

Lake and Reservoir Bioassessment and Biocriteria: Technical Guidance Document



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This guidance document provides a tool to assist lake managers in using scientifically valid, practical biological assessment in the management of the Nation's lakes and reservoirs. The guidance was developed based on the experiences of existing state, regional and national lake monitoring programs, some of which are cited in case studies throughout the document.

Preface

This technical guidance document is based on the concept that bioassessment and biocriteria programs for lakes and reservoirs are interrelated and critical components of comprehensive water resource protection and management. The United States has approximately 40 million acres of lakes, ponds, and reservoirs. For the decade following the passage of the Clean Water Act in 1972, the Nation's lake acreage that experienced a decline in water quality was four times the acreage that experienced improvement (Johnson 1989). Managing, protecting, and restoring these waterbodies has been, and will continue to be, a challenge requiring the balancing of human and environmental health concerns with economic feasibility.

Our increased understanding of how lake systems function and respond to human activity has led to the recognition that environmental protection requires a holistic approach to lake management and protection. It has been necessary to expand our thinking in regard to lake monitoring approaches, incorporating biological assessments into traditional chemical and physical evaluations.

Section 101 of the Clean Water Act requires federal and state governments to "restore and maintain the chemical, physical and biological integrity of the Nation's waters." Natural, undisturbed aquatic ecosystems have high biological integrity, which is defined as "the condition of an aquatic community inhabiting unimpaired waterbodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota. Three critical components of biological integrity are that the biota is (1) the product of the evolutionary process for that locality, or site, (2) inclusive of a broad range of biological and ecological characteristics such as taxonomic richness and composition, trophic structure, and (3) is found in the study biogeographic region." (USEPA 1996a).

In 1992, the National Research Council of the National Academy of Sciences, calling for improved assessment programs to more effectively target lake restoration efforts, recommended the following (NRC 1992):

There is a great need for cost-effective, reliable indicators of ecosystem function, including those that will reflect long-term change and response to stress. Research on indicators should include traditional community and ecosystem measurements, paleoecological trend assessments, and remote sensing.

Many natural resource agencies throughout the country have begun the process of developing and implementing biological assessment and criteria programs primarily for rivers and streams. This document is part of the effort to advance the use of these strategies with regards to lakes and reservoirs, thereby fostering the development of credible and practical bioassessment programs.

The goal of this guidance is to assist in protecting the ecological integrity of the Nation's lake and reservoir resources. It does not address issues of human health assessments as these concerns are widely discussed in other technical documents and regulations. This guidance was developed through the experience of existing state, regional, and national lake monitoring programs. Several existing lake programs are used as case

studies and examples throughout the document illustrating specific concepts or methods. It is important to remember that circumstances vary throughout the country and this document cannot specifically address every situation or experience.

The orientation of this document is toward practical decision making rather than research and its primary target audiences are state and tribal natural resource agencies. It is intended to provide managers and field biologists with functional methods and approaches that will facilitate the implementation of viable lake bioassessment and biocriteria programs that meet their needs and resources.

The methods, or protocols, presented here are organized in a tiered framework, ranging from trophic state surveys to more detailed bioassessment, allowing users flexibility in designing programs appropriate to their needs and resources. Procedures for program design, reference condition determination, field biosurveys, biocriteria development and data analysis are detailed. In addition, the document provides information on the application and effectiveness of lake bioassessment to existing EPA and state/tribal programs such as the Clean Lakes Program, 305(b) assessments, NPDES permitting, risk assessment, and watershed management. The appendices of the document include a glossary of terms, summaries of existing programs and protocols, detailed descriptions of biological assemblages, and procedures for statistical analysis of biological data.

The following is a summary of the information contained in each chapter:

Chapter 1: The Protection of Biological Integrity

This chapter introduces biological integrity, bioassessment and biocriteria as fundamental considerations in developing and implementing lake monitoring programs and discusses the relationship between these concepts and the Clean Water Act's goal of restoring and protecting the Nation's water resources. Chapter 1 provides a rationale for biomonitoring as an integral component of natural resource agency lake management and protection programs.

Chapter 2: Lake Biological Monitoring in USEPA, Local, State, Tribal, and Regional Protection and Management Programs

Monitoring is a vital element in natural resource protection programs. Chapter 2 summarizes the relationship of biological surveys and biocriteria to various programs in the Clean Water Act. The application of lake biomonitoring and the development of biocriteria in these programs play a critical role and can have significant benefits for natural resource agencies and their constituents. This chapter addresses where and how biomonitoring and biocriteria fit into these programs. In addition, this chapter explores some nonregulatory applications and benefits of biomonitoring programs.

Chapter 3: Overview of Bioassessment and Biocriteria

This chapter provides a sketch of the conceptual framework, application and approaches of bioassessment and biocriteria that are detailed in the remaining chapters.

Chapter 4: Selection and Characterization of Reference Conditions

Establishing reference conditions, which represent the best attainable conditions for lakes in a given region, lays the groundwork for the development of biomonitoring and biocriteria programs. The ecological health of a lake, as measured through biosurveys, is evaluated through comparison to the reference conditions. This chapter recommends and details an approach for designating and identifying reference conditions.

Chapter 5: Habitat Measurement

The evaluation of habitat provides essential clues as to the status of a lake's biological organisms. Chapter 5 discusses habitat, including both watershed and in-lake components, as an element of bioassessment programs.

Chapter 6: Biological Assemblages

This chapter describes the various biological organisms that are surveyed in lake bioassessment programs. Target assemblages were chosen primarily based on their ability to be sampled and analyzed in a cost-effective way and their use in existing programs.

Chapter 7: Tiered Sampling

Chapter 7 details an additive tiered approach to lake biosurveys that includes evaluation of habitat and biological assemblages, or organisms. The purpose of the tiered approach is to provide natural resource agencies a menu of assessment and protocol options that take into consideration varying levels of familiarity with biosurveys, regional needs, resource limitations, and regulatory requirements.

Chapter 8: Index Development

The final step toward functional bioassessment is the development of an index, comprised of the sum of a series of metrics, or measurement scores. The total index value of a test site is then compared to the index value for the reference condition. Chapter 8 provides an overview of procedures involved in selecting appropriate measurements and determining an index. The Tennessee Valley Authority's experience in developing metrics and indices is highlighted in this chapter as an example. (Appendix E provides more detailed discussions and examples of statistical methods used in data analysis.)

Chapter 9: Quality Assurance

This chapter discusses the various factors to consider in ensuring the reliability of monitoring and measurement data. Chapter 9 addresses quality assurance and control considerations for each step of the process including sampling design, field operations, laboratory operations, data analysis, and data reporting.

Chapter 10: Biocriteria Implementation

Chapter 10 discusses the characteristics of biocriteria and details the steps to implement a biocriteria program. Biocriteria provide natural resource agencies with a mechanism to protect the biological integrity of lakes and to establish aquatic life-use classifications. Issues of focus in this chapter include technical and resource considerations.

Appendix A: Glossary of Terms

Appendix B: Comparison of Existing Lakes Protocols

Appendix C: Paleolimnological Sampling

Appendix D: Biological Assemblages

Appendix E: Statistical Analysis Methods for Biological Assessment

Appendix F: Executive Summaries of State Pilot Studies

Appendix G: Literature Cited

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