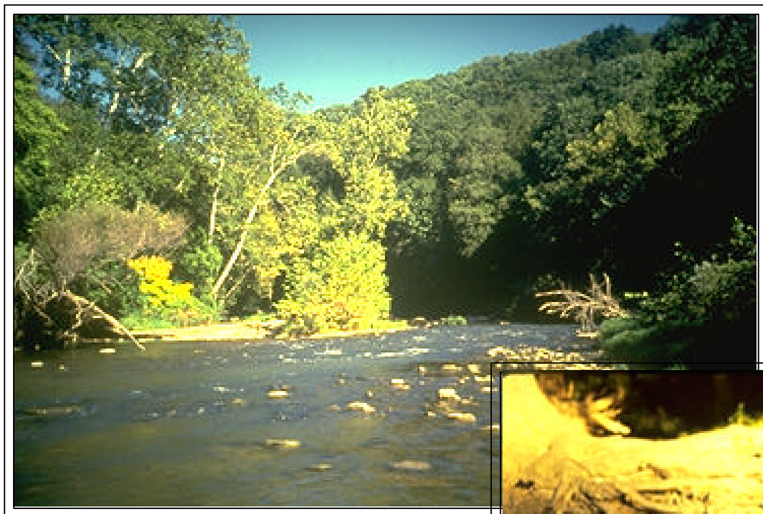
Ohio Water Resource Inventory



Executive Summary:

Summary, Conclusions and Recommendations

1996

Division of Surface Water
Monitoring & Assessment Section

Edward T. Rankin
Chris O. Yoder
Dennis Mishne

State of Ohio Environmental Protection Agency

P.O. Box 1049
1800 WaterMark Drive
Columbus, Ohio 43266-0149

1996 Ohio Water Resource Inventory:
Summary, Conclusions, and Recommendations

FOREWORD

Ohio is a water-rich state with more than 25,000 miles of named and designated streams and rivers, a 451-mile border on the Ohio River, more than 5000 lakes, ponds, and reservoirs (>1 acre), and 236 miles of Lake Erie shoreline (Figure 1). Ohio has 10 scenic rivers comprising more than 629 river miles, the fourth largest total of any state in the nation. Ohio also has extensive, high quality ground water resources. The economic and social well-being of Ohioans is closely linked to the quantity and quality of these water resources and the goods and services each provide. Section 305(b) of the Clean Water Act requires states to submit to U.S. EPA a biennial report summarizing the status and trends in water quality of both surface and ground waters. U.S. EPA, in turn, compiles the State supplied information into a national summary that it reports to Congress. The intent is for the 305(b) report to be a routine check on the progress that states are making toward achieving the goals of the Clean Water Act. Ideally, the 305(b) is a "report card" on the nation's water quality and water pollution control efforts. Unfortunately, the ambient monitoring data needed to support this process has been inconsistent, inadequate, or lacking altogether thus making national statistics unreliable or so general as to lack the necessary resolution or accuracy. This dilemma has been recognized for several years and is exemplified by former U.S. EPA Administrator Will-

One of Ohio's highest quality waters, the Kokosing River in Knox Co.

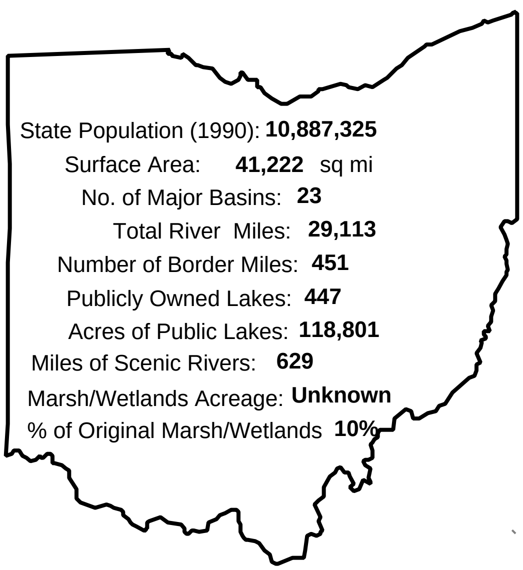


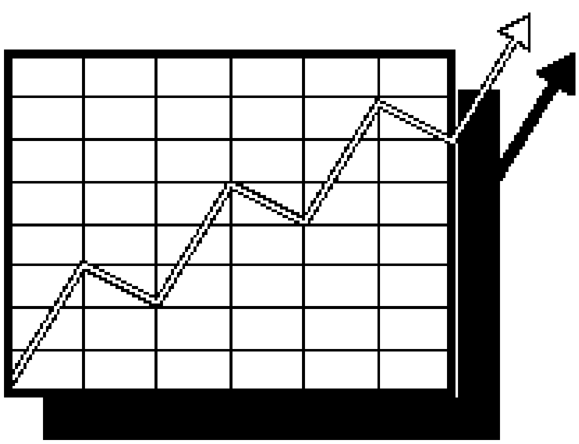
Figure 1. Atlas of Ohio statistics.

"The economic and social well-being of Ohioans is closely linked to the . . . quality of water resources and the goods and services each provides."

iam Reilly's "good news/bad news" statement to Congress. The good news was that U.S. EPA and the States have accomplished much in the way of administrative activities (*e.g.,* issuing permits, awarding grants, *etc*.) since passage of the Clean Water Act in 1972; the bad news is the failure to document this with real information from the environment. Fortunately, U.S. EPA, other federal agencies, and the States have recognized the need to devote more resources to information gathering in support of the reporting and assessment process. Also implicit is the recognition that monitoring and assessment tools and evaluation criteria need to be founded on good science and be sufficiently comprehensive to detect, characterize, and rank environmental problems. Recently, the Intergovernmental Task Force on Monitoring Water Quality completed a three-year project to define the details of a comprehensive and adequate ambient monitoring framework (ITFM 1995).

Ideally, the 305(b) is a "report card" on the nation's water quality and water pollution control efforts.

Ohio EPA anticipated many of these needs in the late 1970s and has endeavored to develop ambient monitoring capabilities that will provide the type of "vital signs" information needed to accurately assess and characterize the state of Ohio's surface and ground waters. The principles of good science and cost-effectiveness have guided this process. The result is one of the most comprehensive databases in the nation in terms of the period of record, geographic coverage, standardization of methods, comparability of data, and the strength of the environmental indicators used. As will be seen in this summary, Ohio EPA is not only able to report on what has been accomplished in terms of real environmental results, but can anticipate the key issues that will emerge into the next century. The forecast analysis for streams and rivers through the year 2000 in this report (see p. 30) exemplifies this capability. Other waterbody types including lakes, ponds, and reservoirs, Lake Erie, and wetlands, however, presently lack the indicators and database to adequately



assess their status. Without adequate status information there can be no trend assessment for these water bodies. Further development and refinement of ambient indicators by Ohio EPA is presently underway for Lake Erie, the Ohio River, and wetlands.

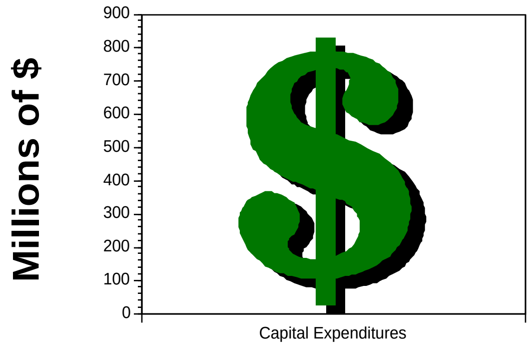


Figure 2. Capital expenditures made on municipal wastewater treatment plant construction during 1991 and 1992 in Ohio.

More than $6 billion of public and private funds have been spent in Ohio on the control of point source pollution during the past 25 years. Expenditures on municipal wastewater treatment during 1991 and 1992 alone totaled more than $825 million (Figure 2). Ohio EPA has supported an intensive and integrated surface water monitoring program over the past 16 years, thus developing an ability to document the results of these substantial economic expenditures. By maintaining a strong ambient monitoring program Ohio EPA has been able to document the effectiveness of 20+ years of intensive water pollution control efforts on site-specific, regional, and statewide scales. Since substantial follow-up monitoring has been completed since 1988 (*i.e.*, following the July 1, 1988 National Municipal Policy deadline), the 1996 Ohio Water Resource Inventory seems an appropriate vehicle to evaluate the effectiveness of pollution control programs during the past 20 years and to project where these efforts might lead in the future. Because of a principal reliance on ambient performance indicators, the success of Ohio's water resource management programs can be evaluated directly on the basis of environmental results rather than administrative accomplishments alone (*i.e.*, numbers of permits issued, grant dollars awarded, compliance rates, enforcement actions, *etc*.). In this sense, the 1996 Ohio Water Resource Inventory represents an environmental audit of Ohio's water resource management efforts, both public and private, using ambient environmental measures and indicators. The Ohio EPA has published environmental indicator-based 305(b) reports biennially since 1988, which

"More than $6 billion dollars . . . have been spent in Ohio on the control of point sources . . . during the past 25 years."

City of Columbus Jackson Pike wastewater treatment plant discharge to the Scioto River in Franklin Co. The flow in many Ohio streams and rivers is dominated by such effluent during low flow periods.

marked the first report based on ecoregionally calibrated biological indicators (the first Ohio EPA 305b report was produced in 1974).

In 1994, the Ohio EPA established the Ohio 2000 goal of reaching 75% full attainment of beneficial uses in surface waters by the year 2000. A major feature of the 1996 report is a forecast analysis of aquatic life use attainment in rivers and streams. By examining the rate of recovery (*i.e.*, rate of change in status from partial or nonattainment to full attainment of designated aquatic life uses) since 1988, the likelihood of achieving the 75% goal was projected through the year 2000 . The results of this analysis should help guide the Ohio EPA water program and reveal what changes, if any, will be needed to meet the Ohio 2000 goal.

" . . . Ohio EPA established the Ohio 2000 goal of reaching 75% full attainment of beneficial uses in surface waters by the year 2000."

1996 Ohio Water Resource Inventory

Section 305(b) of the Clean Water Act requires each state to submit a biennial report to U.S. EPA describing the quality of the state's waters. Accomplishing this task requires the compilation, computerization, and integration of chemical/physical and ecological information for streams, rivers, lakes, wetlands, and groundwater from numerous sources. The 1996 Ohio Water Resource Inventory is comprised of this summary and four major volumes covering; 1) inland rivers and streams, wetlands, Lake Erie, and water program descriptions, 2) fish tissue contaminants, 3) inland lakes, ponds, and reservoirs, and 4) groundwater. A separate document prepared by the Ohio River Valley Sanitation Commission (ORSANCO) provides similar information for the Ohio River mainstem. Specific information summarized by each volume includes:

Muskellunge from the Scioto R. in Franklin Co.

1) an analysis of the extent to which Ohio's surface and ground waters provide for healthy and viable aquatic communities, recreation, water supply, and fish and wildlife that are virtually free from contaminants at concentrations of concern;

2) an analysis of the extent to which previously impaired waters have improved;

3) identification of water bodies where additional actions are needed (*e.g.*, lists of impaired waterbodies as required by Sections 303[d] and 304[l] of the Clean Water Act);

4) geographic portrayals of the major surface water resource attributes, conditions, and problems throughout the state;

5) an estimate of the economic expenditures for water pollution abatement during the biennial reporting period;

6) a description of the quality of Ohio's inland rivers and streams, inland lakes, ponds, and reservoirs, wetlands, Lake Erie, and the Ohio River;

7) a description of the nature and extent of nonpoint sources of pollution;

8) a historical perspective of water pollution and surface water degradation in Ohio and how this affects the goals established for the Ohio EPA water programs;

Electrofishing in the lower Cuyahoga River in Cuyahoga Co.

9) a description of Ohio's first comprehensive fish tissue contaminant monitoring efforts and an analysis of the contaminants data base through the year 1995; and,

10) an updated forecast of the miles of streams and rivers projected to attain designated uses through the year 2000 with respect to tracking progress toward meeting the Ohio 2000 goal of 75% full attainment.

Indicators Hierarchy

A carefully conceived ambient monitoring approach, which uses cost-effective indicators comprised of ecological, chemical, toxicological, and administrative measures, can ensure that all sources are judged objectively on the basis of environmental results rather than prescriptive, administrative goals alone (*i.e.*, administrative "bean counting") in managing for water resource improvements. Such an integrated approach is outlined in Figure 3 and includes a hierarchical continuum from administrative to true environmental indicators. The six "levels" of indicators include: 1) actions by regulatory agencies (permits, enforcement, grants); 2) responses by the regulated community (treatment works, management practices); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or assimilation (tissue contaminants, productivity, biomarkers); and, 6) changes in health, ecology (ecological indicators), or other effects. Thus the administrative activities that have predominated water pollution control efforts since the early 1970s (levels 1, 2, and 3), which have prompted the expenditure of billions of dollars, can now be tracked through to "the results" in the environment as revealed by chemical/physical and ecological indicators. This process also serves as a feedback loop taking the observations made in levels 4, 5, and 6 as environmental "cues" to effect changes and adjustments within levels 1, 2 and 3. This hierarchy is essentially in place within the Ohio EPA water programs.

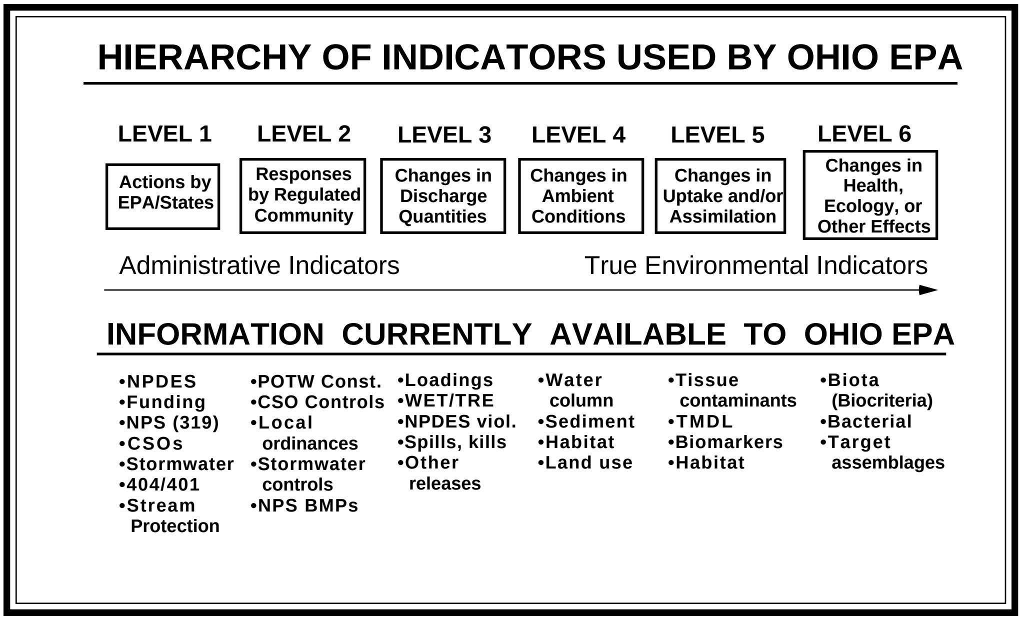


Figure 3. Hierarchy of administrative and environmental indicators used by Ohio EPA for monitoring and assessment, reporting, and evaluating program effectiveness. This is patterned after a model developed by the U.S. EPA, Office of Water.

"A carefully conceived ambient monitoring approach . . . can ensure that all sources are judged objectively on the basis of environmental results . . . in managing for water resource improvements."

Essential Technical Elements of a Watershed Approach

Ohio EPA's approach to surface water monitoring and management (Five-Year Basin Approach, see p. 28) is, from a technical assessment and indicators framework standpoint, a watershed approach. The environmental indicators used in this process are categorized as stressor, exposure, and response indicators. ***Stressor*** indicators generally include activities that impact, but do not necessarily degrade, the environment. This can include point and nonpoint source loadings, land use changes, and other broad-scale influences generally resulting from anthropogenic activities. ***Exposure*** indicators include chemical-specific, whole effluent toxicity, tissue residues, and biomarkers, each of which suggest or provide evidence of biological exposure to stressor agents. ***Response*** indicators include the more *direct* measures of community and population response and are represented here by the biological indices that comprise Ohio EPA's biological criteria. The key to having a successful watershed approach is in using the different types of indicators *within the roles that are the most appropriate for each.* The inappropriate use of stressor and exposure indicators as substitutes for response indicators is at the root of the national problem of widely divergent 305(b) statistics reported between the States. Such divergent approaches have, unfortunately, led to an impression of poorer environmental quality in those states with more complete indicator frameworks. States that follow the aforementioned indicators framework are better able to detect and properly characterize a wider range of environmental problems than are States with more limited monitoring and assessment frameworks, hence the widely divergent statistics between States. This problem is explained in more detail on pp. 24-28.

KEY POINT

"The inappropriate use of stressor and exposure indicators as substitutes for response indicators is at the root of the national problem of widely divergent 305(b) statistics reported between the States."

The Ohio EPA approach to assessing surface waters relies on evidence of the attainment or non-attainment of calibrated ecological indicator criteria (*i.e.*, response indicators) which collectively express water resource integrity directly. This results in a fundamentally more accurate portrayal of environmental conditions and provides the opportunity to invest pollution abatement resources where needed the most. For example, the emergence of nonpoint source related impacts in streams that were previously impaired by wastewater treatment plants (WWTPs) dur-

Fish community data provides important information about the response of the aquatic environment to stressors and exposures. Along with macroinvertebrates this ecological indicator group comprises the Ohio EPA biological criteria.

ing the 1970s and 1980s should prompt an increased emphasis toward certain nonpoint source abatement efforts (*e.g.*, riparian restoration).

"The Ohio EPA approach to assessing surface waters relies on evidence of the attainment . . . of calibrated indicator criteria which collectively express water resource integrity directly."

The emphasis of the 1996 Ohio Water Resource Inventory (305[b] report) is on: (1) summarizing the present quality and integrity of surface and ground waters using an array of chemical, physical, and ecological indicators and different spatial scales, (2) describing trends in the quality of Ohio's inland rivers and streams before and after 1988, and (3) forecasting the quality of inland rivers and streams through the year 2000. This latter effort provides a unique opportunity to assess the effectiveness of Ohio EPA's approach to water resource quality protection, past and present. The conclusions and recommendations of the 1996 report are the result of a continuing endeavor toward these ends. Proportionately focusing water resource management efforts on the sources most responsible for observed impairments is a continuing goal of the Ohio EPA water program. The Ohio Water Resource Inventory and the attendant data analyses should also enhance the development of a watershed-based approach.

Copies of this summary and the four major supporting volumes may be obtained by contacting:

Ohio EPA, Division of Surface Water
Monitoring & Assessment Section
1685 Westbelt Drive
Columbus, Ohio 43228-3809
(614) 728-3377
FAX: 728-3380

In addition, this summary and Volume I are available in electronic form (readable with the free Adobe Acrobat viewer software in Windows 3.1, Windows 95, Windows NT, OS/2, UNIX, and the MacOS) from the Ohio EPA World Wide Web page:

http://www.epa.ohio.gov/oepa.html

or

http://chagrin.epa.ohio.gov/documents.html

Questions about the 1996 Ohio Water Resource Inventory can be sent to the above address or via e-mail at:

erankin@central.epa.ohio.gov

PART I: CONCLUSIONS AND RECOMMENDATIONS OF THE 1996 OHIO WATER RESOURCE INVENTORY

While the 1996 Ohio Water Resource Inventory includes information on all aquatic resource types and indicator frameworks, the database is sufficiently robust to support a comprehensive analysis of temporal trends and spatial patterns only for inland rivers and streams. Statistics and highlights for Lake Erie, the Ohio River, inland lakes, ponds, and reservoirs, the statewide fish contaminant monitoring program, wetlands, and ground water appear in Part III of this summary.

"The overall quality of Ohio's inland streams and rivers has improved since passage of the Federal Water Pollution Control Act in 1972 . . . "

Inland Rivers and Streams

√ The overall quality (*i.e.*, integrity) of Ohio's inland streams and rivers has improved since passage of the Federal Water Pollution Control Act in 1972 as follows:

- Presently, 28.2% of the miles of streams and rivers fail to meet criteria for the protection of aquatic life; this is an improvement over that determined prior to 1988 (44%). This estimate is most applicable to streams and rivers with watershed areas >20 square miles.

- Results from streams and rivers monitored more than once (*i.e.*, before and after the application of water quality-based controls) show a statistically significant improvement in biological performance indicators such as the Index of Biotic Integrity (IBI) and Invertebrate Community Index (ICI).

- Much of the observed improvement has resulted from reduced loadings of oxygen demanding substances, ammonia, and chlorine due to upgraded municipal wastewater treatment facilities. More than $4 billion has been spent on these upgrades in Ohio since 1972, largely prompted by the July 1, 1988 National Municipal Policy deadline.

- Toxic impacts still cause locally severe impairments in selected stream and river reaches. The remaining problems are generally located in or near most of the larger urban/industrial centers, particularly those with steel making, glass making, metal finishing, chemical, and petroleum refining industries. Biological and chemical indicators of toxic impacts (*e.g.*, poor and very poor community performance, highly elevated incidences of anomalies on fish, highly elevated metals and/or organic compounds in bottom sediments, chemical residues in fish tissues, *etc*.) are geographically correlated with these areas and types of industry across the state.

- The impacts from sources such as combined sewer overflows, urban storm water, siltation of substrates, and habitat degradation are becoming increasingly evident as historically more pronounced impacts from point sources (*e.g.*, municipal WWTPs, some industrial effluents) are reduced.

"Since 1988, there has been a 48% decline in point sources as a major source of impairment in reassessed streams."

√ Recreational use (primary and secondary contact) attainment has improved to 57%, up from 49% prior to 1988, and nonattainment has declined from 48% to 23%. Improved municipal wastewater treatment and reduced bypasses of untreated and partially treated sewage are responsible for improvements in this water quality indicator. Problems do remain, however, in areas impacted primarily by combined and sanitary sewer overflows, urban runoff, and livestock operations.

√ A forecast analysis was conducted in an attempt to evaluate the likelihood of meeting the Ohio 2000 goal of 75% full attainment of aquatic life criteria by the year 2000. The major findings of the analysis are:

- Since 1988, there has been a 48% decline in point sources as a major source of impairment in reassessed stream and river segments.

- Nonpoint sources have emerged as a major source of impairment in streams and rivers during this period, with increases including 70% for agricul-

". . . impacts from sources such as combined sewer overflows, urban storm water, siltation of substrates, and habitat degradation are becoming increasingly evident . . . "

tural sources to 123% for hydromodication related nonpoint source impairments.

- Based on the observed rate of restoration since 1988, full attainment of aquatic life criteria is projected for 65.7% of streams and rivers by the water year 2000.

"Siltation of substrates and habitat degradation are now the second and third leading causes of aquatic life impairment in Ohio streams and rivers."

- The Ohio 2000 goal will not be achieved by the restoration of point source related impairments alone. Even if point source associated impairment is virtually eliminated (and assuming no new nonpoint source impacts are revealed) the result would be just over 70% of streams and rivers fully attaining aquatic life criteria by the year 2000. Given these facts, "new" successes in controlling, abating, and preventing nonpoint and other sources of impairment will be needed to reach the Ohio 2000 goal.

√ While successes resulting from the abatement of point sources have been documented, there are other indications that impacts from nonpoint source runoff, habitat degradation, and watershed disturbances may be worsening. Siltation of substrates and habitat degradation are now the second and third leading causes of aquatic life impairment in Ohio streams and rivers, surpassing ammonia and heavy metals. These impairments are principally the result of agricultural land use, intensive urbanization, and suburban development, the latter of which is emerging as one of the most significant threats to watersheds in the 1990s. These "non-chemical" problems have been identified by many as perhaps the major problems and threats to America's river systems (U.S. National

Riparian/land use interface along the Scioto R. in Pike Co.

Research Council 1992, Doppelt *et al*. 1993). Some ecological symptoms of these lingering and emerging problems include the following:

- The status of many indigenous Ohio aquatic species, principally fish and naiad mollusks (freshwater mussels), remain in various states of imperilment. Thirty (30) percent of Ohio's fish species are classified as rare, endangered, threatened, or special status (at the state level). Based on data collected since 1978, the proportion of imperiled fish species may now be as high as 40%. At least 15 additional species (which are not presently listed in one of the aforementioned imperilment categories) appear to be declining throughout Ohio.

River chub, a declining Ohio species.

- These declining species are among the more intolerant forms and are dependent on permanent stream flow, clean substrates, and good quality habitat (*i.e.*, intact riparian buffer, pools, runs, riffles). Several of these species are inhabitants of headwater streams and reflect the high level of disturbance to this stream type.

"The restoration and maintenance of minimum width riparian buffer zones is . . . essential . . . "

- These emerging problems could "undo" some of the gains recently made in the restoration of point source associated impairments given the ultimate dependence of mainstem reaches on the network of headwater streams. This would constitute an unanticipated deterrent to achieving the Ohio 2000 goal.

- The restoration and preservation of riparian buffer zones are viewed as essential components in preventing these impacts from emerging as new threats and for increasing the rate of restoration toward achieving the Ohio

2000 goals. Land use is an important factor that affects the quality of riparian buffers that are essential to healthy aquatic ecosystems. Land use and landscape elements (*i.e.*, ecoregion characteristics) are additionally important factors that need to be integrated with riparian protection efforts throughout Ohio.

Wide angle view of riparian degradation caused by mature tree removal along the Scioto River at Circleville in Pickaway Co. Uncontrolled, this is the type of activity that could "undo" the water quality gains made through controlling point sources of pollution.

PART II: OHIO EPA WATER PROGRAM UPDATE

This section provides a summary of important issues and initiatives being dealt with by the Division of Surface Water (DSW). Since publication of the 1994 305(b) report three important subjects have emerged as high priorities within DSW. These are the development of a strategic plan, the adoption of a revised antidegradation rule in the Ohio WQS, and activities related to the Great Lakes Initiative (GLI).

Division of Surface Water Strategic Plan

Water quality management programs have historically been predominated by efforts to control and remediate point source impacts, specifically the reduction of conventional pollutants and toxic substances through the issuance and enforcement of NPDES permits. This focus has gradually broadened during the past 10 years as more awareness and understanding of the role of other sources and a need to go beyond a concern for chemicals alone has been gained. Understandably however, point source oriented approaches established over the past 25 years have been slow to change.

". . . the Divsion of Surface Water initiated a strategic management process . . . . a strategic plan was published in August 1996."

In response to the need to bring about orderly and rational change within the surface water management programs at the Ohio EPA, DSW initiated a strategic management process. As an interim step in the overall process a strategic plan was published in August 1996. The purpose of the resulting document is to present the themes and key strategies that will focus DSW activities on meeting the Ohio 2000 goals. The five themes are:

1) a reliance on the watershed approach as the principal management framework;
2) building on the successes of the monitoring and assessment programs to produce the environmental indicators that will be used to assess water program effectiveness;

3) focusing on process improvement to achieve cost-effective and integrated program elements that deliver environmental results;
4) development of effective communication regarding watersheds, water quality conditions, and DSW activities; and,
5) seeking opportunities to develop more effective legislation, regulations, and policies to improve the quality of waters of the state.

The strategic plan emphasizes three key areas that the Ohio Water Resource Inventory has attempted to reflect since 1988 - the importance of an information management system, the concept of water resource integrity, and the importance of conducting all activities within the structure of a watershed approach.

Watershed Approach

Past strategies in water pollution control have focused primarily on facilities and administrative activities such as permitting. While this approach has resulted in measurable environmental benefits, it simply has been insufficient in restoring degraded aquatic ecosystems. By focusing more on watersheds greater emphasis is placed on achieving real environmental results, not just administrative accomplishments. This strategic direction should produce water resource quality improvements that can be measured with environmental indicators. The shift to such a geographically defined framework should also promote greater local involvement and ownership of water resources. Key strategies included in a watershed approach are the targeting of available tools and resources (*e.g.*, permits, grants, enforcement, etc.) where the need is greatest and promises the most return for our efforts. This includes consideration and use of innovative options and technologies such as pollution prevention, phased total maximum daily loads (TMDLs), and compliance incentives. There is the expectation that a watershed approach will present opportunities for new partnerships with stakeholders and reshape how Ohio EPA functions.

Water Resource Integrity

The strategic plan also acknowledges the concept of water resource integrity as the fundamental goal toward which the Ohio EPA water programs should strive. Water resource integrity is more than water quality incorporating all essential factors that comprise the character and attributes of watersheds (Fig. 4). The concept of water resource integrity includes the five major factors of water quality, habitat, energy dynamics, biotic interactions, and hydrology and how these interact to produce the "goods and services" important to healthy and sustainable aquatic ecosystems. In terms of the importance to humans, water resource integrity pertains directly to clean and safe drinking water supplies, safe consumption of fish, assimilation of wastewater, and healthy and diverse populations of aquatic organisms and other wildlife. Key to successfully managing for water resource integrity is having the indicators, monitoring, and information management systems in place so that program managers and staff continually gain feedback about their protection and restoration efforts.

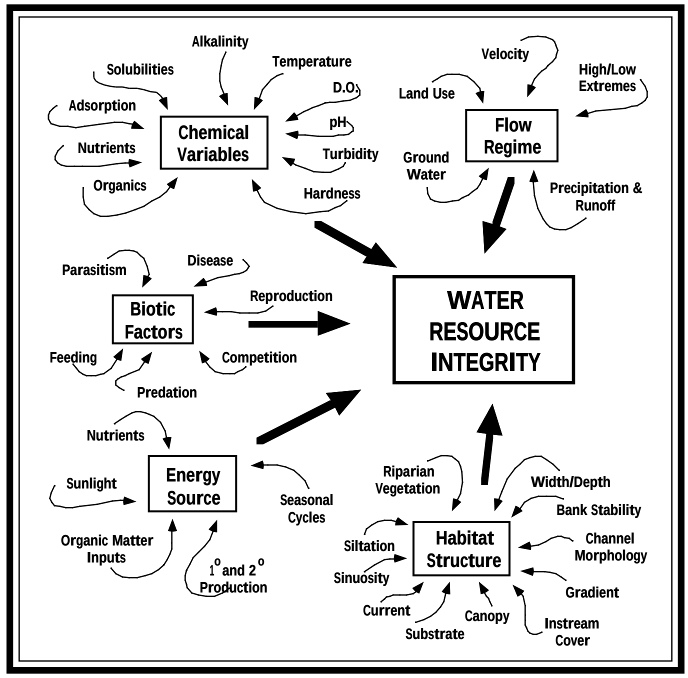


Figure 4. The five major factors which determine the integrity of the water resource, a fundamental and conceptual component of the DSW strategic management process.

Monitoring and Assessment/Information Management

Since 1980 Ohio EPA has operated a watershed-based and systematic monitoring of the state's river, stream, and lake resources utilizing biological, chemical, and physical assessment tools and indicators. This sustained effort has provided the data and indicators needed to produce the type of feedback such as that produced in the 305(b) report. While the importance and value of this type of information is widely acknowledged there is a need to make better linkages with regulatory and watershed based activities both inside and outside of Ohio EPA. To this end the DSW strategic plan recognizes the need to improve and expand the collection, conversion, and integration of environmental data into useful information that can be more easily accessed and utilized. The wide variety of data within Ohio EPA will need to be made more readily available to a wider array of users and include access to non-Ohio EPA data sources.

". . . Ohio EPA increased the resources devoted to the monitoring and assessment component so that approximately 60% of the priority needs could be addressed in any one year of the Five-Year Basin Approach."

In 1990 Ohio EPA initiated the Five-Year Basin Approach for Monitoring and NPDES Permit Reissuance that better organized and sequenced the existing monitoring and permit programs. A principal goal of this approach was to ensure that ambient monitoring and assessment information would be available prior to the time of NPDES permit reissuance. In 1994 Ohio EPA increased the resources devoted to the monitoring and assessment component so that approximately 60% of the priority needs could be addressed in any one year of the Five-Year Basin Approach. This was made possible, in part, by the NPDES permit fees that fund the Ohio EPA water program. However, this level of effort falls short of the goal of addressing 80% of the monitoring and assessment needs in any one year. Compounding this shortfall is the increasing demand for this type of monitoring and assessment over that originally projected in 1990. The strategic plan, recognizing the importance of having complete and timely information to guide Ohio EPA's water programs, encourages the expansion of the current efforts and the development of new monitoring and assessment tools. In partial response DSW initiated a bioassessment comparability research effort and an environmental indicators pilot project, both of which are aimed at supporting efforts to achieve the Ohio EPA goal of 80% of priority needs assessed in each year of the Five-Year Basin Approach.

Antidegradation

Federal regulations require that state water quality standards (WQS) include an antidegradation policy. The antidegradation rule applies in situations where the existing water quality is better than the minimum required by the designated use. Thus there is a public trust of higher water quality that must be considered in situations where a discharger wants to add to the existing pollutant load and potentially lower existing water quality. Ohio's revised antidegradation rule became effective on October 1, 1996. It spells out the applicability of the rule in permitting and provides criteria to consider in the review process. In all cases the existing designated uses must be protected. The Ohio EPA antidegradation rule applies to wastewater discharge (NPDES) permits and permit-to-install applications (PTIs) if an increase in the permitted loading of pollutants to surface waters is indicated. With few exceptions this rule requires Ohio EPA to perform an antidegradation review for all new or expanded discharges and Section 401 water quality certifications (dredge and fill permits). Nonpoint source pollution is covered to the extent that regulatory authority exists (*e.g.*, stormwater permits).

Increases in existing discharges that would lower water quality in general high quality waters or above will require an antidegradation review.

The rule requires the applicant to submit information that will be used as part of the antidegradation review. The agency may use various environmental, technical, social, and economic information in deciding whether the lowering of water quality (again, always protecting the designated use) will be allowed. The rule requires applicants to analyze alternatives that generate less pollution than the preferred option. Ohio EPA may require the applicant to implement a less-polluting option. Public involvement is an important part of the antidegradation review process. Applications that would lower water quality are public noticed in local newspapers. Public hearings are mandatory for all waters classified as Outstanding High Quality Waters, State Resource Waters, and Superior High Quality Waters. Public hearings may be held if there is significant public interest in applications on General High Quality Waters.

" In all cases the existing designated uses must be protected."

The agency's decision will be public noticed and another public hearing held if significant public interest is evident.

All streams and rivers will be placed in one of five levels of protection or “tiers” that reflect increasing levels of protection of existing water quality, as follows:

Limited Quality Waters - These are waters that cannot attain the baseline biological integrity goal of the Clean Water Act and are designated in the Ohio WQS as Limited Resource Waters (LRW), Nuisance Protection (NP), Limited Warmwater Habitat (LWH), or Modified Warmwater Habitat (MWH). All waters in this category have previously been the subject of a use attainability analysis and are reviewed periodically. These waters are excluded from the antidegradation submittal and review requirements.

"All streams and rivers will be placed in one of five levels of protection or “tiers” that reflect increasing levels of protection of existing water quality . . ."

General High Quality Waters - These include waters designated in the Ohio WQS as Warmwater Habitat (WWH), Exceptional Warmwater Habitat (EWH), Coldwater Habitat (CWH), and any other surface water not designated as a Limited Quality Water, but which do not meet the requirements for Superior High Quality Waters (SHQW), Outstanding High Quality Waters (OHQW), State Resource Waters (SRW), or Outstanding National Resource Waters (ONRW). Water quality may be lowered if the antidegradation review finds that it is necessary to support important social and economic development. However, discharges must meet the WQS in accordance with the designated use(s).

Superior High Quality Waters - These are surface waters that possess exceptional ecological values, recreational values, or both. Exceptional ecological values include high biological integrity and the presence of imperiled aquatic species and declining fish species (see Section 4). Exceptional recreational values may include providing outstanding or unique opportunities for recreational boating, fishing, or other personal enjoyment. Although some lowering of water quality may be permitted in these waters, some of the assimilative capacity, above that required to meet WQS will be set aside or held in reserve as an added measure of protection.

Outstanding High Quality Waters - These are surface waters that have national ecological or recreational significance. Such significance may include providing habitat for populations of federally endangered or threatened species or some other unique ecological characteristics besides those found in SHQWs. National recreational significance may include designation as a national wild and scenic river or park. New or expanded sources will be permitted if the discharge maintains or is cleaner than background levels.

Outstanding National Resource Waters - These waters are similar to OHQWs, except that additional sources of pollution *will not be permitted*.

Big Darby Creek in Pickaway Co., one of Ohio's most ecologically important resources.

The comprehensive monitoring and assessment program provides Ohio EPA with a robust measure of the efficacy of discharge permits. This provides an additional layer of protection against permitting inappropriate discharge increases and provides, along with data from Ohio DNR and other state and federal agencies, a comprehensive information source for the designation of appropriate levels of protection for sensitive and high quality waters.

Great Lakes Water Quality Initiative

U.S. EPA issued "Water Quality Guidance for the Great Lakes System" in March 1995 under the terms of the Great Lakes Critical Programs Act. This guidance, termed the Great Lakes Water Quality Initiative (GLI), was developed with the joint cooperation of all great lakes states. Implementation of the GLI has been a major priority for the Division of Surface Water ever since. The guidance describes a process for the adoption of consistent, Great Lakes-

"The purpose of the GLI is to reduce the amounts of toxic chemicals and other pollutants that are released into the Great Lakes system."

specific water quality criteria for toxic pollutants. Following adoption of these criteria into state WQS the GLI criteria will serve as the basis for water quality-based permits and other regulatory requirements. Despite their great size, the Great Lakes are extremely sensitive to toxic pollutants because the water, and the pollutants, remain within the system for many years. This is of particular concern for pollutants that bioaccumulate and are passed on through the food chain.

The purpose of the GLI is to reduce the amounts of toxic chemicals and other pollutants released into the Great Lakes system. Consistent application throughout the Great Lake basin is needed to assure meeting environmental goals and preserving the economic foundation of the region. The guidance consists of five elements to be included in state WQS:

1) water quality criteria for the protection of human health;
2) water quality criteria for the protection of wildlife;
3) water quality criteria for the protection of aquatic life;
4) antidegradation requirements to maintain existing water quality where it is better than minimum requirements; and,
5) requirements that will ensure more consistent application throughout the Great Lakes basin.

Ohio EPA established an external advisory group in January 1996 to assist the agency with the adoption and implementation of the GLI requirements. The adoption of revised WQS is scheduled for November 1997.

PART III. OVERVIEW OF SURFACE AND GROUNDWATER CONDITIONS

Introduction

Ohio EPA and other water resource agencies are faced with an increasingly complex array of different, subtle, and diffuse water pollution problems. Thus the need for a robust, comprehensive, and integrated assessment process quickly becomes apparent. A continued reliance on prescriptive, technology-based (*i.e.*, "end-of-pipe"), and even some water quality-based approaches will be inadequate for resolving the remaining environmental problems and in preventing new ones.

"Ohio EPA and other water resource agencies are faced with an increasingly complex array of different, increasingly subtle, and diffuse water pollution problems."

Water resource management efforts are maturing beyond a sole reliance on worst-case, dilution-based techniques for load allocations and surface water assessments. Integrated ambient monitoring including chemical/physical and ecological indicators comprises an integral component of the information and feedback that is needed to more effectively manage water resource restoration and protection efforts. We can no longer afford to regard ambient monitoring of this type as an optional "luxury" if these efforts are to truly succeed. Integrated monitoring and assessment will also play an important role in the emerging watershed and ecosystem approaches as it not only provides evidence of present impairments, but critical baseline information as well.

"We can no longer afford to regard ambient monitoring . . . as an optional "luxury" if these efforts are to truly succeed."

The 1988 Ohio Water Resource Inventory (Ohio EPA 1988) was the first Ohio 305b report based entirely on an integrated, comprehensive, and standardized chemical/physical and ecological assessment for determining the status of Ohio's aquatic resources. The 1988 report also identified the causes and sources associated with impairments of individual waterbody segments. This information was then aggregated to yield the statewide statistics that are reported to U.S. EPA. The 1990, 1992, and 1994 reports also utilized this approach and the 1996 report is the latest update.

Monitoring and Design Issues

"Some of the most useful aspects of this framework include . . . a watershed focus in ranking and addressing water quality problems."

The integrated water quality management framework developed by Ohio EPA includes: 1) comprehensive ambient monitoring utilizing multiple chemical/physical and ecological indicators; 2) an ecoregion based landscape partitioning framework; 3) tiered aquatic life and non-aquatic life use designations; 4) a triad of chemical/physical, toxicological, and ecological criteria (including biological criteria); and, 5) a sequential hierarchy of administrative and environmental indicators (see Fig. 3). This process was developed through the early and mid-1980s and, since 1988, has provided Ohio EPA with a comprehensive, standardized, scientifically sound, and cost-effective assessment of the status of Ohio's water resources. Some of the most useful aspects of this framework include basing clean water goals and management actions on realistically attainable expectations for ecological, chemical, and physical performance indicators, the discovery and improved understanding of previously unknown or poorly understood problems, and a watershed focus in ranking and addressing water quality problems.

Inconsistencies in State 305(b) Statistics

One constant in a perusal of the summary statistics produced by individual states for the National Water Quality Inventory (National 305[b] report; U.S. EPA 1994) is inconsistency and variability. Adjoining states and those with similar types and levels of water quality impacts may report widely divergent stories about the status of their respective surface waters. Some examples that are evident in the national 305(b) statistics include: 1) full attainment of aquatic life uses among the states ranged from a low of zero (0) to a high of 98%; 2) 13 states did not report on aquatic life uses, but instead reported on a much broader category of overall use support; 3) the proportion of assessed waters among states ranged from a low of 5% to a high of 100%; and, 4) the near complete lack of reporting on aquatic habitat degradation by many states. Another area of inconsistency is with the extrapolation of monitoring results. Some states extrapolate the results of single, fixed monitoring stations to entire drainage basins whereas other states take a much more conservative approach. The result is the impression of a much higher proportion of waters assessed by the former compared to the latter.

The aforementioned variability and inconsistency are attributable to different frameworks for reporting, monitoring, assessment, and usage of indicators. Most apparent in these statistics is the inappropriate reliance by many states on stressor and exposure indicators (*e.g.*, source information, loadings, chemical assessments) as substitutes for response indicators (*e.g.*, direct biological assessments) in their assessments of aquatic life use attainment. While this approach was sufficient to detect the gross water pollution problems of previous decades, it now commonly results in the gross underreporting of problems (*e.g.*, the states that reported no habitat impaired waters) or an overstatement of problems in some instances (*e.g.*, the reporting of zero miles in full attainment by one state). Individual states are essentially free to approach surface water monitoring and assessment quite differently; the result is an uneven "playing field" nationally. An unfortunate result of this national inconsistency is the erroneous impression that some states have been less successful than their peers in achieving Clean Water Act goals.

"Most apparent in these statistics is the inappropriate reliance . . . on stressor and exposure indicators (**e.g.*****, source information, loadings, chemical assessments) as substitutes for response indicators (*****e.g.*****, direct biological assessments) . . ."***

It needs to be more widely recognized that this is the result of incomplete monitoring, assessment, and indicator frameworks. One remedy would be to even the "playing field" by requiring a complete framework. The greatest deficiency is with the lack of appropriate response indicators. For aquatic life uses, this means direct assessments of biological communities using biological criteria. At least 30 states have used *some* type of biological indicator data (*e.g.*, fish, algae, and/or macroinvertebrates) in their 305(b) reporting (U.S. EPA 1995). However, only 12 states have sufficiently developed the assessment criteria needed to properly use this indicator (U.S. EPA 1995). Even fewer states have progressed to the point of developing formal biological criteria (exceptions include Ohio, North Carolina, and Maine), but 22 states have the underlying research and development efforts in progress.

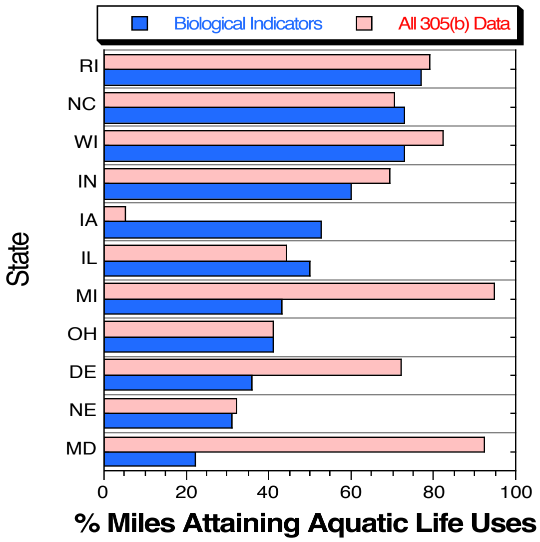


Figure 6. Percent of stream and river miles attaining aquatic life uses as reported in the National 305(b) report in 1992 and the subset of these statsitics for assessments made with biological indicators. Only states that have assessed > 10% of their waters and have used biological indicators to assess some of their waters are included.

Another deficiency is that some states have only one generic aquatic life use (in contrast to Ohio's multiple, tiered aquatic life uses) which also contributes to the likelihood of underestimating impacts to high quality waters and overestimating impacts to low quality waters. Figure 6 shows the aquatic life use statistics reported in the 1992 national 305(b) report (U.S. EPA 1994) by selected states (which were based on the prevailing assessment framework employed by the individual state) and for a subset based only on biological indicators (termed the biological integrity indicator by U.S. EPA) as extracted from individual state 305(b) reports by U.S. EPA. For some states, the two statistics are either identical (*e.g.*, Ohio) or very close. For other states (*e.g.*, Michigan, Delaware, Maryland, Iowa) the aquatic life use and biological integrity statistics are widely divergent. The key point illustrated here is that *there is a tendency for states to overestimate the quality of their aquatic resources when biological indicators are not used* to drive the determination of aquatic life use attainment statistics, even though the basic biological data may be available. The statistics for Michigan (43%) and Ohio (42%) were similar based on the biological integrity indicator, but very different based on the statistics reported in the 1994 national 305(b) report (96% compared to 42%).

KEY POINT

"...there is a tendency for states to overestimate the quality of their aquatic resources when biological indicators are not used..."

The quality and power of the data that states use in developing 305(b) statistics range from gross estimates based on opinion, complaints, visual impressions, data collected by volunteers, and chemical grab sampling to watershed-level biological surveys. The unfortunate tendency to equate these very different types of assessments in the national 305(b) report results in the highly skewed statistics between states. Recent efforts by U.S. EPA to improve consistency, particularly the development of more robust environmental indicator frameworks, biological criteria, and improved 305(b) guidelines should improve the situation. While it will take several years to fully correct these deficiencies, we can now distinguish the reasons behind the widely divergent state reported 305(b) statistics.

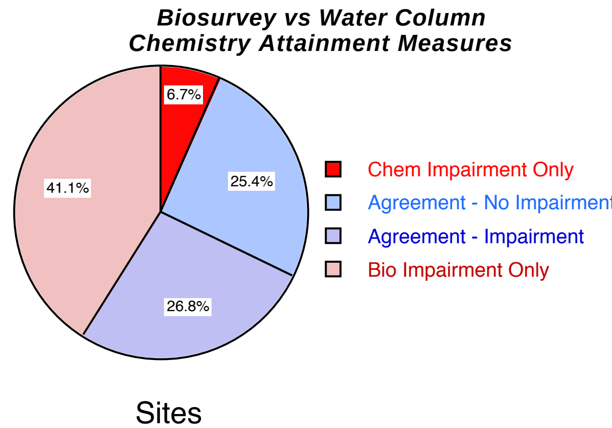


Figure 7. Detection of aquatic life impairment between biosurvey-based monitoring efforts (including water chemistry data) and water chemistry data alone in Ohio (n = 2543 sites).

Ohio's comparatively low national ranking for aquatic life use attainment, compared to nearby states in the national 305(b) report, is an artifact of methodological differences. Figure 7 illustrates the increased power of a biological based assessment framework (which includes stressor and exposure indicators in appropriate roles) compared to a water chemistry only approach. This example illustrates that *41% of the impairment now detected with a biological indicator driven framework would have been overlooked with a water chemistry only approach*. There is a high likelihood of seriously underestimating the extent of impairment to aquatic life with an exclusive reliance on chemical-based exposure indicators. The states that report a high percentage of full aquatic life use attainment and therefore rank well ahead of Ohio in this category generally employ water chemistry driven assessments. This is further supported by the lack of habitat related impairment reported by many states in the national 305(b) report. While the number of states reporting at least some type of habitat impairment has declined from 25 to 15 between the 1992 and 1994 national 305(b) reports, a significant number failed to recognize riparian zone degradation (29) or channelization (30) as causes of impairment. Aquatic habitat degradation was recognized as a widespread and serious national problem in a recent report sponsored by the National Academy of Sciences (U.S. National Research Council 1992) and others (Judy *et al.* 1984; Benke 1992). The Pacific Rivers Council (Doppelt *et al.* 1993) recently summarized a new

"Ohio's comparatively low national ranking for aquatic life use attainment . . . in the national 305(b) report is an artifact of methodological differences."

approach to conserving riverine ecosystems and documented the significant decline in these resources.

Five-Year Basin Approach: A Summary of Progress

Ohio EPA initiated the five-year basin approach to NPDES permit reissuance and monitoring beginning with the 1990 field season (Figure 9). The completion of field work in 1994 marked completion of the first five-year cycle. An assessment of issues addressed versus identified needs revealed some significant shortfalls in terms of addressing high priority issues once every five years:

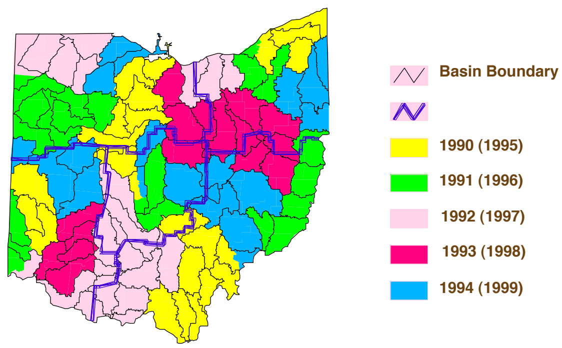


Figure 9. Five-Year Basin Approach map showing the distribution of major subbasin aggregations by biosurvey year. Biosurveys are conducted within each basin area with water quality standards rulemakings and NPDES permit reissuance following in succeeding years.

- Of more than 2300 sites targeted for monitoring between 1990 and 1994, over 1300 (56%) were sampled. Of the 237 NPDES discharges targeted, assessments were conducted downstream from 145 (61%). At this rate reassessments will take place once every 10 years, with some flexibility for addressing high priority issues on a five-year rotation. However, the volume of high priority needs has increased steadily through this period and has outpaced the increases gained in monitoring and assessment resources and efficiency.

"Of the more than 2300 sites targeted for monitoring between 1990 and 1994, over 1300 (56%) were sampled."

- Reference sites are being resampled at a 41% rate (179 out of 440 sites have been resampled through 1994). This represents a 9% shortfall from the once-every-ten-years goal of resampling all reference sites as suggested by the Ohio EPA biological criteria protocols.

Ohio EPA's 17+ years of experience have demonstrated that in larger watersheds, more sampling sites are needed to accurately characterize resource conditions over space and time. This is especially true of concentrated, diverse, and interactive impacts to streams and rivers within urban areas. This is also applicable to the evaluation of significant point sources located on larger mainstem streams and rivers. Here it is important to accurately characterize the longitudinal response of the chemical, physical, and ecological indicators to detect all of the major impacts and accurately assess the extent and severity of any impairments. Most of the larger streams and rivers have been assessed at least once since 1978.

Streams and rivers are the most frequently sampled water body type in Ohio. There are approximately 25,000 miles of named designated streams and rivers in Ohio.

Inland Rivers and Streams

This section includes: 1) descriptions of the condition of inland streams and rivers through the 1994 water year; 2) a summary of changes in aquatic life use attainment status since 1988; 3) forecasts of changes in use attainment status through the year 2000; and, 4) a discussion about possible programmatic changes (*e.g.*, new initiatives, shifts in emphasis) which are needed to make progress toward achieving the Ohio 2000 goal of 75% of Ohio's streams and rivers fully supporting healthy populations of aquatic life, recreational opportunities, and other beneficial uses by the year 2000. In keeping with the pattern established by the 1988, 1990, 1992, and 1994 305(b) reports, the 1996 report emphasizes monitored level information and assessment results (*i.e.*, biosurvey data <5 years old or, if older, not likely to have changed). A separate Ohio EPA document, the Ohio Nonpoint Source Assessment (Ohio EPA 1990a), includes evaluated and opinion/survey level information, much of which was obtained via questionnaires distributed to more than 200 state, local, and federal agencies regarding suspected sources of nonpoint source pollution.

Relation Between Report Year and Monitoring Years:

Report Year	Water Years
96	93-93
94	91-92
92	89-90
90	88-89
88	≤ 88

"Most of the larger streams and rivers have been assessed at least once since 1978."

Approximately 6,560 river miles have been assessed with monitored level data considered "current." There are approximately 25,000 stream and river miles that have designated for uses in the Ohio water quality standards by Ohio EPA, thus more than one-quarter of these waters have current assessments. When stream and river size is considered, Ohio EPA has current data on 72%

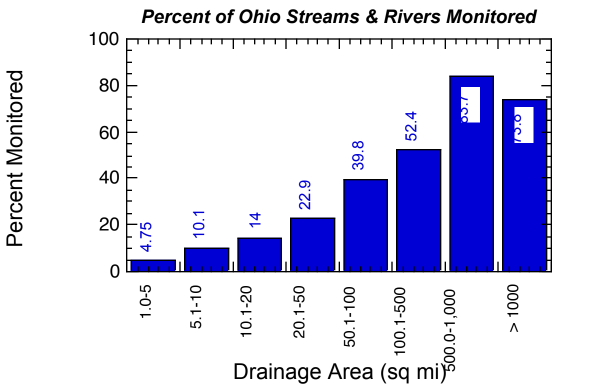


Figure 10. Proportion of Ohio's named and designated streams and rivers which have been monitored at least once with monitored level data since 1978.

of the miles of rivers with drainage areas >1000 square miles, 60% of stream and river miles >100 square miles, and 42% of streams >20 square miles (Figure 10). The largest proportion of unassessed waters consists of headwater streams (<20 square miles) where 9.1% of the named and designated stream miles have current assessments. More than 4,000 stream and river miles have been assessed two or more times during the past 16 years and just over 1850 miles have been reassessed since the 1994 305b report.

Data collected since 1988 gives the best picture of recent conditions and the effectiveness of past water pollution abatement efforts, many of which were made to meet the July 1, 1988 National Municipal Policy deadline. This information indicates that 49.3 percent (2,638 miles) are fully attaining their applicable aquatic life use designations (*i.e.*, all criteria are met), 23.3 percent (1,248 miles) are partially attaining (*i.e.*, some criteria are met, others are not), and 27.4 percent (1,470 miles) are in nonattainment (*i.e.*, none of the criteria are met; Figure 11; lower). This represents a substantial improvement compared to data collected prior to 1988 (Figure 11; upper). These changes signify a substantial improvement in the aquatic life use attainment status of Ohio's surface waters, much of which is the result of reduced pollution from municipal point source discharges. The coverage of the Ohio EPA monitoring program has emphasized the larger streams and rivers; these are where most of the direct use benefits are derived by Ohioans. However, this potential bias should not be construed as diminishing

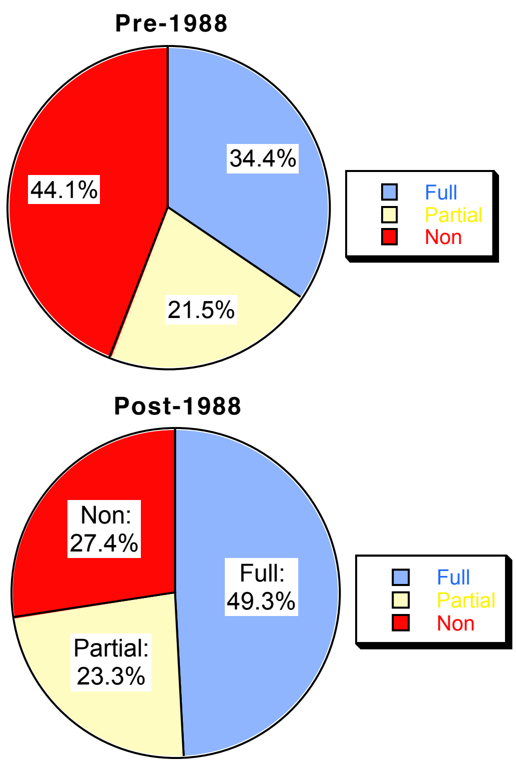


Figure 11. Proportion of stream and river miles which fully attain, partially attain, and which fail to attain aquatic life uses between the pre-1988 and post-1988 305(b) assessment cycles. These results are applicable to monitored level data.

the value of headwater streams since their aggregate integrity indirectly influences that of the larger waterbodies.

Organic enrichment (includes both nutrient and dissolved oxygen related problems) is the most frequent major cause associated with aquatic life use impairment in Ohio's streams and rivers (931 miles; Figure 12). Other significant causes of impairment include habitat modification (847 miles), silt and sedimentation (754 miles), flow alterations (315), heavy metals (226 miles), unknown (192 miles), low pH (180 miles), ammonia (150 miles), and priority organics (principally cyanide and PAHs; 110 miles). The major sources of impairment are point sources (897 miles), habitat modification (833 miles), agriculture (618 miles), mining (490 miles), urban runoff (122 miles), in-place contaminants and other miscellaneous sources (250 miles), and on-site septic systems, landfills, and hazardous waste sites (105 miles). The predominance of organic enrichment, silt and sedimentation, and habitat as the major causes of impairment reflects the nature and extent of problems that have yet to be adequately addressed in Ohio.

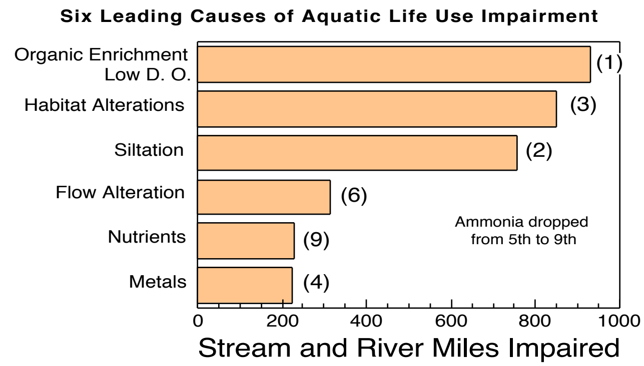


Figure 12 The six leading causes of aquatic life impairment in Ohio streams and rivers based on data from the 1996 assessment cycle. Rankings from the 1992 assessment cycle are shown in parentheses.

The severity of nonattainment (ratio of partial to nonattainment) varied according to stream and river size (Figure 13). Large rivers appear more resilient to the effects of point source discharges (greater proportion of partial/nonattainment), while smaller streams (greater proportion of nonattainment/partial) are typically the most susceptible to the direct effects of nonpoint sources (*e.g.*, hydromodification, runoff) and general watershed modifications. Full use attainment varied little with stream size, indicating that smaller stream and rivers have more miles of severe impairment (i.e., less partial attainment) than large rivers.

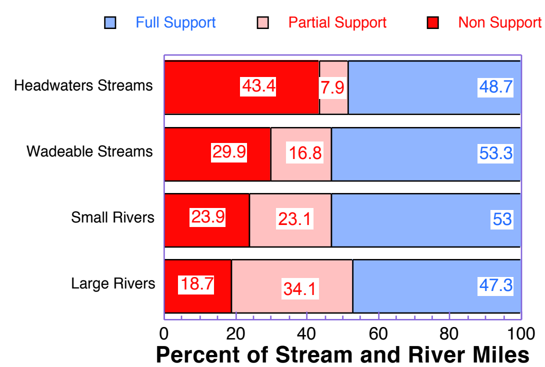


Figure 13. Aquatic life use support in Ohio by watershed size: headwaters ≤ 20 sq. mi.; wadeable streams >20-200 sq. mi.; small rivers, >200-1000 sq. mi.; and, large rivers, ≥ 1,000 sq. mi. (based on information from the 1996 assessment cycle).

Use Attainment by Ohio EPA District

Regional examination of aquatic life use attainment status enables Ohio EPA to further refine the use attainment forecast and better develop strategies to restore and protect rivers and streams. Aquatic life use attainment stratified by Ohio EPA district (which roughly approximates an ecoregion-based breakdown) illustrates some key regional differences in water resource quality. The lowest percentage of fully attaining waters occurred within the Northwest District (33.6%; Figure 14), which is mostly within the extensively impacted Huron/Erie Lake Plain (HELP) ecoregion. This contrasts with the higher percentage of full attainment (57.3%) in the Southeast District that mostly lies within the relatively intact Western Allegheny Plateau (WAP) ecoregion. However, the high proportion of acid mine affected waters results in the Southeast District falling second to the Central District (which occupies parts of the E. Corn Belt Plains, Erie/Ontario Lake Plain, and WAP ecoregions in central Ohio) for the highest percentage (65.8%) of miles fully attaining aquatic life uses.

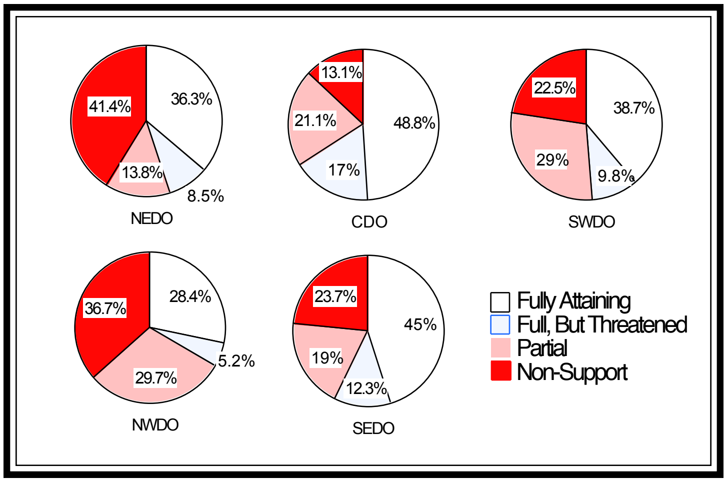


Figure 14. Aquatic life use attainment status based on Ohio EPA district boundaries.

Forecasting Trends in Use Attainment Status

"A major challenge facing the Ohio EPA water program is the goal of achieving full attainment of aquatic life use criteria in 75% of streams and rivers by the year 2000."

A major challenge facing the Ohio EPA water program is the goal of achieving full attainment of aquatic life use criteria in 75% of streams and rivers by the year 2000. To determine the likelihood of achieving this goal, an attempt was made to look forward based on what has been observed in the recent past.

Sufficient stream and river segments have been reassessed since 1988 to enable a forecast of the possible future rate of restoration (Figures 15 and 16). This analysis provides the basis to evaluate whether the Ohio 2000 goal of 75% full attainment is likely with current water resource management and regulatory programs. This analysis revealed the following:

√ Extrapolating changes in use attainment status observed between 1988 and 1996 indicates that aquatic life uses have been restored in more than 1000 miles of streams and rivers.

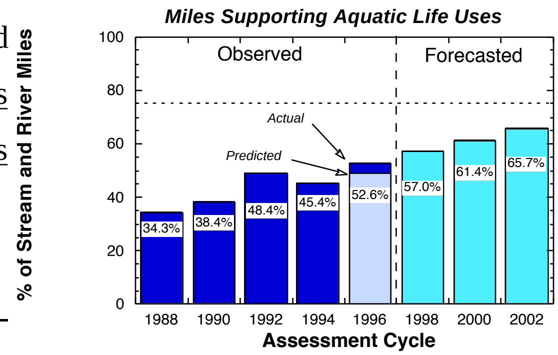


Figure 15. Measured improvement of aquatic life use attainment from the 1988 to the 1996 assessment cycles and forecast to the year 2000.

√ The predominant factor in this restoration has been municipal wastewater treatment plant (WWTP) upgrades. An analysis of reassessed segments shows that approximately 57% of the previous WWTP associated impairment is abated by the time a segment is reassessed (Figure 17). At the current rate of restoration of point sources(3.8%/year) they are predicted to be virtually eliminated by the 2002 assessment cycle (water year 2000). This assumes gains continue in the same linear rate we have observed since 1988. Examining changes in the types of point sources indicates that CSOs are emerging as a major limiting factor in areas where industrial and municipal impacts are being abated. This fact alone may slow the rate of point source abatement over the next few years.

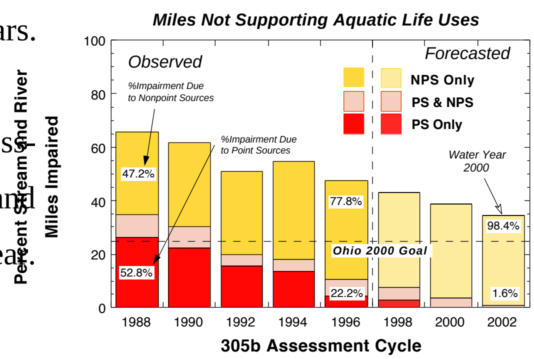


Figure 16. Change in total percent impairment of aquatic life uses (by assessment cycle) between 1988 and 1996 and forecasted to the year 2000 based on the observed restoration rate. The proportion of impairment attributed to point sources as a major source is represented by the darker (lower) portion of each column.

The current rate of improvement, projected from the reassessment results observed between 1988 and 1996 (Figures 15 and 16), is an accumulated addition of 2% restored miles per year. The major conclusions of the forecast analysis are:

√ Over the past 8 years, a 47% decline in point sources as a major source of impairment in reassessed streams and rivers has occurred (Figure 17, lower panel). Based on this rate of restoration, aquatic life uses will be fully attained in 65.7% of assessed streams by the year 2000 (Figure 16). This represents a slight increase compared to the forecast in the 1994 305(b) report.

√ To meet the Ohio 2000 goal of 75% of streams and rivers fully supporting aquatic life uses, a net gain of an *additional* 9.3% over that forecasted will need to be achieved during the next six years.

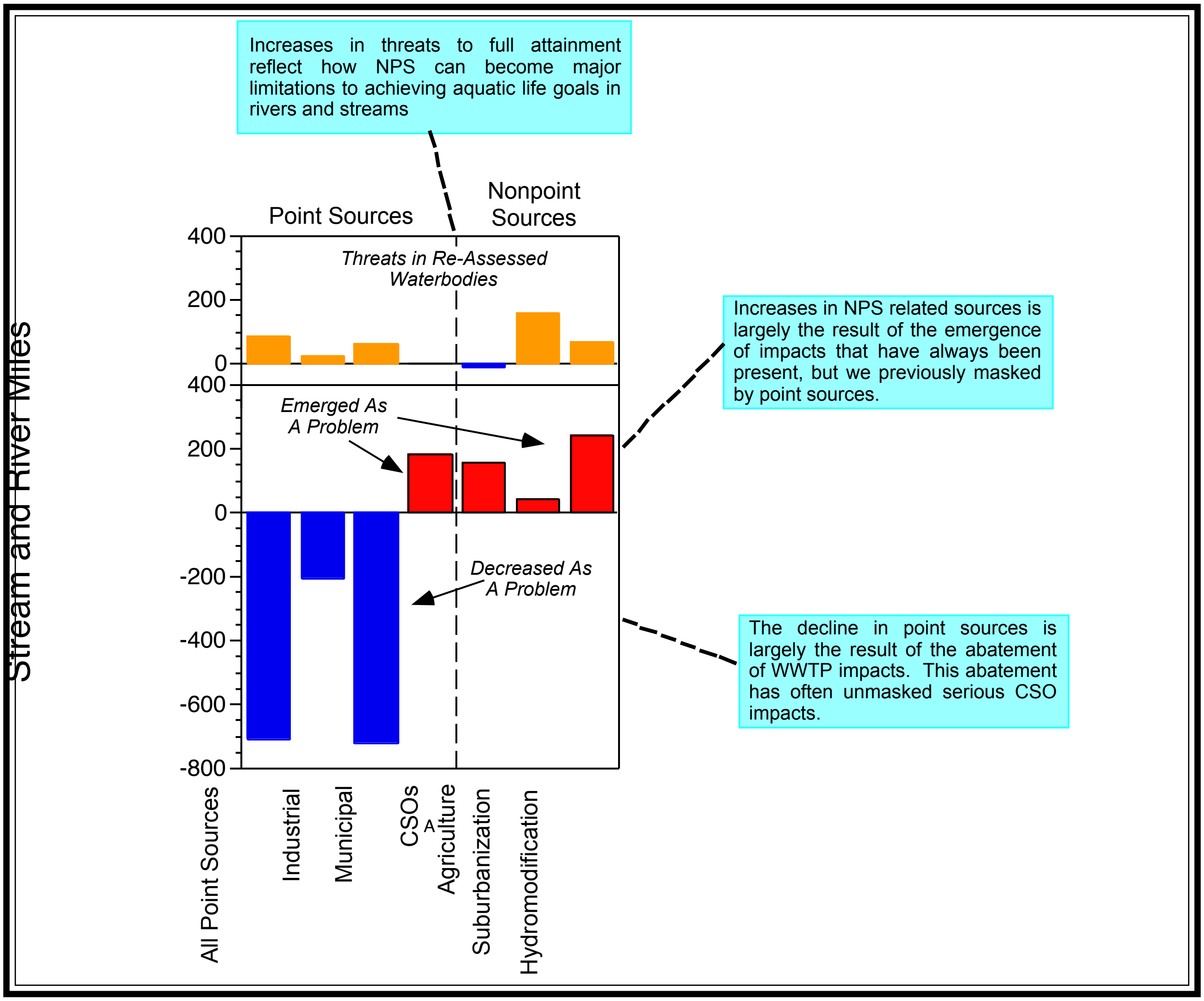


Figure 17. Change in the sources of threats to rivers and streams which exhibit full attainment of aquatic life criteria (top panel), and declines (increase in miles; middle panel) or improvements (reduction in miles) in impairment among the major sources of aquatic life use impairment between the 1988 and 1996 305(b) assessment cycles for waters that have been reassessed since the 1988 cycle.

√ Nonpoint sources have emerged as the predominant source of impairment in streams and rivers (Figure 17, middle panel). The proportional increase in nonpoint sources of impairment is due largely to the emergence of preexisting problems masked by historically more severe point source impairments.

√ Nonpoint sources are major threats to segments that fully attain designated aquatic life use criteria. The principal threats are suburbanization and hydromodification (Figure 17, upper panel).

One of the most important findings of the forecast analysis is that the quality of Ohio's aquatic resources are improving steadily with time. However, achieving the magnitude of improvement needed to attain the Ohio 2000 goal with existing program emphases (*i.e.*, primarily on point sources) is unlikely because point sources are declining as major causes of impairment both proportionately and in absolute terms (Figure 17; lower). The pattern observed during the past eight years (1988-1996) has been one of: 1) a gradual lessening of point source associated impairment; and 2) an emergence in the predominance of nonpoint source associated impairments (Figure 18). The emergence of nonpoint source associated impairments is largely the result of an "unmasking" of these sources as a major effect (as the formerly more prevalent and locally severe point source associated impairments are abated) rather than any substantial net increases in nonpoint associated impairments. Thus, as point source impairments are abated, underlying problems are becoming increasingly apparent. A comparison of the major causes and sources of aquatic life impairment between the pre- and post-1988 assessment cycles illustrates the character of these changes (Figures 18).

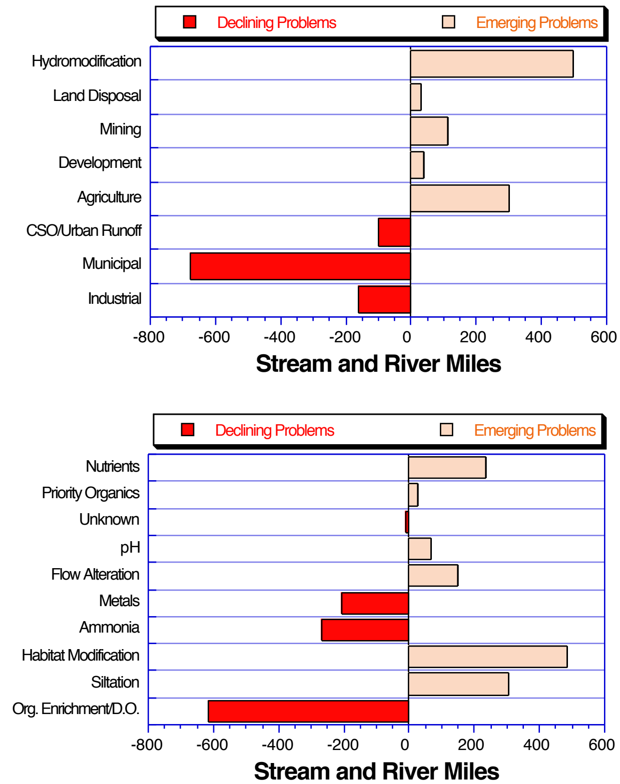


Figure 18. Reduction (decrease in impaired miles) and emergence (increase in impaired miles) of major sources (upper) and causes (lower) of aquatic life impairment between the 1988 and 1996 assessment cycles.

Strategies To Increase the Rate of Restoration

Given that the current rate of restoration will increase the full attainment fraction of streams and rivers to 65% by the year 2000, are there actions Ohio EPA could take to accelerate restoration to meet the Ohio 2000 goal? Accelerating the rate of point source restoration alone will not achieve the 75% goal by the year 2000 or soon thereafter. Full attainment of aquatic life uses reaches only 70% when extrapolated through the year 2002 when point sources are "forecasted" to be virtually eliminated. Again, this presumes no new nonpoint source impacts and the unlikely elimination of CSO impacts by that time. Furthermore, it is likely that the "easy" and straightforward point source impairments have already been dealt with and the remaining ones will be less tractable.

Forecast Analysis Summary: Inland Streams & Rivers

Designated Use Class.	*1996 305(b)*	*Year 2000*
Aquatic Life	*49.3%*	*65.7%*
Recreation	*56.9%*	*63.2%*

The projected restoration rates also need to be tempered with an understanding of the role of threats to existing aquatic life use attainment. The most rapidly increasing threats are those associated with suburban development, watershed level modifications (*e.g.*, wetland losses), and hydromodification (Figure 17). As the monitoring and assessment of Ohio surface waters continues, the threats to waters that are currently attaining aquatic life use criteria will become increasingly evident. More than 570 miles of streams and rivers which presently attain the applicable aquatic life uses are considered threatened by impacts that, if not preempted, could soon emerge as impairments. The leading threats are habitat degradation (244 miles), silt and sedimentation (198 miles), and organic enrichment/dissolved oxygen (113 miles). Organic enrichment (includes nutrient enrichment), habitat, and sedimentation are likely to show the most rapid increases in the future due to the growing number of wastewater treatment plant expansions, the increased development of once rural watersheds, and the lack of an overall process to adequately control these impacts. Major sources associated with these threats include hydromodification (196 miles), agriculture (153 miles), mining (95 miles), point sources (154 miles), and urban runoff (36 miles). Many threatened surface waters include streams and rivers designated as Exceptional Warmwater Habitat (EWH) or Warmwater Habitat (WWH) designated streams that perform well above the minimum criteria (*e.g.*, those WWH streams at issue under antidegradation).

"The most rapidly increasing threats are . . . suburban development, watershed level modifications (e.g., wetland losses), and hydromodification"

Based on these statistics, clearly new strategies in controlling, abating, and preventing other sources of impairment will be needed to reach the Ohio 2000 goal. Any new or increased impacts from either point or nonpoint sources could erode gains made through point source abatement since 1988 and/or result in a slowing of the overall rate of restoration. In an attempt to address some of these issues, efforts within Ohio EPA have been initiated to directly address two of the leading sources of impairment, nonpoint sources and hydromodification. A summary of the technical justification and supporting material regarding these sources follows:

"Functionally healthy and intact riparian zones . . . are essential for the attainment of the clean water goals embodied by the Ohio Water Quality Standards (WQS)."

- The land and terrestrial vegetation immediately adjacent to the stream channel (*i.e.*, riparian zone) are an integral part of stream and river ecosystems. Functionally healthy and intact riparian zones perform several important functions that are essential for the attainment of the clean water goals embodied by the Ohio Water Quality Standards (WQS). The National Academy of Sciences (U.S. National Research Council 1992) established a goal of restoring riparian buffer zones to 400,000 miles of streams and rivers nationally over the next 20 years.

- Minimum riparian widths specified by other states, federal agencies, local jurisdictions, and the technical literature range from 50 to more than 100 feet. A riparian width ranging between 50 feet and 120 feet for waters designated as Warmwater Habitat (WWH), Exceptional Warmwater Habitat (EWH), and other high quality waters (*e.g.*, proposed Superior High Quality Waters classification) would substantially help protect and restore Ohio's rivers and streams. This is not completely a "hands-off" zone, but rather an area within which special precautions would need to be taken to protect the structural and functional integrity of aquatic ecosystems.

The lower Little Miami R. in Warren Co. exemplifies an intact riparian zone.

• Riparian zones have been documented as providing the following ecosystem services: assimilation and removal of nutrients from both surface and subsurface waters, sediment retention and removal, temperature moderation, shading, and the principal source of raw energy (*e.g.*, tree leaves).

• The mature tree component of a riparian buffer zone provides bank stabilization, instream habitat formation (source of woody debris necessary for habitat formation), water retention, nutrient uptake and assimilation, raw energy source, and shading. *Grass filter strips alone do not provide equivalent ecosystem functions and services.*

• Big Darby Creek and other high quality Ohio streams and rivers have largely intact riparian buffer zones that provide tangible evidence of the natural resource benefits that result from retaining and restoring the riparian attributes described above.

• The status and condition of mainstem streams and rivers (*i.e.*, 4th order and larger) appears linked to the aggregate condition of the headwater streams (*i.e.*, 1st through 3rd order) in a watershed. Direct degradation of headwater streams by activities that encroach on riparian zones and by gross habitat modification will eventually become manifest in the sub-par performance of the ecological indicators used to assess the condition of mainstem streams and rivers. This could, over time, erode some gains recently made via point source controls.

High quality Ohio headwater stream - Sugarcamp Run in the Interior Plateau ecoregion (Clermont Co.). These streams are vulnerable to activities which fracture or destroy the bedrock substrates.

• Riparian buffer zones have been identified as a critical component with land use types (Steedman 1988) in determining the ability of streams and rivers to attain the aquatic life use criteria codified in the Ohio WQS. Attainment of indicator performance values compatible with these criteria is dependent on a balanced combination of urban land use and minimum riparian buffer zone widths.

An eventual result of riparian zone degradation and land use encroachment - severe bank erosion along the Scioto R. in Pickaway Co. This contributes to siltation and embeddedness of substrates downstream.

- Although land use stewardship (fostered through watershed-based strategies that include outreach, education, partnerships, etc.,) is important for protecting and restoring Ohio's streams *the maintenance of riparian buffer zones is essential if such restoration plans are to succeed*. Streams that have intact riparian zones in Ohio are those that can maintain good to exceptional levels of biotic integrity (see top categories on Figure 19). Conversely, streams that have lost much of their riparian vegetation generally have only fair to fair/poor levels of biological condition (see Figure19) and are less amenable to restoration focused only on upland areas.

". . . the maintenance of riparian buffer zones is essential if restoration plans are to succeed. "

Trends in Selected Ohio Rivers and Streams

Our continuing analysis of biological monitoring results from streams and rivers with multiple years of data indicate that the greatest improvements have occurred where organic enrichment and dissolved oxygen impacts from point sources (particularly WWTPs) were the predominant influences. This reflects the past emphasis of regulatory and financial assistance efforts toward municipal wastewater treatment. Impairments associated with a combination of complex toxic and urban/industrial impacts have also improved, but to a lesser degree, reflecting the greater difficulties in dealing with these issues and the longer recovery periods. Prior to 1993, no major stream or river segment with significant historical impairments had completely recovered to the point where full attainment of the applicable aquatic life uses occurred in virtually 100% of the formerly impaired miles. The Licking River and S. Fork Licking River mainstem biological monitoring results in 1993 revealed the first such "complete" recovery. Later, in 1994 and 1995, other major river segments such as the upper and middle Great Miami River, Portage River, upper Muskingum River, and Twin Creek showed similar results. Many other segments are more then 90 percent recovered. These reductions in the miles of point source impaired streams and rivers are directly reflected in the forecast analysis described earlier.

". . . the greatest improvements have occurred where organic enrichment and dissolved oxygen were the predominant impact types."

A description of the extent and direction of these changes in selected Ohio streams and rivers appears in Tables 1 and 2. Along with Figure 19, these provide information intended to illustrate the general status and trends in principal Ohio rivers and streams. Tables 1 and 2 have been updated from the 1994 Ohio Water Resource Inventory and indicate the year(s) of monitoring, the trend (increase, decrease, no change) indicated by the latest year of monitoring, a qualitative indication of the strength of the trend, and a narrative description of the principal attributes and point or nonpoint source problems. Major portions of 41 rivers and streams have been reassessed since the initial biosurveys of the late 1970s and 1980s. Of these, 21 show consistent improvements (*i.e.,* many sites now fully attain aquatic life use criteria), 11 show no change, seven show a mix of decline and improvement, and only two have exhibited complete or partial declines. In many of the latter two categories, the declines were usually due to the worsening of an already impaired status. First time reassessments of trends in a minimum of 15 additional rivers and streams and second or third time reassessments will occur in many others during the next 5-10 years, provided monitoring resources remain stable.

"Assessments of trends in a minimum of 26 additional rivers and streams will occur during the next 5-10 years, provided monitoring resources remain stable."

The Ohio EPA biological criteria are fundamental to the process of determining the attainment status of rivers and streams for the 305(b) report. However, simply delineating full, partial, and non-attainment does not provide a quantitative ranking of Ohio's water resources. We recently developed a new mea-

Table 1. Summary of aquatic community status and trends for the principal rivers and streams monitored by Ohio EPA between 1979 and 1995 in the Lake Erie drainage basin. For study areas where before and after surveys have been performed, an indication of any significant change as greatly improved (▲▲), improved (▲), decline (▼), or no change (↔) was made under the Trends column (some areas are described as simultaneously improving, declining, etc. which reflects conditions in different segments of the study area). Under the Trends column, the year (e.g. 1998) indicates the next opportunity for a follow up survey within the Five-Year Basin Approach schedule. A qualitative description of the nonpoint source and habitat conditions, and general highlights of major events in the study are also noted.

River/ Stream	**Earliest/ Latest Yr.**	**Trends**	**Nonpoint Status**	**Habitat Status**	**Comments/Observations**
Lake Erie Drainage Basins					
Grand River	1987/1995	▲	Good	Excell.-Good	EWH attainment; chromate lagoon impacts.
Maumee River	1984/93	↔	Poor	Good-Fair	NPS background impacts; WWTP/CSO impacts.
Auglaize R.	1985/91	▲	Fair-Poor	Good-Fair	1985 agency enforcement Farm Services, Inc.
St. Marys R.	1991	1996	Fair-Poor	Fair-Poor	Silt/habitat impacts; HELP ecoregion effect.
Tiffin River	1984	▲	Fair	Fair	Significant NPS; some habitat recovery.
Blanchard R.	1983/91	▲	Fair	Fair	Findlay WWTP upgrade; CSO abatement eval.
Ottawa R.(Lima)	1985/91	▼↔▲	Good-Fair	Good-Fair	Historically improved; fish anomalies remain.
Sandusky River	1979/90	▼▲	Fair-Poor	Good	WWTP upgrades; NPS impacts worsened.
Ashtabula River	1989/1995	↔	Good	Good	Good quality ust. Ashtabula; toxics in harbor area.
Huron River	1982/84	1998	Good	Good	Generally good quality; local WWTP impacts.
Rocky River	1981/1992	▼↔▲	Good	Good	Many WWTP upgrades since 1981.
Chagrin River	1986/1991	1996	Good	Good	Industrial impacts evident in 1986 & 1991.
Portage River	1985/1994	↔	Good-Poor	Good-Poor	NPS impacts; impacts remain severe in E. Branch.
Cuyahoga River	1984/91	▲▲	Good-Fair	Excell.-Fair	WWTP upgrades, pretreatment; CSO impacts.
Black River	1982/92/94	▼↔▲	Fair/Poor	Good-Fair	WWTP/CSO, industrial; NPS worse in upper basin.
Vermilion River	1987	1997	Good-Fair	Excell.-Good	High quality in areas; NPS impacts in upper basin.

Table 2. Summary of aquatic community status and trends for the principal rivers and streams monitored by Ohio EPA between 1979 and 1995 in the Ohio River drainage basin. For study areas where before and after surveys have been performed, an indication of any significant change as greatly improved (▲▲), improved (▲), decline (▼), or no change (↔) was made under the Trends column (some areas are described as simultaneously improving, declining, etc. which reflects conditions in different segments of the study area). Under the Trends column, the year (e.g. 1998) indicates the next opportunity for a follow up survey within the Five-Year Basin Approach schedule. A qualitative description of the nonpoint source and habitat conditions, and general highlights of major events in the study are also noted.

River/ Stream	Earliest/ Latest Yr.	Trends	Nonpoint Status	Habitat Status	Comments/Observations
Ohio River Drainage Basins					
Hocking River	1982/1990	▲▲	Poor	Good-Poor	Lancaster WWTP upgraded; serious bank erosion.
Scioto River	1979/1993	▲▲	Fair	Excell.-Good	WWTP upgrades; CSO, siltation impact remains.
Paint Cr	1989	1997	Fair-Poor	Excell.-Good	Upgraded to EWH; NPS problems upstream.
Olentangy R.	1989/1995	▲	Good	Excell.-Good	Upper segment improved; lower to EWH.
Big Darby Cr	1979/1992	↔	Good	Excellent	High quality waters; NPS impacts in upper basin.
Mill Cr (Scioto)	1978/1995	▲	Good-Fair	Excell.-Good	Previous decline reversed; local problems remain.

Table 2. (continued).

River/Stream	Earliest/ Latest Yr.	Trends	Nonpoint Status	Habitat Status	Comments/Observations
Central Ohio R. Tribs.					
Yellow Cr.	1983/1991	↔	Good-Poor	Good	Locally severe acid mine impacts.
Cross Cr.	1983	1996	Good-Poor	Good	Locally severe acid mine impacts.
Captina Cr.	1983/1991	↔	Good	Excellent	High quality (EWH); improvements in tribs.
McMahon Cr.	1983/1991	▲	Good-Poor	Good	Locally improved; acid mine impacts in tribs.
Sunfish Cr.	1983/1991	↔	Excell.-Good	Excellent	High quality (EWH).
L. Muskingum	1983/1991	↔	Good-Fair	Excell.-Good	High quality (EWH); some local NPS impacts.
Little Beaver Cr.	1985	2001	Excellent	Excellent	High quality (EWH).
Middle Fork	1985	2001	Good	Good	Fish tissue advisory; Nease Chem. site.
West Fork	1984	2001	Excellent	Excellent	Consistent EWH attainment.
Southeast Ohio R. Tribs.					
Symmes Cr.	1990	2000	Good-Fair	Excell.-Good	NPS sediment impacts from surface mining.
LeadingCr.	1990/1993	▼▼	Good-Fair	Excell.-Good	Recovering from Meigs Mine #31 discharge.
Raccoon Cr.	1990/1995	▲	Good-Poor	Good-Fair	Improvement downstream; headwaters impaired.
L. Scioto R.	1990	2000	Good-Fair	Good	NPS sediment and oil & gas well impacts.
Southwest Ohio R. Tribs.					
Ohio Brush Cr.	1987	1997	Good	Excell.-Good	High qual. (EWH); WWTP impacts to tribs.
Whiteoak Cr.	1987	1997	Good	Excellent	High qual. (EWH); some NPS in upper basin.
Little Miami R.	1983/1993	▼↔▲	Good-Fair	Excell.-Good	WWTP impacts still evident; NPS in upper basin.
E. Fk. L. Miami	1982/1993	▼↔▲	Good-Fair	Excell.-Good	High quality (EWH); NPS impacts upper basin.
Great Miami River	1980/89/95	▲▲	Good	Excell.-Fair	Substantial improvements due to WWTP upgrades.
Twin Cr	1986/1995	▲	Excell.-Good	Excellent	EWH attainment at all sites; threatened areas.
Stillwater River	1982/1990	▲	Good-Fair	Excell.-Good	Improved since 1982; NPS impacts in upper basin.
Greenville Cr	1982/1990	▲	Good	Excellent	Improvements due to WWTP upgrade.
Mad River	1984/1994	▲	Good	Excell.-Good	Lower half improved; habitat problems upper half.
Muskingum R	1988/1994	▲	Good-Fair	Good-Fair	Upper part improved; thermal impacts reduced.
Upper Tusc	1983/1995	↔	Good-Fair	Good-Poor	Extensive channel mod., in-place contaminants.
Lower Tusc.	1983/1988	▲▲	Good	Excell.-Good	Upgraded to EWH due to PS improvements.
Nimishillen Cr.	1985	1998	Good-Fair	Excell.-Fair	Extensive industrial, WWTP, and CSO impacts.
E.Br. Nimishillen	1985/1993	▼↔	Fair-Poor	Poor	Industrial, toxics; NPS worsening in headwaters
Killbuck Cr.	1981/85/93	▼↔	Good-Fair	Good-Fair	WWTP, NPS impacts, channel mod., wetlands.
Rocky Fork	1979/1993	▼↔▲	Good	Excell.-Good	Industrial, toxics worsened; WWTP improved.
Black Fork	1984/1989	▼	Good-Fair	Fair-Poor	Decline due to worsening industrial impacts.
Kokosing R.	1987	1998	Excellent	Excellent	High quality (EWH); few impacts noted.
Licking River	1981/1993	▲▲	Good	Excell.-Good	WWTP impacts abated since 1981.
S.Fk. Licking	1984/1993	▲▲	Good	Excell.-Good	WWTP impacts abated since 1984.
Wills Creek	1984/1994	↔▲	Fair-Poor	Fair-Poor	Extensive NPS impacts still evident.
Mahoning River	1980/1994	↔	Good-Fair	Good-Fair	Detectable, but only slight recovery.
Mill Cr (Cinci.)	1988/1992	↔	Poor	Fair-Poor	Extensive channel mod., CSOs, urban, toxics.

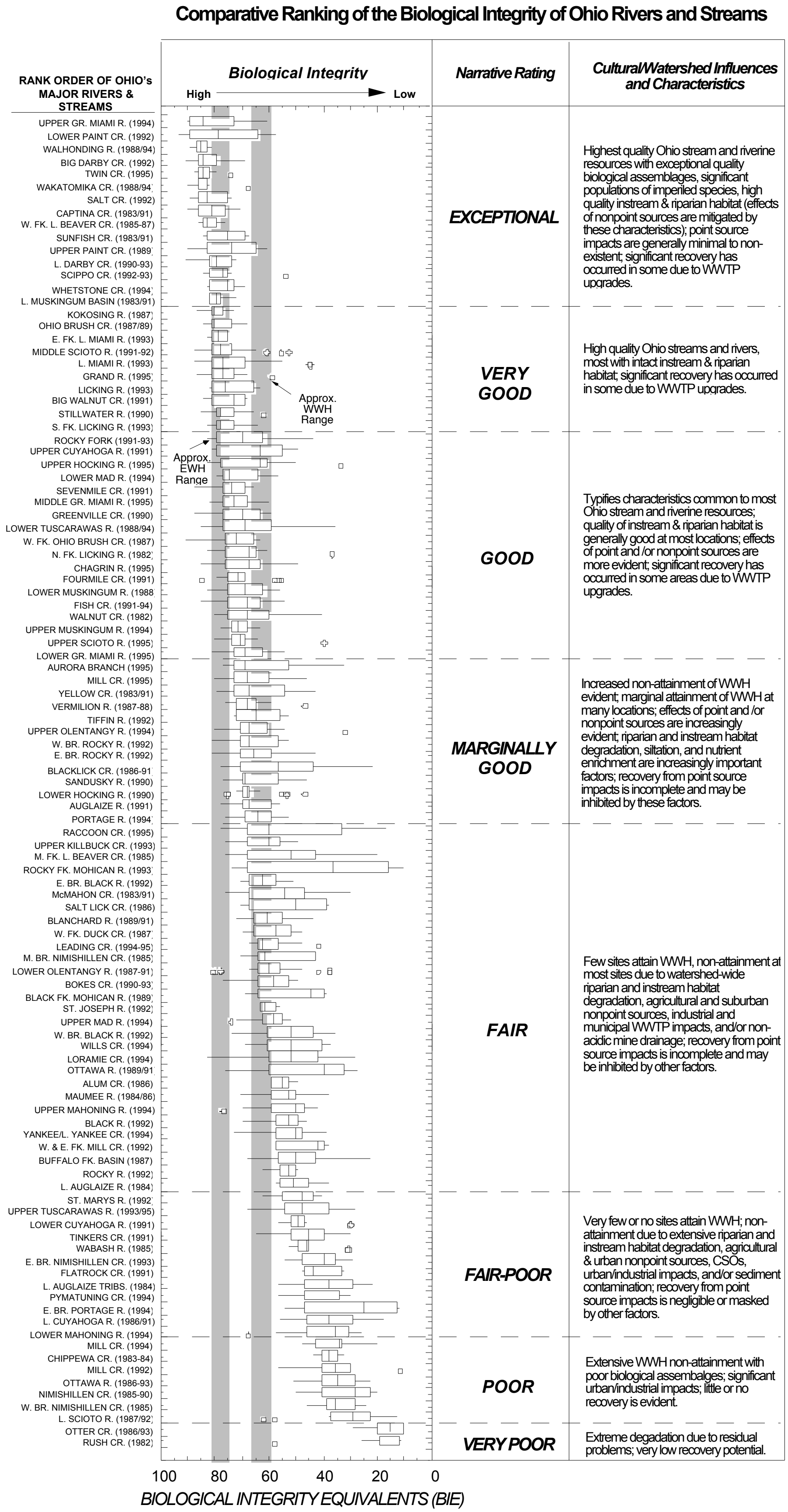


Figure 19. Comparative ranking of biological integrity of 106 Ohio rivers and streams based on a frequency analysis of Biological Integrity Equivalents (BIE).

sure of comparative biological integrity termed Biological Integrity Equivalents (BIE; Yoder and Rankin 1997) which integrates the three principal biological indices that comprise the biocriteria (IBI, Modified Index of well-being, and Invertebrate Community Index) into a single measured value. The degree to which a water body exhibits biological integrity is an important and emerging national indicator (U.S. EPA 1995). The BIE utilizes a 0-100 scale that reflects the degree to which biological integrity is achieved. This is somewhat different from assessing the use attainment status as each aquatic life use (or subdivision thereof) can reflect differing degrees of biological integrity. In the 1994 305(b) report the Index of Biotic Integrity (IBI) alone was used to accomplish a comparative ranking of major streams and rivers. The BIE concept was used here to numerically and quantitatively portray the quality of 106 major rivers and streams with drainage areas generally >50 and <6000 square miles. The resulting graphic (Figure 19) demonstrates both statewide and regional patterns in biological integrity besides approximating use attainment status. Streams and rivers were ranked by upper quartile BIE values (75th %ile) according to the results of box-and-whisker plots showing the median, upper quartile, lower quartile (25th %ile), maximum, minimum, and outlier (*i.e.*, values >2 interquartile ranges above the median) values. Data from multiple years were combined when no between year differences were evident; however, if differences were evident, data from the most recent monitoring year(s) was used. Some streams and rivers showed little variation between the minimum and maximum IBI values which is an indication of uniform conditions throughout the segment or subbasin. Others exhibited wide variations that reflect variable quality owing to differences between relatively unimpacted sites and severely impacted sites near and downstream from problem sources. Thus while some streams and rivers

An important component of biological criteria and biological monitoring - setting artificial substrates for the collection of macroinvertebrates.

may have been characterized as marginally good, fair, or poor in terms of the 75th percentile BIE value, this does not necessarily reflect the performance of all sites sampled. What it does reflect is the potential (or lack thereof) for recovery to a higher status.

". . . the highest quality streams [were] distributed principally among the Western Allegheny Plateau (WAP) and the E. Corn Belt Plains (ECBP) ecoregions."

Ecoregional influences were apparent with the highest quality streams distributed principally among the Western Allegheny Plateau (WAP) and the E. Corn Belt Plains (ECBP) ecoregions. While these include some of the better known high quality stream and river resources such as Big Darby Creek, Little Darby Creek, Stillwater River, and Salt Creek, but also include less well known, but equally exceptional resources, such as the upper Great Miami River, lower Paint Creek, Captina Creek, West Fork of Little Beaver Creek, Kokosing River, and Twin Creek. Others, such as the upper and middle Scioto River, Licking River, middle Great Miami River, and upper Hocking River are well along in the recovery process with each ranking in the good and very good ranges. The Interior Plateau (IP) and Erie/Ontario Lake Plain (EOLP) ecoregions were represented by some very good streams and rivers (Ohio Brush Creek, Grand River) and several in the good range. The highest ranking stream or river located mostly within the Huron/Erie Lake Plain (HELP) ecoregion was the Tiffin River (48th out of 106) followed by the Portage River (56th). The remaining nine HELP waters ranked in the lower one-third which demonstrates the extent to which the biological integrity of these watersheds has been reduced by historical and widespread modification to habitat, drainage alterations, and nonpoint source influences.

". . . watersheds with extensive and intensive hydromodification and nonpoint source impacts and mine drainge impacts . . . consistently ranked in the lower one-half to one-third."

A narrative rating scale similar to that which is linked to the biocriteria index score ranges was also included along with a description of the cultural and watershed influences and characteristics associated with each stream or river. For example, watersheds with extensive and intensive hydromodification and nonpoint source impacts (*e.g.,* Auglaize River, Tiffin River, Little Auglaize River, Loramie Creek, Chippewa Creek, W. Branch Black River) and mine drainage impacts (*e.g.,* Raccoon Creek, McMahon Creek, W. Fork Duck Creek, Leading Creek, Wills Creek, Buffalo Fork) scored primarily in the fair, fair-poor, or poor ranges and consistently ranked in the lower one-half to one-third. Streams and rivers impacted by multiple urban and industrial impacts (*e.g.*, Rocky Fork Mohican, Ottawa River (Lima), Mill Creek (Cincinnatti), Black River, upper Tuscarawas River, Nimishillen Creek, lower Mahoning River, Little Cuyahoga River, Little Scioto River) generally scored in the fair-poor and poor ranges and most ranked in the lower one-fourth. Otter Creek (HELP ecoregion), with severe urban/industrial impacts, and Rush Creek (WAP ecoregion), which has severe acid mine drainage problems, scored the lowest of all 106 streams with uniformly very poor quality.

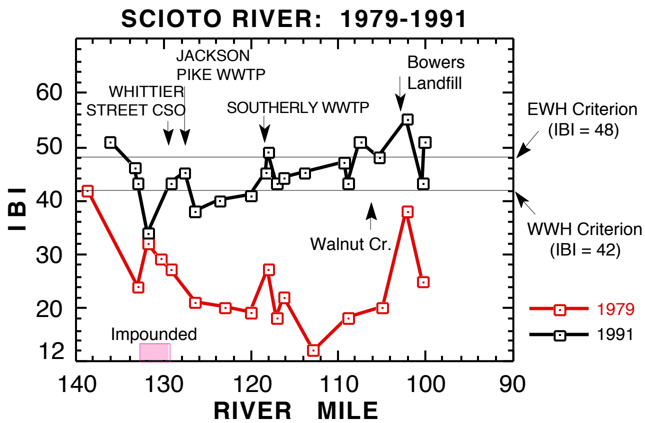


Figure 20. Longitudinal and temporal trend of the Index of Biotic Integrity in the middle Scioto River in and downstream from Columbus, Ohio. The improvement towards attainment of the IBI criterion for the Warmwater Habitat use is a result of improvements made at the two municipal wastewater treatment facilities.

"Streams and rivers impacted by multiple urban and industrial impacts . . . generally scored in the fair-poor and poor ranges and most ranked in the lower one-fourth."

Figure 20 demonstrates method used routinely by Ohio EPA to portray biological sampling results from individual river segments. This example depicts the Index of Biotic Integrity (IBI) for the middle Scioto River within and downstream from Columbus, Ohio. The results of two different sampling years, before and after the imposition of water quality-based effluent limits at the major municipal wastewater treatment plants, are shown for a 40-mile segment. This permits the visualization of departures from the ecoregional biocriteria and any changes over space and time. This example typifies the positive biological response we have observed in numerous river and stream segments to reductions in loadings of sewage constituents (oxygen demanding wastes, ammonia, chlorine) that have taken place since the late 1980s and early 1990s.

Recreational Uses

The principal measurement for assessing whether waters are suitable for human body contact (*i.e.*, swimming, canoeing, or wading as specified by the Primary Contact Recreation and Secondary Contact Recreation uses) are fecal bacteria counts. A total of 5,686 miles of rivers and streams have been assessed since 1978 with 2402 miles assessed since 1988. Of this latter figure, 616 miles were new assessments and 1226 miles were reassessments. The observed improvements in recreation use attainment (Figure 21) are attributed to improved municipal wastewater treatment, particularly reductions in bypasses of raw or partially treated sewage. The remaining nonattainment is the result of: 1) urban runoff and combined sewer overflows; 2) unresolved WWTP treatment problems (bypassing); and, 3) livestock and agricultural runoff. At the observed rate of improvement reflected in Figure 20, 63.2% of stream and river miles should fully attain designated recreational uses by the year 2000.

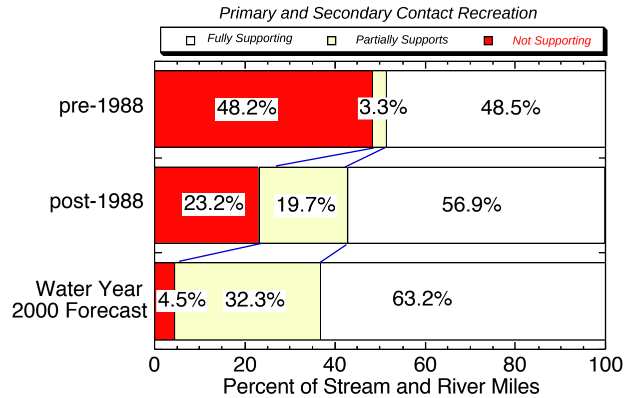


Figure 21. Miles of rivers and streams fully attaining, partially attaining, or not attaining recreational uses (primary or secondary contact) between the pre-1988 and post-1988 305[b] assessment cycles.

Inland Lakes, Ponds, and Reservoirs

Monitoring of inland lakes, ponds, and reservoirs has historically been less intensive than for rivers and streams, but the recent Lake Water Quality Assessments (LWQAs) and Citizen Lakes Initiative Program (CLIP) have helped to close the gap. The information presented here was collected primarily during the past six years as part of the LWQA program and from a Lake Condition Index questionnaire completed by managers of publicly owned lakes. Davic and DeShon (1990) devised a Lake Condition Index (LCI) which aggregates a wide range of lake indicators such as secchi disk depth, presence of contami-

Most of Ohio's lakes are artificially created, although a number of natural lakes exist in the northeast and west central parts of Ohio.

nants, and trophic state to assess lake water quality conditions and to track the progress of lake restoration activities. The paucity of long-term monitoring data limits our analysis to the present status of the publicly owned lakes that have been recently monitored.

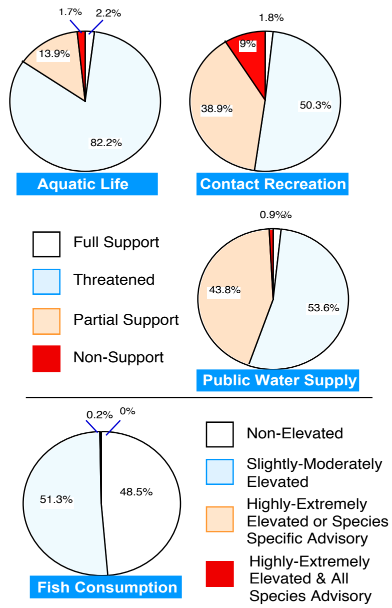


Figure 22. Designated use and fish consumption status for acres of lakes, ponds, and reservoirs in Ohio.

Ohio has an aggregate total of 118,801 acres among 447 public lakes, ponds, and reservoirs greater than five acres in surface area. Of this acreage, 76,813 acres (64.7%) were assessed for aquatic life use support, 85.606 acres (72.1%) were assessed for fish tissue contaminants, 76,185 acres (64.1%) were assessed for public water supply uses, and 76,636 acres (64.4%) were assessed for recreational uses. For aquatic life uses, there was full attainment in 64,825 acres (84.4%), partial attainment in 10,686 acres (13.9%), and nonattainment in 1,302 acres (1.7%; Figure 22). However, 92% of the fully attaining lake acres were considered threatened. For fish consumption, 41,496 acres (48.5%) had nonelevated concentrations of contaminants and 43,930 acres (51.3%) had slightly-moderately elevated levels of contaminants (mostly mercury). Highly or extremely elevated levels of PCBs have resulted in advisories in two small lakes in northeast Ohio). For the public water supply use, 42,147 acres (85 lakes) fully attained, but all except 1301 acres were considered threatened; 33,365 acres were partially attaining, and 673 acres were in nonattainment. For recreational uses, 39,891 acres fully attained (38,499 of these acres were considered threatened), 23,793 acres were partially attaining, and 6,852 acres were in nonattainment.

For the most part, Ohio's publicly owned lakes, ponds, and reservoirs (recreation, public water supply, and aquatic life) were at least in partial attainment. The assessment methodology, based on the Ohio Lake Condition Index (LCI), includes multiple metrics and a classification of partial attainment may indicate a minor problem in only one or two (*e.g.*, low hypolimnetic dissolved oxygen during the summer months) with the remainder indicating acceptable conditions. The LCI is most useful for assisting lake managers in identifying water resource problems and actions that will improve overall lake quality. It is also useful for classifying outstanding and high quality lakes that meet all of the criteria of the LCI. Thus, partial attainment should be used only to indicate the partial presence of specific problems, not as an indication of complete impairment. The nonattainment category is the most reliable indicator of lake impairment and should be used exclusively in statewide or national reporting statistics. Recreational use was the only major category where most Ohio lake acres are in bonafide nonattainment.

"The non-attainment category is the most reliable indicator of lake impairment . . ."

Major magnitude sources associated with partial and non-attainment were (in order of acreage affected): point sources (9,075 acres), agricultural nonpoint sources (1,678 acres), urban runoff (602 acres), on-lot septic systems (570 acres), and habitat modifications (489 acres). Major magnitude causes were identified as turbidity (983 acres), algal/nutrients (5,377 acres), siltation (2,898 acres), and organic enrichment/dissolved oxygen (4,837 acres). Similar to Ohio's streams and rivers, abatement of nonpoint sources is a key for improving and maintaining lake conditions.

Shoreline development along Lake Erie in Erie Co.

Lake Erie

Lake Erie was similarly evaluated for aquatic life use attainment status, but neither recent nor comprehensive information is available. Thus, much of the assessment is based on older data primarily from Lake Erie river mouth and harbor areas. None of the open lake was considered to fully attain the Exceptional Warmwater Habitat (EWH) use designation (based on chemical criteria exceedences alone). The entire 231 shoreline miles of the near shore were considered in partial attainment of EWH, which is based primarily on a lake-wide fish consumption advisory for carp and channel catfish, and exceedences of chemical water quality criteria for copper and cadmium in the water column. Associated sources (major and moderate influence) included point sources (69%), nonpoint sources (19%), in-place pollutants (3.5%), and other (8.5%). Associated causes include toxics (mostly heavy metals, 77%), organic enrichment/ D.O. (14%), and pH (9%). *The lack of a comprehensive set of ecological indicators for Lake Erie makes these estimates of use attainment/nonattainment tenuous.*

The George B. Garrett, shown here in the lower Maumee R. (Lucas Co.), has expanded Ohio EPA's ability to conduct ambient monitoring in Lake Erie nearshore, river mouth, and harbor areas.

Ohio EPA is presently working to develop numerical biological criteria for the nearshore, river mouth, and harbor areas of Lake Erie. This effort will be similar in scope to that accomplished for Ohio's inland streams and rivers in the late 1980s. However, the specific metrics and evaluation tools will be appropriately developed and calibrated for applicability to these areas. The first year of data collection and method development has been completed. The second is underway and a third year is planned. It is anticipated that a fourth year will be needed to finalize the biocriteria. Hopefully, the availability of these criteria and the attendant monitoring and assessment tools will improve the present situation.

"Ohio EPA is presently working to develop numerical biological criteria for the nearshore, river mouth, and harbor areas of Lake Erie."

The development of a Lakewide Management Plan (LaMP) for Lake Erie has also been initiated. A concept paper, developed as an initial starting point for the LaMP, recommends that a much broader approach be taken than the present emphasis on toxic compounds alone. It is widely recognized that multiple stressors impact the lake, some more so than toxics.

These include habitat destruction, wetlands losses, exotic species introductions, overfishing, and nutrient enrichment.

Ohio's Coastal Zone Management Plan recently received federal approval. This plan will deal with managing activities in erosion prone areas and restoring and enhancing coastal marshes and other important coastal issues. This program is managed by the Office of Real Estate and Land Management at ODNR

" . . . RAPs are . . . developed through a systematic, ecosystem approach with . . . local community and stakeholder involvement."

Remedial Action Plans (RAPs)

Since 1988, Ohio EPA has been working toward completion of remedial action plans (RAPs) for Ohio's four Areas of Concern. These include the lower Ashtabula, Cuyahoga, and Maumee rivers, and the entire Black River watershed. A provision of the Great Lakes Water Quality Agreement, RAPs are to be developed through a systematic, ecosystem approach with a considerable amount of local community and stakeholder involvement. Important highlights from the RAPs are further summarized in Volume I.

Ohio River

The assessment of the Ohio River focused on the status of multiple designated uses (Warmwater Habitat, Public Water Supply, Recreation) and fish consumption performed by the Ohio River Valley Sanitation Commission (ORSANCO) and summarized in their 1996 305(b) report (ORSANCO 1996). Unlike the procedures used by Ohio EPA for inland rivers and streams, use attainment status is based on a combination of chemical-specific and qualitative biological information. A new improvement to the tracking of aquatic life use attainment is ORSANCO's subdivision of the partial category into three sub-categories: substantially supporting, moderately supporting, and marginally supporting. This approach deals with problems that arise where there are "minor" exceedences of chemical criteria where

The Ohio River mainstem near Martins Ferry in Belmont Co.

biosurvey data evidence no problem (see "Independent Application" in glossary). For the Warmwater Habitat aquatic life use (Ohio boundary waters only), 134.6 mainstem miles (29.9%) were fully attaining, 150.8 miles (33.4 %) were substantially attaining, and 165.5 miles (36.7 %) were moderately attaining. For fish consumption, all Ohio mainstem miles were in partial attainment due primarily to a fish consumption advisory for selected species. For the public water supply use, which has major application in the Ohio River, all 163.7 miles (36.30%) were in full attainment and 287.2 miles (63.7%) were partially attaining due to spills. No miles (0%) fully attained the primary contact recreation use, 367.3 miles (81.4%) were in partial attainment, and 77.4 miles (17.2%) were impaired (nonattainment due to elevated bacteria levels).

Biological sampling in large water bodies requires the use of boat mounted methods. This photo shows boat electrofishing in a Lake Erie river mouth area. A similar method is used on the Ohio River.

The principal causes associated with aquatic life use impairment in the Ohio River were heavy metals, particularly chemical criteria exceedences of copper and lead. However, fish community data collected by Ohio EPA and ORSANCO generally show good to exceptional community performance, which is at odds with the status and condition of the mainstem based solely on ambient water column chemistry results. Metals in the water column are likely not present in their most toxic forms, thus an assessment based on chemical criteria violations alone may be misleading. The two metals showing criteria exceedences, copper and lead, are prone to this type of phenomenon. However, lacking more formal biological assessment criteria currently precludes "overruleing" the chemical criteria exceedences in deciding use attainment status. Work is underway to develop formal biological criteria that may help to resolve this situation in the future.

" . . . fish community data collected by the Ohio EPA and ORSANCO generally shows good to exceptional community performance."

Ohio's Fish Tissue Contaminant Monitoring Program

Ohio lacked a formal and comprehensive fish tissue monitoring program until recently. Besides serving as a human health risk indicator, contaminated tissue is a useful indicator for identifying lakes, streams, and rivers that have been affected by hydrophobic toxic substances and for tracking the success of pollution abatement efforts. Ohio's fish tissue sampling program historically has been small in scope (approximately 50 sites/year pre-1988, 100 sites/year 1989-1993) and the information herein largely reflects the results of that effort. However, in 1993, Ohio EPA, in cooperation with Ohio DNR, the Ohio Department of Health, and Ohio Department of Agriculture, initiated a statewide monitoring effort for fish tissue contaminants (approximately 600 samples/year). This effort is continuing. Data collected from 1978 to 1995, analyzed herein, provide a baseline for evaluating future results. Recent changes in the screening levels for mercury contamination have resulted in some significant changes to the tissue results compared to our 1994 analyses. Volume II of this report summarizes fish tissue results by stream basin, discusses the procedures for issuing fish consumption and contact advisories in Ohio, and provides a list of existing advisories.

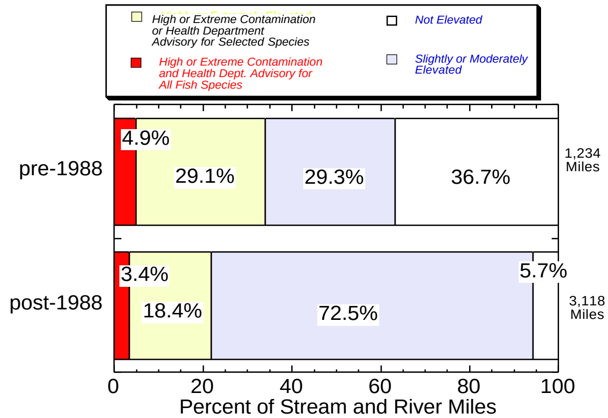


Figure 23. Miles of streams and rivers with fish tissue samples which exhibited no contamination, slightly or moderately elevated contamination, highly or extremely elevated contamination, or highly or extremely elevated contamination in segments with a State or local health advisory, during pre-1988 and post-1988 assessment cycles.

"More than 40% of fish tissue samples analyzed . . . were essentially free from elevated concentrations of PCBs, pesticides, metals, or other organic compounds."

On the basis of data collected from 1988 to 1995 (90-96 assessment cycles), 5.7% of the monitored stream and river miles (Table 3-5) had fish samples with low or non-detectable ("not-elevated") concentrations of PCBs, pesticides, metals, or other organic compounds. Levels of contaminants in fish considered slightly or moderately elevated were found in 72.5 % of monitored stream miles. Highly or extremely elevated levels of contaminants comprised 18.4% of the total stream and river miles. State and/or local consumption advisories for selected species have been issued for only a small proportion of these latter miles. Health advisories for all species have been issued for 3.8% of the miles monitored for fish tissue contaminants. A thorough assessment of trends awaits the data that will be generated by the intensive data collection efforts planned over the next several years, especially for parameters such as mercury that have only been recently collected in Ohio.

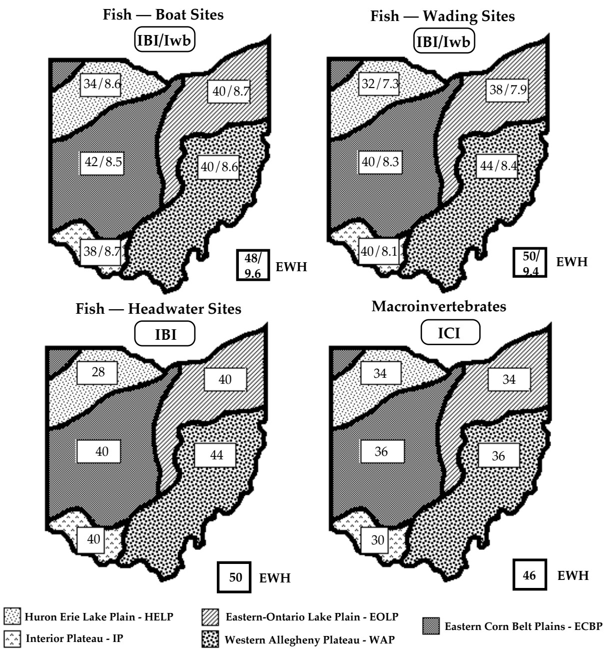


Figure 24. Numerical biological criteria codified in the Ohio Water Quality Standards shown by index, site type, and ecoregion for the Warmwater Habitat and Exceptional Warmwater Habitat use designations.

Biological Criteria in the Ohio Water Quality Standards

Biological criteria (biocriteria) are narrative or numerical expressions that reflect the overall quality of the aquatic life that inhabit the aquatic environment (*i.e.*, direct measures of fish and macroinvertebrate population and community characteristics). As such they represent a method for directly measuring whether a stream or river is attaining a designated aquatic life use. Biological criteria are fundamentally different from chemical-specific criteria in that the latter, being based on laboratory studies of representative aquatic species, serve as surrogates for what biocriteria are designed to measure directly. Biocriteria function within a monitoring and assessment effort as response indicators whereas chemical-specific criteria function as exposure indicators. Chemical-specific criteria also serve as design endpoints for determining water quality based limitations whereas biocriteria serve as an ambient aquatic life goal assessment tool. U.S. EPA has demonstrated their interest and support of biocriteria by producing bioassessment guidance (Plafkin *et al.* 1989), national biocriteria program guidance (U.S. EPA 1990), a policy statement on biocriteria (April 1990), and a technical guidance manual for developing biocriteria in wadeable streams (U.S. EPA 1995). Similar efforts are in various stages of development for lake, wetland, and large river biocriteria.

"Biocriteria function within a monitoring and assessment effort as response indicators . . ."

Ohio EPA adopted numerical biological criteria for rivers and streams in February 1990. A regional reference site approach was used to derive these criteria (Figure 24). Within this framework, numerical biological community performance expectations are based on what the least impacted reference sites within a given geographic region demonstrate as being attainable. This process includes consideration of background factors that influence and determine the inherent character of watersheds (*i.e.*, land use, geology, soils, *etc*.), stream and river size, and inherent biological characteristics and attributes. As such, biocriteria should provide a more accurate reflection of both the existing and restorable condition of aquatic resources that should lead to a better identification of critical issues, appropriate designated uses, and the formulation of abatement strategies that are inherently more cost-effective and environmentally effective.

Biological criteria for wetlands are in the developmental stage. Biocriteria differ from chemical criteria in that they measure ecological attributes directly.

A key policy issue facing states is the U.S. EPA policy of independent application. This policy requires that biological criteria, chemical-specific criteria, and whole effluent toxicity test results be evaluated independently with no one indicator being viewed as preemptive of another. Others (including most states) have advocated a weight-of-evidence approach in which the application of each indicator is done on a more flexible, case-specific basis. Most states already employ a weight-of-evidence approach in their ambient bioassessments. Ohio EPA has recently advocated consideration of a hierarchical process in which the strength of the biological survey and underlying biological criteria development process be used to determine how much flexibility might be granted in the regulatory usage of biological criteria.

". . . biological criteria . . . significantly adds to the capability to detect, characterize, and more effectively manage water resource impairments.

Based on analyses presented in the 1990 Ohio Water Resource Inventory (Ohio EPA 1990b) and elsewhere (Yoder 1991a, 1991b, 1995; Yoder and Rankin 1995a), there is little doubt that the addition of biological criteria and ambient biological monitoring and assessment significantly adds to the capability to detect, characterize, and more effectively manage water resource impairments. Because it represents a direct and tangible product of the environment, biological criteria and assessment provide a meaningful way to demonstrate the benefits that expenditures on pollution controls have achieved. Furthermore, the information bases accumulated as a consequence of the ambient monitoring and assessment process have led to a more informed and cost-beneficial expenditure of both public and private funds. Problem discovery and comprehension would not be nearly as effective without an integrated chemical, physical, and biological approach to surface water monitoring and assessment. Aquatic life use impairments that we have identified and characterized during the past 15 years simply would not have been understood or even detected using chemical criteria and assessment tools alone. Identification of the three leading causes of aquatic life use impairment reported by this inventory would not have been possible without this type of integrated approach, including the use of numerical biological criteria derived within a regional reference site framework. While these biocriteria are restricted to rivers and streams, the development of biocriteria for Lake Erie river mouth, harbor, and nearshore areas, the Ohio River, and wetlands are either underway or under consideration.

"Aquatic life use impairments . . . simply would not have been understood or even detected using chemical criteria and assessment tools alone."

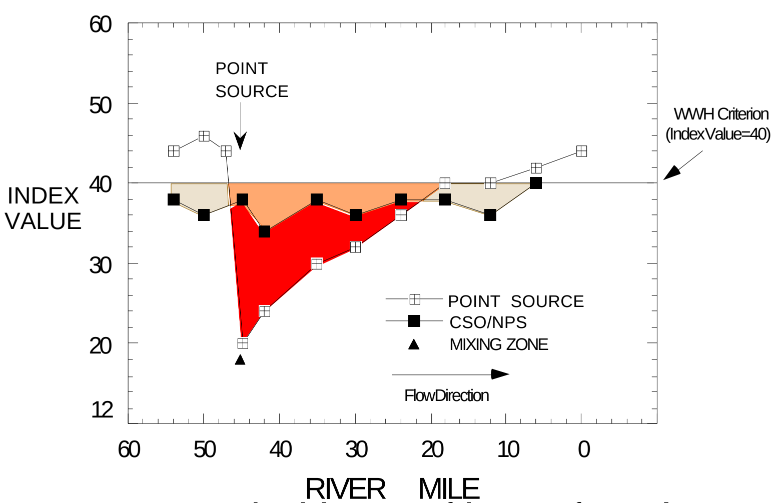


Figure 25. Graphical depiction of the Area of Degradation Value which is used by Ohio EPA to quantify the extent and severity of departures from biocriteria benchmarks (e.g., WWH criterion).

Priority Setting and the 303(d) List

Ohio EPA continues to incorporate the concepts and information produced from having biological criteria into water resource management efforts. An example is the use of the Area of Degradation Value (ADV; Yoder and Rankin 1995b, Fig. 25), along with other criteria (e.g., waterbodies with fish consumption advisories, high quality waters, etc.,) in the creation of prioritization process for impaired waterbodies needing TMDL development (i.e., 303(d) list). Details of the TMDL priority-setting process and Ohio's 1996 303(d) list are found in the Appendix of Volume I of the 305(b) report. The ADV is also used in setting priorities for funding in the present State Revolving Loan Fund programs. Other ongoing efforts include the development of a "restorability" rating for waterbodies based on Ohio EPA's Qualitative Habitat Evaluation Index (QHEI). Such a restorability rating could be combined with a stream classification system, such as that developed by Rosgen (1994), to provide a framework for stream protection and restoration efforts.

Economic Assessment

The Ohio EPA economic assessment for point sources is detailed in Volume I of this report. An analysis of incremental wastewater treatment expenditures for Publicly Owned Treatment Works (POTW) showed that more than $6 billion was spent between 1970 and 1992 to meet water quality-based effluent limitations at publicly owned treatment works. More than $0.8 billion was spent on point source pollution controls between December 1991 and January 1992. The total spending on pollution controls for all point sources is even higher when industrial and other treatment facilities are included. An effort to compare the environmental improvements derived from these expenditures has recently been initiated.

High quality wetland habitat in Columbiana Co. While not all wetlands exhibit surface water, specialized types of vegetation and hydric soils are generally present.

Wetlands

The Ohio Comprehensive Wetlands Strategy

"The [Wetlands] Strategy . . . proposed an interim goal of restoring 50,000 acres of wetlands and riparian ecosystems by the year 2000 . . ."

The Ohio Wetlands Task Force published a Report and Recommendations for wetlands in the State of Ohio in 1994, including a statement of goals and objectives and recommendations to meet these goals. The task force was convened by Ohio EPA and was made up of representatives of business, agricultural, environmental and conservation groups, universities, federal, state and local government agencies. Implementation of many of the recommendations of the Task Force is underway. Highlights of the implementation process include the development of a coordinated wetlands program by Ohio EPA and the Ohio Department of Natural Resources (ODNR). In addition, Ohio EPA has secured federal grant funds for development of several projects based on Task Force recommendations, including the development of wetland water quality standards, creation of an Ohio Landowner's Wetlands Assistance Guide, and utilizing the watershed approach to strategically plan wetland restoration and mitigation efforts to maximize water quality benefits.

Program Developments

A statewide inventory of wetlands, the Ohio Wetlands Inventory (OWI), has been completed by the Remote Sensing Program in the ODNR, Division of Soil and Water Conservation, the ODNR, Division of Wildlife, and the U.S. Natural Resource Conservation Service (NRCS). Digital data from the LANDSAT Thematic Mapper were computer classified to identify shallow marsh, shrub/scrub wetland, wet meadow, wet woodland, open water, and farmed wetland. The satellite multi-spectral data, which comes at a resolution of 30 meters by 30 meters, was combined with digitized soils data to improve wetland identification. In 1994, NRCS personnel finalized a review of the draft maps for each county, leading to the completion of the first edition of the OWI.

The loss of wetland habitat is frequently at issue in Section 401 certifications.

Ohio EPA has received several wetlands program development grants and a watershed management grant from U.S. EPA. As a result, there are currently five initiatives underway including the development of water quality standards for wetlands, the construction of a rapid assessment technique in conjunction with the development and testing of environmental indicators for wetlands, a pilot project testing the Floristic Quality Assessment Index to determine its sensitivity in evaluating wetlands, development of a watershed plan for the strategic wetland restoration and mitigation, and development of a Status and Trends Report for Ohio's wetlands.

"Ohio EPA has begun establishing reference wetlands and identifying potential indicators of wetland integrity...."

The draft wetland water quality standards are based on the philosophy that the level of protection a wetland receives be commensurate with its quality. Wetland quality will be evaluated using a rapid wetland assessment method also under development. Ohio EPA's requirements for mitigation (including avoidance of wetlands, minimization of impacts and mitigation of a specified acreage of wetland to compensate for unavoidable impacts) will be based on the quality of the wetland as indicated by the results of the wetland assessment. This represents a codification of the current practice using best professional judgement to make regulatory decisions. The wetland water quality standards will offer more consistent and defensible protection for wetlands, and make permit decisions more predictable.

While information has been compiled on the quantity of wetlands in Ohio (as in the OWI), there is little information regarding their quality. A two-tier approach is being taken to develop both ecological indicators of wetland ecosystem condition and rapid assessment techniques that can be used, for example, to help implement the wetland water quality standards. The results of the ecological monitoring program will be used to help calibrate the rapid assessment techniques. Ohio EPA has begun establishing reference wetlands and identifying potential indicators of wetland integrity and/or impairment. Ultimately biocriteria for wetlands may result. Reference sites have been selected based on wetland hydrogeomorphic (HGM) class (Brinson 1993), and other considerations of the landscape (e.g. ecoregion, position in the watershed and site accessibility).

One potential indicator under study is the Floristic Quality Assessment Index (FQAI). The FQAI is a vegetative metric tailored specifically to the flora of Ohio which reflects the impact of human disturbance by accounting for the presence of alien taxa. This index has potential for development as a biocriteria because it assigns a repeatable and quantitative value in assessing the condition of wetland ecosystems. This allows for an objective quantitative comparison of different wetlands.

Wetlands and Watershed Planning

A pilot project is underway to use a watershed approach to strategically plan wetland restoration and mitigation with the goal of maximizing water quality and habitat benefits to the watershed. A watershed level site-suitability model is being constructed using a geographic information system (GIS) in the Cuyahoga River watershed. Existing wetlands will be identified and integrated with the proposed restoration/mitigation locations to maximize both nonpoint source pollution control and habitat restoration. This represents implementation of goals set out by the Cuyahoga Remedial Action Plan (RAP) committee, a partner in the project.

In addition, the Division of Surface Water (DSW) recently secured U.S. EPA funds to develop a methodology to analyze the correlation between wetlands and water quality (i.e., attainment of aquatic life use designations), on a watershed basis. This will allow DSW to establish priority watersheds for wetland protection and restoration programs and incorporate information on the cumulative impacts to wetlands into Ohio's 401 water quality certification decision making process as well as other water quality programs.

Section 401 Water Quality Certification

The Section 401 water quality certification program administered by Ohio EPA is the major regulatory tool used protect wetlands in Ohio. The 401 water quality certification program provides protection to wetlands and other surface water by regulating projects which require a federal dredge and fill permit (Sec. 404 of the CWA). In the Ohio Revised Code, wetlands are specifically included in the definition of waters of the state and are protected by those portions of the Ohio water quality standards (i.e. narrative criteria) which apply to all surface waters, including narrative criteria and the Antidegradation Rule.

Section 401 certifications are required for dredge and fill activities affecting both streams and wetlands. Ohio EPA reviewed a total of 462 Section 401 certifications from 1994 to 1996. Of the total Section 401 certification applications reviewed between 1994 and 1996, 59 of them involved wetland impacts with a total of 129 acres of impacted wetlands. There were 319 acres of wetland mitigation, including restoration, creation, enhancement and managed

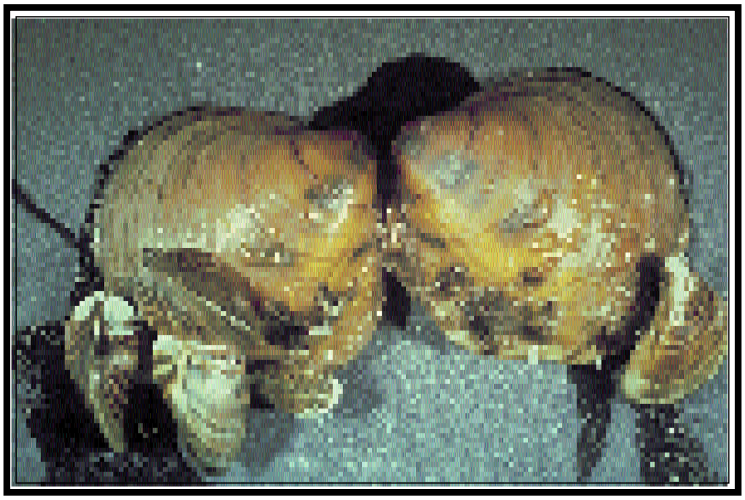
Round goby collected from Lake Erie by the Ohio EPA near the Grand River (Lake Co.), 1996.

wetland acreage required by the Section 401 certification actions. This results in a mitigation ratio of 2.4 acres wetland mitigation to 1 acre of wetland impact.

"The introduction of exotic (non-native) species in Ohio surface waters is a form of biological pollution . . . "

Alien Species in Ohio Waters

The introduction of alien (nonnative) species in Ohio surface waters is a form of biological pollution that has posed a threat to Ohio's indigenous aquatic fauna for more than 100 years. Nonnative species such as carp and goldfish are well established in Ohio waters and are now accepted parts of the fauna. However, these two species have their highest populations in areas with moderate to high degradation of habitat and/or water quality (see Volume I of this report). Recently introduced exotic species have become the focus of concern in Lake Erie, however, their impacts are presently unknown. Many of these species have been introduced as a result of shipping. This makes controlling and preventing future introductions difficult. Zebra mussels *(Dreissena polymorpha)*, which are native to southern and central Asia, are the best known of these introductions. It is believed that their entry into the Great Lakes occurred in 1986 via the discharge of ballast water from ocean going ships. By 1989, the zebra mussel had spread throughout Lake Erie. It has already had significant economic impacts by fouling water intake systems. The environmental effects of its high filtering capacity and rapid rate of colonization in Lake Erie remain unclear. Thus, it will be important to monitor the effects of the zebra mussel introduction, especially given the economic and recreational importance of Lake Erie to Ohio. More recently, zebra mussels have been collected in the Ohio River and some larger tributaries that may pose a threat to populations of native naiad mollusks in this drainage basin.



Zebra mussels attached to a (native) pimpleback mussel from the Ohio River downstream of the Little Miami River confluence (1994).

Although less well known than the zebra mussel, other more recently introduced exotic species are also of concern in Ohio. Two other recent invaders in the Great Lakes are the spiny water flea *(Bythotrephes cederstroemi)* and the river ruffe *(Gymnocephalus cernua)*. It is unclear if the spiny water flea has the potential to affect trophic relationships in Lake Erie or whether it will simply replace the zooplankton consumed as forage by fish. Other exotic invaders of the Great Lakes are the tube-nosed goby and round goby. In 1993 Ohio EPA collected round gobies in the nearshore of Lake Erie near the mouth of the Grand River. These are small, bottom-dwelling fish species that also arrived via oceangoing freighter ballast water discharges. Because of their bottom-dwelling habits, the gobies may compete with indigenous darter and sculpin species (such as the deepwater sculpin, *Myoxocephalus thompsoni*, designated a "special concern" species by Ohio DNR) present in Lake Erie. All these exotic species have the same Eurasian origins as the zebra mussel.

Many Ohio communities depend wholly or in part on groundwater. Well-head protection measures ensure the quality of these public water supplies.

Ground Water Quality

Ambient ground water monitoring has progressed significantly over the past two years in Ohio. The ambient network currently consists of approximately 215 selected industrial and municipal production wells at 170 sites which represent all of the major aquifer systems in the state. Most stations are sampled annually or semi-annually for organic and inorganic parameters. During 1994 and 1995, a total of 408 water samples were collected. A significant effort was made to improve and update the 1994 305(b) report on Ohio’s ground water quality. This report reflects the progress that the Ohio EPA, Division of Drinking and Ground Waters has made in computerizing databases and linking these databases to geographic information systems. This progress will continue as these skills are applied to analyzing and documenting the quality of Ohio’s ground water.

In the past two years, the ambient data has been entered into a database which will allow temporal and spatial analysis of the data. The initial use of this ability has focused on identifying ground water quality by aquifer type. A subset of the ambient database, with aquifer type identified, is presented in Volume IV of this report. It should be noted that these are preliminary analyses and that a quality assurance review has yet to be completed. These data begin to illustrate trends in Ohio's ground water quality by aquifer type. In addition, the data have been linked to a geographic information system. The ability to present ambient or public water system data in a geographical information format (geology, aquifer type, *etc*.) is a major improvement in assessing ground water quality. This will foster advancements in defining background water quality and in identifying impacted ground waters through special studies.

Ohio's public water supply systems which rely on ground water sources have been monitored during the past two years in compliance with requirements mandated by the federal Safe Drinking Water Act and Ohio state legislation. In particular, testing of public water supply systems has continued for inorganic parameters, synthetic organic chemicals, volatile organic chemicals, nitrates, radionuclides, and asbestos. The water quality information requested for public water systems in the U.S. EPA Guidance for 305(b) reports is provided for community and non-transient, non-community systems. These data confirm the high quality of water provided by public water systems. To maintain this quality, a wellhead protection program has been implemented. Approximately 200 public water systems have initiated wellhead protection efforts to date.

A recent update of the ground water component of the Ohio Nonpoint Source Assessment was used to document sources of ground water contamination, specific contaminants, and their relative priority. As facility owners have been required to complete on-site pollution source monitoring by the federal Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) legislation, the focus of Ohio EPA's pollution source monitoring has shifted toward nonpoint source pollution such as fertilizer usage and road salt application.

REFERENCES

Benke, A.C. 1990. A perspective on America's vanishing streams. J. N. Am. Benth. Soc., 9 (1): 77-88.

Judy, R. D., Jr., P. N. Seely, T. M. Murray, S.C. Svirsky, M. R. Whitworth, and L.S. Ischinger. 1984. 1982 national fisheries survey, Vol. 1. Technical Report Initial Findings. U.S. Fish and Wildlife Service, FWS/OBS-84/06.

DeShon, J.D. 1995. Development and application of the invertebrate community index (ICI), pp. 217-244. *in* W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton.

Gammon, J.R., Spacie, A., Hamelink, J.L., and R.L. Kaesler. 1981. Role of electrofishing in assessing environmental quality of the Wabash River, in Ecological assessments of effluent impacts on communities of indigenous aquatic organisms, in Bates, J. M. and Weber, C. I., Eds., ASTM STP 730, 307 pp..

Gammon, J.R. 1976. The fish populations of the middle 340 km of the Wabash River, Purdue University, Water Resources Res. Cen. Tech. Rep. 86. 73 p.

ITFM (Intergovernmental Task Force on Monitoring Water Quality). 1992. Ambient water quality monitoring in the United States: first year review, evaluation, and recommendations. Interagency Advisory Committee on Water Data, Washington, D.C.

ITFM (Intergovernmental Task Force on Monitoring Water Quality). 1993. Ambient water quality monitoring in the United States: second year review, evaluation, and recommendations (+ Tech. App.). Interagency Advisory Committee on Water Data, Washington, D.C.

ITFM (Intergovernmental Task Force on Monitoring Water Quality). 1995. The strategy for improving water quality monitoring in the United States. Final report of the Intergovernmental Task Force on Monitoring Water Quality. Interagency Advisory Committee on Water Data, Washington, D.C. + Appendices.

Karr, J. R. 1981. Biological integrity: a long-neglected aspect of water resource management, Ecological Applications, 1: 66.

Karr, J. R., K. D. Fausch, P. L. Angermier, P. R. Yant, and I. J. Schlosser. 1986. Assessing biological integrity in running waters: a method and its rationale. Ill. Nat. Hist. Surv. Spec. Publ. 5: 28 pp.

McCarthy, J. F. and L. R. Shugart (eds). 1990. Biomarkers of environmental contamination. Lewis Publishers, Boca Raton, Florida.

Ohio Environmental Protection Agency. 1988. Ohio water quality inventory - 1988 305(b) report, volume I and executive summary. Rankin, E. T., Yoder, C. O., and Mishne, D. A. (eds.), Div. Water Qual. Plan.& Assess. Columbus, Ohio.

Ohio Environmental Protection Agency. 1990. Ohio's nonpoint source pollution assessment. Div. Water Qual. Plan.& Assess. Columbus, Ohio.

ORSANCO. 1994. Assessment of water quality conditions: Ohio River 1992-1993. Ohio River Valley Water Sanitation Commission, Cincinnati, OH

Plafkin, J. L. and others. 1989. Rapid Bioassessment Protocols for use in rivers and streams: benthic macroinvertebrates and fish. EPA/444/4-89-001. U.S. EPA. Washington, D.C.

Rankin, E. T. 1989. The qualitative habitat evaluation index (QHEI), rationale, methods, and application, Ohio EPA, Div. Water Qual. Plan.& Assess., Ecological Assessment Section, Columbus, Ohio.

Rankin, E.T. 1995. The qualitative habitat evaluation index (QHEI), pp. 181-208. *in* W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Risk-based Planning and Decision Making. Lewis Publishers, Boca Raton.

Rosgen, D. L. 1994. A classification of natural rivers. Catena 22: 169-184.

Steedman, R.J. 1988. Modification and assessment of an index of biotic integrity to quantify stream quality in southern Ontario. Can. J. Fish. Aquatic Sci. 45: 492-501.

U.S. Environmental Protection Agency. 1996. Environmental indicators of water quality in the United States. U. S. EPA, Office of Water, Washington, D. C. EPA 841-R-96-002.

U.S. Environmental Protection Agency. 1995a. Biological Criteria, technical guidance for streams and small rivers. U. S. EPA, Office of

Water Regulations and Standards, Washington, D. C. EPA 822-B-94-001.

U.S. Environmental Protection Agency. 1995b. A summary of state bioassessment programs for streams (draft). Prepared for U.S. EPA, Offc. Policy Plan. & Eval. by Tetra Tech, Inc. Washington, D.C.

U.S. Environmental Protection Agency. 1994. National water quality inventory: 1992 report to congress. U. S. EPA, Office of Water, Washington, D. C. EPA 841-R-94-001.

U.S. Environmental Protection Agency. 1990. Biological Criteria, national program guidance for surface waters. U. S. EPA, Office of Water Regulations and Standards, Washington, D. C. EPA-440/5-90-004.

U.S. National Research Council. 1992. Restoration of aquatic ecosystems: science, technology, and public policy. Committee on Restoration of Aquatic Ecosystems, Water Science and Technology Board. National Academy Press, Washington, D.C. 552 pp.

Yoder, C.O. and E.T. Rankin. 1995a. Biological criteria program development and implementation in Ohio, pp. 109-144. *in* W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Risk-based Planning and Decision Making. Lewis Publishers, Boca Raton.

Yoder, C.O. and E.T. Rankin. 1995b. Biological response signatures and the area of degradation value: new tools for interpreting multimetric data, pp. 263-286. *in* W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Risk-based Planning and Decision Making. Lewis Publishers, Boca Raton.

Yoder, C.O. 1995. Policy issues and management applications of biological criteria, pp. 327-344. *in* W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Risk-based Planning and Decision Making. Lewis Publishers, Boca Raton.

Yoder, C. O. 1991a. Answering some concerns about biological criteria based on experiences in Ohio. In: Gretchin H. Flock, editor. Water quality standards for the 21st century. Proceedings of a National Conference, U. S. EPA, Office of Water, Washington, D.C.

Yoder, C. O. 1991b. The integrated biosurvey as a tool for the evaluation of aquatic life use attainment and impairment in Ohio surface waters. Biological Criteria: Research and Regulation, Proceedings of a Symposium, December 12-13, 1990, Arlington, VA, U. S. EPA, Office of Water, Washington, D.C. EPA-440/5-91-005: 110.

GLOSSARY

Aquatic Life Use – A designation assigned to a waterbody based on the *potential* aquatic assemblage that can be sustained given the ecoregion potential; (*e.g.*, EWH, WWH, CWH, LRW, designated uses).

Aquatic Life Use Attainment – The condition when a waterbody has demonstrated, through the use of ambient biological and/or chemical data, that it does not significantly violate biological or water quality criteria for the designated aquatic life use.

Antidegradation – A provision of the state water quality standards that limits the amount of degradation that can be permitted in waters where the existing quality is better than that prescribed by the designated use.

Biological (Biotic) Integrity – The ability of an aquatic community 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 habitats within a region.

Biological Integrity Equivalents (BIE) – An index which combines the three principal indices which comprise the Ohio EPA biological criteria giving each index equal weighting on a 0-100 scoring scale.

Biological Survey (Biosurvey) – In-field (ambient) sampling of resident aquatic organisms to assess biological integrity and designated aquatic life use attainment status. In Ohio, the accepted methods include pulsed–DC methods of electrofishing for sampling fish and Hester–Dendy Multiple Plate Artificial Substrate Samplers and dip nets for sampling macroinvertebrates. Other synonyms: ambient (or instream) biological sampling, biomonitoring, bioassessment.

Biomarkers – Measurements made at the molecular, biochemical, or cellular level in either wild populations or in organisms experimentally exposed to pollutants which indicate organism exposure to toxic chemicals based on the magnitude of the organism response to contaminants (McCarthy and Shigart 1990).

Channelization – A term applied to stream channel modifications designed to improve sub-surface drainage of agricultural fields and/or to prevent surface flooding. This includes channel straightening and widening and includes riparian vegetation removal. These activities almost always result in degraded biological quality via habitat loss and trophic (energy pathway) disruptions.

Chemical-Specific Approach – Traditional water quality approach of regulating point sources by using chemical/physical water quality criteria as surrogates for assessing biological goals. The criteria consist of safe concentrations of individual chemicals in the water which, if not exceeded instream, are presumed to protect aquatic life and maintain designated aquatic life uses.

Clean Water Act (CWA) – An act of the U.S. Congress, first passed in 1972 as the Federal Water Pollution Control Act, which provides the legal framework for reducing pollutants and protecting and restoring chemical, physical, and biological integrity in waters of the U.S. The 305(b) report is required by a section (305[b]) of the CWA.

Combined Sewer Overflow (CSO) – Combined sewers carry both sanitary wastewater and storm water together in the same conduit. A combined sewer overflow (CSO) is the location where the mixed storm water and sanitary wastes are discharged to a water body usually during rainfall events. Overflows occur when the increased amount of flow cannot be carried by the sewer to the municipal wastewater treatment plant (WWTP).

Conventional Pollutants – Pollutants commonly discharged by WWTPs as byproducts of the treatment process and include parameters such as ammonia, nutrients (phosphorus and nitrates), dissolved oxygen, suspended solids, and chlorine. Some of these are also constituents of urban and agricultural nonpoint source runoff.

Criteria – The chemical, physical, or biological conditions demonstrated or presumed to support or protect a designated use (*e.g.,* WWH, MWH, *etc*.).

Degradation – A lowering of the existing water, habitat, or biological quality of surface or ground waters.

Designated Use – The general purpose(s), benefit(s), or use(s) to be derived from a waterbody, *e.g.,* drinking water, aquatic life, swimming, fishing, *etc*.

Ecoregion – Regions of comparative geographic homogeneity based on an overlay of maps of land–surface form, soils, land use, and potential natural vegetation. Such regions are likely to contain similar watershed characteristics and, hence, similar water quality, habitat, and aquatic communities.

Ecoregional Biocriteria – Biological index values which represent the base level of what is needed to meet the designated aquatic life use in a particular ecoregion and waters of respective of the designated use, ecoregion, and stream size.

Effluent – The wastewater discharge from a fixed point such as a WWTP or industry. This term is most commonly associated with point source discharges.

Electrofishing – A method of collecting fish using an electrical field designed to non-lethally stun and immobilize fish for capture and observation. Electrical power is provided by a gas–powered generator or battery. Captured fish are released after processing which includes species identification, counting, weighing, and an examination for external anomalies. These results are used to calculate the Index of Biotic Integrity (IBI) and the modified Index of Well–

Being (MIwb), two of the indices which comprise the Ohio EPA biological criteria.

Environmental Indicator – A measureable feature of the environment which either singly or in the aggregate provides managerially and scientifically useful information about the quality of the environment and trends in environmental quality.

Eutrophic – A highly "productive" body of water that has elevated concentrations of organic matter, nutrients, and algae. The trophic state index (TSI) is used to determine the degree of eutrophication.

Eutrophication – The process by which a lentic (lake or reservoir) system becomes eutrophic.

Evaluated Level Data – Data which originated from sources *OTHER* than intensive surveys of biological or chemical conditions and which follow Ohio EPA protocols. These sources may include predictive modeling, the Ohio nonpoint source survey, citizen complaints, and chemical data less than five years old.

Exceptional Warmwater Habitat (EWH) – The aquatic life use designed to protect aquatic communities of exceptional diversity and biological integrity. Such communities typically have a high species richness, often include strong populations of rare, endangered, threatened, and declining species, and/or provide an exceptional recreational fishery.

FDA Action Limit – The "safety" limits for concentrations of compounds in fish flesh that above which consumption of the flesh carries an increasing risk of cancer or other health problems. These limits are determined by the U. S. Food and Drug Administration (FDA).

Fecal Coliform – A bacterial group which is present in the intestines of warm–blooded animals and is evidence of the presence of human and/or animal wastes. Fecal coliform bacteria criteria are the principal means of assessing attainment of the recreational use designations in the Ohio WQS.

Fish Consumption Advisory – An official notification to the public about specific areas where fish tissue samples have been found to be contaminated by toxic chemicals which exceed FDA action limits or other accepted guidelines. Advisories may be species specific or community wide. A decision to issue such an advisory is based on an agreement between the Ohio EPA, Ohio Dept. of Natural Resources, the Ohio Dept. of Agriculture, and the Ohio Dept. of Health, with the latter agency having the authority to issue such advisories.

Hester–Dendy Multiple Plate Sampler (also known as an artificial substrate) – A device for sampling macroinvertebrates which consists of a set of square hardboard plates (approximating an aggregate surface area of one square foot), bolted together, and separated by spacers of increasing width. Aquatic macroinvertebrates colonize or reproduce on this device which is placed at a stream or river sampling site for a six week colonization period during a July 1 - September 30 index period. Counts of individuals and taxa are used in the calculation of the Invertebrate Community Index (ICI) which is part of the Ohio EPA biological criteria. (see Invertebrate Community Index).

Impacted – A situation where there is a suspected impairment based on the presence of sources (*e.g.,* nonpoint source survey). In such cases there may be anecdotal evidence that some changes or disturbance may have occurred, but corroborating instream indicator data to establish the status of a designated use is lacking.

Impaired – The situation where monitored level data establishes a violation or exceedence of one or more water quality or biological criteria, and hence, an impairment of the designated use.

Index of Biotic Integrity (IBI) – An ecologically–based, multimetric index which utilizes fish community data and aggregates results across 12 ecological metrics that can be classified into four categories: species richness, species composition, trophic composition, and fish density and community condition. Developed by Karr (1981), further explained in Karr *et al.* (1986), this index was modified for application to Ohio rivers and streams by Ohio EPA. This comprises part of the Ohio EPA biological criteria.

Index of Well–Being (Iwb) – A composite index of diversity and abundance measures (density and biomass) based on fish community data. The Iwb was originally developed by Gammon (1976), further explained by Gammon *et al.* (1981), and modified for application to Ohio rivers and streams (as the Modified Iwb [MIwb]) by Ohio EPA. This comprises part of the Ohio EPA biological criteria.

Invertebrate Community Index (ICI) – A multimetric index of biological condition based on ten metrics which measure various structural and tolerance components of macroinvertebrate communities. This index was developed by Ohio EPA (DeShon 1995). This comprises part of the Ohio EPA biological criteria.

In–Place Pollutants – Chemical pollutants deposited in the sediments of a waterbody (*i.e., they* occur "in–place").

Limited Resource Water (LRW) – An aquatic life use assigned to streams with a very limited aquatic life potential, usually restricted to highly acidic mine drainage streams or highly modified small streams (<3 sq. mi. drainage area) in urban or agricultural areas with little or no water during the summer months.

Major Cause or Source – The primary cause or source associated with partial or non-attainment of a given designated use.

Metals – A specific class of chemical elements that have unique characteristics (such as conductance). Also known as heavy metals, some are commonly found in water or sediments as pollutants. In Ohio waters this commonly includes lead, copper, cadmium, arsenic, zinc, iron, mercury, and nickel.

Moderate Cause or Source – A secondary or contributing (but not primary) cause or source associated with partial or non-attainment of a given designated use.

Modified Warmwater Habitat (MWH) – Aquatic life use assigned to streams that have irretrievable, extensive, man-induced modifications that preclude attainment of the Warmwater Habitat use, but which harbor the semblance of an aquatic community. Such waters are characterized by species that are tolerant of poor chemical quality (low and fluctuating dissolved oxygen) and degraded habitat conditions (siltation, habitat simplification) that are characteristic of modified streams.

Monitored Level Data – Chemical or biological data used in this report that originated from sources such as intensive surveys of biological or chemical conditions and which follow Ohio EPA protocols. Chemical data less than 5 years old also qualifies.

Named Stream – Streams large enough to be named on USGS 71/2 minute topographic maps and/or listed in the Gazetteer of Ohio streams. There are approximately 25,000 miles of named streams in Ohio out of 61,000 miles of streams listed by the U.S. EPA RF3 database.

Natural Conditions – Those conditions that are measured outside of the influence of anthropogenic activities.

Non–conventional Pollutant – Pollutants *other* than the common nitrogen compounds (ammonia, nitrates), phosphorus, dissolved oxygen, or chlorine; examples of non–conventional pollutants are pesticides, herbicides, other organic compounds, and heavy metals.

Nonpoint Pollution Source – Diffuse sources of pollutants such as urban storm water, construction site runoff, agricultural runoff, and mine drainage that are usually delivered to waterbodies via precipitation runoff and ground water infiltration.

Point Source of Pollution – Any source of pollution that emanates from a single identifiable point, such as a discharge pipe of an industry or WWTP.

Pollutant Loading – Amount (mass) of a compound discharged into a waterbody per unit of time, *e.g.*, kg/day.

Priority Monitoring Needs – Criteria which are considered in selecting study areas within the Five-Year Basin Approach to Monitoring and NPDES Permit Reissuance which includes the following:

1) areas previously sampled 8-12 years ago and where new pollution controls have been implemented;
2) areas that have never been sampled or that lack adequate coverage;
3) priority nonpoint source projects where Section 319 and related projects are planned or underway;
4) potential use designation issues, particularly EWH and MWH potential;
5) existing SRW designated segments that will require an evaluation for the anticipated Superior High Quality Waters (SHQW) classification under the revised anti-degradation rule;
6) complex urban/industrial centers;
7) rapidly developing suburban areas;
8) discharges with recurring chronic or acute toxicity;
9) discharges with a history of non-compliance, spills, and unauthorized releases;
10) potential coordination with DERR sites.

Priority Pollutant – One of the 126 toxic compounds (a subset of 65 classes of toxic compounds) listed by U.S. EPA under Section 307[a] of the CWA.

QHEI (Qualitative Habitat Evaluation Index) – A habitat assessment index designed as a screening tool to assist in assigning designated uses and as an aid in interpreting changes in aquatic communities associated with habitat variations.

Recreation Use – A designated use related to human body contact (*i.e.*, swimming, wading, canoeing) with surface waters.

Reference Site – A relatively unimpacted site which is used to define the expected or potential biological community or water quality within a region such as a ecoregion. In Ohio reference sites were used to calibrate the ICI and IBI and to establish background chemical water quality concentrations.

Stream Mile (also River Mile) – A method used by Ohio EPA to identify locations along a stream or river. Mileage is defined as the lineal distance from the downstream terminus (*i.e.*, mouth) and moving in an upstream direction.

Storm Sewer – A sewer system designed to collect and remove precipitation runoff from land areas and discharge to nearby water bodies.

Threatened – The state in which a water body is currently meeting the designated use, but because of trends in land use (see urban encroachment), or other activities, are threatened with a future decline in quality and which may become impaired unless precautionary measures or changes in current practices take place.

Toxic Substances – Any substance which can cause death, disease, mutations, cancer, deformities, or reproductive malfunctions in an organism.

Trophic State - The status of a lentic (lake or reservoir) system which reflects the degree of algal productivity as measured by indices such as the trophic state index (TSI).

Unnamed Stream – Small streams for which there are no names curreently provided on USGS 71/2 minute topographic maps, the Gazetteer of Ohio Streams, or the Ohio WQS; there are approximately 36,000 miles of unnamed streams in Ohio.

Urban Encroachment – Increased urban development in a watershed, especially where the quality of the floodplain, riparian zone, and runoff characteristics of a watershed which either threaten or result in an impairent of a designated use.

Use Designation – See "Designated Use".

Wasteload Allocation – The portion of the capacity of a water body which can assimilate pollutants without exceeding a water quality criterion and which is allocated to existing (or future) discharges (*e.g.*, WWTPs), *i.e.*, the loading (kg/day) of a pollutant allowed to be discharged by a source without violating WQS.

Waterbody Segment – A lake, wetland, or length of stream or river, based on an Ohio EPA mapping system and which is defined for analysis of water quality trends for this report. Water body stream or river segments are approximately 5-10 miles in length. More than 3800 water body stream and river segments have been delineated. Individual lakes and reservoirs are separate waterbodies.

Water Quality Based Effluent Limits – Parameter specific limitations calculated for individual point source discharges based on water quality considerations (criteria) as opposed to a technological approach in which a specific type of treatment technology is mandated by the CWA or U.S. EPA guidelines.

Water Quality Standards – The administrative rules which set forth use designations and criteria protective of such uses. These apply to all surface waters of the state.

Whole Effluent Toxicity – The aggregate toxicity of an effluent to bioassay test organisms expressed as the LC_{50} and irrespective of individual chemical concentrations. The procedure includes exposing test organisms, in a laboratory setting, to varying dilutions (*i.e.*, strengths) of effluent. For complex effluents containing numerous compounds, whole effluent toxicity testing is a more realistic predictor of the true effects on the resident biota than that inferred by chemical characterizations.

305(b) – The section of the Clean Water Act requiring States to submit a biennial report to U.S. EPA and Congress for the purpose of reporting on the progress of Clean Water Act programs.