas

SOURCE: Kansas Register, Notice/Regulations, Administrative Regulations, Kansas Department of Health and Environment, Water Pollution Control, Chapter 28-1, Volume 20, Number 33, August 16, 2001:

http://www.kdhe.state.ks.us/water/index.html#Proposed%20Regulations%20and%20 and
http://www.kdhe.state.ks.us/environment/qmp_2000/SBMP_QAMP.pdf

Article 16. Surface Water Quality Standards

28-16-28b. Definitions.

(h) ''Bioassessment methods and procedures'' means the use of biological methods of assessing surface water quality including, but not limited to, field investigations of aquatic organisms and laboratory or field aquatic toxicity tests.

(k) ''Biota'' means the animal and plant life of a given geographical region.

(v) ''Ecological integrity'' means the natural or unimpaired structure and functioning of an aquatic or terrestrial ecosystem.

(oo) ''Outstanding natural resource water'' means any of the surface waters or surface water segments of exceptional recreational or ecological significance identified in the surface water register, as defined in K.A.R. 28-16-28b(uu), and afforded the highest level of water quality protection under the antidegradation provisions of K.A.R. 28-16-28c(a) and the mixing zone provisions of K.A.R. 28-16-28c(b).

(ddd) ''Surface waters'' means all of the following:

(1) Streams, including rivers, creeks, brooks, sloughs, draws, arroyos, canals, springs, seeps, and cavern streams, and any alluvial aquifers associated with these surface waters;

(2) lakes, including oxbow lakes and other natural lakes and man-made reservoirs, lakes, and ponds; and

(3) wetlands, including water bodies meeting the technical definition for jurisdictional wetlands given in the corps of engineers wetlands delineation manual,'' as published in January 1987, which is hereby adopted by reference.

28-16-28d. Surface water use designation and classification.

(a) Designated uses of surface waters are defined as follows.

(2) ''Aquatic life support use'' means the use of surface water for the maintenance of the ecological integrity of streams, lakes and wetlands, including the sustained growth and propagation of native aquatic life, indigenous or migratory semi-aquatic life, or terrestrial wildlife directly or indirectly dependent on surface water for survival.

(A) ''Special aquatic life use waters'' means either surface waters that contain combinations of habitat types and indigenous biota not found commonly in the state or surface waters that contain representative populations of threatened or endangered species.

(B) ''Expected aquatic life use waters'' means surface waters containing habitat types and indigenous biota commonly found or expected in the state.

(C) ''Restricted aquatic life use waters'' means surface waters containing indigenous biota limited in abundance diversity by the physical quality or availability of habitat, due to natural deficiencies or artificial modifications, compared to more suitable habitats in adjacent waters.

28-16-28e. Surface water quality criteria.

(a) Criteria development guidance. The development of surface water quality criteria for substances not listed in these standards shall be guided by water quality criteria published by the United States environmental protection agency. If the department finds that the criteria listed in this regulation are underprotective or overprotective for given surface water segment, appropriate site-specific criteria may be developed and applied by the department, in accordance with K.A.R. 28-16-28f(f), using bioassessment methods or other related scientific procedures...

(c) Criteria for designated uses of surface waters. The numeric criteria in tables 1a, 1b, 1c, 1d, and 1e shall not apply if the critical low flow is less than 0.03 cubic meters per second for waters designated as expected aquatic life use waters and restricted aquatic life use waters, unless studies conducted or approved by the department show that water present during periods of no flow, or flow below critical low flow, provides important refuges for aquatic life and permits biological recolonization of intermittently flowing segments. The numeric criteria in tables 1a, 1b, 1c, 1d, and 1e shall not apply if the critical low flow is less than 0.003 cubic meters per second for waters designated as special aquatic life use waters, unless studies conducted or approved by the department show that water present during periods of no flow, or flow below critical low flow, provides important refuges for aquatic life and permits biological

recolonization of intermittently flowing segments. The following critieria shall apply to all classified surface waters for the indicated designated uses.

Kentucky

SOURCE: Title 401, Chapter 5, Kentucky Administrative Regulations (KAR), effective December 8, 1999: http://www.lrc.state.ky.us/kar/401/005/026.htm

401 KAR 5:002. Definitions for 401 KAR Chapter 5.

Section 1. Definitions.

(8) "Adversely affect" or "adversely change" means, for purposes of 401 KAR 5:026 through 5:031, to alter or change the community structure or function, to reduce the number or proportion of sensitive species, or to increase the number or proportion of pollution tolerant aquatic species so that aquatic life use support or aquatic habitat is impaired.

(54) "Cold water aquatic habitat" or "CAH" means surface waters and associated substrate that will support indigenous aquatic life or self-sustaining or reproducing trout populations on a year-round basis.

(124) "Impairment" means, for the purpose of 401 KAR 5:026 through 5:031, a detrimental impact to a surface water that prevents attainment of a designated use.

(127) "Indigenous aquatic life" means naturally occurring aquatic organisms including but not limited to bacteria, fungi, algae, aquatic insects, other aquatic invertebrates, reptiles, amphibians, and fishes. Under some natural conditions one (1) or more of the above groups may be absent from a surface water.

(233) "Productive aquatic community" means an assemblage of indigenous aquatic life capable of reproduction and growth.

(236) "Propagation" means the continuance of a species by successful spawning, hatching, and development or natural generation in the natural environment, as opposed to the maintenance of the species by artificial culture and stocking.

(250) "Representative important species" means species which are representative, in terms of their biological needs, of a balanced, indigenous community of shellfish, fish, and wildlife in the body of water into which a discharge of heat is made.

(317) "Warm water aquatic habitat" or "WAH" means any surface water and associated substrate capable of supporting indigenous warm water aquatic life.

401 KAR 5:026.Designation of uses of surface waters.

Section 1. Scope of Designation.

(2) Designated uses are:
- (a) Warm water aquatic habitat;
- (b) Cold water aquatic habitat;
- (f) Outstanding state resource water.

(4) Outstanding state resource waters may have unique water quality characteristics that shall be protected by additional criteria established in 401 KAR 5:031, Section 7.

401 KAR 5:029.General provisions.

Section 3. Documentation for Redesignations.

(3) Documentation to support the redesignation of a surface water of the Commonwealth shall be:
- (g) An assessment of the existing and potential aquatic life habitat in the surface waters under consideration and the adjacent upstream surface waters. The existing aquatic life shall be

documented and livestock and natural wildlife dependence on the surface water shall be assessed. The occurrence of individuals or populations, indices of diversity and well-being, and abundance of species of any unique native biota shall be documented;

401 KAR 5:030. Antidegradation policy implementation methodology.

Section 1. Implementation of Antidegradation Policy..

(1) Categorization. Surface waters shall be placed into one (1) of three (3) categories:

(a) Outstanding national resource waters:

(b) Exceptional waters:

1. Surface water designated as a Kentucky Wild River, unless it is categorized as an outstanding national resource water;
2. Outstanding state resource water that does not support a federally threatened or endangered aquatic species;
3. Surface water that fully supports all applicable designated uses and contains:
   a. A fish community that is rated "excellent" by the use of the Index of Biotic Integrity included in "Methods for Assessing Biological Integrity of Surface Waters", incorporated by reference in Section 4 of this administration regulation; or
   b. A macroinvertebrate community that is rated "excellent" by the Macroinvertebrate Bioassessment Index included in "A Macroinvertebrate Bioassessment Index for Streams of the Interior Plateau Ecoregion in Kentucky", incorporated by reference in Section 4 of this administrative regulation; and
4. Water in the cabinet's reference reach network.

401 KAR 5:031.Surface water standards.

Section 2. Minimum Criteria Applicable to All Surface Waters.

(1) The following minimum water quality criteria are applicable to all surface waters including mixing zones, with the exception that toxicity to aquatic life in mixing zones shall be subject to the provisions of 401 KAR 5:029, Section 4. Surface waters shall not be aesthetically or otherwise degraded by substances that:

(d) Injure, are chronically or acutely toxic to or produce adverse physiological or behavioral responses in humans, animals, fish and other aquatic life;

(e) Produce undesirable aquatic life or result in the dominance of nuisance species;

Section 4. Aquatic Life.

(1) Warm water aquatic habitat. The following parameters and associated criteria shall apply for the protection of productive warm water aquatic communities, fowl, animal wildlife, arboreous growth, agricultural, and industrial uses:

(a) Natural alkalinity as CaCO3 shall not be reduced by more than twenty-five (25) percent. If natural alkalinity is below twenty (20) mg/l CaCO3, there shall not be a reduction below the natural level. Alkalinity shall not be reduced or increased to a degree which may adversely affect the aquatic community.

(c) Flow shall not be altered to a degree which will adversely affect the aquatic community.

(d) Temperature shall not exceed thirty-one and seven-tenths (31.7) degrees Celsius (eighty-nine (89) degrees Fahrenheit).

2. The cabinet may determine allowable surface water temperatures on a site-specific basis utilizing available data which shall be based on the effects of temperature on the aquatic biota which utilize specific surface waters of the Commonwealth and which may be affected by person-induced temperature changes. Effects on downstream uses will also be considered in determining site-specific temperatures...
3. A successful demonstration concerning thermal discharge limits carried out under Section 316(a) of the Clean Water Act shall constitute compliance with the temperature requirements of this subsection. A successful demonstration assures the protection and propagation of a balanced indigenous population of shellfish, fish and wildlife in or on the water into which the discharge is made.

(f) Solids.

1. Total dissolved solids. Total dissolved solids shall not be changed to the extent that the indigenous aquatic community is adversely affected.
2. Total suspended solids. Total suspended solids shall not be changed to the extent that the

indigenous aquatic community is adversely affected.

3. Settleable solids. The addition of settleable solids that may alter the stream bottom so as to adversely affect productive aquatic communities is prohibited.

Louisiana

SOURCE: Louisiana Administrative Code, Title 33: Environmental Regulatory Code, Part IX, Water Quality, March 20, 2001: http://www.deq.state.la.us/planning/regs/title33/33v09.pdf

Chapter 11. Surface Water Quality Standards

§1101. Introduction

A. The purpose of this Chapter is to establish surface water quality standards which will:
   1. provide for the protection and preservation of the abundant natural resources of Louisiana's many and varied aquatic ecosystems;

§1105. Definitions

Biological and Aquatic Community Integrity—the condition of the aquatic community inhabiting a specified habitat as measured by community structure and function.

Biological Succession—the gradual and orderly process of ecosystem or community development brought about by changes in species populations that culminates in the production of a climax characteristic of a particular geographic region.

Fresh Warmwater Biota—those aquatic life species whose populations typically inhabit waters with warm temperatures (seasonal averages above 20 o C, 68 o F) and low salinities (less than 2 parts per thousand,‰), including but not limited to, black basses and freshwater sunfish and catfish and characteristic freshwater aquatic invertebrates and wildlife.

Marine Water Biota—those aquatic life species whose populations typically inhabit waters with salinities equal to or greater than 2 parts per thousand (‰) including but not limited to characteristic fishes, invertebrates and wildlife of coastal waters and the Gulf of Mexico.

§1109. Policy

B. Water Use
   1. It is the policy of the state of Louisiana that all state waters should be protected for recreational uses and for the preservation and propagation of desirable species of aquatic biota and indigenous species of wildlife...
   2. In applying this policy, the terms "recreational uses" and "desirable species of aquatic biota" will be given common sense applications. Recreational uses will be classified as either "primary contact" or "secondary contact." "Desirable species of aquatic biota" refers to a diverse and naturally occurring range of aquatic biota and not to species that exist in the area in question in disproportionate numbers as a result of wastewater discharges. Desirable species of fish, shellfish and other invertebrates, wildlife, and other aquatic biota will be specified as "fresh warmwater" or "marine water" species. All future designations of water uses and their associated criteria must, at a minimum, adhere to these classifications, except as provided in LAC 33:IX.1109.B.3 and C. will be viewed as a problem to be solved, not as an impediment to categorizing water bodies or assigning designated uses...

§1111. Water Use Designations

C. Fish and Wildlife Propagation. Fish and wildlife propagation includes the use of water for aquatic habitat, food, resting, reproduction, cover, and/or travel corridors for any indigenous wildlife and aquatic life species associated with the aquatic environment. This use also includes the maintenance of water quality at a level that prevents damage to indigenous wildlife and aquatic life species associated with the aquatic environment and contamination of aquatic biota consumed by humans. The subcategory of "limited aquatic life and wildlife use" recognizes the natural variability of aquatic habitats, community requirements, and local environmental conditions. Limited aquatic life and wildlife use may be designated for water bodies having habitat that is uniform in structure and morphology with most of the regionally expected

aquatic species absent, low species diversity and richness, and/or a severely imbalanced trophic structure. Aquatic life able to survive and/or propagate in such water bodies include species tolerant of severe or variable environmental conditions. Water bodies that might qualify for the limited aquatic life and wildlife use subcategory include intermittent streams and man-made water bodies with characteristics including, but not limited to, irreversible hydrologic modification, anthropogenically and irreversibly degraded water quality, uniform channel morphology, lack of channel structure, uniform substrate, lack of riparian structure, and similar characteristics making the available habitat for aquatic life and wildlife suboptimal. Limited aquatic life and wildlife use will be denoted in Table 3 (LAC 33:IX.1123) as an "L."

E. Oyster Propagation. Oyster propagation is the use of water to maintain biological systems that support economically important species of oysters, clams, mussels, or other mollusks so that their productivity is preserved and the health of human consumers of these species is protected.
This use shall apply only to those water bodies named in the Numerical Criteria and Designated Uses Table and not to their tributaries or distributaries unless so specified.

G. Outstanding Natural Resource Waters. Outstanding natural resource waters include water bodies designated for preservation, protection, reclamation, or enhancement of wilderness, aesthetic qualities, and ecological regimes, such as those designated under the Louisiana Natural and Scenic Rivers System or those designated by the department as waters of ecological significance. Characteristics of outstanding natural resource waters include, but are not limited to, highly diverse or unique instream and/or riparian habitat, high species diversity, balanced trophic structure, unique species, or similar qualities. This use designation applies only to the water bodies specifically identified in Table 3 (LAC 33:IX.1123) and not to their tributaries or distributaries unless so specified.

§1113. Criteria

B. General Criteria.

12. Biological and Aquatic Community Integrity. The biological and community structure and function in state waters shall be maintained, protected, and restored except where not attainable and feasible as defined in LAC 33:IX.1109.B.3. This is the ideal condition of the aquatic community inhabiting the unimpaired water bodies of a specified habitat and region as measured by community structure and function. The biological integrity will be guided by the fish and wildlife propagation use designated for that particular water body. Fish and wildlife propagation uses are defined in LAC 33:IX.1111.C. The condition of these aquatic communities shall be determined from the measures of physical, chemical, and biological characteristics of each surface water body type, according to its designated use (LAC 33:IX.1123). Reference site conditions will represent naturally attainable conditions. These sites should be the least impacted and most representative of water body types. Such reference sites or segments of water bodies shall be those observed to support the greatest variety and abundance of aquatic life in the region as is expected to be or has been recorded during past surveys in natural settings essentially undisturbed by human impacts, development, or discharges. This condition shall be determined by consistent sampling and reliable measures of selected, indicative communities of animals and/or invertebrates as established by the department and may be used in conjunction with acceptable chemical, physical, and microbial water quality measurements and records as deemed for this purpose.

Maine

SOURCE: Title 38, Section 464, Maine Revised Statutes, 1999:
http://janus.state.me.us/legis/statutes/38/title38sec464.html and http://www.state.me.us/dep/blwq

38 MRSA Section 464. Classification of Maine waters:

1. **Findings; objectives; purpose.**...The Legislature declares that it is the State's objective to restore and maintain the chemical, physical and biological integrity of the State's waters and to preserve certain pristine state waters. The Legislature further declares that in order to achieve this objective the State's goals are:

C. That water quality be sufficient to provide for the protection and propagation of fish, shellfish and wildlife and provide for recreation in and on the water.

4. **General provisions.** The classification system for surface waters established by this article shall be subject to the following provisions.
   F. The antidegradation policy of the State is governed by the following provisions.
      (1) ...Determinations of what constitutes an existing in-stream water use on a particular water body must be made on a case-by-case basis by the department. In making its determination of uses to be protected and maintained, the department shall consider designated uses for that water body and:
         (a) Aquatic, estuarine and marine life present in the water body;
         (b) Wildlife that utilize the water body;
         (c) Habitat, including significant wetlands, within a water body supporting existing populations of wildlife or aquatic, estuarine or marine life, or plant life that is maintained by the water body;
         (d) Any other evidence that, for divisions (a), (b) and (c), demonstrates their ecological significance because of their role or importance in the functioning of the ecosystem or their rarity and, for division (d), demonstrates its historical or social significance.

      (1-A) The department may only issue a waste discharge license pursuant to section 414-A, or approve a water quality certification pursuant to the United States Clean Water Act, Section 401, Public Law 92-500, as amended, when the department finds that:
         (a) The existing in-stream use involves use of the water body by a population of plant life, wildlife, or aquatic, estuarine or marine life, or as aquatic, estuarine, marine, wildlife, or plant habitat, and the applicant has demonstrated that the proposed activity would not have a significant impact on the existing use. For purpose of this division, significant impact means:
            (i) Impairing the viability of the existing population, including significant impairment to growth and reproduction or an alteration of the habitat which impairs viability of the existing population; or

      The department shall determine what constitutes a population of a particular species based upon the degree of geographic and reproductive isolation from other individuals of the same species.

6. **Implementation of biological water quality criteria.** The implementation of water quality criteria pertaining to the protection of the resident biological community shall be governed by the provisions of this subsection.
   A. At any time during the term of a valid wastewater discharge license that was issued prior to the effective date of this article, the board may modify that license in accordance with section 341-D, subsection 3 if the discharger is not in compliance with the water quality criteria pertaining to the protection of the resident biological community. When a discharge license is modified under this subsection, the board shall establish a reasonable schedule to bring the discharge into compliance with the water quality criteria pertaining to the protection of the resident biological community.
   B. When a discharge license is issued after the effective date of this article and before the effective date of the rules adopted pursuant to subsection 5, the department shall establish a reasonable schedule to bring the discharge into compliance with the water quality criteria pertaining to the protection of the resident biological community.

38 MRSA § 465. Standards for classification of fresh surface waters

The department shall have 4 standards for the classification of fresh surface waters which are not classified as great ponds.

1. Class AA waters. Class AA shall be the highest classification and shall be applied to waters which are outstanding natural resources and which should be preserved because of their ecological, social, scenic or recreational importance.
   A. Class AA waters shall be of such quality that they are suitable... as habitat for fish and other aquatic life. The habitat shall be characterized as free flowing and natural.
   B. The aquatic life, dissolved oxygen and bacteria content of Class AA waters shall be as naturally occurs.

2. Class A waters. Class A shall be the 2nd highest classification.
   A. Class A waters shall be of such quality that they are suitable...as habitat for fish and other aquatic life.

The habitat shall be characterized as natural.

B. ...The aquatic life and bacteria content of Class A waters shall be as naturally occurs.

3. Class B waters. Class B shall be the 3rd highest classification.
   A. Class B waters shall be of such quality that they are suitable... as habitat for fish and other aquatic life. The habitat shall be characterized as unimpaired.
   B. The dissolved oxygen content of Class B waters shall be not less than 7 parts per million or 75% of saturation, whichever is higher, except that for the period from October 1st to May 14th, in order to ensure spawning and egg incubation of indigenous fish species...
   C. Discharges to Class B waters shall not cause adverse impact to aquatic life in that the receiving waters shall be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community.

4. Class C waters. Class C shall be the 4th highest classification.
   A. Class C waters shall be of such quality that they are suitable...as a habitat for fish and other aquatic life.
   B. The dissolved oxygen content of Class C water may be not less than 5 parts per million or 60% of saturation, whichever is higher, except that in identified salmonid spawning areas where water quality is sufficient to ensure spawning, egg incubation and survival of early life stages, that water quality sufficient for these purposes must be maintained...
   C. Discharges to Class C waters may cause some changes to aquatic life, provided that the receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.

38 MRSA § 466. Definitions: http://janus.state.me.us/legis/statutes/38/title38sec466.html

1. **Aquatic life.** "Aquatic life" means any plants or animals which live at least part of their life cycle in fresh water.

2. **As naturally occurs.** "As naturally occurs" means conditions with essentially the same physical, chemical and biological characteristics as found in situations with similar habitats free of measurable effects of human activity.

3. **Community function.** "Community function" means mechanisms of uptake, storage and transfer of life-sustaining materials available to a biological community which determines the efficiency of use and the amount of export of the materials from the community.

4. **Community structure.** "Community structure" means the organization of a biological community based on numbers of individuals within different taxonomic groups and the proportion each taxonomic group represents of the total community.

10. **Resident biological community.** "Resident biological community" means aquatic life expected to exist in a habitat which is free from the influence of the discharge of any pollutant. This shall be established by accepted biomonitoring techniques.

11. **Unimpaired.** "Unimpaired" means without a diminished capacity to support aquatic life.

12. **Without detrimental changes in the resident biological community.** "Without detrimental changes in the resident biological community" means no significant loss of species or excessive dominance by any species or group of species attributable to human activity.

Maryland

SOURCE: Code of Maryland Regulations, Title 26, Department of the Environment, Subtitle 08 Water Pollution, Subpart 26.0.02, November 6, 1995: COMAR 26.08.02.01, Surface Water Quality Protection and 26.08.02.02, Designated Uses: https://constmail.gov.state.md.us/comar/26/26.08.02.01.htm and https://constmail.gov.state.md.us/comar/26/26.08.02.02.htm

.01 Surface Water Quality Protection

A. Purpose. To protect surface water quality, this State shall adopt water quality standards to:
   (1) Protect public health or welfare;
   (2) Enhance the quality of water;
   (3) Protect aquatic resources; and
   (4) Serve the purposes of the Federal Act.

B. Water Quality Standards.
   (2) Water quality standards shall, wherever attainable, provide water quality for the designated uses of:
      (b) Fishing;
      (c) Propagation of fish, other aquatic life, and wildlife...

.02 Designated Uses

A. General.
   (1) Waters of this State shall, wherever attainable, be protected for the basic uses of water contact recreation, fishing, protection of aquatic life and wildlife, and agricultural and industrial water supply as identified in Use I.

B. Specific Designated Uses.
   (1) Use I: Water Contact Recreation, and Protection of Aquatic Life. This use designation includes waters which are suitable for:
      (c) Fishing;
      (d) The growth and propagation of fish (other than trout), other aquatic life, and wildlife;

   (2) Use I-P: Water Contact Recreation, Protection of Aquatic Life, and Public Water Supply. This use designation includes:
      (a) All uses identified for Use I....

   (3) Use II: Shellfish Harvesting Waters. This use designation includes waters where:
      (a) Shellfish are propagated, stored, or gathered for marketing purposes; and
      (b) There are actual or potential areas for the harvesting of oysters, softshell clams, hardshell clams, and brackish water clams.

   (4) Use III: Natural Trout Waters. This use designation includes waters which have the potential for or are:
      (a) Suitable for the growth and propagation of trout; and
      (b) Capable of supporting self-sustaining trout populations and their associated food organisms.

   (5) Use III-P: Natural Trout Waters and Public Water Supply. This use designation includes:
      (a) All uses identified for Use III waters; and...

   (6) Use IV: Recreational Trout Waters. This use designation includes cold or warm waters which have the potential for or are:
      (a) Capable of holding or supporting adult trout for put-and-take fishing; and
      (b) Managed as a special fishery by periodic stocking and seasonal catching.

   (7) Use IV-P: Recreational Trout Waters and Public Water Supply. This use designation includes:
      (a) All uses identified for Use IV waters; and...

Massachusetts

SOURCE: 314 CMR 4.00: Massachusetts Surface Water Quality Standards, effective May 12, 2000: http://www.state.ma.us/dep/bwp/iww/files/314cmr4.htm

4.02: Definitions

Aquatic Life - A native, naturally diverse, community of aquatic flora and fauna.

Cold Water Fishery - Waters in which the maximum mean monthly temperature generally does not exceed 68°F (20°C) and, when other ecological factors are favorable (such as habitat), are capable of supporting a year-round population of cold water stenothermal aquatic life such as trout (*salmonidae*).

Vernal Pool - A waterbody that has been certified by the Massachusetts Division of Fisheries and Wildlife as a vernal pool.

Warm Water Fishery - Waters in which the maximum mean monthly temperature generally exceeds 68°F (20°C) during the summer months and are not capable of sustaining a year-round population of cold water stenothermal aquatic life.

4.05 Classes and Criteria

(3) Inland Water Classes:

(a) Class A - These waters are designated as a source of public water supply. To the extent compatible with this use they shall be an excellent habitat for fish, other aquatic life and wildlife, and suitable for primary secondary contact recreation. These waters shall have excellent aesthetic value. These waters are designated for protection as Outstanding Resource Waters under 314 CMR 4.04(3).

1. Dissolved Oxygen -
   a. Shall not be less than six mg/l unless background conditions are lower;
   b. natural seasonal and daily variations above this level shall be maintained; levels shall not be lowered below 75% of saturation due to a discharge; and
   c. site-specific criteria may apply where back-ground levels are lower than specified levels or to the hypolimnion of stratified lakes where the Department determines that designated uses are not impaired.

2. Temperature -
   a. Shall not exceed 68˚F (20˚C) in cold water fisheries, nor 83˚F (28.3˚C) in warm water fisheries, and the rise in temperature due to a discharge shall not exceed 1.5˚F (0.8˚C); and
   b. natural seasonal and daily variations shall be maintained. There shall be no changes from background conditions that would impair any use assigned to this Class, including site-specific limits necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms.

5. Solids - These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.

(b) Class B - These waters are designated as a habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation. Where designated they shall be suitable as a source of public water supply with appropriate treatment. They shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.

1. Dissolved Oxygen
   a. Shall not be less than 6.0 mg/l in cold water fisheries nor less than 5.0 mg/l in warm water fisheries unless background conditions are lower;
   b. natural seasonal and daily variations above these levels shall be maintained; levels shall not be lowered below 75% of saturation in cold water fisheries nor 60% of saturation in warm water fisheries due to a discharge; and
   c. site-specific criteria may apply where background levels are lower than specified levels, to the hypolimnion of stratified lakes or where the Department determines that designated uses are not impaired.

2. Temperature -
   a. Shall not exceed 68˚F (20˚C) in cold water fisheries nor 83˚F (28.3˚C) in warm water fisheries, and the rise in temperature due to a discharge shall not exceed 3˚F (1.7˚C) in rivers and streams designated as cold water fisheries nor 5˚F (2.8˚C) in rivers and streams designated as warm water fisheries (based on the minimum expected flow for the month); in lakes and ponds the rise shall not exceed 3˚F (1.7˚C) in the epilimnion (based on the monthly average of maximum daily temperature); and
   b. natural seasonal and daily variations shall be maintained. There shall be no changes from

background conditions that would impair any use assigned to this Class, including site-specific limits necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms.

5. Solids - These waters shall be free from floating, suspended and settleable solids in concentrations and combinations that would impair any use assigned to this Class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.

(c) Class C - These waters are designated as a habitat for fish, other aquatic life and wildlife, and for secondary contact recreation. These waters shall be suitable for the irrigation of crops used for consumption after cooking and for compatible industrial cooling and process uses. These waters shall have good aesthetic value.

1. Dissolved Oxygen -
   a. Shall not be less than 5.0 mg/l at least 16 hours of any 24-hour period and not less than 3.0 mg/l at any time unless background conditions are lower;
   b. natural seasonal and daily variations above these levels shall be maintained; levels shall not be lowered below 50% of saturation due to a discharge; and (c) site-specific criteria may apply where background levels are lower than specified levels, or to the hypolimnion of stratified lakes where the Department determines that designated uses are not impaired.
2. Temperature -
   a. Shall not exceed 85˚F (29.4˚C) nor shall the rise due to a discharge exceed 5F (2.8˚C); and
   b. Natural seasonal and daily variations shall be maintained. There shall be no changes from background conditions that would impair any use assigned to this Class, including the site-specific limits necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms.
5. Solids - These waters shall be free from floating, suspended and settleable solids in concentrations and combinations that would impair any use assigned to this Class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.

Michigan*

*This language has not been reviewed for accuracy by state/tribal agency.

SOURCE: Department of Environmental Quality Environmental Response Division General Rules, Part 4. Water Quality Standards: http://www.deq.state.mi.us/documents/deq-swq-gleas-305b2002Appl.doc

R 323.1043 Definitions; A to L

Rule 43

(b) "Acceptable wildlife endpoints" means subchronic and chronic endpoints that affect reproductive or developmental success, organismal viability, or growth or any other endpoint that is, or is directly related to, a parameter that influences population dynamics.

(d) "Adverse effect" means any deleterious effect to organisms due to exposure to a substance. The term includes effects that are or may become debilitating, harmful, or toxic to the normal functions of the organism. The term does not include nonharmful effects such as tissue discoloration alone or the induction of enzymes involved in the metabolism of the substance.

(f) "Anadromous salmonids" means trout and salmon that ascend streams to spawn.

(r) "Coldwater fishery" means waterbodies that contain fish species which thrive in relatively cold water, including any of the following:
   (i) Trout.
   (ii) Salmon.
   (iii) Whitefish.
   (iv) Cisco.

(x) "Designated use" means a use of the surface waters of the state as established by these rules, including use for any of the following:
   (i) Industrial, agricultural, and public water supply.
   (ii) Recreation.

(iii) Warmwater and coldwater fisheries, other aquatic life, and wildlife.
(iv) Navigation.

(hh)"Fisheries, other aquatic life, and wildlife use" means the use of the surface waters of the state by fish, other aquatic life, and wildlife for any life history stage or activity and the protection of fish for human consumption.

R 323.1044 Definitions; M to W.

Rule 44.

(c) "Natural water temperature" means the temperature of a body of water without an influence from an artificial source or a temperature as otherwise determined by the department.

(dd)"Warmwater fishery" means a waterbody that contains fish species which thrive in relatively warm water, including any of the following:
(i) Bass.
(ii) Pike.
(iii) Walleye.
(iv) Panfish.

Minnesota

SOURCE: Minnesota Rules, Chapter 7050, Minnesota Pollution Control Agency Waters of the State, October 11, 2000: http://www.revisor.leg.state.mn.us/arule/7050/

7050.0150 Determination of Water Quality Condition and Compliance,

The intent of the state is to protect and maintain surface waters in a condition which allows for the maintenance of all existing beneficial uses. The condition of a surface water body is determined by its physical, chemical, and biological qualities.

The biological quality of any given surface water body shall be assessed by comparison to the biological integrity of a reference condition or conditions which best represents the most natural condition for that surface water body type within a geographic region. The biological quality shall be determined by reliable measures of indicative communities of fauna and flora.

7050.0200 Water Use Classifications for Waters of the State:

Subpart. 3. Class 2 waters, aquatic life and recreation. Aquatic life and recreation includes all waters of the state which do or may support fish, other aquatic life, bathing, boating, or other recreational purposes, and where quality control is or may be necessary to protect aquatic or terrestrial life or their habitats, or the public health, safety, or welfare.

Subp. 5. Class 4 waters, agriculture and wildlife. Agriculture and wildlife includes all waters of the state which are or may be used for any agriculture 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.

Subp. 8. Class 7 waters, limited resource value waters. Limited resource value waters include surface waters of the state which have been subject to a use attainability analysis and have been found to have limited value as a water resource... 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:

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; or
B. the quality of the resource has been significantly altered by human activity and the effect is essentially irreversible; and
C. there are limited recreational opportunities (such as fishing, swimming, wading, or boating) in and on the water resource...

7050.0222 SPECIFIC STANDARDS OF QUALITY AND PURITY FOR CLASS 2 WATERS OF THE STATE; AQUATIC LIFE AND RECREATION.

Subp. 2. Class 2A waters; aquatic life and recreation. 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. 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...

Subp. 3. Class 2Bd waters. The quality of Class 2Bd 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. 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 are also protected as a source of drinking water...

Subp. 4. Class 2B waters. 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. These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. This class of surface water is not protected as a source of drinking water...

Subp. 5. Class 2C waters. The quality of Class 2C surface waters shall be such as to permit the propagation and maintenance of a healthy community of indigenous fish and associated aquatic life, and their habitats. These waters shall be suitable for boating and other forms of aquatic recreation for which the waters may be usable...

Subp. 6. Class 2D waters. The quality of Class 2D wetlands shall be such as to permit the propagation and maintenance of a healthy community of aquatic and terrestrial species indigenous to wetlands, and their habitats. Wetlands also add to the biological diversity of the landscape. These waters shall be suitable for boating and other forms of aquatic recreation for which the wetland may be usable...

Mississippi

SOURCE: State of Mississippi Water Quality Criteria for Intrastate, Interstate and Coastal Waters, Adopted November 16, 1995: http://www.deq.state.ms.us/newweb/opchome.nsf/pages/SurfaceWaterfiles/$file/wqc.pdf

SECTION III. SPECIFIC WATER QUALITY CRITERIA

4. FISH AND WILDLIFE:

Waters in this classification are intended for fishing and for propagation of fish, aquatic life, and wildlife. Waters that meet the Fish and Wildlife Criteria shall also be suitable for secondary contact recreation. Secondary contact recreation is defined as incidental contact with the water, including wading and occasional swimming.

5. EPHEMERAL STREAM:

Waters in this classification do not support a fisheries resource and are not usable for human consumption or aquatic life. Ephemeral streams normally are natural watercourses, including natural watercourses that have been modified by channelization or manmade drainage ditches, that without the influent of point source discharges flow only in direct response to precipitation or irrigation return-water discharge in the immediate vicinity and whose channels are normally above the groundwater table. These streams may contain a transient population of aquatic life during the portion of the year when there is suitable habitat for fish survival. Normally, aquatic habitat in these streams is not adequate to support a reproductive cycle for fish and other aquatic life. Wetlands are excluded from this classification.

Waters in this classification shall be protective of wildlife and humans which may come in contact with the waters. Waters contained in ephemeral streams shall also allow maintenance of the standards applicable to all downstream waters.

Missouri

SOURCE: Missouri Rules of Department of Natural Resources Division 20—Clean Water Commission Chapter 7—Water Quality, August 31, 2000:
http://www.epa.gov/waterscience/standards/wqslibrary/mo/mo_7_wqs.pdf;
http://mosl.sos.state.mo.us/csr/10csr/10c20-7a.pdf and www.dnr.state.mo.us/water

10 CSR 20-7.031 Water Quality Standards:

(1) Definitions.

(C) Beneficial water uses...

2. Livestock and wildlife watering—Maintenance of conditions to support health in livestock and wildlife.
3. Cold-water fishery—Waters in which naturally occurring water quality and habitat conditions allow the maintenance of a naturally reproducing or stocked trout fishery and other naturally reproducing populations of recreationally important fish species.
4. Cool-water fishery—Waters in which naturally occurring water quality and habitat conditions allow the maintenance of a sensitive, high-quality sport fishery (including smallmouth bass and rock bass) and other naturally reproducing populations of recreationally important fish species.
5. Protection of aquatic life (General warm-water fishery)—Waters in which naturally occurring water quality and habitat conditions allow the maintenance of a wide variety of warm-water biota, including naturally reproducing populations of recreationally important fish species...
6. Protection of aquatic life (Limited warm-water fishery)—Waters in which natural water quality and/or habitat conditions prevent the maintenance of naturally reproducing populations of recreationally important fish species.
13. Habitat for resident and migratory wildlife species, including rare and endangered species—Waters that provide essential breeding, nesting, feeding and predator escape habitats for wildlife including water-fowl, birds, mammals, fish, amphibians and reptiles.

(D) Biocriteria—Numeric values or narrative expressions that describe the reference biological integrity of aquatic communities inhabiting waters that have been designated for aquatic-life protection.

(G) Ecoregion—A major region within the logical, hydrological, chemical and biological characteristics.

(O) Outstanding national resource waters—Waters which have outstanding national recreational and ecological significance.

(R) Reference stream reaches—Stream reaches determined by the department to be the best available representatives of ecoregion waters in a natural condition, with respect to habitat, water quality, biological integrity and diversity, watershed land use and riparian conditions.

(4) Specific Criteria

(Q) Biocriteria. The biological integrity of waters, as measured by lists or numeric diversity indices of benthic invertebrates, fish, algae or other appropriate biological indicators, shall not be significantly different from reference waters. Waters shall be compared with reference waters of similar size within an ecoregion.

Montana

SOURCE: Administrative Rules of Montana, Rule 17, Chapter 30, Water Quality, Subchapter 6, Surface Water Quality Standards and Procedures, June 30, 1996:
http://www.deq.state.mt.us/dir/Legal/Chapters/CH30-06.pdf and www.deq.state.mt.us

17.30.601 POLICY

(1) The following standards are adopted to conserve water by protecting, maintaining, and improving the quality and potability of water for public water supplies, wildlife, fish and aquatic life, agriculture, industry,

recreation, and other beneficial uses.

17.30.602 DEFINITIONS

(10)"Ephemeral stream" means a stream or part of a stream which flows only in direct response to precipitation in the immediate watershed or in response to the melting of a cover of snow and ice and whose channel bottom is always above the local water table.

(13)"Intermittent stream" means a stream or reach of a stream that is below the local water table for at least some part of the year, and obtains its flow from both surface runoff and groundwater discharge.

(17)"Naturally occurring" means conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil and water conservation practices have been applied. Conditions resulting from the reasonable operation of dams in existence as of July 1, 1971 are natural.

17.30.621 A-CLOSED CLASSIFICATION STANDARDS

(1) Waters classified A-Closed are suitable for drinking, culinary, and food processing purposes after simple disinfection. Water quality is suitable for swimming, recreation, growth, and propagation of fishes and associated aquatic life...

(3) No person may violate the following specific water quality standards for waters classified A-Closed:

(f) No increases are allowed above naturally occurring concentrations of sediment, settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.

17.30.622-17.30.627 CLASSIFICATION STANDARDS

A-1, B-1, B-2, B-3, C-1, and C-2 classification standards state that water quality must be suitable for...growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers....[and other uses as assigned for each class]. [The following condition applies to these classifications:]

(3) No person may violate the following specific water quality standards for waters classified A-1:

(f) No increases are allowed above naturally occurring concentrations of sediment, settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.

17.30.628 I CLASSIFICATION STANDARDS

(1) The goal of the state of Montana is to have these waters fully support the following uses: drinking, culinary, and food processing purposes after conventional treatment; bathing, swimming, and recreation; growth and propagation of fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply...

17.30.629 C-3 CLASSIFICATION STANDARDS

(1) Waters classified C-3 are suitable for bathing, swimming and recreation, growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers...

Nebraska

SOURCE: Title 117 - Nebraska Surface Water Quality Standards, Nebraska Department of Environmental Quality, Chapter 4: Standards for Water Quality, August 22, 2000: http://www.deq.state.ne.us/

001 It is the public policy of the State of Nebraska to protect and improve the quality of surface water for human consumption, wildlife, fish and other aquatic life, industry, recreation, and other productive, beneficial uses.

The beneficial uses defined by these standards are:

Aquatic Life

Coldwater (Class A and B)

Warmwater (Class A and B)

003.01G Biological Criteria. Any human activity causing water pollution which would significantly degrade the biological integrity of a body of water or significantly impact or displace an identified "key species" shall not be allowed except as specified in Chapter 2.

003.01G1 Key Species. Key species are identified endangered, threatened, sensitive, or recreationally-important aquatic species. Key species are designated by stream segment (Chapter 5). The following list defines the aquatic species considered by the Department to be key species.

COMMON NAME	**SCIENTIFIC NAME**
<u>Endangered Species:</u>	
Pallid sturgeon	*Scaphirhynchus albus*
Topeka shiner	*Notropis topeka*
<u>Threatened Species:</u>	
Lake sturgeon	*Acipenser fulvescens*
Northern redbelly dace	*Phoxinus eos*
Pearl dace	*Semotilus margarita*
Finescale dace	*Phoxinus neogaeus*
Blacknose shiner	*Notropis heterolepis*
<u>Sensitive Species:</u>	
Lake chub	*Couesius plumbeus*
Brook stickleback	*Culea inconstans*
Iowa darter	*Etheostoma exile*
Johnny darter	*Etheostoma nigrum*
Orangethroat darter	*Etheostoma spectabile*
Blacknose dace	*Rhinichthys atratulus*
Grass pickerel	*Esox americanus*
Pumpkinseed	*Lepomis gibbosus*
Golden shiner	*Notemigonus crysoleucas*
Common shiner	*Notropis cornutus*

COMMON NAME	SCIENTIFIC NAME
Recreationally-Important Species:	
Shovelnose sturgeon	*Scaphirhynchus platorynchus*
Paddlefish	*Polyodon spathula*
Brook trout	*Salvelinus fontinalis*
Brown trout	*Salmo trutta*
Rainbow trout	*Oncorhynchus mykiss*
Northern pike	*Esox lucius*
Muskellunge	*Esox masquinongy*
Blue catfish	*Ictalurus furcatus*
Channel catfish	*Ictalurus punctatus*
Flathead catfish	*Pylodictis olivaris*
Striped bass	*Morone saxatilis*
White bass	*Morone chrysops*
Rock bass	*Ambloplites rupestris*
Largemouth bass	*Micropterus salmoides*
Smallmouth bass	*Micropterus dolomieui*
Spotted bass	*Micropterus punctulatus*
Redear sunfish	*Lepomis microlophus*
Bluegill	*Lepomis macrochirus*
Black crappie	*Pomoxis nigromaculatus*
White crappie	*Pomoxis annularis*
Yellow perch	*Perca flavescens*
Sauger	*Stizostedion canadense*
Walleye	*Stizostedion vitreum vitreum*

[1] Endangered, threatened, and recreationally-important aquatic species are not included.

003.02 Site-Specific Criteria for Aquatic Life.

003.02A1 The following are acceptable conditions for developing site-specific criteria.

003.02A1a Resident species of a water body are more or less sensitive than those species used to develop a water quality criterion.

003.02A1a(1) Natural adaptive processes have enabled a viable, balanced aquatic community to exist in waters where natural background levels of a chemical exceed the criterion (e.g., resident species have evolved a genetically-based greater resistance to high concentrations of a chemical).

003.02A1a(2) The composition of aquatic species in a water body is different from those used in deriving a criterion (e.g., most of the species considered among the most sensitive, such as salmonids or the cladoceran, Daphnia magna, which were used in developing a criterion, are absent from a water body).

003.02A3 Site-specific criteria shall protect all life stages of resident species year-round (or seasonally for seasonally dependent criteria) and prevent acute and chronic toxicity in all parts of a water body...

Nevada

SOURCE: Nevada Administrative Code, Chapter 445A, Standards for Water Quality, September 2000: http://www.ndep.state.nv.us/nac/445a119.pdf

NAC 445A.119 Criteria for water quality for designated beneficial uses. The water quality criteria for designated beneficial uses for the various waters of the state are in the following table.

[NOTE: In this section of NV's standards, the table titled *Water Quality Criteria for Designated Beneficial Uses* includes Aquatic Life with the following levels: Warmwater: propagation and put and take and Coldwater:

propagation and put and take.]

NAC 445A.122 Standards applicable to beneficial uses.

1. The following standards are intended to protect both existing and designated beneficial uses and must not be used to prohibit the use of the water as authorized under Title 48 of NRS:
   (c) Aquatic life. The water must be suitable as a habitat for fish and other aquatic life existing in a body of water. This does not preclude the reestablishment of other fish or aquatic life.
   (h) Propagation of wildlife. The water must be suitable for the propagation of wildlife and waterfowl without treatment.
   (i) Waters of extraordinary ecological or aesthetic value. The unique ecological or aesthetic value of the water must be maintained.

NAC 445A.124 Class A waters: Description; beneficial uses; quality standards.

1. Class A waters include waters or portions of waters located in areas of little human habitation, no industrial development or intensive agriculture and where the watershed is relatively undisturbed by man's activity.
2. The beneficial uses of class A waters are... aquatic life, propagation of wildlife, irrigation, watering of livestock, recreation including contact with the water and recreation not involving contact with the water.

NAC 445A.125 Class B waters: Description; beneficial uses; quality standards.

1. Class B waters include waters or portions of waters which are located in areas of light or moderate human habitation, little industrial development, light-to-moderate agricultural development and where the watershed is only moderately influenced by man's activity.
2. The beneficial uses of class B water are ...aquatic life and propagation of wildlife, recreation involving contact with the water...

NAC 445A.126 Class C waters: Description; beneficial uses; quality standards.

1. Class C waters include waters or portions of waters which are located in areas of moderate-to-urban human habitation, where industrial development is present in moderate amounts, agricultural practices are intensive and where the watershed is considerably altered by man's activity.
2. The beneficial uses of class C water are ... aquatic life, propagation of wildlife...

NAC 445A.127 Class D waters: Description; beneficial uses; quality standards.

1. Class D waters include waters or portions of waters located in areas of urban development, highly industrialized or intensively used for agriculture or a combination of all the above and where effluent sources include a multiplicity of waste discharges from the highly altered watershed.
2. The beneficial uses of class D waters are ... aquatic life, propagation of wildlife...

New Hampshire

SOURCE: New Hampshire Code of Administrative Rules Chapter Env-Ws 1700 Surface Water Quality Regulations, December 10, 1999: http://www.des.state.nh.us/wmb/Env-Ws1700.pdf

PART Env-Ws 1702 DEFINITIONS

Env-Ws 1702.04 "Benthic community" mean the community of plants and animals that live on, over, or in the substrate of the surface water.

Env-Ws 1702.07 "Biological integrity" means the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

Env-Ws 1702.08 "Biota" means species of plants or animals occurring in surface waters.

PART Env-Ws 1703 WATER QUALITY STANDARDS

Env-Ws 1703.01 Water Use Classifications.

(b) All surface waters shall be restored to meet the water quality criteria for their designated classification

including existing and designated uses, and to maintain the chemical, physical, and biological integrity of surface waters.

(c) All surface waters shall provide, wherever attainable, for the protection and propagation of fish, shellfish and wildlife, and for recreation in and on the surface waters.

Env-Ws 1703.19 Biological and Aquatic Community Integrity.

(a) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(b) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

PART Env-Ws 1707 MIXING ZONES

Env-Ws 1707.02 Minimum Criteria. Mixing zones shall be subject to site specific criteria that, as a minimum:

(b) Do not interfere with biological communities or populations of indigenous species;

(f) Do not impinge upon spawning grounds and/or nursery areas of any indigenous aquatic species;

(g) Do not result in the mortality of any plants, animals, humans, or aquatic life within the mixing zone.

New Jersey

SOURCE: New Jersey Administrative Code 7:9-B (Chapter 9B. Surface Water Quality Standards), as amended May 18, 1998: http://www.state.nj.us/dep/watershedmgt/swqs/98swqs_web.pdf

7:9B-1.4 Definitions

"Anadromous fish" means fish that spend most of their life in saline waters and migrate to fresh waters to spawn.

"Aquatic substrata" means soil material and associated biota underlying the water.

"Biota" means the animal and plant life of an ecosystem; flora and fauna collectively.

"Diadromous fish" means fish that spend most of their life in one type of water, either fresh or saline, and migrate to the other type to spawn.

"FW1" means those fresh waters, as designated in N.J.A.C. 7:9B-1.15(h) Table 6, that are to be maintained in their natural state of quality (set aside for posterity) and not subjected to any man-made wastewater discharges or increases in runoff from anthropogenic activities. These waters are set aside for posterity because of their clarity, color, scenic setting, other characteristic of aesthetic value, unique ecological significance, exceptional recreational significance, exceptional water supply significance, or exceptional fisheries resource(s).

"FW2" means the general surface water classification applied to those fresh waters that are not designated as FW1 or Pinelands Waters.

"Important species" means species that are commercially valuable (for example, within the top 10 species landed, by dollar value); recreationally valuable; threatened or endangered; critical to the organization and/or maintenance of the ecosystem; or other species necessary in the food web for the well-being of the species identified in this definition.

"Measurable changes" means changes measured or determined by a biological, chemical, physical, or analytical method, conducted in accordance with USEPA approved methods as identified in 40 C.F.R. 136 or other analytical methods (for example, mathematical models, ecological indices) approved by the Department, that might adversely impact a water use (including, but not limited to, aesthetics).

"Natural water quality" means the water quality that would exist in a waterway or a waterbody without the

addition of water or waterborne substances from artificial origin.

"Outstanding National Resource Waters" means high quality waters that constitute an outstanding national resource (for example, waters of National/State Parks and Wildlife Refuges and waters of exceptional recreational or ecological significance) as designated in N.J.A.C. 7:9B-1.15(i).

"SC" means the general surface water classification applied to coastal saline waters.

"SE" means the general surface water classification applied to saline waters of estuaries.

"Trout maintenance waters" means waters designated at N.J.A.C. 7:9B-1.15(b) through (g) for the support of trout throughout the year.

"Trout production waters" means waters designated at N.J.A.C. 7:9B-1.15(b) through (g) for use by trout for spawning or nursery purposes during their first summer.

7:9B-1.5 Statements of policy

(a) General policies are as follows:
   2. Water is vital to life and comprises an invaluable natural resource which is not to be abused by any segment of the State's population or economy. It is the policy of the State to restore, maintain and enhance the chemical, physical and biological integrity of its waters, to protect the public health, to safeguard the aquatic biota, protect scenic and ecological values, and to enhance the domestic, municipal, recreational, industrial, agricultural and other reasonable uses of the State's waters.
   3. Toxic substances in waters of the State shall not be at levels that are toxic to humans or the aquatic biota, or that bioaccumulate in the aquatic biota so as to render them unfit for human consumption.

(f) Bioassay and biomonitoring policies are as follows:
   1. Bioassay test species selection criteria follow:
      i. The objective of the Department is to use test species for toxicity testing bioassays that are representative of the more sensitive aquatic biota from the different trophic levels of the waters in question.
      ii. Test species need not be indigenous to, nor occur in the waters in question.
      iii. When the bioassay test protocol being utilized falls under the scope of N.J.A.C. 7:18 the Department shall designate the approved representative species considered to be the most sensitive to the discharge.

   2. Acute definitive bioassay tests, in accordance with N.J.A.C. 7:18, will normally be utilized in determining the toxicity of a discharge to the aquatic biota.
   3. The Department, in order to further characterize the toxicity of a discharge, may allow or require the use of other procedures including, but not limited to:
      iii. Measures of the structure and function of the aquatic community in the receiving waters.

7:9B-1.12 Designated uses of FW1, PL, FW2, SE1, SE2, SE3, and SC waters

(a) In all FW1 waters the designated uses are:
   1. Set aside for posterity to represent the natural aquatic environment and its associated biota;
   3. Maintenance, migration and propagation of the natural and established aquatic biota...

(b) In all PL waters the designated uses are:
   2. Maintenance, migration and propagation of the natural and established biota indigenous to this unique ecological system;...

(c) In all FW2 waters the designated uses are:
   1. Maintenance, migration and propagation of the natural and established biota...

(d) In all SE1 waters the designated uses are:
   2. Maintenance, migration and propagation of the natural and established biota....

(e) In all SE2 waters the designated uses are:

1. Maintenance, migration and propagation of the natural and established biota;
2. Migration of diadromous fish;
3. Maintenance of wildlife;...

(f) In all SE3 waters the designated uses are:
2. Maintenance and migration of fish populations;
3. Migration of diadromous fish;
4. Maintenance of wildlife;...

(g) In all SC waters the designated uses are:
1. Maintenance, migration and propagation of the natural and established biota;...

New Mexico

SOURCE: State of New Mexico Standards For Interstate And Intrastate Surface Waters, Title 20 Environmental Protection, Chapter 6 Water Quality, Standards For Interstate And Intrastate Surface Waters (20.6.4.12 New Mexico Administrative Code), New Mexico Water Quality Control Commission, December 16, 2001: http://www.nmenv.state.nm.us/NMED_regs/swqb/20_6_4_nmac.html#12 and http://www.nmenv.state.nm.us

20.6.4.7 DEFINITIONS:

I. "Coldwater fishery" means a surface water of the State where the water temperature and other characteristics are suitable for the support or propagation or both of coldwater fishes.

U. "High quality coldwater fishery" means a perennial surface water of the State in a minimally disturbed condition which has considerable aesthetic value and is a superior coldwater fishery habitat. A surface water of the State to be so categorized must have water quality, stream bed characteristics, and other attributes of habitat sufficient to protect and maintain a propagating coldwater fishery.

BB. "Limited warmwater fishery" means a surface water of the State where intermittent flow may severely limit the ability of the reach to sustain a natural fish population on a continuous annual basis; or a surface water of the State where historical data indicate that water temperature may routinely exceed 32.2˚C (90˚F).

DD. "Marginal coldwater fishery" means a surface water of the State known to support a coldwater fish population during at least some portion of the year, even though historical data indicate that the maximum temperature in the surface water of the State may exceed 20˚C (68˚F).

XX. "Warmwater fishery" means a surface water of the State where the water temperature and other characteristics are suitable for the support or propagation or both of warmwater fishes.

CCC. "Wetlands" means those areas which are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soft conditions in New Mexico. Constructed wetlands used for wastewater treatment purposes are not included in this definition.

DDD. "Wildlife habitat" means a surface water of the State used by plants and animals not considered as pathogens, vectors for pathogens or intermediate hosts for pathogens for humans or domesticated livestock and plants.

20.6.4.12. GENERAL STANDARDS.

A. Bottom Deposits: Surface waters of the State shall be free of water contaminants from other than natural causes that will settle and damage or impair the normal growth, function, or reproduction of aquatic life or significantly alter the physical or chemical properties of the bottom.

20.6.4.14. USE ATTAINABILITY ANALYSIS.

D. Physical, chemical and biological evaluations of surface waters of the State other than lakes and reservoirs for purposes of use attainability analyses or equivalent studies shall be conducted according to the procedures outlined in the "Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses," ...

E. Physical, chemical and biological evaluations of lakes and reservoirs for purposes of use attainability analyses or equivalent studies shall be conducted according to the procedures outlined in the "Technical Support Manual' Waterbody Surveys and Assessments for Conducting Use Attainability Analyses, Volume III: Lake Systems,"...

F. A use attainability analysis or equivalent study should include any applicable information concerning the following:

5. A physical and biological evaluation of the surface water of the State to be reviewed to identify any factors unrelated to water quality which impair attainment of designated uses and to determine which designated uses are feasible to attain in such surface water of the State given existing physical limitations,

7. An evaluation of the aquatic and terrestrial biota utilizing the surface water of the State to determine resident species and which species could potentially exist in such water if physical and chemical factors impairing a designated use are corrected.

New York

SOURCE: Official Compilation of Codes, Rules, and Regulations of the State of New York, Title 6, Environmental Conservation Rules and Regulations, Chapter X, Division of Water Resources, Part 701, Classifications-Surface Waters and Groundwaters, amended March 1998:
http://www.dec.state.ny.us/website/regs/701.htm

§ 701.2 Class N fresh surface waters.

(a) The best usages of Class N waters are the enjoyment of water in its natural condition and, where compatible, as a source of water for drinking or culinary purposes, bathing, fishing, fish propagation, and recreation.

§ 701.3 Class AA-Special (AA-S) fresh surface waters.

(a) The best usages of Class AA-S waters are: a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival.

§ 701.4 Class A-Special (A-S) fresh surface waters.

(a) The best usages of Class A-S waters are: a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival.

§ 701.5 Class AA fresh surface waters.

(a) The best usages of Class AA waters are: a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival.

§ 701.6 Class A fresh surface waters.

(a) The best usages of Class A waters are: a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival.

§ 701.7 Class B fresh surface waters.

The best usages of Class B waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival.

§ 701.8 Class C fresh surface waters.
The best usage of Class C waters is fishing. These waters shall be suitable for fish propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.

§ 701.9 Class D fresh surface waters.
The best usage of Class D waters is fishing. Due to such natural conditions as intermittency of flow, water conditions not conducive to propagation of game fishery, or stream bed conditions, the waters will not support fish propagation. These waters shall be suitable for fish survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.

North Carolina

SOURCE: North Carolina Administrative Code, Title 15A Environment and Natural Resources, Subchapter 2B Surface Water Standards: Monitoring, January 1, 2002:
http://h2o.enr.state.nc.us/admin/rules/rb010102.pdf and www.esb.enr.state.nc.us

15A NCAC 02B .0101 General Procedures
(e) The following are supplemental classifications:
(1) Trout waters (Tr): freshwaters protected for natural trout propagation and survival of stocked trout.
(2) Swamp waters (Sw): waters which have low velocities and other natural characteristics which are different from adjacent streams.
(4) Outstanding Resource Waters (ORW): unique and special waters of exceptional state or national recreational or ecological significance which require special protection to maintain existing uses.
(5) High Quality Waters (HQW): waters which are rated as excellent based on biological and physical/chemical characteristics through Division monitoring or special studies, native and special native trout waters (and their tributaries) designated by the Wildlife Resources Commission, primary nursery areas (PNA) designated by the Marine Fisheries Commission and other functional nursery areas designated by the Marine Fisheries Commission, all water supply watersheds which are either classified as WS-I or WS-II or those for which a formal petition for reclassification as WS-I or WS-II has been received from the appropriate local government and accepted by the Division of Water Quality and all Class SA waters.
(7) Unique wetland (UWL): wetlands of exceptional state or national ecological significance which require special protection to maintain existing uses. These wetlands may include wetlands that have been documented to the satisfaction of the Commission as habitat essential for the conservation of state or federally listed threatened or endangered species.

15A NCAC 02B.0202 Definitions

(11)Biological integrity means the ability of an aquatic ecosystem to support and maintain a balanced and indigenous community of organisms having species composition, diversity, population densities and functional organization similar to that of reference conditions.

15A NCAC 02B .0211 Fresh Surface Water Quality Standards for Class C Waters
(1) Best Usage of Waters. Aquatic life propagation and maintenance of biological integrity (including fishing, and fish), wildlife, secondary recreation, agriculture and any other usage except for primary recreation or as a source of water supply for drinking, culinary or food processing purposes;
(2) Conditions Related to Best Usage. The waters shall be suitable for aquatic life propagation and maintenance of biological integrity, wildlife, secondary recreation, and agriculture; sources of water pollution which preclude any of these uses on either a short-term or long-term basis shall be considered to be violating a water quality standard;

15A NCAC 02B .0212, .0214-.0216, .0218-.0219 Fresh Surface Water Quality Standards for Class WS-I -WS-V and Class B Waters
...Water quality standards applicable to Class C waters as described in Rule .0211 of this Section also apply to Class WS-I waters [and other uses as assigned for each class].

15A NCAC 02B .0220 TIDAL SALT WATER QUALITY STANDARDS FOR CLASS SC WATERS

General. The water quality standards for all tidal salt waters are the basic standards applicable to Class SC waters. Additional and more stringent standards applicable to other specific tidal salt water classifications are specified in Rules .0221 and .0222 of this Section.

(1) Best Usage of Waters. Aquatic life propagation and maintenance of biological integrity (including fishing, fish and functioning PNAs [Primary Nursery Areas]), wildlife, secondary recreation, and any other usage except primary recreation or shellfishing for market purposes.

(2) Conditions Related to Best Usage. The waters shall be suitable for aquatic life propagation and maintenance of biological integrity, wildlife, and secondary recreation; Any source of water pollution which precludes any of these uses, including their functioning as PNAs, on either a short-term or a long-term basis shall be considered to be violating a water quality standard.

15A NCAC 02B .0221 Tidal Salt Water Quality Standards for Class SA Waters

The following water quality standards apply to surface waters that are used for shellfishing for market purposes and are classified SA. Water quality standards applicable to Class SC waters as described in Rule .0220 of this Section also apply to Class SA waters.

(1) Best Usage of Waters. Shellfishing for market purposes and any other usage specified by the "SB" or "SC" classification...

15A NCAC 02B .0222 Tidal Salt Water Quality Standards for Class SB Waters

The following water quality standards apply to surface waters that are used for primary recreation, including frequent or organized swimming, and are classified SB. Water quality standards applicable to Class SC waters [as] described in Rule .0220 of this Section also apply to SB waters...

15A NCAC 02B .0225 Outstanding Resource Waters

(a) General In addition to the existing classifications, the Commission may classify unique and special surface waters of the state as outstanding resource waters (ORW) upon finding that such waters are of exceptional state or national recreational or ecological significance and that the waters have exceptional water quality while meeting the following conditions:
(1) that the water quality is rated as excellent based on physical, chemical or biological information...

(b) Outstanding Resource Values. In order to be classified as ORW, a water body must exhibit one or more of the following values or uses to demonstrate it is of exceptional state or national recreational or ecological significance:
(1) there are outstanding fish (or commercially important aquatic species) habitat and fisheries;
(5) the waters are of special ecological or scientific significance such as habitat for rare or endangered species or as areas for research and education.

North Dakota

SOURCE: Standards of Water Quality for State of North Dakota, Rule 33-16-02, North Dakota State Department of Health and Consolidated Laboratories, June 1, 2001:
http://www.epa.gov/ost/standards/wqslibrary/

33-16-02-08. General water quality standards.

2. **Narrative Biological Goal**

a. Goal. The biological condition of surface waters shall be similar to that of sites or waterbodies determined by the department to be regional reference sites.

b. Definitions:

(1) “Assemblage” means an association of aquatic organisms of similar taxonomic classification living in the same area. Examples of assemblages include, but are not limited to, fish, macroinvertebrates, algae, and vascular plants.

(2) “Aquatic organism”means any plant or animal which lives at least part of its life cycle in water.

(3) “Biological condition” means the taxonomic composition, richness, and functional organization of an assemblage of aquatic organisms at a site or within a water body.

(4) “Functional organization” means the number of species or abundance of organisms within an assemblage which perform the same or similar ecological functions.

(5) "Metric" means an expression of biological community composition, richness, or function which displays a predictable, measurable change in value along a gradient of pollution or other anthropogenic disturbance.
(6) "Regional reference sites" are sites or water bodies which are determined by the department to be representative of sites or water bodies of similar type (e.g., hydrology and ecoregion) and are least impaired with respect to habitat, water quality, watershed land use, and riparian and biological condition.
(7) "Richness" means the absolute number of taxa in an assemblage at a site or within a water body.
(8) "Taxonomic composition" means the identity and abundance of species or taxonomic groupings within an assemblage at a site or within a water body.

c. Implementation. The intent of the state in adopting a narrative biological goal is solely to provide an additional assessment method that can be used to identify impaired surface waters. Regulatory or enforcement actions based solely on a narrative biological goal, such as the development and enforcement of North Dakota pollutant discharge elimination system permit limits, are not authorized. However, adequate and representative biological assessment information may be used in combination with other information to assist in determining whether designated uses are attained and to assist in determining whether new or revised chemical-specific permit limitations may be needed. Implementation will be based on the comparison of current biological conditions at a particular site to the biological conditions deemed attainable based on regional reference sites. In implementing a narrative biological goal, biological condition may be expressed through an index composed of multiple metrics or through appropriate statistical procedures.

33-20-02-09. Surface water classifications, mixing zones, and numeric standards.

1. **Classifications**...

a. Class I streams. The quality of the waters in this class shall be suitable for the propagation and/or protection of resident fish species and other aquatic biota and for swimming, boating, and other water recreation. The quality of the waters shall be for irrigation, stock watering, and wildlife without injurious effects. After treatment consisting of coagulation, settling, filtration, and chlorination, or equivalent treatment processes, the water quality shall meet the bacteriological, physical, and chemical requirements of the department for municipal or domestic use.

b. Class IA streams. The quality of the waters in this class shall be the same as the quality of class I streams, except that treatment for municipal use may also require softening to meet the requirements of the department.

c. Class II streams. The quality of the waters in this class shall be the same as the quality of class I streams, except that additional treatment may be required to meet the drinking water requirements of the department. Streams in this classification may be intermittent in nature which would make these waters of limited value for beneficial uses such as municipal water, fish life, or irrigation.

d. Class III streams. The quality of the waters in this class shall be suitable for agricultural and industrial uses such as stock watering, irrigation, washing, and cooling. These streams have low average flows and, generally, prolonged periods of no flow. They are of limited seasonal value for immersion recreation, fish life, and aquatic biota. The quality of these waters must be maintained to protect recreation, fish, and aquatic biota.

Ohio

SOURCE: Ohio Administrative Code, Chapter 3745-1-07 Water use designations and statewide criteria, February 22, 2002: http://www.epa.state.oh.us/dsw/rules/01-07.pdf

(A) Water quality standards contain two distinct elements: designated uses; and numerical or narrative criteria designed to protect and measure attainment of the uses.
(1) Each water body in the state is assigned one or more aquatic life habitat use designations. Each water body may be assigned one or more water supply use designations and/or one recreational use designation. These use designations are defined in paragraph (B) of this rule. Water bodies are assigned use designations in rules 3745-1-08 to 3745-1-32 of the Administrative Code. In addition, a water body may be assigned designations as described in the antidegradation rule (rule 3745-1-05 of the Administrative Code).

(6) Biological criteria presented in table 7-14 of this rule provide a direct measure of attainment of the warmwater habitat, exceptional warmwater habitat and modified warmwater habitat aquatic life uses. Biological criteria and the exceptions to chemical-specific or whole-effluent criteria allowed by this paragraph do not apply to any other use designations.

(a) Demonstrated attainment of the applicable biological criteria in a water body will take precedence over the application of selected chemical-specific aquatic life or whole-effluent criteria associated with these uses when the director, upon considering appropriately detailed chemical, physical and biological data, finds that one or more chemical-specific or whole-effluent criteria are inappropriate. In such cases the options which exist include:

(i) The director may develop, or a discharger may provide for the director's approval, a justification for a site-specific water quality criterion according to methods described in "Water Quality Standards Handbook, 1983, U.S. EPA Office of Water";

(ii) The director may proceed with establishing water quality based effluent limits consistent with attainment of the designated use.

(b) Demonstrated nonattainment of the applicable biological criteria in a water body with concomitant evidence that the associated chemical-specific aquatic life criteria and whole-effluent criteria are met will cause the director to seek and establish, if possible, the cause of the nonattainment of the designated use. The director shall evaluate the existing designated use and, where not attainable, propose to change the designated use. Where the designated use is attainable and the cause of the nonattainment has been established, the director shall, wherever necessary and appropriate, implement regulatory controls or make other recommendations regarding water resource management to restore the designated use...

(B) Use designations are defined as follows:

(1) Aquatic life habitat

(a) "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 upon 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.

(b) "Limited warmwater" - these are waters that were temporarily designated in the 1978 water quality standards as not meeting specific warmwater habitat criteria. Criteria for the support of this use designation are the same as the criteria for the support of the use designation warmwater habitat. However, individual criteria are varied on a case-by-case basis and supersede the criteria for warmwater habitat where applicable. Any exceptions from warmwater habitat criteria apply only to specific criteria during specified time periods and/or flow conditions. The adjusted criteria and conditions for specified stream segments are denoted as comments in rules 3745-1-08 to 3745-1-30 of the Administrative Code. Stream segments currently designated limited warmwater habitats will undergo use attainability analyses and will be redesignated other aquatic life habitats. No additional stream segments will be designated limited warmwater habitats.

(c) "Exceptional warmwater" - these are waters capable of supporting and maintaining an exceptional or unusual community of warmwater aquatic organisms having a species composition, diversity, and functional organization comparable to the seventy-fifth percentile of the identified reference sites on a statewide basis. 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 lakes and reservoirs, except upground storage reservoirs, are designated exceptional warmwater habitats. Attainment of this use designation (except for lakes and 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.

(d) "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 Chapter 6131. of the Revised Code, extensive sedimentation resulting from abandoned mine land runoff, and extensive permanent impoundment of free-flowing water bodies. 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. Attainment of this use designation is based on the criteria in table 7-14 of this rule. Each water body designated modified warmwater habitat will be listed in the appropriate use designation rule (rules 3745-1-08 to 3745-1-32 of the Administrative Code) and will be identified by ecoregion and type of physical habitat modification as listed in table 7-14 of this rule. The modified warmwater habitat designation can be applied only to those waters that do not attain the warmwater habitat biological criteria in table 7-14 of this rule because of irretrievable modifications of the physical habitat. All water body segments designated modified warmwater habitat will be reviewed on a triennial basis (or sooner) to determine whether the use designation should be changed. 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.

(e) "Seasonal salmonid" - these are rivers, streams and embayments capable of supporting the passage of salmonids from October to May and are water bodies large enough to support recreational fishing. This use will be in effect the months of October to May. Another aquatic life habitat use designation will be enforced the remainder of the year (June to September). 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.

(f) "Coldwater" - these are waters that meet one or both of the characteristics described in paragraphs (B)(1)(f)(i) and (B)(1)(f)(ii) 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.

(i) "Coldwater habitat, inland trout streams" -these are waters which support trout stocking and management under the auspices of the Ohio department of natural resources, division of wildlife, excluding waters in lake run stocking programs, lake or reservoir stocking programs, experimental or trial stocking programs, and put and take programs on waters without, or without the potential restoration of, natural coldwater attributes of temperature and flow. The director shall designate these waters in consultation with the director of the Ohio department of natural resources.

(ii) "Coldwater habitat, native fauna" - these are waters capable of supporting populations of native coldwater fish and associated vertebrate and invertebrate organisms and plants on an annual basis. The director shall designate these waters based upon results of use attainability analyses.

(g) "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 habitat as determined by the biological criteria in table 7-14 of this rule. 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 due to natural background conditions or irretrievable human-induced conditions. All water body segments designated limited resource water will be reviewed on a triennial basis (or

sooner) to determine whether the use designation should be changed. Limited resource waters are also termed nuisance prevention for some water bodies designated in rules 3745-1-08 to 3745-1-30 of the Administrative Code. 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. Waters designated limited resource water will be assigned one or more of the following causative factors. These causative factors will be listed as comments in rules 3745-1-08 to 3745-1-30 of the Administrative Code.

(i) "Acid mine drainage" - these are surface waters with sustained pH values below 4.1 s.u. or with intermittently acidic conditions combined with severe streambed siltation, and have a demonstrated biological performance below that of the modified warmwater habitat biological criteria.

(ii) "Small drainageway maintenance" - these are highly modified surface water drainageways (usually less than three square miles in drainage area) that do not possess the stream morphology and habitat characteristics necessary to support any other aquatic life habitat use. The potential for habitat improvements must be precluded due to regular stream channel maintenance required for drainage purposes.

(iii) Other specified conditions.

(2) Nuisance prevention This use designation is being replaced by the limited resource water use designation described in paragraph (A)(1)(g) of this rule. All water body segments currently designated nuisance prevention in rules 3745-1-08 to 3745-1-30 of the Administrative Code must meet the limited resource water criteria in this rule. All references to the nuisance prevention use designation in rules 3745-1-08 to 3745-1-30 of the Administrative Code will be phased out over time and replaced with limited resource water.

(3) Water supply

(a) "Public" - these are waters that, with conventional treatment, will be suitable for human intake and meet federal regulations for drinking water. Criteria associated with this use designation apply within five hundred yards of surface water intakes. Although not necessarily included in rules 3745-1-08 to 3745-1-30 of the Administrative Code, the bodies of water with one or more of the following characteristics are designated public water supply: (i) All publicly owned lakes and reservoirs, with the exception of Piedmont reservoir;
(ii) All privately owned lakes and reservoirs used as a source of public drinking water; (iii) All surface waters within five hundred yards of an existing public water supply surface water intake; (iv) All surface waters used as emergency water supplies.

(b) "Agricultural" - these are waters suitable for irrigation and livestock watering without treatment.

(c) "Industrial" - these are waters suitable for commercial and industrial uses, with or without treatment. Criteria for the support of the industrial water supply use designation will vary with the type of industry involved.

(4) Recreation. These use designations are in effect only during the recreation season, which is the period from May first to October fifteenth, for all water bodies except those designated seasonal salmonid habitat. The recreation season for streams designated seasonal salmonid habitat is June first to September thirtieth.

(a) "Bathing waters" - these are waters that, during the recreation season are suitable for swimming where a lifeguard and/or bathhouse facilities are present, and include any additional such areas where the water quality is approved by the director. Water bodies assigned the bathing waters use designation are not necessarily indicated in rules 3745-1-08 to 3745-1-30 of the Administrative Code but include local areas of those water bodies meeting this definition.

(b) "Primary contact" - these are waters that, during the recreation season, are suitable for full-body contact recreation such as, but not limited to, swimming, canoeing, and scuba diving with minimal threat to public health as a result of water quality. In addition to those water body segments designated in rules 3745-1-08 to 3745-1-32 of the Administrative Code, all lakes and reservoirs, except upground storage reservoirs and those lakes and reservoirs meeting the definition of bathing waters, are designated primary contact recreation.

(c) "Secondary contact" - these are waters that, during the recreation season, are suitable for partial body contact recreation such as, but not limited to, wading with minimal threat to public health as a result of water quality.

(C) Protection of aquatic life - whole-effluent approach. Whole-effluent toxicity levels shall be applied in accordance with rules 3745-2-09 and 3745-33-07 of the Administrative Code.

Table 7-14

Biological criteria for warmwater, exceptional warmwater and modified warmwater habitats. Description and derivation of indices and ecoregions are contained in "Biological Criteria for the Protection of Aquatic Life: Volume II, Users Manual for Biological Field Assessment of Ohio Surface Waters" cited in paragraph (B) of rule 3745-1-03 of the Administrative Code. These criteria do not apply to the Ohio river, lakes or Lake Erie river mouths

Index	Modified Warmwater Habitat				
Sampling Site Ecoregion[1]	Channel Modif.	Mine Affected	Impounded	Warmwater Habitat	Exceptional Warmwater Habitat
(A) Index of biotic integrity (fish)					
(1) Wading sites*					
HELP	22	–	–	32	50
IP	24	–	–	40	50
EOLP	24	–	–	38	50
WAP	24	24	–	44	50
ECBP	24	–	–	40	50
(2) Boat sites[2]					
HELP	20	–	22	34	48
IP	24	–	30	38	48
EOLP	24	–	30	40	48
WAP	24	24	30	40	48
ECBP	24	–	30	42	48
(3) Headwater sites**					
HELP	20	–	–	28	50
IP	24	–	–	40	50
EOLP	24	–	–	40	50
WAP	24	24	–	44	50
ECBP	24	–	–	40	50

* Sampling methods descriptions are found in the "Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices," cited in paragraph (B) of rule 3745-1-03 of the Administrative Code.

** Modification of the IBI that applies to sites with drainage areas less than twenty square miles.

Index	Modified Warmwater Habitat				
Sampling Site Ecoregion[1]	Channel Modif.	Mine Affected	Impounded	Warmwater Habitat	Exceptional Warmwater Habitat
(B) Modified index of well-being (fish)***					
(1) Wading sites[2]					
HELP	5.6	—	—	7.3	9.4
IP	6.2	—	—	8.1	9.4
EOLP	6.2	—	—	7.9	9.4
WAP	6.2	5.5	—	8.4	9.4
ECBP	6.2	—	—	8.3	9.4
(2) Boat sites[2]					
HELP	5.7	—	5.7	8.6	9.6
IP	5.8	—	6.6	8.7	9.6
EOLP	5.8	—	6.6	8.7	9.6
WAP	5.8	5.4	6.6	8.6	9.6
ECBP	5.8	—	6.6	8.5	9.6
(C) Invertebrate community index (macroinvertebrates)					
(1) Artificial substrate samplers[2]					
HELP	22	–	–	34	46
IP	22	–	–	30	46
EOLP	22	–	–	34	46
WAP	22	30	–	36	46
ECBP	22	–	–	36	46

Oklahoma

SOURCE: Oklahoma Administrative Code, Title 785, Oklahoma Water Resources Board Rules, Chapter 45 Oklahoma Water Quality Standards, August 13, 2001:
http://www.oklaosf.state.ok.us/~owrb/rules/Chap45.pdf,
http://www.oklaosf.state.ok.us/~owrb/rules/Chap46.pdf and www.state.ok.us/~owrb

785:45-1-2. Definitions
"Benthic macroinvertebrates" means invertebrate animals that are large enough to be seen by the unaided eye, can be retained by a U. S. Standard No. 30 sieve, and live at least part of their life cycles within or upon available substrate in a body of water or water transport system.

*** Does not apply to sites with drainage areas less than twenty square miles.

"Intolerant climax fish community" means habitat and water quality adequate to support game fishes or other sensitive species introduced or native to the biotic province or ecological region, which require specific or narrow ranges of high quality environmental conditions.

"Sensitive representative species" means Ceriodaphnia dubia, Daphnia magna, Daphnia pulex, Pimphales promelas (Fathead minnow), Lepomis macrochirus (Bluegill sunfish), or other sensitive organisms indigenous to a particular waterbody.

"Warm Water Aquatic Community" means a subcategory of the beneficial use category "Fish and Wildlife Propagation" where the water quality and habitat are adequate to support intolerant climax fish communities and includes an environment suitable for the full range of warm water benthos.

"Water quality" means physical, chemical, and biological characteristics of water which determine diversity, stability, and productivity of the climax biotic community or affect human health.

785:45-5-12. Fish and wildlife propagation

(b) Habitat Limited Aquatic Community subcategory.
  (1) Habitat limited aquatic community means a subcategory of the beneficial use "Fish and Wildlife Propagation" where the water chemistry and habitat are not adequate to support a "Warm Water Aquatic Community" because:
    (A) Naturally occurring water chemistry prevents the attainment of the use; or
    (B) Naturally occurring 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 a sufficient volume of effluent to enable uses to be met; or
    (C) 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
    (D) Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original condition or to operate such modification in a way that would result in the attainment of the use; or
    (E) Physical conditions related to the natural features of the waterbody, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of the "Warm Water Aquatic Community" beneficial use.
  (2) Habitat Limited Aquatic Community may also be designated where controls more stringent than those required by sections 301(b) and 306 of the federal Clean Water Act as amended, which would be necessary to meet standards or criteria associated with the beneficial use subcategories of Cool Water Aquatic Community or Warm Water Aquatic Community, would result in substantial and widespread economic and social impact.

(c) Warm Water Aquatic Community subcategory. Warm Water Aquatic Community means a subcategory of the beneficial use category "Fish and Wildlife Propagation" where the water quality and habitat are adequate to support climax fish communities.

(d) Cool Water Aquatic Community subcategory. Cool Water Aquatic Community means a subcategory of the beneficial use category "Fish and Wildlife Propagation" where the water quality, water temperature and habitat are adequate to support cool water climax fish communities and includes an environment suitable for the full range of cool water benthos. Typical species may include smallmouth bass, certain darters and stoneflies.

(e) Trout Fishery subcategory. Trout Fishery (Put and Take) means a subcategory of the beneficial use category "Fish and Wildlife Propagation" where the water quality, water temperature and habitat are adequate to support a seasonal put and take trout fishery. Typical species may include trout.

(f) Criteria used in protection of fish and wildlife propagation. The narrative and numerical criteria to maintain and protect the use of "Fish and Wildlife Propagation" and its subcategories shall include...
  (5) Biological Criteria.
    (A) Aquatic life in all waterbodies designated Fish and Wildlife Propagation (excluding waters designated "Trout, put-and-take") shall not exhibit degraded conditions as indicated by one or

both of the following:

(i) comparative regional reference data from a station of reasonably similar watershed size or flow, habitat type and Fish and Wildlife beneficial use subcategory designation or

(ii) by comparison with historical data from the waterbody being evaluated.

(B) Compliance with the requirements of 785:45-5-12(f)(5) shall be based upon measures including, but not limited to, diversity, similarity, community structure, species tolerance, trophic structure, dominant species, indices of biotic integrity (IBI's), indices of well being (IWB's), or other measures.

785:46-15-5. Assessment of Fish and Wildlife Propagation support

(e) **Biological criteria.**

(1) If data demonstrate that an assemblage of fish or macro invertebrates from a waterbody is significantly degraded, according to 785:45-5-12(f)(5), from that expected for thesubcategory of Fish and Wildlife Propagation designated in OAC 785:45 for that waterbody, then that subcategory may be deemed by the appropriate state environmental agency to be not supported.

(2) All physical assessments and biological collections shall be performed in accordance with the requirements set forth in OWRB Technical Report No. 99-3 entitled "Standard Operating Procedures for Stream Assessments and Biological Collections Related to Biological Criteria in Oklahoma".

(3) Evaluation of the biological collections shall include identification of fish samples to species level.

(4) The determination of whether the use of Fish and Wildlife Propagation is supported in wadeable streams in Oklahoma ecoregions shall be made according to all of the requirements of this subsection (e), the application of Appendix C of this Chapter, and the special provisions in subsections (g) through (i), where applicable, of this Section. Streams with undetermined use support status shall be subject to additional investigation that considers stream order, habitat factors and local reference streams before the use support determination is made.

(f) **Turbidity.** The criteria for turbidity stated in 785:45-5-12(f)(7) shall constitute the screening levels for turbidity. The tests for use support shall follow the default protocol in 785:46-15-4(b).

(g) **Special provisions for Ouachita Mountains wadeable streams**. The determination of whether the use of Fish and Wildlife Propagation is supported for wadeable streams located in the Ouachita Mountains ecoregion shall be made according to the application of Appendix C of this Chapter, together with this subsection, as follows:

(1) Where designated, the subcategory of Warm Water Aquatic Community shall be deemed fully supported if the application of Appendix C produces a score of 35 or more. Such subcategory shall be deemed not supported if the application of Appendix C produces a score of 24 or less. If a score is 25 to 34 inclusive, the issue of whether this subcategory is supported shall be deemed undetermined.

(2)Where designated, the subcategory of Habitat Limited Aquatic Community shall be deemed fully supported if the application of Appendix C produces a score of 27 or more. Such subcategory shall be deemed not supported if the application of Appendix C produces a score of 18 or less. If a score is 19 to 26 inclusive, the issue of whether this subcategory is supported shall be deemed undetermined.

(h) **Special provisions for Arkansas Valley wadeable streams.** The determination of whether the use of Fish and Wildlife Propagation is supported for wadeable streams located in the Arkansas Valley ecoregion shall be made according to the application of Appendix C of this Chapter, together with this subsection, as follows:

(1) Where designated, the subcategory of Warm Water Aquatic Community shall be deemed fully supported if the application of Appendix C produces a score of 35 or more. Such subcategory shall be deemed not supported if the application of Appendix C produces a score of 24 or less. If a score is 25 to 34 inclusive, the issue of whether this subcategory is supported shall be deemed undetermined.

(2) Where designated, the subcategory of Habitat Limited Aquatic Community shall be deemed fully supported if the application of Appendix C produces a score of 27 or more. Such subcategory shall be deemed not supported if the application of Appendix C produces a score of 18 or less. If a score is 19 to 26 inclusive, the issue of whether this subcategory is supported shall be deemed undetermined.

(i) **Special provisions for Boston Mountains and Ozark Highlands wadeable streams.** The determination of whether the use of Fish and Wildlife Propagation is supported for wadeable streams located in the Boston Mountains and Ozark Highlands ecoregions shall be made according to the

application of Appendix C of this Chapter, together with this subsection, as follows:
(1) Where designated, the subcategory of Cool Water Aquatic Community shall be deemed fully supported if the application of Appendix C produces a score of 37 or more. Such subcategory shall be deemed not supported if the application of Appendix C produces a score of 29 or less. If a score is 30 to 36 inclusive, the issue of whether this subcategory is supported shall be deemed undetermined.
(2) Where designated, the subcategory of Warm Water Aquatic Community shall be deemed fully supported if the application of Appendix C produces a score of 31 or more. Such subcategory shall be deemed not supported if the application of Appendix C produces a score of 22 or less. If a score is 23 to 30 inclusive, the issue of whether this subcategory is supported shall be deemed undetermined.

(j) **Special provisions for Central Irregular Plains wadeable streams.** The determination of whether the use of Fish and Wildlife Propagation is supported for wadeable streams located in the Central Irregular Plains ecoregion shall be made according to the application of Appendix C of this Chapter, together with this subsection, as follows:
(1) Where designated, the subcategory of Cool Water Aquatic Community shall be deemed fully supported if the application of Appendix C produces a score of 35 or more. Such subcategory shall be deemed not supported if the application of Appendix C produces a score of 28 or less. If a score is 29 to 34 inclusive, the issue of whether this subcategory is supported shall be deemed undetermined.
(2) Where designated, the subcategory of Warm Water Aquatic Community shall be deemed fully supported if the application of Appendix C produces a score of 30 or more. Such subcategory shall be deemed not supported if the application of Appendix C produces a score of 22 or less. If a score is 23 to 29 inclusive, the issue of whether this subcategory is supported shall be deemed undetermined.
3) Where designated, the subcategory of Habitat Limited Aquatic Community shall be deemed fully supported if the application of Appendix C produces a score of 25 or more. Such subcategory shall be deemed not supported if the application of Appendix C produces a score of 16 or less. If a score is 17 to 24 inclusive, the issue of whether this subcategory is supported shall be deemed undetermined.

SOURCE: Added at 17 Ok Reg 1775, effective 7/1/2000; Amended at 18 Ok Reg 3379, effective 8/13/2001; Amended at 19 Ok Reg 2524-2526, eff 7/1/2002

APPENDIX C. INDEX OF BIOLOGICAL INTEGRITY

		5	3	1	SCORE
Sample Composition	Total no. of species	See figure 1*	2.49 -1.50	<1.50	
	Shannon diversity** based upon numbers	>2.50	2 - 3	<2	
	No. of sunfish species	>3	4 - 3	<3	
	No. of species comprising 75% of sample	>5	3 - 5	<3	
	No. of intolerant species <100mi2 area >100mi2 area	>5			
	Percentage of tolerant species	See figure 3*			
Fish Condition	Percentage of lithophils	>36	18 - 36	<18	
	Percentage of DELT anomalies***	<0.1	0.1 -1.3	>1.3	
	Fish numbers (total individuals)	>200	200 - 75	<75	

**Figure 2. Number of Intolerant Species* and *Figure 3. Percent Tolerant Species*, (Unofficial) Oklahoma

Administrative Code, Title 785, Oklahoma Water Resources Board Rules, Chapter 46. Implementation of Oklahoma Water Quality Standards, p. 47, 48.

**$d = -\sum \frac{n_i}{N} In \frac{n_i}{N}$

***DELT = deformities, eroded fins, lesions, tumors

Oregon

SOURCE: Oregon Administrative Rules: Chapter 340 Department of Environmental Quality, Water Pollution, Division 41 State-Wide Water Quality Management Plan; Beneficial Uses, Policies, Standards, and Treatment Criteria for Oregon, amended February 15, 2001:
http://arcweb.sos.state.or.us/rules/OARS_300/OAR_340/340_041.html and
http://www.deq.state.or.us/lab/biomon/bio-rpt.htm

340-04I-0006 Definitions

(32) "Aquatic Species" means any plants or animals which live at least part of their life cycle in waters of the State.

(33) "Biological Criteria" means numerical values or narrative expressions that describe the biological integrity of aquatic communities inhabiting waters of a given designated aquatic life use.

(35) "Indigenous" means supported in a reach of water or known to have been supported according to historical records compiled by State and Federal agencies or published scientific literature.

(36) "Resident Biological Community" means aquatic life expected to exist in a particular habitat when water quality standards for a specific ecoregion, basin, or water body are met. This shall be established by accepted biomonitoring techniques.

(37) "Without Detrimental Changes in the Resident Biological Community" means no loss of ecological integrity when compared to natural conditions at an appropriate reference site or region.

(38) "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 the natural habitat of the region.

(39) "Appropriate Reference Site or Region" means a site on the same water body, or within the same basin or ecoregion that has similar habitat conditions, and represents the water quality and biological community attainable within the areas of concern.

(40) "Critical Habitat" means those areas which support rare, threatened or endangered species, or serve as sensitive spawning and rearing areas for aquatic life.

(41) "High Quality Waters" means those waters which meet or exceed those levels that are necessary to support the propagation of fish, shellfish, and wildlife and recreation in and on the water, and other designated beneficial uses.

(42) "Outstanding Resource Waters" means those waters designated by the Environmental Quality Commission where existing high quality waters constitute an outstanding state or national resource based on their extraordinary water quality or ecological values, or where special water quality protection is needed to maintain critical habitat areas.

(51) "Cold-Water Aquatic Life" -- The aquatic communities that are physiologically restricted to cold water,

composed of one or more species sensitive to reduced oxygen levels. Including but not limited to Salmonidae and cold-water invertebrates.

(52) "Cool-Water Aquatic Life" -- The aquatic communities that are physiologically restricted to cool waters, composed of one or more species having dissolved oxygen requirements believed similar to the cold-water communities. Including but not limited to Cottidae, Osmeridae, Acipenseridae, and sensitive Centrarchidae such as the small-mouth bass.

(53) "Warm-Water Aquatic Life" -- The aquatic communities that are adapted to warm-water conditions and do not contain either cold- or cool-water species.

(57) "Ecologically Significant Cold-Water Refuge" exists when all or a portion of a waterbody supports stenotypic cold-water species (flora or fauna) not otherwise widely supported within the subbasin, and either:
(a) Maintains cold-water temperatures throughout the year relative to other segments in the subbasin, providing summertime cold-water holding or rearing habitat that is limited in supply, or;
(b) Supplies cold water to a receiving stream or downstream reach that supports cold-water biota.

340-041-0027 Biological Criteria
Waters of the state shall be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities.

Pennsylvania

SOURCE: Pennsylvania Code Chapter 93, Title 25, § 93.3, 93.4, 93.6. General water quality criteria, amended November 17, 2000: http://www.pacode.com/secure/data/025/chapter93/s93.3.html, http://www.pacode.com/secure/data/025/chapter93/s93.4.html http://www.pacode.com/secure/data/025/chapter93/s93.6.html www.dep.state.pa.us

§ 93.3. Protected water uses.
Water uses which shall be protected, and upon which the development of water quality criteria shall be based, are set forth, accompanied by their identifying symbols, in Table 1:

Table 1

Symbol	Protected Use
Aquatic Life	
CWF	Cold Water Fishes—Maintenance or propagation, or both, of fish species including the family Salmonidae and additional flora and fauna which are indigenous to a cold water habitat.
WWF	Warm Water Fishes—Maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.
MF	Migratory Fishes—Passage, maintenance and propagation of anadromous and catadromous fishes and other fishes which ascend to flowing waters to complete their life cycle.

Symbol	Protected Use
TSF	Trout Stocking—Maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.
Water Supply	
AWS	Wildlife Water Supply—Use for waterfowl habitat and for drinking and cleansing by wildlife.
Special Protection	
HQ	High Quality Waters
EV	Exceptional Value Waters

§ 93.4. Statewide water uses.

(a) Statewide water uses. Except when otherwise specified in law or regulation, the uses set forth in Table 2 apply to all surface waters. These uses shall be protected in accordance with this chapter, Chapter 96 (relating to water quality standards implementation) and other applicable State and Federal laws and regulations.

Table 2

Symbol	Protected Use
Aquatic Life	
WWF	Warm Water Fishes
AWS	Wildlife Water Supply

§ 93.6. General water quality criteria.

(a) Water may not contain substances attributable to point or nonpoint source discharges in concentration or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant or aquatic life.

Rhode Island

SOURCE: State of Rhode Island And Providence Plantations Department of Environmental Management Water Resources, Water Quality Regulations, Regulation EVM 112-88.97-1, amended June 23, 2000: http://www.epa.gov/waterscience/standards/wqslibrary/ri/ri_1_wqr.pdf, and http://www.state.ri.us/dem/pubs/regs/REGS/WATER/QUALREGS.PDF

Rule 7. - DEFINITIONS

"Outstanding National Resource Waters (ONRW)" means waters of National and State Parks, Wildlife Refuges, and other such waters designated as having special recreational or ecological value.

"Special Resource Protection Waters (SRPW)" means surface waters identified by the Director as having significant recreational or ecological uses, and may include but are not limited to: wildlife refuge or management areas; public drinking water supplies; State and Federal parks; State and Federal designated Estuarine Sanctuary Areas; waterbodies containing critical habitats, including but not limited to waterbodies identified by the RIDEM Natural Heritage Program as critical habitat for rare or endangered species; wetland types or specific wetlands listed as rare, threatened, endangered, of special interest or of special concern by the Rhode Island Natural Heritage Program; waterbodies identified by the U. S. Department of the Interior on the Final List of Rivers for potential inclusion in the National Wild and Scenic Rivers System.

"Undesirable or Nuisance Species" means any plant or animal aquatic species which becomes so numerous due to pollutants or physical or hydrological modifications that it interferes with, or indicates an impairment of, the designated use(s) of a waterbody.

"Use Attainability Analyses" means a structured scientific assessment of the factors affecting the attainment of a use which may include physical, chemical, biological, and economic factors. The physical, chemical and biological factors affecting the attainment of a use shall be evaluated through a waterbody survey and assessment. Waterbody surveys and assessments shall be sufficiently detailed to evaluate at a minimum:

a. current aquatic uses achieved in the waterbody;
b. causes of any impairment of the aquatic uses and why the impairment cannot be rectified; and
c. aquatic uses(s) that can be attained based on the physical, chemical, and biological characteristics of the water body.

Rule 8. - SURFACE WATER QUALITY STANDARDS

B. Water Use Classification
   (1) Freshwater: Class A, Class B, Class B1, and Class C waters are designated... for fish and wildlife habitat...
   (2) Seawater: Class SA, Class SB, Class SB1, and Class SC waters are designated for ... fish and wildlife habitat...

D. Water Quality Criteria - The following physical, chemical and biological criteria are parameters of minimum water quality necessary to support the surface water use classifications of rule 8.B. and shall be applicable to all waters of the State.
   (1) General Criteria - The following minimum criteria are applicable to all waters of the State, unless criteria specified for individual classes are more stringent:
      (a) At a minimum, all waters shall be free of pollutants in concentrations or combinations or from anthropogenic activities subject to these regulations that:
         i. Adversely affect the composition of fish and wildlife;
         ii. Adversely affect the physical, chemical, or biological integrity of the habitat;
         iii. Interfere with the propagation of fish and wildlife;
         iv. Adversely alter the life cycle functions, uses, processes and activities of fish and wildlife;...
      (b) Aesthetics - all waters shall be free from pollutants in concentrations or combinations that:
         iv. Result in the dominance of species of fish and wildlife to such a degree as to create a nuisance or interfere with the existing or designated uses.

South Carolina

SOURCE: South Carolina Regulation 61-68, Water Classification and Standards, September 28, 2001: http://www.lpitr.state.sc.us/coderegs/chap61/61-69.htm, and http://www.scstatehouse.net/coderegs/c061c.htm#61-68

61-68. Water Classifications and Standards

B. DEFINITIONS.
   1. Biological assessment means an evaluation of the biological condition of a waterbody using biological surveys and other direct measurements of resident biota in surface waters and sediments.

   18. Biological criteria, also known as biocriteria, mean narrative expressions or numeric values of the biological characteristics of aquatic communities based on appropriate reference conditions. Biological criteria serve as an index of aquatic community health.

F. NARRATIVE BIOLOGICAL CRITERIA.
   1. Narrative biological criteria are contained in this regulation and are described throughout the sections where applicable. The following are general statements regarding these narrative biological criteria.
      a. Narrative biological criteria in Section A.4. describe the goals of the Department to maintain and improve all surface waters to a level that provides for the survival and propagation of a balanced indigenous aquatic community of fauna and flora. These narrative criteria are determined by the

Department based on the condition of the waters of the State by measurements of physical, chemical, and biological characteristics of the waters according to their classified uses.

b. Section C.10. describes narrative biological criteria relative to surface water mixing zones and specifies requirements necessary for the protection and propagation of a balanced indigenous aquatic community.

c. Narrative biological criteria shall be consistent with the objective of maintaining and improving all surface waters to a level that provides for the survival and propagation of a balanced indigenous aquatic community of fauna and flora attainable in waters of the State; and in all cases shall protect against degradation of the highest existing or classified uses or biological conditions in compliance with the Antidegradation Rules contained in this regulation. Section D.1.a describes narrative biological criteria relative to activities in Outstanding National Resource Waters, Outstanding Resource Waters and Shellfish Harvesting Waters.

d. In order to determine the biological quality of the waters of the State, it is necessary that the biological component be assessed by comparison to a reference condition(s) based upon similar hydrologic and watershed characteristics that represent the optimum natural condition for that system. Such reference condition(s) or reaches of waterbodies shall be those observed to support the greatest variety and abundance of aquatic life in the region as is expected to be or would be with a minimal amount of disturbance from anthropogenic sources. Impacts from urbanization and agriculture should be minimal and natural vegetation should dominate the land cover. There should also be an appropriate diversity of substrate. Reference condition(s) shall be determined by consistent sampling and reliable measures of selected indicative communities of flora and fauna as established by the Department and may be used in conjunction with acceptable physical, chemical, and microbial water quality measurements and records judged to be appropriate for this purpose. Narrative biological criteria relative to activities in all waters are described in Section E.

e. In the Class Descriptions, Designations, and Specific Standards for Surface Waters Section, all water use classifications protect for a balanced indigenous aquatic community of fauna and flora. In addition, Trout Natural and Trout Put, Grow, and Take classifications protect for reproducing trout populations and stocked trout populations, respectively.

Antidegradation Rules.

8. Trout Waters. The State recognizes three types of trout waters: Natural; Put, Grow, and Take; and Put and Take.

   a. Natural (TN) are freshwaters suitable for supporting reproducing trout populations and a cold water balanced indigenous aquatic community of fauna and flora. Also suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the Department. Suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora. Suitable also for industrial and agricultural uses.

   b. Put, Grow, and Take (TPGT) are freshwaters suitable for supporting growth of stocked trout populations and a balanced indigenous aquatic community of fauna and flora. Also suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the Department. Suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora. Suitable also for industrial and agricultural uses.

   c. Put and Take (TPT) are freshwaters suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the Department. Suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora. Suitable also for industrial and agricultural uses. The standards of Freshwaters classification protect these uses.

South Dakota

SOURCE: Administrative Rules of South Dakota, Article 74:51, Surface Water Quality Standards, effective January 27, 1999: http://legis.state.sd.us/rules/rules/7451.htm#74:51:01 and http://www.state.sd.us/denr/denr.html

74:51:01:01. Definitions.

(4) "Aquatic life," an organism dependent on the water environment to either propagate or survive, or both;

(5) "Aquatic community," an association of interacting populations and stages of aquatic life in a given water body or habitat;

(10) "Biological integrity," the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region;

(13) "Coldwater aquatic life," aquatic life including fish of the family Salmonidae, for example, trout and salmon;

(14) "Coldwater marginal fish life propagation," a beneficial use assigned to surface waters of the state which support aquatic life and are suitable for stocked catchable-size coldwater fish during portions of the year, but which, because of critical natural conditions including low flows, siltation, or warm temperatures, are not suitable for a permanent coldwater fish population. Warmwater fish may also be present;

(15) "Coldwater permanent fish life propagation," a beneficial use assigned to surface waters of the state which are capable of supporting aquatic life and are suitable for supporting a permanent population of coldwater fish from natural reproduction or fingerling stocking. Warmwater fish may also be present;

(27) "High-quality fishery waters," surface waters of the state designated for the beneficial use of coldwater permanent fish life propagation, coldwater marginal fish life propagation, or warmwater permanent fish life propagation;

(30) "Impairment," a detrimental effect on the aquatic community caused by an impact that prevents attainment of the designated use;

(57) "Warmwater aquatic life," aquatic life including the Ictaluridae, Centrarchidae, and Cyprinidae families of fish, for example, catfish, sunfish, and minnows, respectively;

(58) "Warmwater marginal fish life propagation," a beneficial use assigned to surface waters of the state which will support aquatic life and more tolerant species of warmwater fish naturally or by frequent stocking and intensive management but which suffer frequent fish kills because of critical natural conditions;

(59) "Warmwater permanent fish life propagation," a beneficial use assigned to surface waters of the state which support aquatic life and are suitable for the permanent propagation or maintenance, or both, of warmwater fish;

(60) "Warmwater semipermanent fish life propagation waters," a beneficial use assigned to surface waters of the state which support aquatic life and are suitable for the propagation or maintenance, or both, of warmwater fish but which may suffer occasional fish kills because of critical natural conditions;

62) "Wetlands," those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions including swamps, marshes, bogs, and similar areas;

(63) "Fish and wildlife propagation, recreation, and stock watering," a beneficial use classification assigned to all surface waters of the state which may support recreation in and on the water and fish and aquatic life, when sufficient quantities of water are present for sufficient duration to support those uses; provide habitat for aquatic and semi-aquatic wild animals and fowl; provide natural food chain maintenance; and are of suitable quality for watering domestic and wild animals;

74:51:01:12. Biological integrity of waters.
All waters of the state must be free from substances, whether attributable to human-induced point source discharges or nonpoint source activities, in concentrations or combinations which will adversely impact the structure and function of indigenous or intentionally introduced aquatic communities.

Tennessee

SOURCE: Rules of the Tennessee Department of Health and Tennessee Department of Environment and Conservation, Chapter 1200-4-3 General Water Quality Criteria, revised October 1999: http://www.state.tn.us/sos/rules/1200/1200-04/1200-04-03.pdf and www.state.tn.us/environment

1200-4-3-.03 Criteria for Water Uses:
(3) Fish and Aquatic Life.
(j) Biological Integrity - The waters shall not be modified through the addition of pollutants or through physical alteration to the extent that the diversity and/or productivity of aquatic biota within the receiving waters are substantially decreased or adversely affected, except as allowed under 1200-4-3-.06. The condition of biological communities will be measured by use of metrices suggested in guidance such as Rapid Bioassessment Protocols for Use in Streams and Rivers (EPA/444/4-89-001) or other scientifically defensible methods. Effects to biological populations will be measured by comparisons to upstream conditions or to appropriately selected reference sites in the same ecoregion.

Texas

SOURCE: Texas Administrative Code, Title 30 Environmental Quality, Part 1, Texas Natural Resource Conservation Commission, Chapter 307, Texas Surface Water Quality Standards, amended effective August 17, 2000: http://info.sos.state.tx.us:80/pub/plsql/readtac$ext.ViewTAC?tac_view=4&ti=30&pt=1&ch=307&rl=Y

Rule 307.3 Definitions and Abbreviations
(a) Definitions
(9) Biological integrity--The species composition, diversity, and functional organization of a community of organisms in an environment relatively unaffected by pollution.

(27) Incidental fishery--A level of fishery which applies to water bodies that are not considered to have a sustainable fishery but which have an aquatic life use of limited, intermediate, high, or exceptional.

(45) Seagrass propagation--A water-quality-related existing use which applies to saltwater with significant stands of submerged seagrass.

(50) Significant aquatic life use--A broad characterization of aquatic life which indicates that a subcategory of aquatic life use (limited, intermediate, high, or exceptional) is applicable. Some aquatic life is expected to be present even in water bodies which are not designated for specific categories of aquatic life use. Some provisions to protect aquatic life applies to any water body in the state whether an aquatic life use is assigned or not.

Rule 307.7 Site-specific Uses and Criteria
(a) Aquatic life. The establishment of numerical criteria for aquatic life is highly dependent on desired use, sensitivities of usual aquatic communities, and local physical and chemical characteristics. Five subcategories of aquatic life use are established. They include limited, intermediate, high, and exceptional aquatic life and oyster waters. Aquatic life use subcategories designated for segments listed in Appendix A of §307.10 of this title recognize the natural variability of aquatic community requirements and local environmental conditions.

(b) Appropriate uses and criteria for site-specific standards are defined as follows.

(3) Aquatic life. The establishment of numerical criteria for aquatic life is highly dependent on desired use, sensitivities of usual aquatic communities, and local physical and chemical characteristics. Five subcategories of aquatic life use are established. They include limited, intermediate, high, and exceptional aquatic life and oyster waters. Aquatic life use subcategories designated for segments listed in Appendix A of §307.10 of this title recognize the natural variability of aquatic community requirements and local environmental conditions.

(5) Additional uses. Other basic uses, such as navigation, agricultural water supply, industrial water supply, seagrass propagation, and wetland water quality functions will be maintained and protected for all water in the state in which these uses can be achieved

Table 4: Aquatic Life Subcategories (Figure: 30 TAC §307.7(b)(3)(A)(i))

Aquatic Life Use Subcategory	Dissolved Oxygen, mg/L			Aquatic Life Attributes					
	Freshwater mean/ minimum	Freshwater in Spring mean/ minimum	Saltwater mean/ minimum	Habitat Characteristics	Species Assemblage	Sensitive Species	Diversity	Species Richness	Trophic Structure
Exceptional	6.0/4.0	6.0/5.0	5.0/4.0	Outstanding natural variability	Exceptional or unusual	Abundant	Exceptionally high	Exceptionally high	Balanced
High	5.30/3.0	5.5/4.5	4.0/3.0	Highly diverse	Usual association of regionally expected species	Present	High	High	Balanced to slightly imbalanced
Intermediate	4.0/3.0	5.0/4.0	3.0/2.0	Moderately diverse	Some expected species	Very low in abundance	Moderate	Moderate	Moderately imbalanced
Limited	3.0/2.0	4.0/3.0		Uniform	Most regionally expected species absent	Absent	Low	Low	Severely imbalanced

Utah

SOURCE: Title R317. Environmental Quality, Water Quality, R317-1. Definitions and General Requirements and Rule R317.2 Standards of Quality for Waters of the State, as in effect January 1, 2002: http://www.rules.state.ut.us/publicat/code/r317/r317-001.htm#T1 , and http://www.rules.state.ut.us/publicat/code/r317/r317-002.htm#T7

R317-1-1. Definitions

1.20 "Pollution" means such contamination, or other alteration of the physical, chemical, or biological properties of any waters of the state, or such discharge of any liquid, gaseous or solid substance into any waters of the state as will create a nuisance or render such waters harmful or detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life.

317-2-6. Use Designations

6.3 Class 3 -- Protected for use by aquatic wildlife.

(a) Class 3A -- Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.

(b) Class 3B -- Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.

(c) Class 3C -- Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain.

(d) Class 3D -- Protected for waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain.

(e) Class 3E -- Severely habitat-limited waters. Narrative standards will be applied to protect these waters for aquatic wildlife.

6.5 Class 5 -- The Great Salt Lake. Protected for primary and secondary contact recreation, aquatic wildlife, and mineral extraction.

Vermont

SOURCE: Vermont Water Quality Standards, effective July 2, 2000:
http://www.state.vt.us/wtrboard/docs/adoptedwqs.pdf

Section 1-01B. Applicability and Definitions

5. **Aquatic biota** means all organisms that, as part of their natural life cycle, live in or on waters.

6. **Aquatic habitat** means the physical, chemical, and biological components of the water environment.

10. **Biological integrity** means the ability of an aquatic ecosystem to support and maintain, when consistent with reference conditions, a community of organisms that is not dominated by any particular species or functions (balanced), is fully functional (integrated), and is resilient to change or impact (adaptive), and which has the expected species composition, diversity, and functional organization.

20. **Functional component** of the aquatic ecosystem means a portion of the aquatic biological community identified by its role in the processing of energy within the aquatic ecosystem (e.g., primary producers, predators, detritivores, etc.).

23. **Intolerant aquatic organisms** means those organisms which are particularly sensitive to, and likely to be adversely affected by, the stress of pollution, flow modification or habitat alteration (e.g., mayflies and stoneflies).

29. **Natural condition** means the condition representing chemical, physical, and biological characteristics that occur naturally with only minimal effects from human influences.

39. **Reference condition** means the range of chemical, physical, and biological characteristics of waters minimally affected by human influences. In the context of an evaluation of biological indices, or where necessary to perform other evaluations of water quality, the reference condition establishes attainable chemical, physical, and biological conditions for specific water body types against which the condition of waters of similar water body type is evaluated.

44. **Taxonomic component of the aquatic ecosystem** means a portion of the biological community identified by a hierarchical classification system for identifying biological organisms that uses physical and biological characteristics (e.g., Insecta: Plecoptera: Perlidae: Agnetina capitata).

45. **Tolerant aquatic organisms** means organisms (e.g., midges and annelids) that, although they may be affected by the stress of pollution, flow modification or habitat alteration, are less sensitive and less likely to be adversely affected than are intolerant aquatic organisms.

Section 3-01C. Numeric Biological Criteria

C. Numeric Biological Indices

1. In addition to other applicable provisions of these rules and other appropriate methods of evaluation, the Secretary may establish and apply numeric biological indices to determine whether there is full support of aquatic biota and aquatic habitat uses. These numeric biological indices shall be derived from measures of the biological integrity of the reference condition for different water body types. In establishing numeric biological indices, the Secretary shall establish procedures that employ standard sampling and analytical methods to characterize the biological integrity of the appropriate reference condition. Characteristic measures of biological integrity include but are not limited to community level measurement such as: species richness, diversity, relative abundance of tolerant and intolerant species, density, and functional composition.
2. In addition, the Secretary may determine whether there is full support of aquatic biota and aquatic

habitat uses through other appropriate methods of evaluation, including habitat assessments.

Section 3-02 Class A(1) Ecological Waters

B. Water Quality Criteria for Class A(1) Ecological Waters

3. Aquatic Biota, Wildlife, and Aquatic Habitat - Change from the natural condition limited to minimal impacts from human activity. Measures of biological integrity for aquatic macroinvertebrates and fish assemblages are within the range of the natural condition. Uses related to either the physical, chemical, or biological integrity of the aquatic habitat or the composition or life cycle functions of aquatic biota or wildlife are fully supported. All life cycle functions, including overwintering and reproductive requirements are maintained and protected.

Section 3-03. Class A(2) Public Water Supplies

A. Management Objectives. Waters managed for public water supply purposes to achieve and maintain waters with a uniformly excellent character and a level of water quality that is compatible with the following designated uses:

1. Aquatic Biota, Wildlife, and Aquatic Habitat - high quality aquatic biota and wildlife sustained by high quality aquatic habitat necessary to support their life-cycle and reproductive requirements.

B. Water Quality Criteria for Class A(2) Public Water Supplies. The following water quality criteria shall be achieved in all Class A(2) public water supplies.

3. Aquatic Biota, Wildlife and Aquatic Habitat - Biological integrity is maintained, no change from the reference condition that would prevent the full support of aquatic biota, wildlife or aquatic habitat uses. Change from the reference condition for aquatic macroinvertebrates and fish assemblages shall not exceed moderate changes in the relative proportions of taxonomic, functional, tolerant and intolerant components. All expected functional groups are present in a high quality habitat and none shall be eliminated. All life cycle functions, including overwintering and reproductive requirements are maintained and protected. Changes in the aquatic habitat shall not exceed moderate differences from the reference condition consistent with the full support of all aquatic biota and wildlife uses.

Section 3-04. Class B Waters

A. Management Objectives. Class B waters shall be managed to achieve and maintain a level of quality that fully supports the following designated uses:

1. Aquatic Biota, Wildlife, and Aquatic Habitat - aquatic biota and wildlife sustained by high quality aquatic habitat with additional protection in those waters where these uses are sustainable at a higher level based on Water Management Type designation.

B. Water Quality Criteria for Class B waters. In addition to the criteria specified in §3-01 of these rules, the following criteria shall be met in all Class B waters:

4. Aquatic Biota, Wildlife and Aquatic Habitat - No change from the reference condition that would prevent the full support of aquatic biota, wildlife, or aquatic habitat uses. Biological integrity is maintained and all expected functional groups are present in a high quality habitat. All life-cycle functions, including overwintering and reproductive requirements are maintained and protected. In addition, the following criteria shall be achieved:

a. In Water Management Type One waters - change from the reference condition for aquatic macroinvertebrate and fish assemblages shall be limited to minor changes in the relative proportions of taxonomic and functional components; relative proportions of tolerant and intolerant components are within the range of the reference condition. Changes in the aquatic habitat shall be limited to minimal differences from the reference condition consistent with the full support of all aquatic biota and wildlife uses.

b. In Water Management Type Two waters - change from the reference condition for aquatic macroinvertebrate and fish assemblages shall be limited to moderate changes in the relative proportions of tolerant, intolerant, taxonomic, and functional components. Changes in the aquatic habitat shall be limited to minor differences from the reference condition consistent with the full support of all aquatic biota and wildlife uses.

c. In Water Management Type Three waters - change from the reference condition for aquatic macroinvertebrate and fish assemblages shall be limited to moderate changes in the relative proportions of tolerant, intolerant, taxonomic, and functional components. Changes in the aquatic habitat shall be limited to moderate differences from the reference condition consistent with the full support of all aquatic biota and wildlife uses. When such habitat changes are a result of hydrological modification or water level fluctuation, compliance may be determined on the basis

of aquatic habitat studies.

d. In all other Class B waters - no change from reference conditions that would have an undue adverse effect on the composition of the aquatic biota, the physical or chemical nature of the substrate or the species composition or propagation of fishes.

Section 3-05 Fish Habitat Designation

To provide for the protection and management of fisheries, the waters of the State are designated in Appendix A as being either a cold or a warm water fish habitat. Where appropriate, such designations may be seasonal.

Virginia

SOURCE: State Water Control Board, Virginia Administrative Code (9 VAC 25-260-5 et seq. Water Quality Standards). Statutory Authority: § 62.1-44.15(3a) of the Code of Virginia. Effective Date: December 10, 1997: http://www.deq.state.va.us/wqs/

PART I
SURFACE WATER STANDARDS WITH GENERAL, STATEWIDE APPLICATION

9 VAC 25-260-10. Designation of uses.

A. All state waters, including wetlands, are designated for the following uses: recreational uses, e.g., swimming and boating; the propagation and growth of a balanced, indigenous population of aquatic life, including game fish, which might reasonably be expected to inhabit them; wildlife; and the production of edible and marketable natural resources, e.g., fish and shellfish.

9 VAC 25-260-20. General standard.

A. All state waters, including wetlands, shall be free from substances attributable to sewage, industrial waste, or other waste in concentrations, amounts, or combinations which contravene established standards or interfere directly or indirectly with designated uses of such water or which are inimical or harmful to human, animal, plant, or aquatic life.

9 VAC 25-260-370. Classification column.

B. DGIF trout waters. The Department of Game and Inland Fisheries (DGIF) has established a classification system for trout waters based on aesthetics, productivity, resident fish population and stream structure. Classes i through iv rate wild trout habitat; Classes v through vii rate cold water habitat not suitable for wild trout but adequate for year-round hold-over of stocked trout. The DGIF classification system is included in this publication with the board's trout water classes (Class V - Stockable trout waters and Class VI - Natural trout waters) in the class column of the River Basin Section Tables 9 VAC 25-260-390 et seq.

DGIF trout water classifications which are not consistent with board classifications for stockable trout waters or natural trout waters are shown with a double asterisk (**) in the class column of the River Basin Section Tables 9 VAC 25-260-390 et seq. These trout waters have been identified for reevaluation by the DGIF. Those trout waters which have no DGIF classification are shown with a triple asterisk (***). The DGIF classes are described below. Inclusion of these DGIF classes provides additional information about specific streams for permit writers and other interested persons. Trout waters classified as classes i or ii by the DGIF are also recognized in 9 VAC 25-260-110.

DGIF STREAM CLASS DESCRIPTIONS.

Wild natural trout streams.

Class i. Stream of outstanding natural beauty possessing wilderness or at least remote characteristics, an abundance of large deep pools, and excellent fish cover. Substrate is variable with an abundance of coarse gravel and rubble. Stream contains a good population of wild trout or has the potential for such. Would be considered an exceptional wild trout stream.

Class ii. Stream contains a good wild trout population or the potential for one but is lacking in aesthetic quality, productivity, and/or in some structural characteristic. Stream maintains good water quality

and temperature, maintains at least a fair summer flow, and adjacent land is not extensively developed. Stream would be considered a good wild trout stream and would represent a major portion of Virginia's wild trout waters.

Class iii. Stream which contains a fair population of wild trout with carrying capacity depressed by natural factors or more commonly man-related land use practices. Land use activities may result in heavy siltation of the stream, destruction of banks and fish cover, water quality degradation, increased water temperature, etc. Most streams would be considered to be in the active state of degradation or recovery from degradation. Alteration in land use practices would generally improve carrying capacity of the stream.

Class iv. Stream which contains an adequately reproducing wild trout population but has severely reduced summer flow characteristics. Fish are trapped in isolated pools where they are highly susceptible to predators and fishermen. Such streams could quickly be over-exploited and, therefore, provide difficult management problems.

Stockable trout streams.

Class v. Stream does not contain an adequately reproducing wild trout population nor does it have the potential for such. However, water quality is adequate, water temperature is good, and invertebrate productivity is exceptional. Pools are abundant with good size and depth and fish cover is excellent. Stream would be good for stocked trout but may offer more potential for a fingerling stocking program.

Class vi. Stream does not contain a significant number of trout nor a significant population of warmwater gamefish. Water quality is adequate and water temperature good for summer carryover of stocked trout. Summer flow remains fair and adjacent land is not extensively developed. All streams in this class would be considered good trout stocking water.

Class vii. Stream does not contain a significant number of trout nor a significant population of warmwater gamefish. Water quality and temperature are adequate for trout survival but productivity is marginal as are structural characteristics. Streams in this class could be included in a stocking program but they would be considered marginal and generally would not be recommended for stocking.

Class viii. Stream does not contain a significant number of trout nor a significant population of warmwater gamefish. Water quality and temperature are adequate for trout but summer flows are very poor (less than 30% of channel). Streams in this class can provide good trout fishing during spring and early summer but would not be recommended for summer or fall stocking.

Other. Remaining streams would be considered unsuitable for any type of trout fishery. Streams would be considered unsuitable under any of the following conditions:

(a) summer temperatures unsuitable for trout survival;
(b) stream contains a significant population of warmwater gamefish;
(c) insufficient flow; or
(d) intolerable water quality.

Washington

SOURCE: Chapter 173-201A Washington Administrative Code. Water Quality Standards for Surface Waters of the State of Washington, November 18, 1997: http://www.ecy.wa.gov/pubs/wac173201a.pdf

WAC 173-201A-010 Introduction.

(1) The purpose of this chapter is to establish water quality standards for surface waters of the state of Washington consistent with public health and public enjoyment thereof, and the propagation and protection of fish, shellfish, and wildlife, pursuant to the provisions of chapter 90.48 RCW [Revised Code of Washington] and the policies and purposes thereof.

WAC 173-201A-020 Definitions.

"Biological assessment" is an evaluation of the biological condition of a water body using surveys of aquatic community structure and function and other direct measurements of resident biota in surface waters.

"Damage to the ecosystem" means any demonstrated or predicted stress to aquatic or terrestrial organisms

or communities of organisms which the department reasonably concludes may interfere in the health or survival success or natural structure of such populations. This stress may be due to, but is not limited to, alteration in habitat or changes in water temperature, chemistry, or turbidity, and shall consider the potential build up of discharge constituents or temporal increases in habitat alteration which may create such stress in the long term.

"Ecoregions" are defined using EPA's *Ecoregions of the Pacific Northwest* Document No. 600/3-86/033 July 1986 by Omernik and Gallant.

"Wildlife habitat" means waters of the state used by, or that directly or indirectly provide food support to, fish, other aquatic life, and wildlife for any life history stage or activity.

WAC 173-201A-030 General water use and criteria classes.
The following criteria shall apply to the various classes of surface waters in the state of Washington:

Class AA (extraordinary), Class A (excellent), and Class B (good). Characteristic uses shall include, but not be limited to, the following:

(iii) Fish and shellfish: Salmonid migration, rearing, spawning, and harvesting. Other fish migration, rearing, spawning, and harvesting. Clam, oyster, and mussel rearing, spawning, and harvesting. Crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing, spawning, and harvesting.
(iv) Wildlife habitat.

Class C (fair). Characteristic uses shall include, but not be limited to, the following:

(ii) Fish (salmonid and other fish migration).

Lake class. Characteristic uses shall include, but not be limited to, the following:

(iii) Fish and shellfish: Salmonid migration, rearing, spawning, and harvesting. Other fish migration, rearing, spawning, and harvesting. Clam and mussel rearing, spawning, and harvesting. Crayfish rearing, spawning, and harvesting.
(iv) Wildlife habitat.

West Virginia

SOURCE: Title 46, West Virginia Secretary of State, Code of State Rules (CSR), Legislative Rule, Environmental Quality Board, Series 1, Requirements Governing Water Quality Standards, effective May 17, 2001: http://www.state.wv.us/csr/verify.asp?TitleSeries=46-01

§46-1-3. Conditions Not Allowable In State Waters.

3.2.i. Any other condition, including radiological exposure, which adversely alters the integrity of the waters of the State including wetlands; no significant adverse impact to the chemical, physical, hydrologic, or biological components of aquatic ecosystems shall be allowed.

§46-1-6. Water Use Categories.

6.3. Category B – Propagation and maintenance of fish and other aquatic life. -- This category includes:

6.3.a. Category B1 -- Warm water fishery streams. -- Streams or stream segments which contain populations composed of all warm water aquatic life.
6.3.b. Category B2 -- Trout Waters. -- As defined in Section 2.19 (See Appendix A for a representative list.)
6.3.c. Category B4 -- Wetlands. -- As defined in section 2.22; certain numeric stream criteria may not be appropriate for application to wetlands (see Appendix E).

6.5. Category D. -- Agriculture and wildlife uses.

6.5.c. Category D3 -- Wildlife. -- This category includes all stream segments and wetlands used by wildlife.

Wisconsin

Source: Wisconsin Administrative Code, Department of Natural Resources, Chapter NR 102, Water Quality Standards for Wisconsin Surface Waters, February 1998: http://www.legis.state.wi.us/rsb/code/nr/nr102.pdf

NR 102.04 Categories of standards.

(3) FISH AND OTHER AQUATIC LIFE USES. The department shall classify all surface waters into one of the fish and other aquatic life subcategories described in this subsection. Only those use subcategories identified in pars. (a) to (c) shall be considered suitable for the protection and propagation of a balanced fish and other aquatic life community as provided in the federal water pollution control act amendments of 1972, P.L. 92–500; 33 USC 1251 et seq.

(a) *Cold water communities*. This subcategory includes surface waters capable of supporting a community of cold water fish and other aquatic life, or serving as a spawning area for cold water fish species. This subcategory includes, but is not restricted to, surface waters identified as trout water by the department of natural resources (Wisconsin Trout Streams, publication 6–3600 (80)).

(b) *Warm water sport fish communities*. This subcategory includes surface waters capable of supporting a community of warm water sport fish or serving as a spawning area for warm water sport fish.

(c) *Warm water forage fish communities.* This subcategory includes surface waters capable of supporting an abundant diverse community of forage fish and other aquatic life.

(d) *Limited forage fish communities*. (Intermediate surface waters). This subcategory includes surface waters of limited capacity and naturally poor water quality or habitat. These surface waters are capable of supporting only a limited community of forage fish and other aquatic life.

(e) *Limited aquatic life*. (Marginal surface waters). This sub-category includes surface waters of severely limited capacity and naturally poor water quality or habitat. These surface waters are capable of supporting only a limited community of aquatic life.

(7) STANDARDS FOR WILDLIFE. All surface waters shall be classified for wildlife uses and meet the wildlife criteria specified in or developed pursuant to NR 105.07.

Wyoming

SOURCE: Wyoming Rules and Regulations, Water Quality Rules and Regulations: Chapter 1, Quality Standards for Wyoming Surface Waters Sections 2, 3, and 4, March 7, 2000: http://soswy.state.wy.us/RULES/3925.pdf

Section 2. Definitions. The following definitions supplement those definitions contained in section 35-11-103 of the Wyoming Environmental Quality Act.

(e) "Cold Water Game Fish " means Grayling (Thymallus arcticus), Northern Pike (Esox lucius), Salmon (Oncorhynchus spp.), Sauger (Stizostedion canadense), Tiger muskie (Esox Masquinongy), Trout (Salmo, Oncorhynchus, and Salvelinus spp.), Walleye (Stizostedion vitreum), and Whitefish (Prospium williamsoni).

(p) "Game fish" means Bass (Micropterus spp.), Catfish (Ictalurus punctatus), Crappie (Pomoxis spp.), Grayling (Thymallus arcticus), Ling (Lota lota), Northern Pike (Esox lucius), Perch (Perca flavescens), Salmon (Oncorhynchus spp.), Sauger (Stizostedion canadense), Sunfish (Lepomis spp.), Tiger Muskie (Esox Masquinongy), Trout (Salmo, Oncorhynchus, and Salvelinus spp.), Walleye (Stizostedion vitreum), White Bass (Morone chrysops), and Whitefish (Prospium williamsoni).

(w) "Natural" means that condition which would exist without the measurable effects or measurable influence of man's activities.

(x) "Natural biotic community" means the population structures which were historically or normally present under a given set of chemical and physical conditions or which would potentially exist had not the habitat been degraded.

(y) "Natural water quality" means that quality of water which would exist without the measurable effects or measurable influence of man's activities.

(ll) "Undesirable aquatic life" means organisms generally associated with degraded or eutrophic conditions. These may include the following organisms where they have replaced members of the natural biotic community: nongame fish, bluegreen algae, certain diatoms, fungi, tubificid worms, and certain syrphid flies.

(mm) "Warm water game fish" means Bass (Micropterus spp.), Catfish (Ictalurus punctatus), Crappie (Pomoxis spp.), Ling (Lota lota), Perch (Perca flavescens), Sunfish (Lepomis spp.), and White Bass (Morone Chrysops).

Section 3. Water Uses.
(b) Protection and propagation of fish and wildlife;...and to achieve the goal of the federal act, which is to achieve, wherever attainable, surface water quality which provides for the protection and propagation of fish, shellfish, wildlife, and recreation in and on the water.

Section 4. Surface Water Classes and Uses. There are four classes of surface water in Wyoming:
(a) Class 1 - Those surface waters in which no further water quality degradation by point source discharges other than from dams will be allowed. Nonpoint sources of pollution shall be controlled through implementation of appropriate best management practices. In designating Class 1 waters, the Environmental Quality Council shall consider water quality, aesthetic, scenic, recreational, ecological, agricultural, botanical, zoological, municipal, industrial, historical, geological, cultural, archaeological, fish and wildlife, the presence of significant quantities of developable water and other values of present and future benefit to the people.
(b) Class 2 - Those surface waters, other than those classified as Class 1, which are determined to:
  (i) Be presently supporting game fish; or
  (ii) Have the hydrologic and natural water quality potential to support game fish; or
  (iii) Include nursery areas or food sources for game fish.
(c) Class 3 - Those surface waters, other than those classified as Class 1, which are determined to:
  (i) Be presently supporting nongame fish only; or
  (ii) Have the hydrologic and natural water quality potential to support nongame fish only; or
  (iii) Include nursery areas or food sources for nongame fish only.
(d) Class 4 - Those surface waters, other than those classified as Class 1, which are determined to not have the hydrologic or natural water quality potential to support fish and include all intermittent and ephemeral streams. Class 4 waters shall receive protection for agriculture uses and wildlife watering.

TERRITORIES

American Samoa

SOURCE: American Samoa Water Quality Standards (1999 Revision provided by ASEPA), Sections 24.0205 and 24.0206:

§24.0205 Water Classifications-Protected and Prohibited Uses
(1) Class 1 Fresh Surface Waters
  (A) Class 1 waters are to remain in as near their natural state as possible with a minimum of pollution from any human activity. Protected uses of these waters are: potable water supplies, support and propagation indigenous aquatic and terrestrial life and compatible recreation and aesthetic enjoyment.
  (B) Prohibited uses and activities include, but are not limited to:
    (i) Point source discharges of pollutants
    (ii) Dredging and filling activities
    (iii) Bathing, including washing clothes and dishes
    (iv) Animal pens over or within 100 feet of the water body
    (v) Siting of septic tanks or cesspools within 200 feet of the water body

(vi) Land disturbing (e.g., grading, tillage) activities within 100 feet of the water body
(vii) Wood cutting or clearing within 100 feet of the water body

(2) Class 2 Fresh Surface Waters
(A) Class 2 waters shall be protected for the support and propagation of indigenous aquatic life, recreation in and on the water, and aesthetic enjoyment.
(B) Prohibited uses and activities include, but are not limited to:
(i) No zones of mixing will be granted
(ii) Dredging or filling activities, except as approved by EQC
(iii) Animal pens over or immediately adjacent to the water body

§24.0206 Standards of Water Quality

(i) There shall be no changes in basin geometry or freshwater inflow that will alter current patterns in such a way as to adversely affect existing biological populations or sediment distribution. To protect estuarine organisms, no change in channels, basin geometry, or freshwater influx shall be made which would cause permanent changes in existing isohaline patterns of more than 10 percent.

Commonwealth of Northern Mariana Islands

Source: http://www.epa.gov/ost/standards/wqslibrary/ and http://www.deq.gov.mp/

PART 5 CLASSIFICATION OF WATER USES

5.1 Marine Waters

(a) CLASS AA - It is the objective of this class that these waters remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-related source or actions. To the extent practicable, the wilderness character of such areas shall be protected. No zones of mixing shall be permitted. The uses to be protected in this class of waters are the support and propagation of shellfish and other marine life, conservation of coral reefs and wilderness areas, oceanographic research, and aesthetic enjoyment and compatible recreation inclusive of whole body contact and related activities. / The classification of any water area as Class AA shall not preclude other uses of such waters compatible with these objectives and in conformance with the criteria applicable to them.

(b) CLASS A - It is the objective of this class of waters that their use for recreational purposes and aesthetic enjoyment be protected. Any other use shall be allowed as long as it is compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters of a limited body contact nature. Such waters shall be kept clean of solid waste, oil and grease, and shall not act as receiving waters for any effluent which has not received the best degree of treatment of control practicable under existing technology and economic conditions and compatible with standards established for this class. A zone of mixing is [approvable] in such waters.

5.2 Fresh Surface Waters

(a) Class 1 - It is the objective of this class that these waters remain in their natural state as nearly as possible with an absolute minimum Of pollution from any human-caused source. To the extent possible, the wilderness character of such areas shall be protected. Wastewater discharges and zone of mixing into these waters are prohibited. The uses to be protected in this class of water are for domestic water supplies, food processing, the support and propagation of aquatic life, compatible recreation and aesthetic enjoyment including water contact recreation.

(b) Class 2 - It is the objective of this class of waters that their use for recreational purposes, propagation of fish and other aquatic life, and agricultural and industrial water supply not be limited in any way. The uses to be protected in this class of waters are all uses compatible with the protection and propagation of fish and other aquatic life, and with recreation in and on these waters. Compatible recreation may include limited body contact activities. Such waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control practical under technological and economic conditions and compatible with the standards established for this class. A zone of mixing is permissible in these

waters.

5.3 Protection of wetlands
Wetlands are waters of the State and are subject to the provisions of this rule. Point or nonpoint sources of pollution shall not cause destruction or impairment of wetlands. The general application of the Water Quality Standards shall apply to all wetlands unless replaced by site specific standards for wetlands based on their function are adopted by the Commonwealth and approved by EPA.

7.6 Salinity
Marine Waters (applicable to Class A, Class AA): No alterations of the marine environment shall occur that would: (1) alter the salinity of marine or estuarine waters more than 10% of the ambient conditions, or (2) which would otherwise adversely affect the sedimentary patterns and indigenous biota, except when due to natural causes.

7.10 Oil and Petroleum Products
The concentration of oil or petroleum products shall not:
(b) Cause tainting of fish or other aquatic life, be injurious to the indigenous biota or cause objectionable taste in drinking water.

7.12 General Considerations
(d) The health and life history characteristics of aquatic organisms in waters affected by controllable water quality factors shall not differ substantially from those for the same waters in areas unaffected by controllable water quality factors. Also, controllable water quality factors shall not cause a detrimental increase in concentrations of toxic substances found in bottom sediments or aquatic life.

Guam*

*This language has not been reviewed for accuracy by state/tribal agency.

SOURCE: Section II, Guam STATEMENT OF POLICY, amended 1986:
http://www.epa.gov/ost/standards/wqslibrary/

It shall be the public policy of the Territory of Guam to:
1. conserve, protect, maintain, and improve the quality of the Guam's waters for (drinking and food processing) human consumption, for the growth and propagation of aquatic life, for marine research and for the preservation of coral reefs and wilderness areas, and for domestic, agricultural, commercial, industrial, recreational and other legitimate uses;
4. maintain and improve the chemical, physical, and biological integrity of wetlands water quality as necessary to meet the Clean Water Act Section 101(a), and to protect wetlands...

SECTION I: CATEGORIES OF WATERS
A. **MARINE WATERS.** This category includes all coastal waters off-shore from the mean high water mark, including estuarine waters, lagoons and bays, brackish areas, wetlands and other special aquatic sites, and other inland Waters that are subject to ebb and flow of the tides. Refer to Water Classification Map.

CATEGORY M-1 EXCELLENT: Waters in this category must be of high enough quality to ensure preservation and protection of marine life, including corals and reef dwelling organisms, fish and related fisheries resources, and enable the pursuit of marine scientific research as well as aesthetic enjoyment. This category of water shall remain substantially free from pollution attributed to domestic, commercial and industrial discharges, shipping and boating, or agriculture, construction and other activities which can reduce the waters' quality. Furthermore, there shall be no zones of mixing within this category water.

CATEGORY M-2 GOOD: Water in this category must be of sufficient quality to allow for the propagation and survival of marine organisms, particularly shellfish, corals and other reef related resources. Other important and intended uses include mariculture activities, aesthetic enjoyment and compatible recreation inclusive of whole body contact and related activities.

CATEGORY M-3 FAIR: Water in this category is intended for general, commercial and industrial use. Specific intended uses include the following: shipping, boating and berthing, industrial cooling water, marinas, while allowing for protection of aquatic life, aesthetic enjoyment and compatible recreation with limited body contact.

B. **MIXING ZONES IN RECEIVING WATERS**. ...The following criteria apply to all mixing zones:
3. Biologically important areas, including spawning and nursery areas, shall be protected.

CHAPTER IV DEFINITIONS

BIOTA: The animal, plant and microbial life of a region.

COMMUNITY: An association of living organisms in a given area or region in which the various species are more or less interdependent upon each other.

HABITAT: The environment occupied by individuals of a particular species, population or community.

SPECIAL AQUATIC SITES: Sites possessing special ecological characteristics and values including wetlands, wildlife sanctuaries and refuges, mud flats, vegetated shallows, coral reefs, riffle and pool complexes.

WETLANDS: Means areas of land where the water table is at, near or above the land surface long enough each year to result in the formation of characteristically wet (hydric) soil types, and support the growth of water dependent (hydrophytic) vegetation. Wetlands include, but are not limited to, marshes, swamps, mangroves, natural ponds, surface springs, estuaries, bogs, and
other such low-lying or similar areas. Inland wetlands will include all wetlands meeting the following conditions.
1) Wetlands greater than one hectare in size with less than 0.5% (ocean derived) salinity; and
2) Palustrine, Riverine and Lacustrine wetlands with greater than 30% wetland vegetation cover.

WETLAND FUNCTIONS: The beneficial uses of wetlands which are protected by these Water Quality Standards including but not limited to groundwater recharge/discharge, flood water retention, sediment stabilization, nutrient removal/transformation, wildlife diversity/ abundance,
aquatic diversity/abundance, and recreation.

Puerto Rico

SOURCE: Commonwealth of Puerto Rico, Office of the Governor, Environmental Quality Board, Puerto Rico Water Quality Standards, amended November 1987: http://www.epa.gov/ost/standards/wqslibrary/

Article I. Definitions

Benthic Species. Organisms that inhabit on, over, or in the bottom of the water body.;live adhered to the bottom or crawl over the bottom.

Biota. All living organisms.

Desirable Species. Species indigenous to the area or introduced to the area because of ecological or commercial value.

Ecological Community. Group of organisms dominated by one species or a specific group of species. The ecological community derives its name from that of the dominant species, such as coral reefs and mangroves.

Ecological Value. Refers to the existing interrelations between water body, fauna and flora that result in the continuity, stability and permanence of the ecological community.

Pelagic Species. Organisms that have the ability of self locomotion and can overcome the currents. These organisms can be found anywhere in the water column, near the surface, the bottom or at any point between the surface and the bottom.

Planktonic Species. Marine organisms that mainly inhabit the surface of the receiving body of water. Their main characteristic is that they cannot overcome the currents even if they have self locomotion.

Propagation and Preservation of Desirable Species. This refers to the reproduction and continuance of flora and fauna associated with water bodies and which have ecologic importance and/or commercial value, whether individually or as part of an ecological community.

Wetlands. Areas inundated or saturated by coastal, surface cr ground water at a frequency and duration sufficient to support, and under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions.

ARTICLE 2. CLASSIFICATION OF THE WATERS OF PUERTO RICO ACCORDING TO THE DESIGNATED USES TO BE PROTECTED

3.2 Use Classifications and Water Quality Standards for Specific Classifications:

3.2.1 Class SA:
(A) Usages and Description: Coastal waters and estuarine waters of high quality and/or exceptional ecological or recreational value whose existing characteristics shall not be altered, except by natural causes, in order to preserve the existing natural phenomena.

3.2.2 Class SB:
(A) Usages and Description. Coastal waters and estuarine waters for use in primary and secondary contact recreation, and for propagation and preservation of desirable species.

3.2.3 Class SC:
(A) Usages and Description: Coastal waters intended ...for use in propagation and preservation of desirable species.

3.2.4 Class SD:
(A) Usages and Description: Surface waters intended for ... propagation and preservation of desirable species as well as primary and secondary contact recreation...

3.2.5 Class SE:
(A) Usages and Description: Surface waters and wetlands of exceptional ecological value, whose existing characteristics should not be altered in order to preserve the existing natural phenomena.

U.S. Virgin Islands

SOURCE: T.12 Subchapter 186. Water Quality Standards for Coastal Waters of the Virgin Islands Ch. 7 WATER POLLUTION CONTROL §186-2 - 186.4: http://www.epa.gov/ost/standards/wqslibrary

§ 186-2. Class A

(a) Best usage of waters: Preservation of natural phenomena requiring special conditions, such as the Natural Barrier Reef at Buck Island, St. Croix and the Under Water Trail at Trunk Bay, St. John.
(b) Quality criteria: Existing natural conditions shall not be changed.

§ 186-3. Class B

(a) Best usage of waters: For propagation of desirable species of marine life...

§ 186-4. Class C

(a) Best usage of waters: For the propagation of desirable species of marine life...

TRIBES

Confederated Tribes of the Colville Reservation

SOURCE: Source: 40 CFR 131.35, July 1, 2000 edition:
http://www.epa.gov/ost/standards/wqslibrary/tribes/131.35.pdf

§ 131.35

(f) General water use and criteria classes. The following criteria shall apply to the various classes of surface waters on the Colville Indian Reservation:

(1) *Class I (Extraordinary)—(i) Designated uses.* The designated uses include, but are not limited to, the following:

(C) Fish and shellfish: Salmonid migration, rearing, spawning, and harvesting; other fish migration, rearing, spawning, and harvesting.

(D) Wildlife habitat.

(2) *Class II (Excellent)*—(i) *Designated uses.* The designated uses include but are not limited to, the following:

(C) Fish and shellfish: Salmonid migration, rearing, spawning, and harvesting; other fish migration, rearing, spawning, and harvesting; crayfish rearing, spawning, and harvesting.

(D) Wildlife habitat.

(3) *Class III (Good)*—(i) *Designated uses.* The designated uses include but are not limited to, the following:

(C) Fish and shellfish: Salmonid migration, rearing, spawning, and harvesting; other fish migration, rearing, spawning, and harvesting; crayfish rearing, spawning, and harvesting.

(D) Wildlife habitat.

(4) *Class IV (Fair)*—(i) *Designated uses.* The designated uses include but are not limited to, the following:

(C) Fish (salmonid and other fish migration).

Nez Perce Tribe

WQS under development. Currently collecting chemical and physical habitat data to eventually establish WQS for the reservation area. No website available.

Oneida Nation of Wisconsin

(WQS were federally approved in 1996 and then rescinded after a lawsuit.)
SOURCE: Oneida Nation Water Quality Standards, hard copy provided by contact

Article VII. Narrative Criteria

7-1. Narrative criteria shall be used to guide water management decisions and activities that affect the Waters of the Reservation, and to protect and enhance water quality. The following narrative criteria shall apply to all Waters of the Reservations provided, however, where more stringent criteria exist, the stricter standards shall supersede.

7-2. All Waters of the Reservation shall be free from:

a. pollutants in quantities that, either alone or as a result of interaction with other pollutants, cause any designated use to become impaired.

b. pollutants in quantities that produce or contribute to the production of nuisance aquatic life.

c. pollutants in quantities that produce objectionable color, odor, taste or turbidity.

d. hazardous substances, toxic corrosive, nonconventional materials concentrations, or other deleterious substances, chemicals, and materials, which alone or in combination with other substances or in combination with other components of discharges, or their breakdown products, are acutely or chronically toxic, carcinogenic, teratogenic, and injure, or bioaccumulate, biomagnify, bioconcentrate, or produce adverse physiological responses in human beings and/or fish and aquatic life, or which interfere directly or indirectly with designated, existing, or other uses.

e. exotic nuisance species, e.g. purple loosestrife, zebra mussels, etc.

f. toxic pollutants in quantities that result bioaccumulation in aquatic organisms leading to toxicity to consumers of the aquatic organisms.

g. excess nutrients that may cause a condition harmful to human health, decrease fish habitat, cause nuisance aquatic growths, or that in any way impair designated uses. Nitrogen and phosphorous concentrations shall not exceed the levels stated in Article XIII of this document.

h. microorganisms at levels that make recreation in and on Reservation waters unsafe.

i. floating debris, oil, scum and other floating materials as a result of human activity in amounts sufficient to be unsightly, cause degradation or impair designated uses.

j. materials entering the waters as a result of human activity producing color, odor, taste or other conditions in amounts sufficient to be unsightly, cause degradation or in any way impair designated uses.

k. substances other than from natural causes that may settle to form objectionable deposits or adversely impact designated uses.

l. contaminants, from other than natural causes, that may settle or remain suspended that have a deleterious effect on the aquatic life or that will significantly alter the physical or chemical properties of the water body or that in any way impairs designated uses.

7-3. All wetlands shall be protected to maintain and restore their natural physical, biological, and chemical characteristics, including substrate, vegetative and hydrological conditions necessary to support natural amounts of native vegetation, maintain natural hydrodynamics and maintain natural water temperature variations that are necessary to protect and support all existing and designated uses.

7-4. All naturally occuring biological communities and the habitat needed to support them shall be maintained and protected in all waters and wetlands of the Reservation at all times.

7-5. Concentrations of radioactive materials shall not exceed concentrations caused by local naturally occuring materials.

7-6. All Waters of the Reservation shall be free from unauthorized discharges at all places at all times.

7-7. Any activity that allows storm discharges or base flow conditions to significantly degrade stream morphology or result in a waterway's inability to maintain existing aquatic life shall be prohibited. Cumulative impacts of any such activity shall be considered.

7-8. Waters contained in intermittent and ephemeral streams shall meet all water quality criteria applicable to any perennial streams to which they are tributaries.

7-9. All criteria should be met at all times and all locations, including low flow rates. However, allowance may be made for mixing, on a case by case basis, where compliance with the chronic criteria is not technically feasible. In such cases mixing zones shall be established consistent with 40 C. F. R. Pt. 132, Appendix F, Procedure 3. In no case will mixing be permitted in biologically or recreationally sensitive areas. In no case may the acute criteria be exceeded.

7-10. Natural native biological/ecological communities associated with Waters of the Reservation and their biotic and abiotic components and relationships shall be protected.

7-11. Waters of the Reservation shall not be degraded below their present water quality nor shall new or increased discharges be permitted unless it is determined by the Environmental Department that the accompanying water quality degradation from such discharges will provide unique benefits in

accordance with Section 6-7 and Section 6-8. All existing and designated uses shall be protected at all times.

7-12. Any activities that degrade the aesthetic quality, stability and/or ecological integrity of the Waters of the Reservation shall be prohibited unless authorized in a manner consistent with the water quality standards contained herein.

7-13. The discharge of toxicants into the Waters of Reservations that are known or found to be synergistic with other pollutants shall be addresses on a case by case basis.

7-14. For substances where numeric criteria have not yet been adopted by the Oneida Nation, the numeric criteria and methodologies in 40 C. F. R. Pt. 132, Appendices A-D shall be used and are incorporated into these standards by reference.

Article IX. Designated Uses

9-1. All of the following categories of designated uses shall apply to all Waters of the reservation except where noted.

9-2. *Public Water Supply*. Waters specifically designated as suitable or intended to become suitable for providing an adequate supply of drinking water for the continuation of the health, safety and welfare of the Nation's members and residents of the Oneida Reservation.

9-3. *Wildlife.* All surface waters capable of providing a water supply and vegetative habitat for the support and propagation of all wildlife located within the exterior boundaries of the Oneida Nation Reservation.

9-4. *Aquatic Life.* Waters of the Reservation shall be categorized as one the following:

1. *Cold Water Ecosystems*: Waters of the Reservation where water temperature, habitat and other characteristics are suitable or intended to be suitable for the support and propagation of cold water fish and other aquatic life, or serving as a spawning or nursery area for cold water fish species. Examples of cold water fish include brook trout and rainbow trout. Trout Creek, Lancaster Brook and associated tributaries are hereby designated as cold water ecosystems.
2. *Warm Water Ecosystems:* Waters of the Reservation where water temperature, habitat and other characteristics are suitable or intended to be suitable for support and propagation of warm water fish and other aquatic life, or serving as a spawning or nursery area for warm water fish species. Examples of warm water fish species include large mouth bass and bluegills. All Waters of the Reservation are hereby designated as warm water ecosystems except those mentioned in Section 9-4(a).

9-5. *Subsistence Fishing.* Water of the Reservation where spearing, netting or bow fishing is allowed as stated in the Oneida Conservation Hunting and Fishing Law.

9-6. *Cultural.* Waters that are suitable or intended to be suitable for traditional, cultural, historic and modern ceremonial uses which uses which may include, but are not limited to the harvest and use of medical plants and wildlife associated with aquatic, wetland and riparian habitats; cultural educational uses including but not limited to ethnohydrological learning experiences that are passed from one generation to the next regarding the harvest of plants, fish, and animals; subsistence fishing; and activities that may require the protection of sensitive and valuable aquatic plant and wildlife, and aquatic, wetland and riparian habitat.

9-7. Recreation.

1. *Primary Contact Recreational:* Waters that are suitable for activities involving prolonged human contact where the risk of ingesting small quantities of water is likely; examples of this type of activity include, but are not limited to, swimming, tubing, rafting, skin diving, etc. The Norbert Hill Pond is hereby designated as a primary contact recreational area.
2. *Secondary Contact Recreational:* Waters that are suitable for activities in which human contact with the water may, but need not occur and in which the probability of ingesting raw water is unlikely. Examples of this type of activity include, but are not limited to, fishing, wading, boating, etc. All Waters of the Reservation are hereby designated as secondary contact recreational

areas except for those mentioned in Section 9-5(a).

9-8. *Agricultural.* Waters that are suitable for crop irrigation and livestock ingestion.

9-9. *Navigational.* Waters that are suitable for navigation in and on the water.

9-10. *Industrial.* Waters that are suitable for manufacturing and/or production enterprises.

Passamaquoddy Tribe, Pleasant Point Reservation

[WQS currently awaiting approval by EPA Region 9]

Pyramid Lake Paiute Tribe

[WQS currently awaiting approval by EPA Region 9]

INTERSTATE COMMISSIONS

Delaware River Basin Commission

SOURCE: Delaware River Basin Commission West Trenton, New Jersey. Administrative Manual — Part III, Water Quality Regulations, Revised to Include Amendments Through October 23, 1996, Article 3 Water Quality Standards for the Delaware River Basin [Comprehensive Plan, Section X]:
http://www.state.nj.us/drbc/regs/wq-regs.pdf

3.10 BASINWIDE SURFACE WATER QUALITY STANDARDS

3.10.2 Water Uses

B. Uses to be Protected. The quality of Basin waters, except intermittent streams, shall be maintained in a safe and satisfactory condition of the following uses:

2. wildlife, fish and other aquatic life;

3.10.3 Stream Quality Objectives

A. Antidegradation of Waters

2. Special Protection Waters. It is the policy of the Commission that there be no measurable change in existing water quality except towards natural conditions in waters considered by the Commission to have exceptionally high scenic, recreational, ecological, and/or water supply values. Waters with exceptional values could be classified by the Commission as Outstanding Basin Waters or Significant Resource Waters.

In determining waters suitable for classification as Special Protection Waters, the Commission will consider nomination petitions from local, state and federal agencies and governing bodies, and the public for waters potentially meeting the definition of Outstanding Basin Waters and Significant Resource Waters as described in 3.10.3A.2.a.

The following policies shall apply to waters classified by the Commission as Outstanding Basin Waters or Significant Resource Waters and their drainage areas:

a. Definitions

1) "Outstanding Basin Waters" are interstate and contiguous intrastate waters that are contained within the established boundaries of national parks; national wild, scenic and recreational rivers systems; and/or national wildlife refuges that are classified by the Commission under Subsection 2.g.1). hereof as having exceptionally high scenic,

recreational, and ecological values that require special protection.

2) "Significant Resource Waters" are interstate waters classified by the Commission under Subsection 2.g.2). hereof as having exceptionally high scenic, recreational, ecological, and/or water supply uses that require special protection.

3) "Existing Water Quality" is defined as the actual concentration of a water constituent at an in-stream site or sites, as determined through field measurements and laboratory analysis of data collected over a time period determined by the Commission to adequately reflect the natural range of the hydraulic and climatologic factors which affect water quality. Existing water quality shall be described in terms of (a) an annual or seasonal mean of the available water quality data, (b) two-tailed upper and lower 95 percent confidence limits around the mean, and (c) the 10th and 90th percentiles of the data set from which the mean was calculated. Where available data are insufficient to determine existing water quality, existing water quality may be estimated from data obtained from sites within the same ecoregion or from best scientific judgment.

4) "Measurable Change" is defined as an actual or estimated change in a mean (annual or seasonal) in-stream pollutant concentration that is outside the range of the two-tailed upper and lower 95 percent confidence limits that define existing water quality. In the absence of adequate available data, background concentrations will be assumed to be zero and "measurable change" will be based on in-stream concentrations greater than the detection limit for each parameter, based on the lowest limit of the most sensitive technique specified in 40 CFR Part 136.

Excerpted from Table 1: Definition of Existing Water Quality in the Delaware River Between Hancock, NY and the Delaware Water Gap:

Part A: Upper Delaware Scenic & Recreational River

Parameter	Mean	95 Percent Confidence Limits of Mean	10^{th} and 90^{th} Percentiles	Additional
....	....	....	...	....
Biocriteria: Shannon-Weiner	3.6	3.4 to 3.8	2.7 and 4.3	May - Sept; reachwide
Biocriteria: Equitability	0.8	0.7 to 0.9	0.5 and 1.1	May - Sept; reachwide
Biocriteria:: EPT	15.5	13.8 to 17.2	8.0 and 24.0	May - Sept; reachwide

Part B: Delaware River from Millrift through the Delaware Water Gap Including the Middle Delaware Scenic and Recreational River

Parameter	Mean	95 Percent Confidence Limits of Mean	10^{th} and 90^{th} Percentiles	Additional
....	....	....	...	....
Biocriteria: Shannon-Weiner	3.6	3.4 to 3.7	3.2 and4.1	May - Sept; reachwide
Biocriteria: Equitability	0.8	0.7 to 0.9	0.5 and 1.1	May - Sept; reachwide

Biocriteria: EPT	13.9	12.8 to 15.1	8.0 and 20.0	May - Sept; reachwide

Ohio River Valley Water Sanitation Commission

SOURCE: Ohio River Valley Water Sanitation Commission Pollution Control Standards for discharges to the Ohio River, 2000 Revision: http://www.orsanco.org/watqual/standards/PollutionControl.pdf and http://www.orsanco.org/

II. Definitions

B. "Biological integrity" means the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to those best attainable given ecoregional attributes and the modified habitat types of the river.

H. "Early Life Stages" of fish means the pre-hatch embryonic period, the post-hatch free embryo or yolk-sac fry, and the larval period, during which the organism feeds. Juvenile fish, which are anatomically rather similar to adults, are not considered an early life stage.

R. "Representative Aquatic Species" means those species of aquatic life whose protection and propagation will assure the sustained presence of a balanced indigenous community. Such species are representative in the sense that maintenance of suitable water quality conditions will assure the overall protection and sustain propagation of the balanced, indigenous community.

IV. Water Quality Criteria

B. Aquatic Life Protection. To provide protection of warm water aquatic life habitats, the following criteria shall be met outside the mixing zone:
   1. BIOLOGICAL: The biological integrity of the Ohio River shall be protected and preserved.

5. LIST OF ACRONYMS AND DEFINITION OF TERMS

5.1 Acronyms

AL	Aquatic Life
ALU	Aquatic Life Use
ALUS	Aquatic Life Use Support
ANOVA	Analysis of Variance
BMP	Best Management Practice
CALM	Consolidated Assessment Listing Methodology
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CWA	Clean Water Act
DO	Dissolved Oxygen
DQO	Data Quality Objectives
EDAS	Ecological Data Application System
EMAP	Environmental Monitoring and Assessment Program
EPT	Ephemeroptera, Plecoptera, Trichoptera
FTE	Full Time Employees
GIS	Geographic Information System
GPS	Global Positioning System
HBI	Hilsenhoff Biotic Index
IBI	Index of Biological/Biotic Integrity
MACS	Mid-Atlantic Coastal Streams
NAWQA	National Water Quality Assessment Program
NCBI	North Carolina Biotic Index
NHD	National Hydrography Database
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
POTW	Publicly Owned Treatment Works
QA	Quality Assurance

QAPP	Quality Assurance Project Plan
QC	Quality Control
QHEI	Qualitative Habitat Evaluation Index
QMP	Quality Management Plan
RBP	Rapid Bioassessment Protocols
RCRA	Resource Conservation and Recovery Act
REMAP	Regional Environmental Monitoring and Assessment Program
RIVPACS	River Invertebrate Prediction and Classification System
RF3	River Reach File 3
SOP	Standard Operating Procedures
STORET	Data Storage and Retrieval System
TMDL	Total Maximum Daily Load
UAA	Use Attainability Analyses
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WQ	Water Quality
WQS	Water Quality Standards
WWTP	Waste Water Treatment Plant

5.2 Definition of Terms

Accuracy	the degree of agreement between an observed value and an accepted reference value.
Ambient Monitoring	sampling and evaluation of receiving waters not necessarily associated with episodic perturbations.
Analysis of Variance	a general statistical method for comparing the mean response to different treatments using the ratio of among-group to between-group variance. The method has also been applied to estimating precision and quantifying sources of variance.
Antidegradation Statement	statement that protects existing designated uses and prevents high-quality waterbodies from deteriorating below the water quality necessary to maintain existing or anticipated designated beneficial uses.

Aquatic Assemblage	an association of interacting populations of organisms in a given waterbody, for example, fish assemblage or a benthic macroinvertebrate assemblage.
Aquatic Community	an association of interacting assemblages in a given waterbody, the biotic component of an ecosystem.
Aquatic Life Use	a beneficial use designation in which the waterbody 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 state agency.
Beneficial Uses	desirable uses that 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 sediments, 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 (28 meshes per inch, 0.595 mm openings). Also referred to as benthos, infauna, or macrobenthos.
Benthos	see Benthic Macroinvertebrates.
Best Management Practice	an engineered structure or management activity, or combination of these, that eliminates or reduces an adverse environmental effect of a pollutant.
Bias	the systematic or persistent distortion of a measurement process which deprives the result of representativeness (i.e., the expected sample measurement is different than the sample's true value).
Biological Assessment or Bioassessment	an evaluation of the biological condition of a waterbody using surveys of the structure and function of the community of resident biota.
Biological Criteria or Biocriteria	narrative expressions or numerical values that describe the reference biological condition (structure and function) of aquatic communities inhabiting waters of a given designated aquatic life use. Biocriteria are based on the numbers and kinds of organisms present and are regulatory-based biological measurements.
Biological Diversity or Biodiversity	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 items and their relative frequencies. For biological diversity, these items 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.
Biological Indicator or Bioindicator	an organism, species, assemblage, or community characteristic of a particular habitat, or indicative of a particular set of environmental conditions.

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.
Biological Monitoring or Biomonitoring	use of a biological entity as a detector and its response as a measure to determine environmental conditions. Ambient biological surveys and toxicity tests are common biological monitoring methods.
Biological Survey or Biosurvey	collecting, processing, and analyzing a representative portion of the resident aquatic community to determine its structural and/or functional characteristics.
Bioregion	any geographical region characterized by a distinctive flora and/or fauna.
Clean Water Act	an act passed by the U.S. Congress to control water pollution (formerly referred to as the Federal Water Pollution Control Act of 1972). Public Law 92-500, as amended. 33 U.S.C. 1251 et seq.
Clean Water Act 303(d)	This section of the Act requires States, territories, and authorized tribes to develop lists of impaired waters for which 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.
Clean Water Act 305(b)	biennial reporting requires description of the quality of the Nation's surface waters, evaluation of progress made in maintaining and restoring water quality, and description of the extent of remaining problems.
Criteria	limits on a particular pollutant or condition of a waterbody presumed to support or protect the designated use or uses of a waterbody. Criteria may be narrative or numeric.
Data Quality Objectives	qualitative and quantitative statements developed by data users to specify the quality of data needed to support specific decisions; statements about the level of uncertainty that a decision maker is willing to accept in data used to support a particular decision.
Data Storage and Retrieval System (STORET)	EPA's largest computerized environmental data system; repository for biological, chemical, and physical data used by state environmental agencies, EPA and other federal agencies, universities, private citizens, and many others.
Designated Use	classification specified in water quality standards for each waterbody or segment describing the level of protection from perturbation afforded by the regulatory programs. The designated aquatic life uses established by the state or authorized tribes set forth the goals for the restoration and/or baseline conditions for maintenance and prevention from further degradation of the aquatic life in specific waterbodies.

Ecological Data Application System (EDAS)	relational database system that allows the user to input, compile, and analyze complex ecological data to make assessments of ecosystem condition.
Ecological Integrity	the condition of an unimpaired ecosystem as measured by combined chemical, physical (including habitat), and biological attributes.
Ecoregion	a relatively homogeneous ecological area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables.
Environmental Monitoring and Assessment Program	a US EPA research program to develop the tools necessary to monitor and assess the status and trends of national ecological resources. EMAP's goal is to develop the scientific understanding for translating environmental monitoring data from multiple spatial and temporal scales into assessments of ecological condition and forecasts of the future risks to the sustainability of our natural resources.
Eutrophication	enrichment of a waterbody with nutrients, resulting in high levels of primary production, often leading to depletion of dissolved oxygen.
Habitat	a place where the physical and biological elements of ecosystems provide a suitable environment including the food, cover, and space resources needed for plant and animal livelihood.
Historical Data	data sets from previous studies, which can range from handwritten field notes to published journal articles.
Index of Biological/Biotic Integrity	an integrative expression of site condition across multiple metrics. An index of biological integrity is often composed of at least seven metrics.
Least Disturbed/Impaired	the physical, chemical and biological conditions of a site, reach, segment, or water body that has the least amount of human disturbance in comparison to others within the water body, class, region, or basin. Least disturbed conditions change over time as land use and management practices change and, therefore, are not a "target" or upper bound of water quality potential (Best available current condition).
Macroinvertebrates	see Benthic Macroinvertebrates.
Macrophytes	large aquatic plants that may be rooted, unrooted, vascular, or algiform (such as kelp); includes submerged aquatic vegetation, emergent aquatic vegetation, and floating aquatic vegetation.
Metric	a calculated term or enumeration representing some aspect of biological assemblage, function, or other measurable aspect and is a characteristic of the biota that changes in some predictable way with increased human influence.

Minimally Disturbed/Impaired	the physical, chemical and biological conditions of a site, reach, segment, or water body in the absence of significant, or with minimal, human disturbance. Historical information or models may be used to help describe the minimally disturbed condition. Minimally disturbed conditions change little over time mostly due to natural processes and, therefore, provide a "target" or upper bound of water quality potential (Best potential condition).
Multimetric Index	an index that combines indicators, 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. See Index of Biotic Integrity.
Multivariate Analysis	statistical methods (e.g. ordination or discriminant analysis) for analyzing physical and biological community data using multiple variables.
Narrative Biocriteria	general statements of attainable or attained conditions of biological integrity and water quality for a given designated aquatic life use.
Nonpoint Source Pollution	pollution that occurs when rainfall, snowmelt, or irrigation water runs over land or through the ground, picks up pollutants, and deposits them into rivers, lakes, and coastal waters or introduces them into ground water.
Numeric Biocriteria	specific quantitative measures (metrics) of desired level of biological condition.
Perennial Streams	permanently inundated surface stream courses. Surface water flows throughout the year except in years of drought.
Periphyton	a broad organismal assemblage composed of attached algae, bacteria, their secretions, associated detritus, and various species of microinvertebrates.
Point Source	an origin of pollutant discharge that is known and specific, usually thought of as effluent from the end of a pipe.
Precision	the degree of variation among individual measurements of the same property, usually obtained under similar conditions.
Quality Assurance	includes quality control functions and involves a totally integrated program for ensuring the reliability of monitoring and measurement data; the process of management review and oversight at the planning, implementation, and completion stages of environmental data collection activities. Its goal is to assure that the data provided are of the quality needed and claimed.

Quality Assurance Plan	a written document that describes the quality assurance procedures, quality control requirements, and other technical activities that must be implemented to ensure that the results of the project or task to be performed will meet project requirements; contains several important guidelines for a program to follow such as objectives and milestones for achieving those objectives, lines of responsibility, accountability of staff for meeting data quality objectives, and accountability for ensuring precision, accuracy, completeness of the data collection activities, and documentation of the sample custody process.
Quality Control	refers to the routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurements process; focuses on the detailed technical activities needed to achieve data of the quality specified by data quality objectives. Quality control is implemented at the bench or field level.
Quality Management Plan	a document that describes an organization's quality system. It identifies the organizational structure, policy and procedures, functional responsibilities of management and staff, lines of authority, and its processes for planning, implementing, documenting, and assessing all activities conducted under the organization's quality system.
Rapid Bioassessment Protocols	cost-effective techniques used to survey and evaluate the aquatic community to detect aquatic life impairments and their relative severity.
Reference Condition	the set of selected measurements or conditions of unimpaired or minimally impaired waterbodies characteristic of a waterbody type in a region.
Reference Site	a specific locality on a waterbody which is unimpaired or minimally impaired and is representative of the expected ecological integrity of other localities on the same waterbody or nearby waterbodies.
Regional Environmental Monitoring and Assessment Program	a US EPA program initiated to assess the applicability of the EMAP approach to answer questions about ecological conditions at regional and local scales. REMAP conducts projects at smaller geographic scales and in shorter time frames than the national EMAP program.
Regional Reference Condition	a description of the chemical, physical, or biological condition based on an aggregation of data from minimally impaired sites that are representative of a waterbody type in an ecoregion, subecoregion, watershed, or political unit.
River Invertebrate Prediction and Classification System	a predictive method developed for use in the United Kingdom to assess water quality using a comparison of observed biological species distributions to those expected to occur based on a model derived from reference data.

River Reach File 3	a national database of 1:100,000 scale Digital Line Graph (DLG) hydrography data in a processed, edgematched, hydrologically networked format. RF3 data are a "directed network" dataset meaning that all stream segments, or reaches, are ordered in a uniform direction.
Sensitivity	capability of a method or instrument to discriminate between measurement responses of a variable of interest.
Standard Operating Procedures	a set of written instructions that document a routine or repetitive activity. SOPs describe both technical and administrative operational elements of an organization that would be managed under a Quality Assurance Project Plan and under an organization's Quality Management Plan.
Stressors	physical, chemical, and biological factors that adversely affect aquatic organisms.
Taxa	a grouping of organisms given a formal taxonomic name such as species, genus, family, etc.
Total Maximum Daily Load	calculation of the maximum amount of a pollutant a waterbody can receive and still meet water quality standards and an allocation of that amount to the pollutant's source.
Use Attainability Analysis	structured scientific assessment of the physical, chemical, biological and economic factors affecting attainment of the uses of waterbodies.
Water Quality Standards	a law or regulation that consists of the beneficial designated use or uses of a waterbody, the narrative or numerical water quality criteria (including biocriteria) that are necessary to protect the use or uses of that particular waterbody, and an antidegradation statement.
Water Resource Management (Non-Regulatory)	decisions on management activities relevant to a water resource such as problem identification, need for and placement of best management practices, pollution abatement actions, and effectiveness of program activity.
Zooplankton	refers to animals which are unable to maintain their position or distribution independent of the movement of water or air.

6. LITERATURE CITED AND ADDITIONAL RESOURCES

6.1 Literature Cited

Davis, W.S. and T.P. Simon (editors). 1995. *Biological assessment and criteria: Tools for water resource planning and decision making*. Lewis Publishers, Boca Raton, Florida.

Frey, D.G. 1977. Biological integrity of water – an historical approach. Pages 127-140 in R.K. Ballentine and L.J. Guarraia (editors). *The Integrity of Water. Proceedings of a Symposium, March 10-12, 1975*. U.S. Environmental Protection Agency, Washington, DC.

Karr, J.R. and D.R. Dudley. 1981. Ecological perspectives on water quality goals. *Environmental Management* 5: 55-68.

Karr, J.R., K.D. Fausch, P.L. Angermeier, P.R. Yant, and I.J. Schlosser. 1986. *Assessing biological integrity in running waters: A method and its rationale*. Illinois Natural History Survey. Special Publication 5, Champaign, Illinois.

Leopold, Aldo. 1949. *A Sand County Almanac and sketches here and there*. Oxford University Press, New York (many editions).

USEPA. 1989. *Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish*. EPA 440-4-89-001. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, DC.

USEPA. 1990. *Biological criteria: National program guidance for surface waters*. EPA-440/5-90-004. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1992. *Procedures for initiating narrative biological criteria*. EPA 822-B-92-002. U.S. Environmental Protection Agency, Office of Science and Technology, Washington, DC.

USEPA. 1996a. *Biological criteria: technical guidance for streams and small rivers*. EPA 822-B-96-001. U.S. Environmental Protection Agency, Office of Science and Technology, Washington, DC.

USEPA. 1996b. *Summary of state biological assessment programs for streams and rivers*. EPA 230-R-96-007. U.S. Environmental Protection Agency, Office of Policy, Planning, and Evaluation, Washington, DC.

USEPA. 1998a. *Lake and reservoir bioassessment and biocriteria technical guidance document*. EPA 841-B-98-007. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1998b. *Water quality criteria and standards plan – Priorities for the future*. EPA 822-R-98-003. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1999. *Rapid bioassessment protocols for use in streams and wadeable rivers: Periphyton, benthic macroinvertebrates and fish, Second edition*. EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 2000. *Estuarine and coastal marine waters: Bioassessment and biocriteria technical guidance*. EPA 822-B-00-024. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 2002. *Methods for evaluating wetland condition: Introduction to wetland biological assessment*. EPA-822-R-02-014. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 2002. *Methods for evaluating wetland condition: Developing metrics and indexes of biological integrity*. EPA-822-R-02-016. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 2002. *Methods for evaluating wetland condition: Wetlands classification*. EPA 822-R-02-017. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 2002. *Methods for evaluating wetland condition: Developing an invertebrate index of biological integrity for wetlands*. EPA 822-R-02-019. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 2002. *Methods for evaluating wetland condition: Using amphibians in bioassesments of wetlands.* EPA 822-R-02-022. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 2002. *Methods for evaluating wetland condition: Biological assessment methods for birds.* EPA 822-R-02-023. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

U.S. House of Representatives. 1972. House Report 92-911. Washington, Government Printing Office.

Yoder, C.O. and E.T. Rankin. 1995. Biological criteria program development and implementation in Ohio. In *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making*, W.S. Davis and T.P. Simon (editors), pp. 109-144. Lewis Publishers, Boca Raton, Florida.

6.2 Additional Resources

More information and guidance on biological assessments and criteria can be found in the documents and websites listed below.

Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977: [Commonly Referred to as Clean Water Act] [Enacted by Public Law 92-500, October 18, 1972, 86 Stat. 816; 33 U.S.C. 1251 et seq.; Amended by PL 93-207, December 28, 1973, and PL 93-243, January 2, 1974; PL 93-592, January 2, 1975; PL 94-238, March 23, 1976; PL 94-273, April 21, 1976; PL 94-558, October 19, 1976; PL 95-217, December 28, 1977; PL 95-576, November 2, 1978; PL 96-148, December 16, 1979; PL 96-478, PL 96-483, October 21, 1980; PL 96-510, December 11, 1980; PL 96-561, December 22, 1980; PL 97-35, August 13, 1981; PL 97-117, December 29, 1981; PL 97-164, April 2, 1982; PL 97-440, January 8, 1983; Amended by PL 100-4, February 4, 1987]

Intergovernmental Task Force on Monitoring Water Quality [ITFM]. 1995. *The strategy for improving water-quality monitoring in the United States: Final report of the Intergovernmental Task Force on Monitoring Water Quality. Technical Appendixes.* U.S. Geological Survey, Reston, VA.

USEPA 1983. *Technical support manual: Waterbody surveys and assessments for conducting use attainability analyses*. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Criteria and Standards Division, Washington, DC.

USEPA. 1989. *Regionalization as a tool for managing environmental resources*. EPA/600/3-89/060. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR.

USEPA. 1989. *Standard operating procedures for the collection of and laboratory identification of freshwater benthic macroinvertebrates*. U.S. Environmental Protection Agency, Region 5, Chicago, IL.

USEPA. 1990. *Macroinvertebrate field and laboratory methods for evaluating the biological integrity of surface waters*. EPA/600/4-90/030. U.S. Environmental Agency, Office of Water, Washington, DC.

USEPA. 1991. *Biological criteria: Guide to technical literature*. EPA/5-91-004. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1991. *Biological criteria: Research and regulation – Proceedings of a symposium*. EPA-440/5-91-005. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1991. *Biological criteria: State development and implementation efforts*. EPA-440/5-91-003. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1991. Transmittal of Final Policy on Biological Assessments and Criteria (Memorandum). From Tudor T. Davies, Director, Office of Science and Technology to Waste Management Division Directors, Regions I-X. June 19, 1991. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1994. *Water Quality Standards Handbook, Second Edition*. EPA 823-B-94-005. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1995. *Generic quality assurance project plan guidance for programs using community level biological assessment in wadeable streams and rivers*. EPA 841-B-95-004. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1996. *Bioindicators for assessing ecological integrity of prairie wetlands*. EPA/600/R-96/082. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR.

USEPA. 1996. *Biological assessment methods, biocriteria, and biological indicators. Bibliography of selected technical, policy, and regulatory literature.* EPA 230-B-96-001. U.S. Environmental Protection Agency, Office of Policy, Planning and Evaluation, Washington, DC.

USEPA. 1996. *The volunteer monitor's guide to quality assurance project plans*. EPA 841-B-96-003. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1997. *Volunteer stream monitoring: A methods manual*. EPA 841-B-97-003. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1998. *Development of biological criteria for coral reef ecosystem assessment*. U.S. Environmental Protection Agency, Office of Science and Technology, Health and Ecological Criteria Division, Washington, DC.

USEPA. 1998. *Wetland bioassessment fact sheets*. EPA 843-F-98-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 2000. *Stressor identification guidance document*. EPA 822-B-00-025. U.S. Environmental Protection Agency, Offices of Water and Research and Development, Washington, DC.

USEPA. 2002. *Biological assessment and criteria: Crucial components of water quality programs*. EPA 822-F-02-006. U.S. Environmental Agency, Office of Water, Washington, DC.

USEPA Office of Environmental Information, Biological Indicators of Watershed Health website: http://www.epa.gov/bioindicators/index.html

USEPA Office of Science and Technology, Bioassessment and Biocriteria website: http://www.epa.gov/ost/biocriteria/index.html

USEPA Office of Water, Monitoring and Assessing Water Quality, Biological Assessment website: http://www.epa.gov/owow/monitoring/bioassess.html

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A.

BIOASSESSMENT PROGRAMS FOR STREAMS AND WADEABLE RIVERS (2001)

Appendix A. Bioassessment programs for streams and wadeable rivers (2001)

Entity	Stream/river miles		Number of miles assessed using biology				Assemblages assessed				Habitat assessment	Reference site determination	Characterization of regional reference sites	Data analysis tools & methods	Impairment thresholds	Bioassessment uses				Other waterbody types with biological programs
Name	Total miles	Perennial miles	Total miles assessed	fully supporting for 305(b)	partially/non-supporting for 305(b)	listed for 303(d)	Benthos	Fish	Periphyton	Other	VB = visual based; QM = quantitative measurements; HY = hydrogeomorphology; O = other	SS = site specific; PW = paired watersheds; R =regional; PJ = professional judgment; O = other	HC = historical conditions; LD = least disturbed sites; GR = gradient response; PJ = professional judgment; MD = minimally disturbed; O = other	TG = tables & graphs; PA = parametric ANOVAs; MV = multivariate; BM = biological metrics; DG = disturbance gradients; O = other	MM = multimetric; MV = multivariate; CDF = cumulative distribution function; O = other	Water resource management	Aquatic Life Use Support (ALUS) in 305(b) reporting	Biocriteria in WQS		LR = large rivers; LK = lakes; RES = reservoirs; ENC = estuaries/ near coastal marine; WL = wetlands
																		Narrative	Numeric	
STATES																				
Alabama	77,274	47,077	7,103.5	5,124.4	1,979.1	1,979.1	Y	Y	N	Y	VB	R	LD	TG, BM	MM - O	Y	Y	N	N	LR, WL
Alaska	>3 million	unknown	150 water-sheds	140 water-sheds	10 water-sheds	10 water-sheds	Y	N	UD	N	VB, HY	SS, PJ	MD	TG, BM	MM - 1st quartile from the 95th %tile	Y	UD	N	N	LR, LK, ENC, WL
Arizona	127,505	4,980	0	n/a	n/a	n/a	Y	N	Y	N	VB, QM, HY	R	LD, PJ, MD	BM	MM - 25th %tile of ref. pop.	Y	N	UD	N	RES (UD)
Arkansas	87,617	28,408	245 stream segments	n/a	n/a	n/a	Y	Y	N	N	VB, QM, HY, O	SS, PW, R, PJ, O	HC, LD, PJ	TG, MV, BM, DG	MM - O	Y	N	Y	N	LR, LK, RES, WL
California	211,513	64,438	unknown	unknown	unknown	unknown	Y	N	N	N	VB	PJ, O	LD	PA, MV, BM	MV - UD	Y	UD	Y	N	LR, LK, ENC (limited)
Colorado	107,403	31,415	n/a	n/a	n/a	85.1	Y	Y	**UD**	N	VB, HY, O	SS, PJ	HC, LD, PJ, O	TG, BM	MM - UD	Y	N	UD	N	LR, LK, RES

n/a = not applicable; pop. = population; ref. = reference; UD = under development; WQS = water quality standards; – = none or information not reported

Entity	Stream/river miles		Number of miles assessed using biology				Assemblages assessed				Habitat assessment	Reference site determination	Characterization of regional reference sites	Data analysis tools & methods	Impairment thresholds	Bioassessment uses				Other waterbody types with biological programs
Name	Total miles	Perennial miles	Total miles assessed	fully supporting for 305(b)	partially/non-supporting for 305(b)	listed for 303(d)	Benthos	Fish	Periphyton	Other	VB = visual based; QM = quantitative measurements; HY = hydrogeomorphology; O = other	SS = site specific; PW = paired watersheds; R =regional; PJ = professional judgment; O = other	HC = historical conditions; LD = least disturbed sites; GR = gradient response; PJ = professional judgment; MD = minimally disturbed; O = other	TG = tables & graphs; PA = parametric ANOVAs; MV = multivariate; BM = biological metrics; DG = disturbance gradients; O = other	MM = multimetric; MV = multivariate; CDF = cumulative distribution function; O = other	Water resource management	Aquatic Life Use Support (ALUS) in 305(b) reporting	Biocriteria in WQS		LR = large rivers; LK = lakes; RES = reservoirs; ENC = estuaries/ near coastal marine; WL = wetlands
																		Narrative	Numeric	
Connecticut	5,830	5,484	961	764	195	n/a	Y	Y	Y	Y	VB	SS, O	LD	TG, BM	MM - O	Y	Y	Y	N	ENC
Delaware	2,506	1,778	2,506	741	1,765	1,173	Y	N	N	N	VB	R, PJ	LD	BM	MM - 67th %tile of ref. pop.	Y	N	N	UD	WL
District of Columbia	39	–	39	0	39	unknown	Y	Y	N	Y	HY	PJ	–	BM	–	Y	Y	Y	N	LR, WL
Florida	51,858	22,993	4,795	4,365	430	430	Y	N	Y	Y	VB	R, PJ	LD, GR	TG, BM, DG	MM - quadra-section of best score	Y	Y	Y	Y	LR, LK, RES, ENC, WL
Georgia	70,150	44,056	1,416	477	939	–	Y	Y	N	N	VB, O	R	LD	TG, BM	MM - UD, MV - UD	Y	Y	Y	N	LR
Hawai`i	249	249	15	5	10	10	UD	Y	N	N	VB, O	R	LD	TG, BM	MM - UD	Y	UD	UD	UD	–
Idaho	96,200	49,500	16,742	8,434	8,312	8,312	Y	Y	Y	N	VB, O	R, PJ	LD, PJ, MD	TG, PA, MV, BM, DG	MM - 25th %tile of ref. pop.	Y	Y	Y	N	LK, RES
Illinois	86,021	30,246	15,304	9,498	5,806	unknown	Y	Y	N	N	VB, QM	SS, O	HC, LD, PJ	TG, PA, MV, BM, DG, O	MM - O	Y	Y	UD	N	LR
Indiana	35,673	21,094	35,430	23,000	12,430	unknown	Y	Y	Y	Y	VB	R, PJ	HC, LD, GR, O	TG, PA, MV, BM, DG	MM - CDF, O, MV - O	Y	Y	UD	N	LR, LK, RES, WL

n/a = not applicable; pop. = population; ref. = reference; UD = under development; WQS = water quality standards; – = none or information not reported

Entity	Stream/river miles		Number of miles assessed using biology				Assemblages assessed				Habitat assessment	Reference site determination	Characterization of regional reference sites	Data analysis tools & methods	Impairment thresholds	Bioassessment uses				Other waterbody types with biological programs
Name	Total miles	Perennial miles	Total miles assessed	fully supporting for 305(b)	partially/non-supporting for 305(b)	listed for 303(d)	Benthos	Fish	Periphyton	Other	VB = visual based; QM = quantitative measurements; HY = hydrogeomorphology; O = other	SS = site specific; PW = paired watersheds; R =regional; PJ = professional judgment; O = other	HC = historical conditions; LD = least disturbed sites; GR = gradient response; PJ = professional judgment; MD = minimally disturbed; O = other	TG = tables & graphs; PA = parametric ANOVAs; MV = multivariate; BM = biological metrics; DG = disturbance gradients; O = other	MM = multimetric; MV = multivariate; CDF = cumulative distribution function; O = other	Water resource management	Aquatic Life Use Support (ALUS) in 305(b) reporting	Biocriteria in WQS		LR = large rivers; LK = lakes; RES = reservoirs; ENC = estuaries/ near coastal marine; WL = wetlands
																		Narrative	Numeric	
Iowa	71,665	26,630	2,018	1,418	600	n/a	Y	Y	N	N	VB, QM	R, PJ	LD	TG, PA, MV, BM, DG	MM - 25th %tile of ref. pop.	Y	Y	UD	N	LR
Kansas	134,338	23,731	23,731	n/a	n/a	n/a	Y	Y	Y	Y	VB, QM	PJ	HC, LD	TG, BM, O	MM - UD	Y	Y	Y	N	LK, RES, WL
Kentucky	89,431	34,334	~30,000	~20,000	~10,000	7,500	Y	Y	Y	N	VB	R	LD, MD	MV, BM	MM - 25th %tile of ref. pop.	Y	Y	Y	N	LR
Louisiana	66,294	–	–	n/a	n/a	n/a	Y	Y	N	N	VB	SS, PJ	HC, LD, O	TG, MV, BM, O	MM - CDF, O	Y	N	Y	N	–
Maine	31,672	23,879	1,000	858.5	141.5	141.5	Y	N	Y	N	VB	R, PJ	LD, GR, PJ, MD	TG, MV, BM, DG	MV	Y	Y	Y	UD	LR, LK (UD), RES, ENC
Maryland	17,000	12,343	6,142	3,429	2,713.4	178 actual listings	Y	Y	N	Y	VB, QM, O	O	LD	TG, PA, MV, BM, DG, O	MM - 10th %tile	Y	Y	UD	N	ENC
Massachusetts	8,229	7,133	1,344	649	695	695	Y	Y	Y	Y	VB	SS, PW, R, PJ	LD	TG, BM	MM - 83rd %tile of ref. pop.	Y	Y	N	N	LK, RES
Michigan	49,141	27,873	21,469	15,469	6,000	2,600	Y	Y	N	N	VB	SS	n/a	TG, BM	MM - O	Y	Y	N	N	LR
Minnesota	91,944	32,985	2,047	1,575	472	785	Y	Y	N	Y	QM	R, PJ	LD, O	TG, BM, DG	MM - O	Y	Y	Y	N	LR, LK, RES, WL

n/a = not applicable; pop. = population; ref. = reference; UD = under development; WQS = water quality standards; – = none or information not reported

Entity	Stream/river miles		Number of miles assessed using biology				Assemblages assessed				Habitat assessment	Reference site determination	Characterization of regional reference sites	Data analysis tools & methods	Impairment thresholds	Bioassessment uses				Other waterbody types with biological programs
Name	Total miles	Perennial miles	Total miles assessed	fully supporting for 305(b)	partially/non-supporting for 305(b)	listed for 303(d)	Benthos	Fish	Periphyton	Other	VB = visual based; QM = quantitative measurements; HY = hydrogeomorphology; O = other	SS = site specific; PW = paired watersheds; R =regional; PJ = professional judgment; O = other	HC = historical conditions; LD = least disturbed sites; GR = gradient response; PJ = professional judgment; MD = minimally disturbed; O = other	TG = tables & graphs; PA = parametric ANOVAs; MV = multivariate; BM = biological metrics; DG = disturbance gradients; O = other	MM = multimetric; MV = multivariate; CDF = cumulative distribution function; O = other	Water resource management	Aquatic Life Use Support (ALUS) in 305(b) reporting	Biocriteria in WQS		LR = large rivers; LK = lakes; RES = reservoirs; ENC = estuaries/ near coastal marine; WL = wetlands
																		Narrative	Numeric	
Mississippi	84,003	26,454	1,365	505	860	860	Y	N	N	N	VB, O	R	LD	TG, MV, BM, DG	MM - UD	Y	Y	N	N	LR, LK, ENC
Missouri	52,194	22,194	21,996	11,519	10,477	n/a	Y	Y	N	N	VB, QM, O	SS, R, PJ, O	LD, MD	TG, PA, MV, BM	MM - cumulative score = 81% of ref. condition	Y	Y	Y	UD	LR
Montana	176,750	53,221	9,076	1,340	7,736	7,736	Y	Y	Y	Y	VB, QM, HY, O	SS, R, PJ	HC, LD, PJ, MD	TG, PA, MV, BM, DG	MM - 75% of ref. condition	Y	UD	UD	N	LR, LK, RES
Nebraska	81,573	16,090	16,314	13,867	2,447	0	Y	Y	N	N	VB, QM	SS, R, PJ	LD, O	TG, PA, BM	MM - 25th %tile of ref. pop.	Y	Y	Y	N	LK, RES , WL
Nevada	143,578	14,988	602	0	0	0	Y	N	UD	N	VB, QM, O	SS, PW, R, PJ (all UD)	HC, LD, PJ (all UD)	TG, MV, BM (UD), DG	–	Y	UD	UD	N	RES
New Hampshire	10,881	8,636	400	389	11	0	Y	Y	N	Y	VB	SS, PJ	n/a	TG, BM	–	Y	Y	Y	UD	LK, WL
New Jersey	6,500	–	330	121	209	–	Y	Y	N	N	VB	R, PJ	LD	BM	MM - USEPA RBPs	Y	Y	N	N	LK, ENC (all UD)
New Mexico	110,741	8,682	~5,875	~3,200	~2,675	UD	Y	Y	Y	Y	VB, HY, O	PJ	n/a	TG, BM	MM - 95th %tile of ref. pop.	Y	Y	**N**	N	LR, LK

n/a = not applicable; pop. = population; ref. = reference; UD = under development; WQS = water quality standards; – = none or information not reported

Entity	Stream/river miles		Number of miles assessed using biology				Assemblages assessed				Habitat assessment	Reference site determination	Characterization of regional reference sites	Data analysis tools & methods	Impairment thresholds	Bioassessment uses				Other waterbody types with biological programs
Name	Total miles	Perennial miles	Total miles assessed	fully supporting for 305(b)	partially/non-supporting for 305(b)	listed for 303(d)	Benthos	Fish	Periphyton	Other	VB = visual based; QM = quantitative measurements; HY = hydrogeomorphology; O = other	SS = site specific; PW = paired watersheds; R =regional; PJ = professional judgment; O = other	HC = historical conditions; LD = least disturbed sites; GR = gradient response; PJ = professional judgment; MD = minimally disturbed; O = other	TG = tables & graphs; PA = parametric ANOVAs; MV = multivariate; BM = biological metrics; DG = disturbance gradients; O = other	MM = multimetric; MV = multivariate; CDF = cumulative distribution function; O = other	Water resource management	Aquatic Life Use Support (ALUS) in 305(b) reporting	Biocriteria in WQS		LR = large rivers; LK = lakes; RES = reservoirs; ENC = estuaries/ near coastal marine; WL = wetlands
																		Narrative	Numeric	
New York	52,337	46,266	16,000	15,430	570	484	Y	Y	Y	N	QM	SS	n/a	TG, BM, O	MM - 75th %tile of all sites	Y	Y	N	N	–
North Carolina	37,662	–	32,072	29,929	2,143	2,143	Y	Y	Y	Y	VB	R	LD	TG, PA, BM, DG	MM - O	Y	Y	Y	N	WL, RES
North Dakota	54,427	unknown	14,426	9,923	4,503	–	Y	Y	Y	N	VB, HY	R	LD	TG, BM, DG	MM - O	Y	Y	Y	N	–
Ohio	29,113	29,113	9,535	5,204	4,331	2,052	Y	Y	N	N	VB	R	LD	TG, BM	MM - 25th & 75th %tile of ref. pop.	Y	Y	Y	Y	LR, LK, RES, WL
Oklahoma	78, 778	22,386	13,313	UD	UD	UD	Y	Y	N	N	QM	R, O	LD	TG, BM	MM - CDF	Y	UD	Y	Y	UD
Oregon	114,823	51,695	40,188	12,056	28,132	unknown	Y	Y	Y	Y	QM	R, PJ, O	LD, MD	TG, PA, MV, BM, DG	MM - CDF, MV	Y	Y	Y	UD	LR, ENC
Pennsylvania	83,000	–	45,000	36,900	8,100	8,100	Y	Y	N	Y	VB	PW, R	MD	TG, PA, MV, BM, DG	MM - UD	Y	Y	N	N	LR, LK, ENC, WL
Rhode Island	1,498	979	272.8	188.1	84.7	78.5	Y	N	N	Y	VB	SS, PJ	HC, MD	TG, BM	MM - 75th %tile of ref. pop.	Y	Y	Y	N	–
South Carolina	35,461	25,729	**678.6**	**563.98**	**114.6**	**114.6**	Y	N	N	N	VB	R	LD	TG, BM	MM - CDF	Y	Y	Y	N	LR
South Dakota	9,937	1,932	3.73	n/a	n/a	n/a	Y	N	Y	N	VB, QM, HY	PJ (UD)	LD (UD)	TG, BM	MM - 25th %tile of ref. pop.	Y	N	Y	N	LR, LK, RES

n/a = not applicable; pop. = population; ref. = reference; UD = under development; WQS = water quality standards; – = none or information not reported

Entity	Stream/river miles		Number of miles assessed using biology				Assemblages assessed				Habitat assessment	Reference site determination	Characterization of regional reference sites	Data analysis tools & methods	Impairment thresholds	Bioassessment uses				Other waterbody types with biological programs
Name	Total miles	Perennial miles	Total miles assessed	fully supporting for 305(b)	partially/non-supporting for 305(b)	listed for 303(d)	Benthos	Fish	Periphyton	Other	VB = visual based; QM = quantitative measurements; HY = hydrogeomorphology; O = other	SS = site specific; PW = paired watersheds; R =regional; PJ = professional judgment; O = other	HC = historical conditions; LD = least disturbed sites; GR = gradient response; PJ = professional judgment; MD = minimally disturbed; O = other	TG = tables & graphs; PA = parametric ANOVAs; MV = multivariate; BM = biological metrics; DG = disturbance gradients; O = other	MM = multimetric; MV = multivariate; CDF = cumulative distribution function; O = other	Water resource management	Aquatic Life Use Support (ALUS) in 305(b) reporting	Biocriteria in WQS		LR = large rivers; LK = lakes; RES = reservoirs; ENC = estuaries/ near coastal marine; WL = wetlands
																		Narrative	Numeric	
Tennessee	60,187	–	24,233	16,693	7,540	14,333	Y	N	N	N	VB	R	LD	TG,PA, MV, BM	MM - 25% of 90th %tile of ref. pop.	Y	Y	Y	UD	–
Texas	191,228	40,194	266.9	196.1	70.8	–	Y	Y	N	N	QM	SS, PW, R, PJ	LD	TG, PA, BM	MM - 50th %tile of ref. pop.	Y	Y	Y	N	LR, ENC, WL
Utah	85,916	14,000+	705	75	630	300	Y	N	UD	N	QM, O	n/a	n/a	TG, BM, O	–	Y	N	N	N	LK, RES
Vermont	7,099	7,099	~800	~650	~150	~150	Y	Y	Y	N	VB, HY, O	SS, R, PJ	HC, PJ, MD	TG, PA, MV, BM	MM - CDF	Y	Y	Y	N	–
Virginia	50,329	50,329	15,540.4	13,321.9	2,218.5	2,218.5	Y	N	N	N	VB	SS, PW, PJ	–	TG	–	Y	Y	N	N	LK
Washington	73,886	39,483	3,275	982.5	2,292.5	0	Y	Y	Y	Y	VB, QM, HY	R, PJ	HC, LD, MD	TG, MV, BM	MM - 25th %tile of ref. pop.	Y	Y	UD	N	–
West Virginia	32,278	21,114	5,745	3,706	2,039	1,315	Y	Y	N	N	VB, QM, O	R, PJ	MD	TG, BM	MM - 5th %tile of ref. pop.	Y	Y	N	N	–
Wisconsin	55,000	32,000	24,422	7,989	12,028	–	Y	Y	Y	N	QM	SS, R	LD, PJ, O	TG, PA, MV, BM, DG	MM - 25th %tile of ref. pop.	Y	Y	N	N	LR, LK, RES, WL
Wyoming	113,422	32,520	2,639	2,124	177	177	Y	N	UD	N	VB, QM, HY,	R, PJ	LD, PJ	MV (UD), TG,	MM - 25th %tile	Y	Y	**Y**	UD	LR, LK,

n/a = not applicable; pop. = population; ref. = reference; UD = under development; WQS = water quality standards; – = none or information not reported

Entity	Stream/river miles		Number of miles assessed using biology				Assemblages assessed				Habitat assessment	Reference site determination	Characterization of regional reference sites	Data analysis tools & methods	Impairment thresholds	Bioassessment uses				Other waterbody types with biological programs
Name	Total miles	Perennial miles	Total miles assessed	fully supporting for 305(b)	partially/non-supporting for 305(b)	listed for 303(d)	Benthos	Fish	Periphyton	Other	VB = visual based; QM = quantitative measurements; HY = hydrogeomorphology; O = other	SS = site specific; PW = paired watersheds; R =regional; PJ = professional judgment; O = other	HC = historical conditions; LD = least disturbed sites; GR = gradient response; PJ = professional judgment; MD = minimally disturbed; O = other	TG = tables & graphs; PA = parametric ANOVAs; MV = multivariate; BM = biological metrics; DG = disturbance gradients; O = other	MM = multimetric; MV = multivariate; CDF = cumulative distribution function; O = other	Water resource management	Aquatic Life Use Support (ALUS) in 305(b) reporting	Biocriteria in WQS		LR = large rivers; LK = lakes; RES = reservoirs; ENC = estuaries/ near coastal marine; WL = wetlands
																		Narrative	Numeric	
TERRITORIES																				
American Samoa	–	–	–	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	N	N	N	N	–
Commonwealth of Northern Mariana Islands (CNMI)	–	–	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	N	N	**N**	N	ENC
Puerto Rico	5,394.2	–	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	UD	N	N	N	–
U.S. Virgin Islands	–	–	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	N	N	N	N	–
TRIBES																				
Confederated Tribes of the Colville Res.	–	–	–	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	N	N	N	N	–
Nez Perce Tribe	–	–	–	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	UD	n/a	n/a	n/a	–
Oneida Nation of Wisconsin	233	–	–	n/a	n/a	n/a	Y	Y	N	N	VB, QM	PJ	LD	TG, PA, BM	MM	Y	n/a	n/a	n/a	LR, LK, WL

n/a = not applicable; pop. = population; ref. = reference; UD = under development; WQS = water quality standards; – = none or information not reported

Entity	Stream/river miles		Number of miles assessed using biology				Assemblages assessed				Habitat assessment	Reference site determination	Characterization of regional reference sites	Data analysis tools & methods	Impairment thresholds	Bioassessment uses				Other waterbody types with biological programs
Name	Total miles	Perennial miles	Total miles assessed	fully supporting for 305(b)	partially/non-supporting for 305(b)	listed for 303(d)	Benthos	Fish	Periphyton	Other	VB = visual based; QM = quantitative measurements; HY = hydrogeomorphology; O = other	SS = site specific; PW = paired watersheds; R =regional; PJ = professional judgment; O = other	HC = historical conditions; LD = least disturbed sites; GR = gradient response; PJ = professional judgment; MD = minimally disturbed; O = other	TG = tables & graphs; PA = parametric ANOVAs; MV = multivariate; BM = biological metrics; DG = disturbance gradients; O = other	MM = multimetric; MV = multivariate; CDF = cumulative distribution function; O = other	Water resource management	Aquatic Life Use Support (ALUS) in 305(b) reporting	Biocriteria in WQS		LR = large rivers; LK = lakes; RES = reservoirs; ENC = estuaries/ near coastal marine; WL = wetlands
																		Narrative	Numeric	
Passamaquoddy Tribe, Pleasant Point Res.	–	–	–	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	N	n/a	n/a	n/a	ENC
Pyramid Lake Paiute Tribe	–	–	31+	–	–	–	Y	Y	Y	N	VB, QM	PJ	HC, PJ	UD	UD	Y	n/a	UD	UD	LK
Seminole Tribe of Florida	–	–	–	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	N	N	N	N	–
INTERSTATE COMMISSIONS																				
DRBC	200	–	200	n/a	n/a	n/a	Y	Y	N	Y	VB, HY, O	R, O	HC, LD	TG, BM	–	Y	n/a	Y	Y	LR
ICPRB	383	–	n/a	n/a	n/a	n/a	Y	Y	N	Y	VB	R	LD, GR	TG, PA, MV, BM	MM - UD	Y	n/a	n/a	n/a	–
ORSANCO	981	–	981	974	7	55	Y	Y	N	N	O	SS, R, PJ	LD	TG, PA, MV, BM, DG	MM - 25th %tile of ref. pop.	Y	Y	Y	UD	LR
SRBC	31,193	–	3,520	2,525	995	n/a	Y	N	N	N	VB	R, PJ	LD	TG, BM	MM - O	Y	Y	n/a	n/a	LR

n/a = not applicable; pop. = population; ref. = reference; UD = under development; WQS = water quality standards; – = none or information not reported

APPENDIX B.

EPA CONTACTS

Appendix B. EPA CONTACTS

Regional Biocriteria Coordinators

REGION 1
(CT, ME, MA, NH, Passamaquoddy Tribe - Pleasant Point Reservation, RI, VT)

Peter Nolan, *Regional Biocriteria Coordinator*
USEPA New England Regional Laboratory
Office of Environmental Measurement and Evaluation
11 Technology Drive
North Chelmsford, MA 01863-2431
Phone 617/918-8343, Fax 617/918-8397
email: nolan.peter@epa.gov

REGION 2
(DRBC, NJ, NY, Puerto Rico and the US Virgin Islands)

James Kurtenbach, *Regional Biocriteria Coordinator*
USEPA - Region 2
Facilities - Mail Code MS220
Raritan Depot, 2890 Woodbridge Avenue
Edison, NJ 08837-3679
Phone 732/321-6695, Fax 732/321-6616
email: kurtenbach.james@epa.gov

REGION 3
(DE, DC, ICPRB, MD, PA, SRBC, VA, WV)

Margaret Passmore, *Regional Biocriteria Coordinator*
USEPA - Region 3
Wheeling Operations Office - Mail Code 3ES31
303 Methodist Building
11th and Chapline Streets
Wheeling, WV 26003
Phone 304/234-0245, Fax 304/234-0259
email: passmore.margaret@epa.gov

REGION 4
(AL, FL, GA, KY, MS, NC, Seminole Tribe, SC, TN)

Jim Harrison, *Regional Biocriteria Coordinator*
USEPA - Region 4
61 Forsyth Street, S.W.
Atlanta, GA 30303-8960
Phone 404/562-9271
email: harrison.jim@epa.gov

REGION 5
(IL, IN, MI, MN, OH, ORSANCO, Oneida Nation of Wisconsin, WI)

Ed Hammer, *Regional Biocriteria Coordinator*
USEPA - Region 5
Mail Code WT-15J
77 West Jackson Boulevard
Chicago, IL 60604-3507
Phone 312/886-3019
email: hammer.edward@epa.gov

REGION 6
(AR, LA, NM, OK, TX)

Philip Crocker, *Regional Biocriteria Coordinator*
USEPA - Region 6
Mail Code 6WQ-EW
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733
Phone 214/665-6644, Fax 214/665-7373
email: crocker.philip@epa.gov

Charlie Howell, *Regional Biocriteria Coordinator*
USEPA - Region 6
Mail Code 6WQ-EW
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733
Phone 214/665-8354, Fax 214/665-7373
email: howell.charlie@epa.gov

REGION 7
(IA, KS, MO, NE)

Gary Welker, *Regional Biocriteria Coordinator*
USEPA - Region 7
Mail Code ENSVEMWC
901 North Fifth Street
Kansas City, KS 66101
Phone 913/551-7177, Fax 913/551-9177
email: welker.gary@epa.gov

REGION 8
(CO, MT, ND, SD, UT, WY)

Tina Laidlaw, *Regional Biocriteria Coordinator*
USEPA - Region 8
Phone 303/312-6880, Fax 303/312-6071
email: laidlaw.tina@epa.gov

Jill Minter, *Regional Biocriteria Coordinator*
USEPA - Region 8
Phone 303/312-6084, Fax 303/312-6071
email: minter.jill@epa.gov

REGION 9
(American Samoa, AZ, CA, CNMI, HI, NV, Pyramid Lake Paiute Tribe)

Gary Wolinsky, *Regional Biocriteria Coordinator*
USEPA - Region 9
Mail Code WTR-5
75 Hawthorne Street
San Francisco, CA 94105
Phone 415/972-3498, Fax 415/947-3545
email: wolinsky.gary@epa.gov

REGION 10
(AK, Confederated Tribes of the Colville Reservation,
ID, Nez Perce Tribe, OR, WA)

Gretchen Hayslip, *Regional Biocriteria Coordinator*
USEPA - Region 10
1200 Sixth Avenue
Seattle, WA 98101
Phone 206/553-1685
email: hayslip.gretchen@epa.gov

EPA Headquarters

Bill Swietlik, *Program Manager*
USEPA Office of Water
Office of Science and Technology
Health and Ecological Criteria Division (4304T)
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460
Phone 202/566-1129, Fax 202/566-1140 or 1139
email: swietlik.william@epa.gov

Questions regarding a specific entity's program should be directed to the contact(s) listed at the top of each entity's program summary in Chapter 3. Questions regarding other sections of this document may be directed to any of the following USEPA Headquarters contacts:

Wayne Davis
USEPA Office of Environmental Information
Environmental Science Center
701 Mapes Road
Ft. Meade, Maryland 20755-5350
410-305-3030 410-305-3096 (fax)
email: davis.wayne@epa.gov

Beth Jackson
USEPA Office of Environmental Information
Environmental Analysis Division
1200 Pennsylvania Avenue (2842T)
Washington, D.C. 20460
Phone 202/566-0626, Fax 202/566-0706
email: jackson.elizabeth@epa.gov

Treda Smith
USEPA Office of Water
Office of Science and Technology
1200 Pennsylvania Ave NW (4304T)
Washington, D.C. 20460-0001
Phone 202/566-1128, Fax 202/566-1139
email: smith.treda@epa.gov

APPENDIX C.

ORIGINAL CHECKLIST TEMPLATE

Appendix C. ORIGINAL CHECKLIST TEMPLATE

Form Approved
OMB Control No. 2040-0049
Approval Expiration: 7/31/02

Survey of State/Tribal Water Quality Programs for Protecting Aquatic Life Through the Use of Bioassessments and Biocriteria

Contact Information:

state	
name	
position	
agency/organization	
mailing address	
phone	
fax	
email	
website	

Briefly describe your professional responsibilities as they relate to water quality standards, conducting bioassessments, and establishing biocriteria.

For each waterbody type below with biological programs, please provide a contact (if different than yourself)

	name	**phone**	**email**
non-wadeable rivers			
lakes			
reservoirs			
estuaries/near-coastal marine			
wetlands			

Please attach any ancillary materials that will provide further in insight or background about your program and/or agency. Examples might include an organizational chart, promotional materials, etc. THANK YOU!

State/Tribal WaterQuality Supporting Aquatic Life Use Designations and Biocriteria Development

1 With respect to your program, which waterbody type categories apply ("X"), and which is being described using this checklist ("XX")?

- wadeable streams, creeks, rivers
- non-wadeable rivers
- lakes
- reservoirs
- estuaries and near-coastal marine
- wetlands

2 For lotic systems, how are they defined?

- stream order
- drainage area
- other (please describe)

3 With respect to the resource type for this checklist, what is the percentage of information in your state, tribal land, or basin, coming from the following entities?

- state/tribal water quality agency
- state fish & game agency
- USEPA
- other federal agency
- consultants
- volunteer monitoring programs
- local college or university
- regulated entities
- other (please describe)

4 Do you contract out any or all or your bioassessment work?

- Yes
- No

4a If you answered yes to #4, please specify the percentage contracted out to each type of entity for field and lab work.

field	lab	
		consultants
		other state agency
		volunteer monitoring groups
		federal agency
		college or university
		other (please describe)

5 What is the lead agency USING the bioassessment information?

6 In which ways are bioassessments used within the water quality program in your state, tribe, or basin? Please check Yes (Y), No (N), or Unsure (?) for all that apply.

Y	N	?	
			problem identification (screening)
			nonpoint source assessments
			monitoring the effectiveness of BMPs
			aquatic life use determinations/ambient monitoring
			promulgated into state WQ standards as biocriteria
			support of antidegradation
			evaluation of discharge permit conditions
			TMDL assessment & monitoring
			other (please describe)

7 Which of the following monitoring designs are used (please check all that apply)?

- targeted (i.e., sites selected for a specific purpose)
- fixed station (i.e., WQ monitoring stations)
- probabalistic by stream order/catchment area
- probalistic by ecoregion, or statewide
- rotating basin
- other (please describe)

7a For each monitoring design checked in #7, please indicate how it is implemented (check all that apply for each design).

special projects only	specific river basins or watersheds	comprehensive use throughout jurisdiction

8 Indicate the extent of resources assessed using biology (e.g., miles, acres, etc.)

- [ ] extent of resource assessed for biology (total)
- [ ] extent of resource fully supporting for 305b
- [ ] extent of resource partially supporting/non supporting for 305b
- [ ] extent of resource listed for 303d
- [ ] number of sites sampled
- [ ] extent of resource per site (if predetermined)

8a Please indicate which of the following units of measure you used to answer #8

- [ ] watersheds
- [ ] acreage
- [ ] miles
- [ ] other (please describe)

9 What is the basis for determining the extent of the resource?

- [ ] RF3
- [ ] National Hydrography Database
- [ ] state based
- [ ] other (please describe)

10 Please use this space to add any additional information you'd like about programmatic elements.

11 What are your Aquatic Life Use Support (ALUS) designations based on?

- ☐ Single Aquatic Life Use
- ☐ Class System (A,B,C)
- ☐ Fishery Based Uses
- ☐ Warm Water vs. Cold Water

11a How many different aquatic life use designations are contained in your water quality standards (WQS)? Please describe.

11b Does your state plan to further refine its AL designated uses in the next triennial WQS review?

- ☐ Yes
- ☐ No

12 If you have narrative biocriteria in your WQS. Is the attached description accurate?

- ☐ Yes
- ☐ No

12a If you answered no to #12, please correct below

13 For your narrative biocriteria, do you have formal/informal numeric procedures to support your decisions?

- ☐ Yes
- ☐ No

*If you answered yes to #13, where are these procedures located (e.g., in the WQS)?

13a If you answered no to #13, do you use a qualitative and/or narrative scale of condition?

- ☐ Yes
- ☐ No

*Where are the scale(s) located?

14 Do you have numeric biocriteria?

- ☐ Yes
- ☐ No

*If you answered yes to #14, where are they located?

14a If you have numeric biocriteria, please describe or attach separate description.

15 Are bioassessment data used in an integrated assessment with other environmental data (e.g., toxicity testing and chemical specific criteria)? Please check Yes (Y), No (N), or Unsure (?) for all that apply.

Y	N	?	
☐	☐	☐	for assessment of aquatic resources
☐	☐	☐	for cause and effect determinations
☐	☐	☐	for permitted discharges
☐	☐	☐	for monitoring (e.g., improvements after mitigation)
☐	☐	☐	for watershed based management

15a For each box you answered yes to in #15, do you use

- ☐ independent application (IA)
- ☐ weight-of-evidence
- ☐ combination
- ☐ other (explain)

16 Do you know where bioassessments/biocriteria have been used in making management decisions regarding restoration of the aquatic resources to its designated ALUS?

☐ Yes
☐ No

16a If you answered yes to #16, please elaborate.

17 How many full time employees were devoted to

☐ developing the bioassessment/biocriteria program
☐ maintaining the bioassessment/biocriteria program

18 Please use this space to add any additional information you'd like about your ALUS descision making process

19 How are your reference sites determined?

- ☐ site-specific
- ☐ paired watersheds
- ☐ regional (aggregate of sites)
- ☐ professional judgement
- ☐ other (please describe)

19a How do you define a reference site?

19b Do you have reference site criteria?

- ☐ No
- ☐ Yes (If so, please describe in space below.)

20 If you use regional reference conditions, how do you characterize those sites?

- ☐ historical conditions
- ☐ least-disturbed sites
- ☐ gradient response
- ☐ judgement prescription
- ☐ other (please describe)

21 If you use regional reference sites, how do you characterize (stratify) your streams?

- ☐ ecoregions (or some aggregate)
- ☐ elevation
- ☐ stream type
- ☐ multivariate grouping
- ☐ jurisdictional (i.e., statewide)
- ☐ other (please describe)

22 Please indicate how many reference sites you have

- ☐ by strata
- ☐ total

23 What are your criteria for defining reference sites and, if applicable, disturbed sites (e.g., D.O., sulfates, habitat)?

23a Are your reference sites linked to your aquatic life designated uses?

- ☐ Yes
- ☐ No

23b Are your reference sites/conditions identified or referenced in your WQS?

- ☐ Yes (provide citation_____)
- ☐ No

23c Do any of your reference sites represent acceptable man-induced conditions?

- ☐ Yes
- ☐ No

24 Which of the following assemblages are assessed by your program? Please check Yes (Y), No (N), or Unsure (?) for all that apply.

Y	N	?	
☐	☐	☐	phytoplankton
☐	☐	☐	periphyton
☐	☐	☐	macrophytes
☐	☐	☐	zooplankton
☐	☐	☐	benthos
☐	☐	☐	fish
☐	☐	☐	amphibians/reptiles
☐	☐	☐	waterfowl

24a For each assemblaged assessed in #24, please indicate the range of samples processesed per year

< 100	100-500	> 500
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐

24b For each assemblaged assessed in #24, please indicate the level of rigor by choosing A, B, C, D, or E

- ☐ phytoplankton
- ☐ periphyton
- ☐ macrophytes
- ☐ zooplankton
- ☐ benthos
- ☐ fish
- ☐ amphibians/reptiles
- ☐ waterfowl

A single observation (no discrete season), limited sampling (e.g., 1-2 sites)
B single season, multiple sites (not at watershed level)
C single season, multiple sites (watershed level)
D single season, multiple sites (broad coverage)
E multiple seasons, multiple sites (broad coverage for watershed level)

25 Do you perform habitat assessments at your sites?

- ☐ Yes
- ☐ No

25a If you answered yes to #25, how are they conducted?

- ☐ with bioassessments
- ☐ independent of bioassessments

25b If you answered yes to #25, what type of habitat assessment is used?

- ☐ visual based (e.g., QHEI, RBP, etc.)
- ☐ quantitative measurements (e.g., EMAP)
- ☐ hydrogeomorphology (e.g., Rosgen)
- ☐ other quantitative parameters (e.g., pebble counts, sediment index, etc.) (please describe)

25c Are these habitat reference conditions cited or mentioned in your WQS?

- ☐ Yes (provide citation_____)
- ☐ No

26 Do you use biological information to facilitate public participation in setting WQS?

- ☐ Yes (please describe in space below)
- ☐ No

27 Which of the following are part of your quality assurance (QA) program? Please check Yes (Y), No (N), or Unsure (?) for all that apply.

Y	N	?	
			standard operating procedures (SOPs)
			quality assurance plan (QAP)
			periodic meetings, training for biologists
			sorting proficiency checks
			taxonomic proficiency checks
			specimen archival
			other (please describe)

28 Do you have a certification program for bioassessment?

- ☐ Yes
- ☐ No

If yes, briefly describe:

Questions 29 -33 deal with field issues specific to BENTHOS. Please describe your program by checking all that apply. If your program does not assess this assemblage, please skip these questions.

29 Sampling gear-- please check all that apply to your program

- ☐ Surber
- ☐ Hess
- ☐ Slack (0.5 m)
- ☐ D-frame
- ☐ dipnet
- ☐ kick net (1 m)
- ☐ multiplate
- ☐ rock baskets
- ☐ collect by hand
- ☐ other (please describe)

29a Indicate the mesh size used by your program (in microns)

- ☐ 200 - 400
- ☐ 500 - 600
- ☐ > 800
- ☐ other (please describe)

29b Indicate the area sampled

- ☐ < 1 m^2
- ☐ 1 - 3 m2
- ☐ 3 - 6 m
- ☐ other (please describe)

30 Reach length

- ☐ selected habitat
- ☐ habitat sequences or cycles
- ☐ fixed distance
- ☐ stream width formula
- ☐ time
- ☐ other (please describe)

31 Habitat selection

- ☐ richest habitat
- ☐ riffle/run (cobble)
- ☐ multihabitat
- ☐ artificial substrate
- ☐ woody debris
- ☐ other (please describe)

32 Where are samples processed?

- ☐ field
- ☐ lab

32a What is the target subsample size?

- ☐ 100 count
- ☐ 200 count
- ☐ 300 count
- ☐ 500 count
- ☐ proportional/volume
- ☐ entire sample
- ☐ other (please describe)

33 What level of taxonomy do you use?

- ☐ order
- ☐ family
- ☐ genus
- ☐ species
- ☐ combination
- ☐ other (please describe)

Questions 34 - 38 deal with field issues specific to FISH/AMPHIBIANS. Please describe your program by checking all that apply. If your program does not assess these assemblages, please skip these questions.

34 Sampling gear-- please check all that apply to your program

- ☐ seine
- ☐ backpack electrofisher
- ☐ boat electrofisher
- ☐ pram unit (tote barge)
- ☐ other (please describe)

34a Seine and/or dipnet mesh size (in inches)

- ☐ 1/8"
- ☐ 3/16"
- ☐ 1/4"
- ☐ 3/8"
- ☐ 1/2"

35 Reach length

- ☐ selected habitat
- ☐ habitat sequences or cycles
- ☐ fixed distance
- ☐ stream width formula
- ☐ time
- ☐ other (please describe)

36 Habitat selection

- ☐ pool/glide
- ☐ riffle/run (cobble)
- ☐ multihabitat
- ☐ other (please describe)

37 Where are the samples processed?

- ☐ field
- ☐ lab

37a How are the samples processed?

- ☐ length measurement
- ☐ biomass--individual
- ☐ biomass--batch
- ☐ anomalies

37b How are samples subsampled?

- ☐ selected species
- ☐ batch
- ☐ selected size
- ☐ none
- ☐ other (please describe)

38 What level of taxonomy do you use

- ☐ species
- ☐ subspecies
- ☐ life stage
- ☐ other (please describe)

Questions 39 -43 deal with field issues specific to PERIPHYTON. Please describe your program by checking all that apply. If your program does not assess this assemblage, please skip these questions.

39 Sampling gear-- natural substrate

- ☐ suction device
- ☐ bar clamp sample
- ☐ brushing/scraping device (razor, toothbrush, etc.)
- ☐ collect by hand
- ☐ other (please describe)

39a Sampling gear-- artificial substrate

- ☐ periphytometer
- ☐ microslides or other suitable substratum
- ☐ collect by hand
- ☐ other (please describe)

40 Reach length

- ☐ selected habitat
- ☐ habitat sequences or cycles
- ☐ fixed distance
- ☐ stream width formula
- ☐ time
- ☐ other (please describe)

41 Habitat selection

- ☐ richest habitat
- ☐ riffle/run (cobble)
- ☐ multihabitat
- ☐ artificial substrate
- ☐ other (please describe)

42 How are samples processed?

- ☐ chlorophyll *a/* phaeophytin
- ☐ biomass
- ☐ taxonomic identification
- ☐ other (please describe)

43 What level of taxonomy do you use?

- ☐ diatoms only
- ☐ all algae
- ☐ division level
- ☐ genus level
- ☐ species level
- ☐ other (please describe)

44 Please use this space to add any additional information you'd like about your field and lab methods.

Data Analysis and Interpretation for Determining Biological Condition of Aquatic Life Uses and Deriving Biocriteria

45 Which data analysis tools and methods do you use (check all that apply)?

- [ ] summary tables, illustrative graphs
- [ ] parametric ANOVAs
- [ ] multivariate analysis
- [ ] biological metrics
- [ ] disturbance gradients
- [ ] other (please describe)

46 If you use biological gradients, how are the metrics selected and tested?

- [ ] selected by consensus
- [ ] tested for sensitivity, ecological value
- [ ] calibrated for natural gradients (and covariates)

46a Please describe your response to #46

47 If you use biological metrics, how is the threshold determined for transforming metrics into unitless scores?

- [ ] 25th %tile of reference population
- [ ] 50th %tile of reference population
- [ ] 75th %tile of reference population
- [ ] 95th %tile of reference population
- [ ] 95th %tile of all sites
- [ ] cumulative distribution function
- [ ] other (please describe)

48 If you use biological metrics do you

- [ ] aggregate metrics into an index
- [ ] return single metrics (use endpoint for each single metric)

49 If you use a multimetric index, how do you define the impairment threshold?

- [ ] 25th %tile of reference population
- [ ] 50th %tile of reference population
- [ ] 75th %tile of reference population
- [ ] 95th %tile of reference population
- [ ] 95th %tile of all sites
- [ ] cumulative distribution function
- [ ] other (please describe)

50 If you use a multivariate technique, how do you define the impairment threshold?

- [ ] 5th %tile of reference population
- [ ] 10th %tile of reference population
- [ ] Significant departure from mean of reference population
- [ ] other (please describe)

51 Have you evaluated the performance characteristics of your bioassessment results?

- [ ] Yes
- [ ] No

51a If you answered yes to #51, please describe. Please check Yes (Y), No (N), or Unsure (?) for all that apply.

Y	N	?		
			repeat sampling (please describe)	
			precision (please describe)	
			sensitivity (please describe)	
			bias (please describe)	
			accuracy (please describe)	

52 Please use this space to add any additional information you'd like about your data analysis and interpretation methods.

53 Identify where your biological data are stored. Please check Yes (Y), No (N), or Unsure (?) for all that apply.

Y	N	?	
			STORET
			other database (what program/application)
			spreadsheets (what program/application)
			paper files only
			other (please describe)

54 Please describe how data are retrieved and analyzed. Please check Yes (Y), No (N), or Unsure (?) for all that apply.

Y	N	?	
			SAS
			Systat
			Statistica
			EDAS
			other (please describe)

55 Please list any website URLs for all relevant data.

56 Please list all documents and references used to provide this information (e.g., SOPs, 305(b) reports, etc.)any website URLs for all relevant data.

57 Please use this space to add any additional information you'd like about your information management.

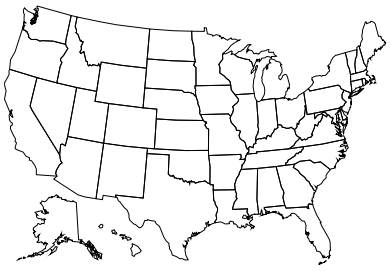
APPENDIX D.

PROGRAM SUMMARY TEMPLATE

Appendix D. PROGRAM SUMMARY TEMPLATE

The numbers of relevant checklist questions (see Appendix C) are colored black and found within each corresponding program summary section.

ENTITY NAME



Contact Information

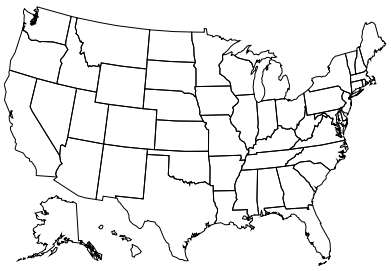
Contact name, title
Agency
Street ■ city/state/zip
Phone ■ Fax
email:

Program Description

Documentation and Further Information

#55, 56

ENTITY NAME



Contact Information

Contact name, title
Agency
Street ■ city/state/zip
Phone ■ Fax
email:

Programmatic Elements

Uses of bioassessment within overall water quality program ***#6***	☐	problem identification (screening)
	☐	nonpoint source assessments
	☐	monitoring the effectiveness of BMPs
	☐	ALU determinations/ambient monitoring
	☐	promulgated into state water quality standards as biocriteria
	☐	support of antidegradation
	☐	evaluation of discharge permit conditions
	☐	TMDL assessment and monitoring
	☐	other:
Applicable monitoring designs ***#7, (7a)***	☐	targeted (i.e., sites selected for specific purpose)
	☐	fixed station (i.e., water quality monitoring stations)
	☐	probabilistic by stream order/catchment area
	☐	probabilistic by ecoregion, or statewide
	☐	rotating basin
	☐	other:

Stream Miles

Total miles

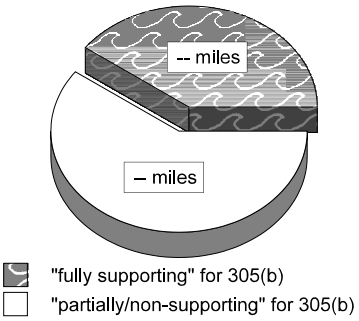
(determined using... ***#8b***)

Total perennial miles

Total miles assessed for biology ***#8***

- fully supporting for 305(b)
- partially/non-supporting for 305(b)
- listed for 303(d)
- number of sites sampled
- number of miles assessed per site

Miles Assessed for Biology



Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis		*#11*
ALU designations in state water quality standards		*#11a*
Narrative Biocriteria in WQS		*#12 to 13a*
Numeric Biocriteria in WQS		*#14, 14a*
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria) *#15*	☐	assessment of aquatic resources
	☐	cause and effect determinations
	☐	permitted discharges
	☐	monitoring (e.g., improvements after mitigation)
	☐	watershed based management
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU		*#16, 16a*

Reference Site/Condition Development

Number of reference sites		*#22*
Reference site determinations *#19*	☐	site-specific
	☐	paired watershed
	☐	regional (aggregate of sites)
	☐	professional judgment
	☐	other:
Reference site criteria		*#19b, 23*
Characterization of reference sites within a regional context *#20*	☐	historical conditions
	☐	least disturbed sites
	☐	gradient response
	☐	professional judgment
	☐	other:
Stream stratification within regional reference conditions *#21*	☐	ecoregions (or some aggregate)
	☐	elevation
	☐	stream type
	☐	multivariate grouping
	☐	jurisdictional (i.e., statewide)
	☐	other:
Additional information	☐	reference sites linked to ALU *#23a*
	☐	reference sites/condition referenced in water quality standards *#23b*
	☐	some reference sites represent acceptable human-induced conditions *#23c*

Field and Lab Methods

Assemblages assessed *#24, (24a, 24b)*	☐	benthos *(# samples/year; level of rigor)*
	☐	fish
	☐	periphyton
	☐	other:
Benthos		
sampling gear	*#29, 29a*	
habitat selection	*#31*	
subsample size	*#32a*	
taxonomy	*#33*	
Fish		
sampling gear	*#34, 34a*	
habitat selection	*#36*	
sample processing	*#37a*	
subsample	*#37b*	
taxonomy	*#38*	
Periphyton		
sampling gear	natural substrate *#39*; artificial substrate *#39a*	
habitat selection	*#41*	
sample processing	*#42*	
taxonomy	*#43*	
Habitat assessments	*#25 to 25c*	
Quality assurance program elements	*#27, 28*	

Data Analysis and Interpretation

Data analysis tools and methods *#45*	☐	summary tables, illustrative graphs
	☐	parametric ANOVAs
	☐	multivariate analysis
	☐	biological metrics *(#48)*
	☐	disturbance gradients
	☐	other:
Multimetric thresholds		
transforming metrics into unitless scores	*#47*	
defining impairment in a multimetric index	*#49*	
Multivariate thresholds		
defining impairment in a multivariate index	*#50*	
Evaluation of performance characteristics *#51, 51a*	☐	repeat sampling
	☐	precision
	☐	sensitivity
	☐	bias
	☐	accuracy
Biological data		
Storage	*#53*	
Retrieval and analysis	*#54*	

THIS PAGE INTENTIONALLY LEFT BLANK

United States
Environmental Protection
Agency

Please make all necessary changes on the below label, detach or copy, and return to the address in the upper left-hand corner.

If you do not wish to receive these reports CHECK HERE ☐; detach, or copy the cover, and return to the address in the upper left-hand corner.

PRESORTED STANDARD
POSTAGE & FEES PAID
EPA
PERMIT No. G-35

**Office of Environmental Information
and Office of Water
Washington, DC 20460**

**Official Business
Penalty for Private Use
$300**

**EPA-822-R-02-048
December 2002**