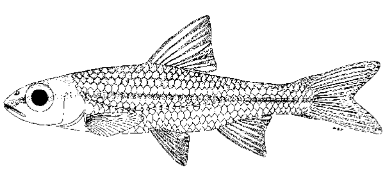
Year 2000
Ohio Water Resource Inventory



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Introduction

Ohio is a water rich state with more than 29,000 miles of named and designated rivers and streams, a 451 mile border on the Ohio River, more than 188,000 acres among more than 446 lakes, ponds, and reservoirs (118,800 acres publicly owned), and more than 230 miles of Lake Erie shoreline (Map 1-1). Ohio is an economically important and diverse state with strong manufacturing and agricultural industries. Many of the historical patterns of environmental impact in Ohio are related to the geographical distribution of basic industries, land use, mineral resources, and population centers. Also important, however, is an understanding of Ohio's geology, land form, land use, and other natural features as these determine the basic characteristics and ecological potential of streams and rivers. Ohio EPA bases the selection, development, and calibration of ecological, toxicological, and chemical/physical indicators on these factors. These are then employed via systematic ambient monitoring to provide information about existing environmental problems, threats to existing high quality waters, and successes in abating some past and current water pollution problems in Ohio's surface waters.

The 2000 Ohio Water Resource Inventory focuses on the status of Ohio's surface and ground water resources through the 1998 data year, a description of our monitoring program including the addition of a stratified sampling component, and a forecast of the status of Ohio's rivers and streams through the year 2010 in an attempt to assess the likelihood of meeting the Ohio 2010 goal of 80% full attainment. Underlying all of this is the theme that a prescriptive, technology-based, or even water quality-based approach to water resource management are *alone* insufficient to deal with many emerging problems. When water quality problems were predominated by much more "obvious" causes, many of which could be easily seen (and smelled), the application of standard wastewater treatment technology (*e.g.*, secondary treatment, BPT, BAT) resulted in noticeable aesthetic, chemical, and ecological improvements in the aquatic environment. The problems remaining today, while comparatively more complex and subtle, are nonetheless real and will be the driving force behind the federally mandated Total Maximum Daily Load (TMDL) process in Ohio. Thus new approaches to water resource management will need to be relied upon.

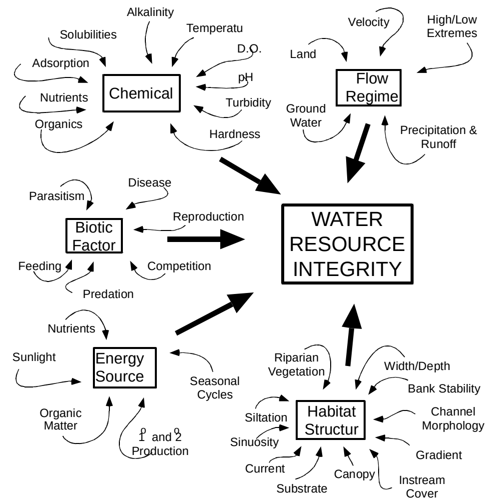
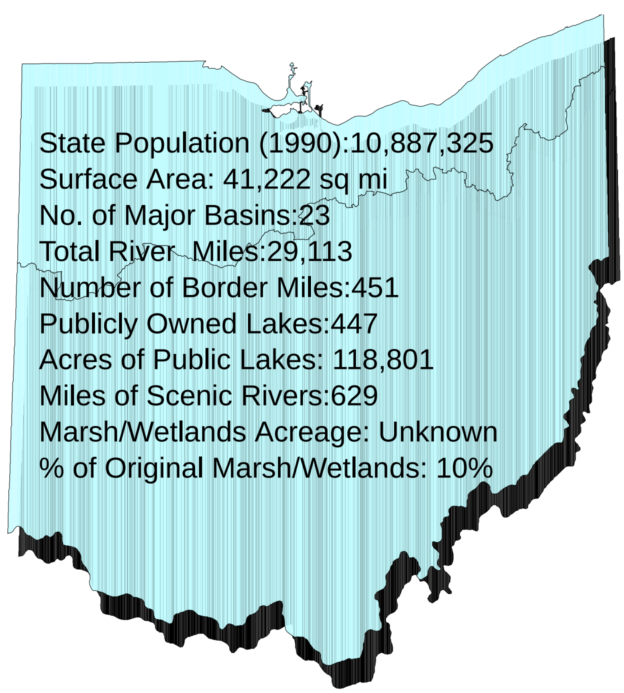


Figure 1-1. The five major factors which determine the integrity of the water resource (modified after Karr et al. 1986). Environmental indicators are chosen to represent important variables and the composite condition of the water resource.

Water resources in Ohio and elsewhere continue to be affected by many other human activities beyond those targeted by the NPDES permit process. Yet the major focus of water programs is still on this permit process. Nonpoint sources are beginning to be addressed through the CWA (*e.g.,* Section 319) and other approaches. The resources allocated thus far, however, are insufficient and the approaches promoted by USEPA are too preoccupied with water column chemical effects. Several of the "non-chemi-

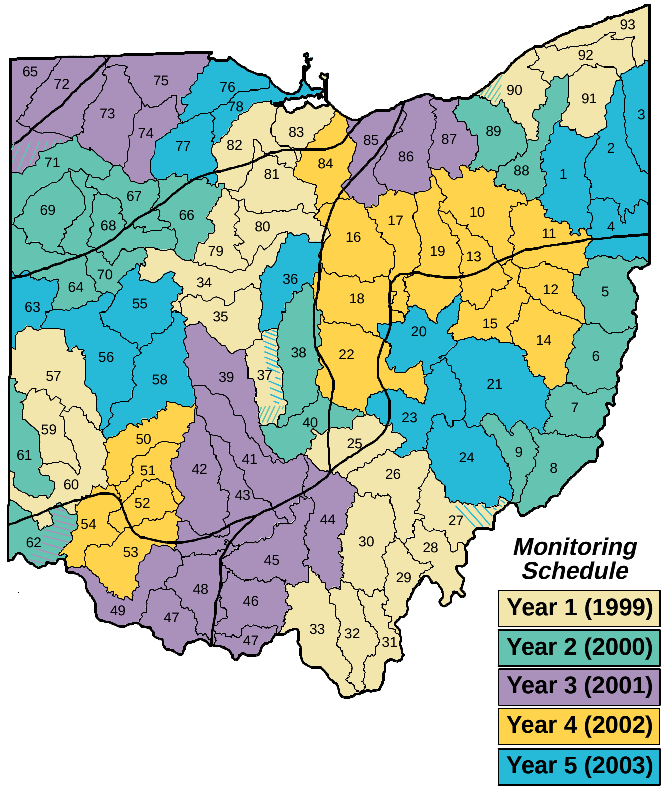


Map 1-1. Atlas of Ohio statistics.

Cumulatively, local impacts can have regional or global impacts

cal" impacts that adversely affect water resource integrity include: direct habitat alterations due to channel modifications, impoundment, and riparian encroachment, land use activities such as suburban, industrial, and commercial development, utility construction, solid waste disposal, and hydrological modifications such as wetlands destruction, water withdrawals, and drainage enhancement. From an environmental perspective most of these activities are uncontrolled and some have resulted in a further decline in water resource integrity during the 1980s and 1990s. Simply stated the control of chemicals alone does not assure the restoration of water resource integrity (Karr *et al*. 1986).

A monitoring approach, integrating biosurvey data that reflects the integrity of the water resource directly, with water chemistry, physical habitat, bioassay, and other monitoring and source information must be central to accurately define these varied and complex problems. Such information must also be used in tracking the progress of efforts to protect and rehabilitate water resources. The arbiter of the success of water resource management programs must shift from a reliance on achieving administrative goals (numbers of permits issued, dollars spent, or management practices



Map 1-2. Ohio EPA five-year basin monitoring schedule for 1999-2003.

installed) and a preoccupation with chemical water quality to more integrated and holistic measurements with water resource integrity as a goal.

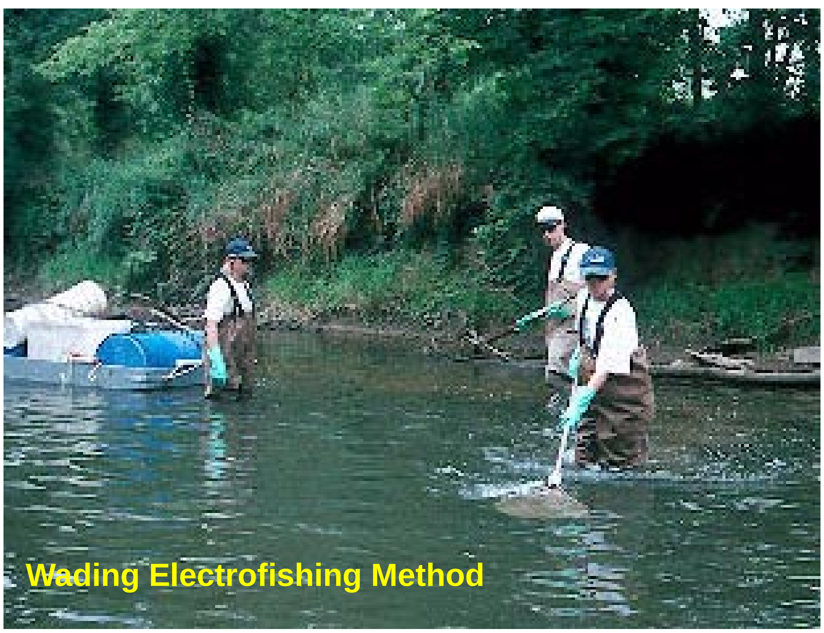
Beginning in 1990 Ohio instituted a "5-Year Basin" approach to monitoring and NPDES permit reissuance for its intensive survey efforts (Map 1-2). This effort should allow the Ohio EPA, provided sufficient resources are available, to monitor major sources of pollution (point and nonpoint) and to begin remediation efforts for these sources. This schedule has been devised so that monitoring data is collected ahead of permit reissuance or BMP implementation. Such an effort required a shift in the schedule for reissuing major NPDES permits. Furthermore, 20 plus years of using an integrated biosurvey approach to monitor major sources of pollution has put Ohio EPA in a position to monitor ambient conditions before and after the installation of water quality based pollution controls. This effort should result in a shift toward using environmental results as measures of the success of regulatory actions and away from the regulatory action itself as a measure of success.

In addition to the five year basin monitoring plan for all waters in Ohio, Ohio has a fifteen year schedule for issuing TMDLs in watersheds with substantial impairment (Maps 1-3 to 1-7). The fifteen year schedule was influenced by the five-year plan, however, given limited resources and the need for intensive monitoring needs in certain TMDL watersheds, some watersheds on the five year plan, without more resources, will be monitored only a 10 or 15 cycle.

Why This Report Emphasizes Aquatic Life Use Support

Boat Electrofishing Method

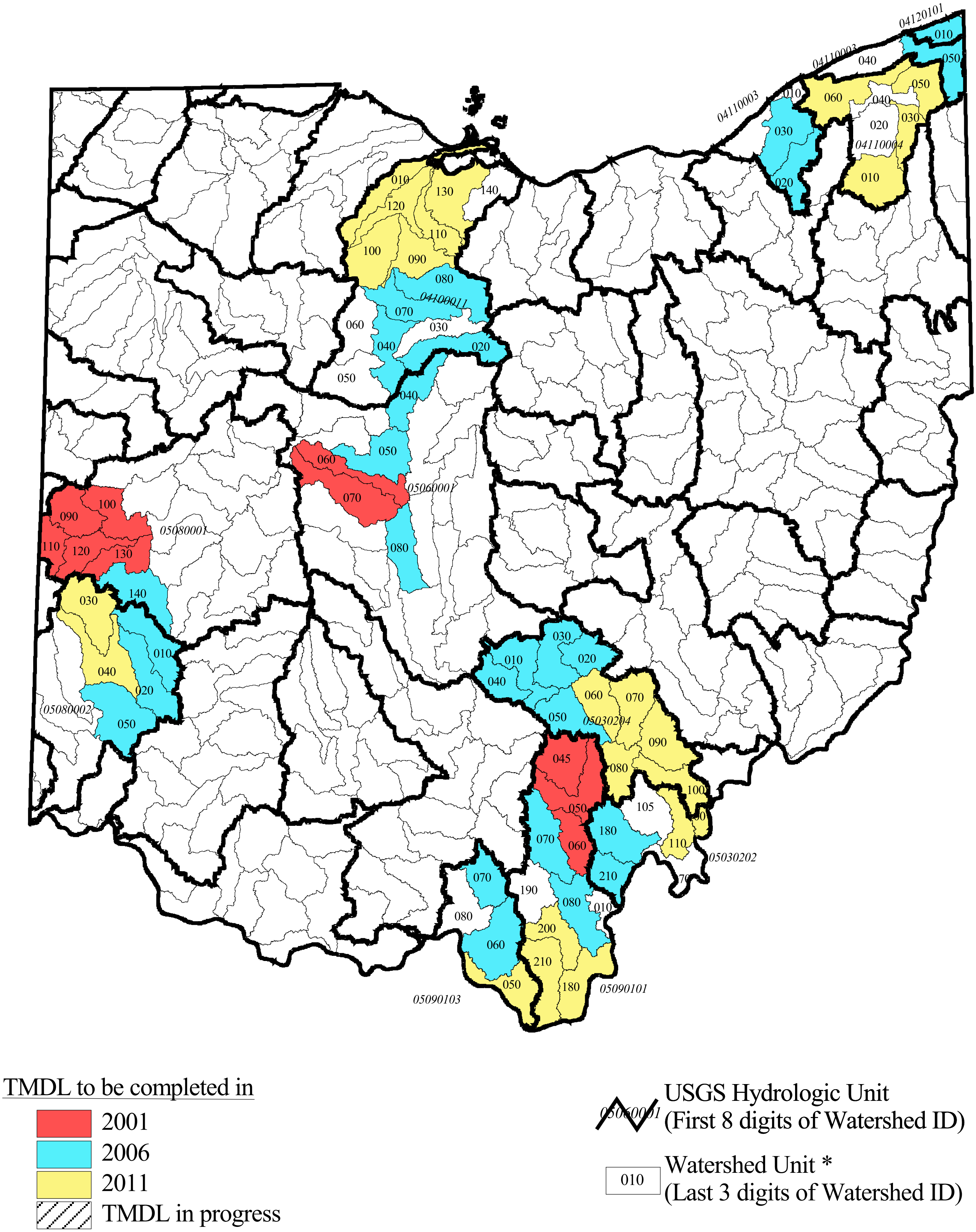
Ohio surface water bodies are assigned to various beneficial "use" categories in the Ohio Water Quality Standards (WQS; OAC 3745-1) related to: (1) aquatic life; (2) public water supply; (3) agricultural water supply; (4) industrial water supply; and, (5) recreational uses. WQS to protect the non-aquatic life uses are primarily based on chemical indicators and criteria. Human health is protected through various routes of exposure which includes direct body contact and consumption based exposures (*i.e.*, contaminated edible portions of fish and wildlife). While it is possible to base protective measures on these criteria, it is much more difficult to practically measure true human health responses in the ambient environment. The emphasis of this report is on aquatic life use attainment because: (1) aquatic life criteria frequently result in the most stringent requirements compared to those for the other use categories, (*i.e.*, protecting for aquatic life uses should assure the protection other uses), (2) aquatic life uses apply to virtually *every* Ohio waterbody and the diverse criteria (*i.e.*, includes conventionals, nutrients, toxics, habitat, physical, and biological factors, etc.) apply to all water resource management issues, (3) aquatic life uses and the accompanying chemical, physical, and biological criteria provide a comprehensive and accurate ecosystem perspective toward water resource management that promotes the protection of "ecological integrity", (4) Ohio has an extensive and comprehensive database of aquatic life, physical habitat, water chemistry, sediment, and effluent data, most of which is readily accessible via electronic databases. Comparably accessible databases for toxic organic contaminants are in development and include fish tissue contamination, effluent concentrations, and information about the impacts of the unregulated disposal of hazardous wastes. These databases will figure prominently in future 305(b) reports.



Wading Electrofishing Method

Figure 1-3 - Map of Watersheds Scheduled for TMDL Development

Ohio EPA Basin Schedule Year 1



* Watershed Unit Number is shown only for watersheds in the Basin Schedule year indicated.

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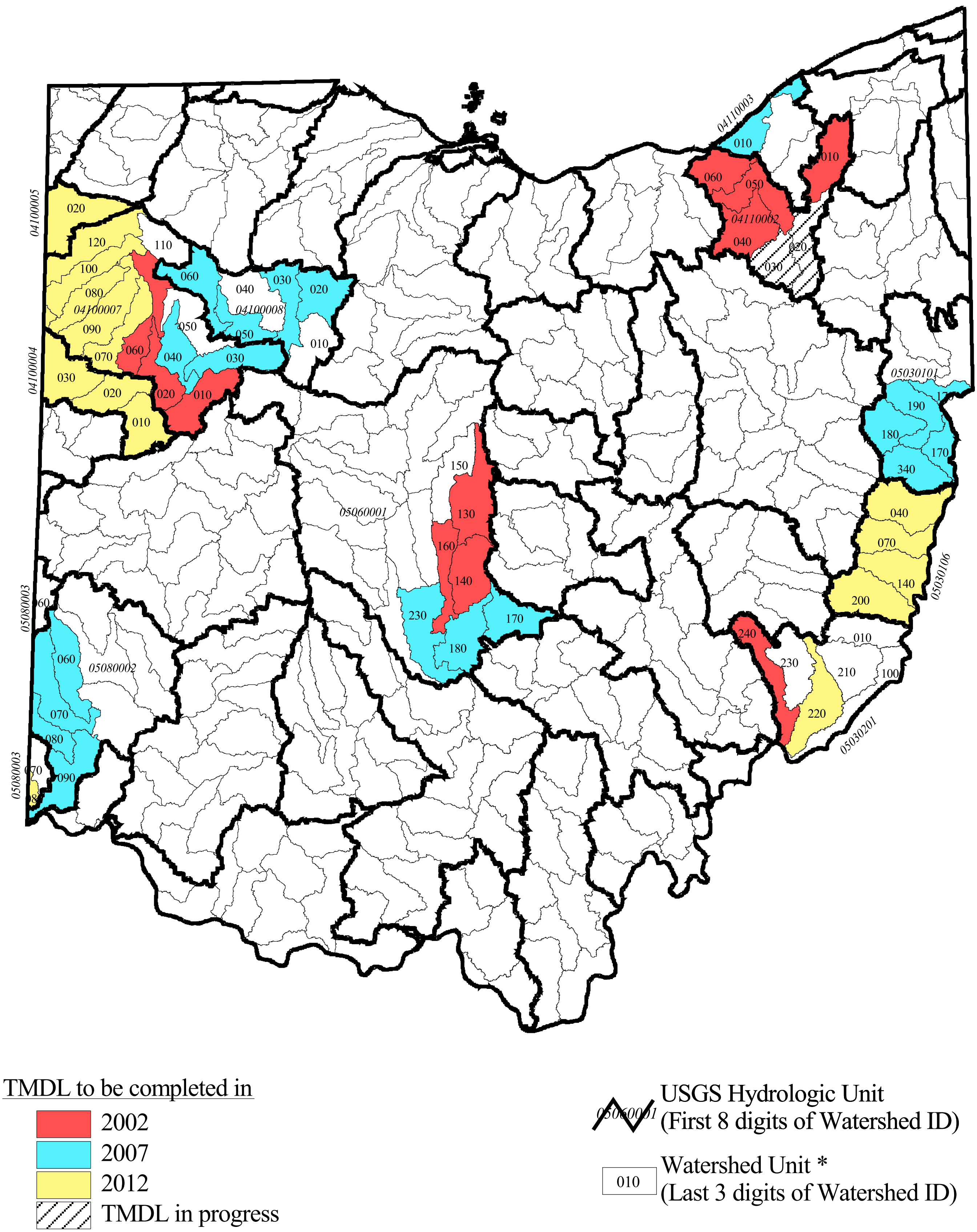
Figure 1-4. - Map of Watersheds Scheduled for TMDL Development

Ohio EPA Basin Schedule Year 2



* Watershed Unit Number is shown only for watersheds in the Basin Schedule year indicated.

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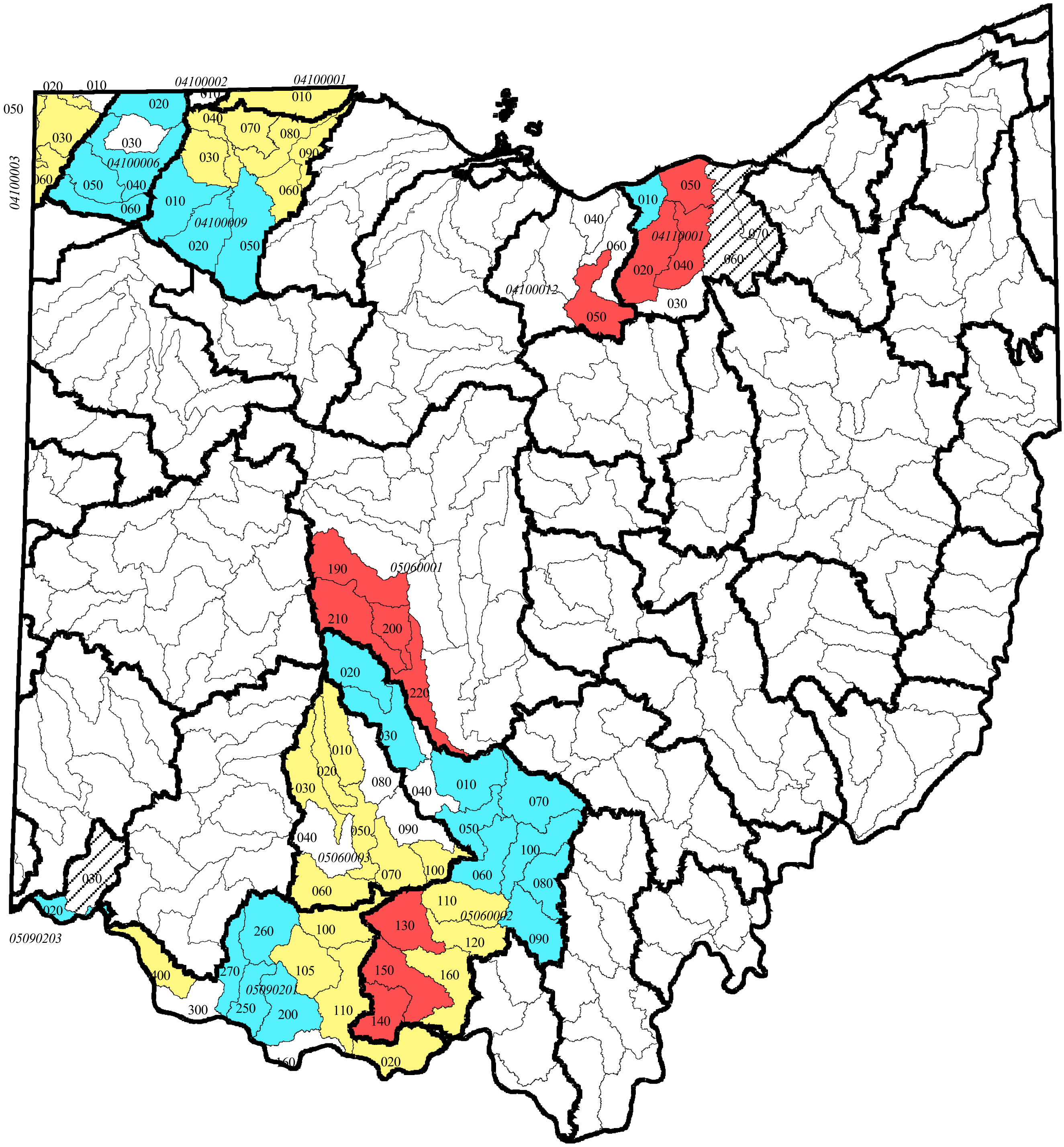
Figure 1-5. - Map of Watersheds Scheduled for TMDL Development

Ohio EPA Basin Schedule Year 3



TMDL to be completed in

- 2003
- 2008
- 2013
- TMDL in progress

USGS Hydrologic Unit (First 8 digits of Watershed ID)

Watershed Unit * (Last 3 digits of Watershed ID)

* Watershed Unit Number is shown only for watersheds in the Basin Schedule year indicated.

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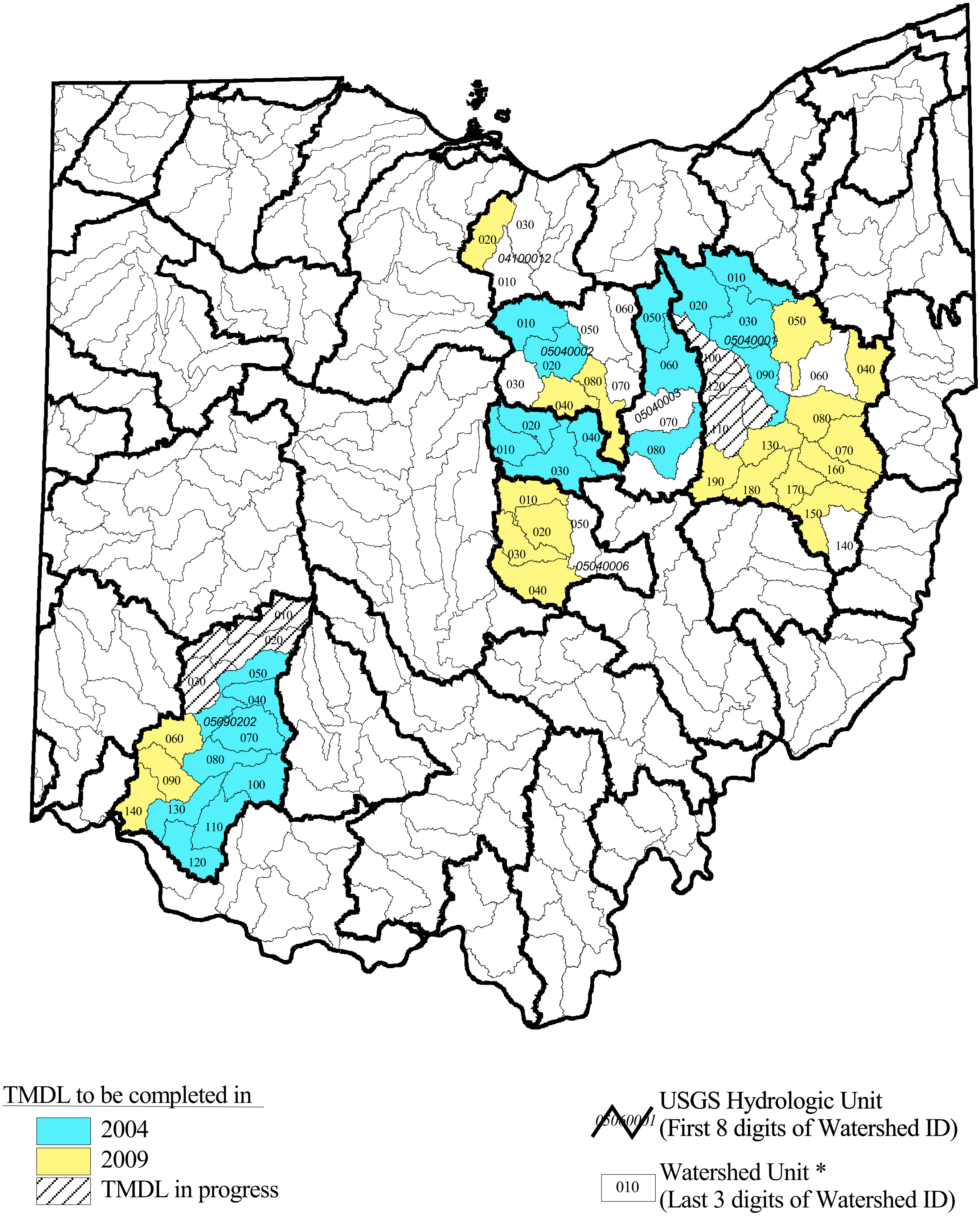
Figure 1-6. - Map of Watersheds Scheduled for TMDL Development

Ohio EPA Basin Schedule Year 4



* Watershed Unit Number is shown only for watersheds in the Basin Schedule year indicated.

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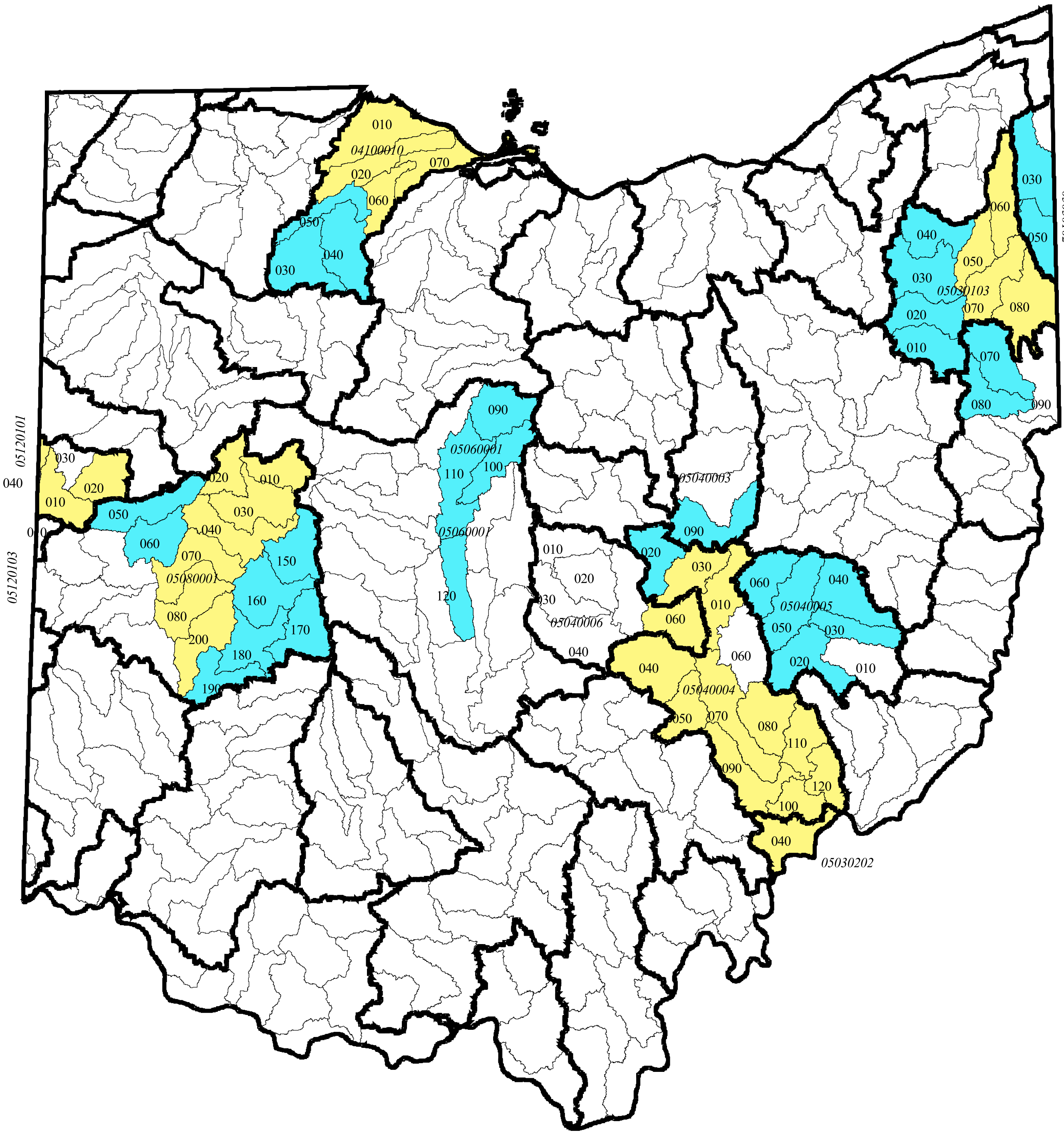
Figure 1-7. - Map of Watersheds Scheduled for TMDL Development

Ohio EPA Basin Schedule Year 5



TMDL to be completed in

- 2005
- 2010
- TMDL in progress

USGS Hydrologic Unit (First 8 digits of Watershed ID)

010 Watershed Unit * (Last 3 digits of Watershed ID)

* Watershed Unit Number is shown only for watersheds in the Basin Schedule year indicated.

2/11/99 RM

The assessment of Ohio surface waters can be a complex process. It is dependent on the interaction of use designations (goals set for waters), water quality criteria designed to protect these uses, and other provisions, such as antidegradation, intended to maintain existing high quality waters. In addition, Ohio EPA has a systematic and comprehensive watershed-based monitoring strategy (Ohio EPA Five-Year Surface Water Monitoring Strategy: 2000-2004, Ohio EPA 1999) designed to assess the status of designated uses and to account for natural, predictable sources of variability such as stream size and ecoregion. Finally, this information forms the basis of the 303(d) (TMDL) list of impaired waters that is a major driving force in developing restoration and protection strategies for these waters.

This section provides background information that will be useful in understanding the above processes and how the various lists of waters that have importance to many USEPA regulatory and non-regulatory programs (e.g., 303(d) and 319) are developed. It also summarizes the decision process for determining designated use attainment status, threats to those designations, and determination of causes and sources of impairment that are associated with each.

Basic to this process is the concept of "designated uses." As part of their custodial responsibility for implementing the Clean Water Act (i.e., the restoration and protection of physical, chemical and biological integrity), delegated States may assign various goals or "designated uses" based on the potential of individual waters to achieve various goals pertaining to the protection of aquatic life, recreation in and on the water, and the suitability for water supplies. The designated uses about which this document reports on are the aquatic life and recreational uses. Although there is no specific "fish consumption" use, we also report on the degree of fish tissue contamination because of its importance to human health, the fishability of various water bodies, and its usefulness as an indicator of stress and exposure to aquatic life.

Water Resources Management.

Ohio EPA follows a philosophy of "protection, restoration, and enhancement" in the management of surface water resources. Of major importance is the need to protect existing high quality waters and watersheds for future generations ("protect"). Towards this goal we monitor waters to ensure that designated uses are both appropriate and protective. The antidegradation policy is the major regulatory tool related to issues affecting waters that have water quality "better than" the minimum required by the base use designation alone. Antidegradation is discussed in more detail later in this section. Non-regulatory efforts, however, to protect high quality waters are also important to the protection of high quality waters especially where nonpoint sources are involved. The identification of "threatened" waters is important for identifying high quality resources that are vulnerable to activities or practices which could result in an unacceptable lowering of quality. The goal is to proactively prevent degradation before it happens.

Impaired Waters

The majority of regulatory and non-regulatory management activities are designed to accomplish the restoration of impaired waters. The Total Maximum Daily Load (TMDL) process is one such example. CWA Section 303(d) and Chapter 40 of the Code of Federal Regulations (CFR) Section 130.7 directs each State to identify and prioritize water quality limited segments for which technology-based pollution controls are not stringent enough to achieve applicable water quality standards (WQS). Further, TMDLs for pollutants that prevent the identified segments from attaining designated uses must be established. As such, TMDLs are a blueprint for restoring degraded water quality which contributes to use impairments in individual water bodies. The consequences of the proposed revised federal regulation and its effect on Ohio's process for developing TMDLs, implementing the process, and restoring degraded

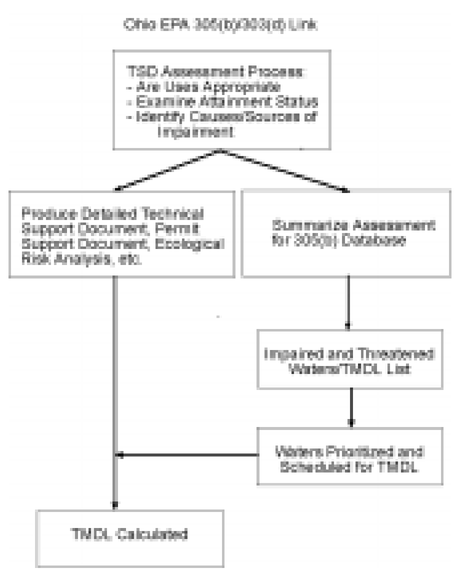


Figure 2-1. Summary of how 305(b) relates to the 303(d) list

waters is still being worked out. Regardless of these new details, however, Ohio is presently on a schedlue to develop TMDLs for all impaired watersheds over the next 13 years (through 2013).

The 305(b) report forms the basis for nearly all of the waters included on the TMDL list. It is important to understand the monitoring process and the way that causes and sources of impairment are identified to have a firm understanding of how the TMDL process will work. The list of impaired waters identified here along with other information will form the basis of how Ohio will prioritize and schedule work in watersheds to restore impaired waters (Figure 2-1). It is not a direct conduit, however, for the calculation of a TMDL. The 305(b) is a summary of a complex assessment process (the Technical Support Document process) that is the foundation and starting point of TMDL development.

Ohio Ecoregions

Central to Ohio EPA's use of ambient biological, chemical, and physical information is the concept of "ecoregions" and the regional reference sites concept. Omernik's (1987) ecoregions (level III) are land-surface areas that are grouped based on similarities in the mosaic of land use, potential natural vegetation, land surface form, and soils that occur within each. These underlying factors determine the character of watersheds and have a profound influence on background water quality, the type and composition of the biological communities in a stream or river, and the manner in which human impacts are exhibited. An ecoregion map of Ohio was updated in 1998 (available from Ohio EPA) and "subecoregions" (level IV) that explain some of ecological variation we observe within the level III ecoregions. Future work will be required to associate these level III and IV ecoregions with patterns of species and assemblage distribution in Ohio. This, in turn, will be used to fine tune the biological criteria or expectations for rivers and streams.

The following is a brief description of Ohio's six level III ecoregions (Map 2-1) mostly taken from Omernik and Gallant (1988) and Woods et al. (1998). Details on the level IV ecoregions are found in Woods et al. 1998.

Huron Erie Lake Plain (HELP, Ecoregion 57): The HELP ecore-

gion "is a broad, fertile, nearly flat plain punctuated by relict sand dunes, beach ridges, and end moraines" (Woods et al. 1988). This former lake bed is distinguished by its soils (fine lake silts) with very poor drainage. In Ohio, this area is largely the remnant of the Black Swamp which was a forested wetland. Most of this region was channelized and drained for cropland by the turn of the 20th century. Stream gradients are extremely low with most less than 1-2 ft/mi. This region has the most widespread and severe agricultural impacts of any of the Ohio ecoregions which is related to the lack of woody riparian vegetation, channelization, and low stream gradients that virtually preclude any recovery of original stream habitats.

Interior Plateau (IP, Ecoregion 71): The IP "has rolling to deeply dissected, rugged terrain with areas of karst topography" (Woods 1998). A large portion of the former Interior Plateau ecoregion, that was

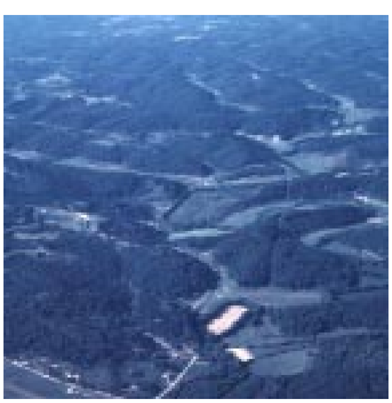
transitional between the Eastern Corn Belt Plain is now considered a subregion of the Eastern Corn Belt Plain (Ecoregion 55). The current IP ecoregion hugs the area along the Ohio River. "The soils of Ecoregion 71 [IP] developed from the underlying sandstone, siltstone, shale, and limestone and are not from till like those of Ecoregion 55 [ECBP](Woods et al. 1998). In Ohio, streams are often predominated by limestone bedrock and flat rubble.

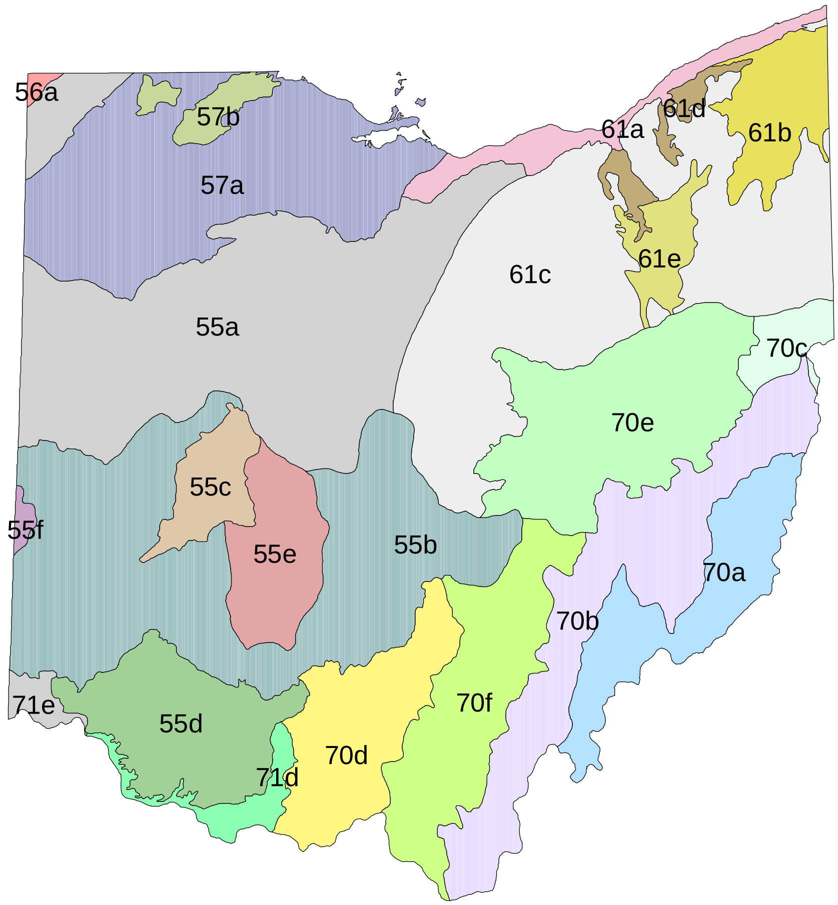
Erie Ontario [Drift and] Lake Plain (EOLP, Ecoregion 61): A region characterized by moderate to high relief intermediate between the

rolling Eastern Corn Belt Plain and the hillier Western Allegheny Plateau. "Low lime drift and lacustrine deposits blanket the rolling to level terrain of Ecoregion 61" (Woods et al. 1998). Land use varies between cropland, pasture, livestock and for-

est lands; not as heavily agricultural as the HELP ecoregion nor as heavily forested as the WAP ecoregion. This area contains the major urban areas of Cleveland, Akron/Canton, and Youngstown, which are major centers of heavy industry in Ohio.

Eastern Corn Belt Plain (ECBP, Ecoregion 55): This ecoregion is: “primarily a rolling till plain with local end moraines” Woods et al. (1998). It is also a region of extensive (>75%) cropland agriculture. Some streams have been channelized, but not to the extent of the Huron Erie Lake Plain. The better streams have some wooded riparian vegetation remaining containing species such as cottonwood, sycamore, silver maple, black willow, and box elder. Besides cropland agriculture, this ecoregion is characterized by pasture, small woodlots, and small to medium urban areas. Unlike the EOLP ecoregion, this area lacks the extensively developed, heavy industrial centers.





Map 2-1. Level IV ecoregions of Ohio (from Woods et al. 1998). Codes: 55a-Clayey, High Lime Till Plains; 55b-Loamy, High Lime Till Plains; 55c-Mad River Interlobate Area; 55d-Pre-Wisconsin Drift Plains; 55e- Darby Plains; 55f - Whitewater Interlobate Area; 56a -Lake Country; 57a - Maumee Lake Plains; 57b - Oak Openings; 57c - Paulding Plains; 57d - Marblehead Drift.Limestone Plains; 61a - Erie Lake Plain; 61b - Mosquito Creek/Pymatuning Lowlands; 61c - Low Lime Drift Plain; 61d - Erie Gorges; 61e - Summit Interlobate Area, 70a - Permian Hills, 70b - Monongahela Transition Zone; 70c - Pittsburgh Low Plateau; 70d - Lower Scioto Dissected Plain; 70e - Unglaciated Upper Muskingum

Western Allegheny Plateau (WAP, Ecoregion 70): This is a highly dissected (rugged) ecoregion (steep valleys) of sandstone, siltstone, shale, and limestone with the highest relief in the state. It largely comprises the unglaciated region of the state and, because of its relief, is the most heavily forested ecoregion in Ohio. Coal mining and timber harvesting are among the major land uses in this region with some agriculture occurring on the valley floors. This is also the least densely populated area of Ohio.

Steam Channel Types and Classification

In addition to the use of ecoregions to explain differences in biological assemblages there is a need to explain differences in stream types or potential at smaller scales than ecoregion or subecoregion. A number of approaches are being examined across the country that attempt to categorize streams by geomorphological aspects (e.g., Rosgen 1995, Montgomery 1999) for use in various aspects of environmental management of streams and watersheds. As these tools such as these become developed and tested they will incorporated into our environmental assessment and management processes.

Southern Michigan/Northern Indiana Drift Plains (SMNIDP, Ecoregion 56): This level III ecoregion was not originally classified as being part of Ohio. The recent mapping effort (Woods et al. 1998) designated the extreme northwest corner of Ohio (see Map 2-1) as being in this ecoregion. "Ecoregion 56 is distinguished from adjacent ecoregions by its many lakes and marshes as well as its wider assortment of landforms, soil types, soil textures, and landuses" Woods et al. (1998).

Aquatic Life Uses in Ohio Water Quality Standards (WQS)

Ohio EPA has employed the concept of tiered aquatic life uses in the Ohio Water Quality Standards (WQS) since 1978. These tiers recognizes that 1.) even under minimally impacted conditions, not all streams have the same inherent potential to harbor aquatic life, 2.) some streams have been, essentially, irretrievably altered (e.g., streams have been physically modified and *are being maintained* in this state for drainage or flood control) and cannot support the same diverse assemblage of aquatic life found in least impacted waters, and 3.) some of the variation in aquatic life expectation is related to underlying natural factors, partly explained through the partitioning of expectation by "ecoregions. Aquatic life uses in Ohio include the Warmwater Habitat (WWH), Exceptional Warmwater Habitat (EWH), Cold Water Habitat (CWH), Seasonal Salmonid Habitat (SSH), Modified Warmwater Habitat (three subcategories: channel-modified, MWH-C; mine affected,

Table 2-1. Summary of classified aquatic and non-aquatic life uses for Ohio surface waters in the Ohio WQS (OAC 3745-1).

Use Designation	Streams/Rivers	Lakes		Lake Erie
	Miles	Number	Acre	Shore Miles
Ohio Estimate[1]				
All	43,917	50,000	200,000[2]	236
Perennial (Named)	24,348.7	NA	NA	NA
USEPA Estimate				
Total[3]	61,532.0	5,130	188,461	
Perennial[3]	29,113.0	—	—	—
Ohio Streams in State Water Quality Standards				
EWH	3,053.6	—	193,903[4]	236
WWH	18,610.4	—	—	—
CWH	424.30	—	—	—
SSH	103.0	—	—	—
MWH	889.9	—	—	—
LWH	493.0	—	—	—
LRW	599.1	—	—	—
No Use	1,633.2	—	—	—
Water Supply				
PWS	—	447	118,801	—
Recreation				
PC	22,730.5	50,000[5]	200,000[5]	236
SC	1,259.5	—	—	—
Old State Resource Waters (SRW)				
SRW (Old)	3,812	446	118,801	—
Antidegradation Waters (Under Review)				
ONRW	TBD	TBD	TBD	TBD
SRW	TBD	TBD	TBD	TBD
SHQW	TBD	TBD	TBD	TBD
GHQW	TBD	TBD	TBD	TBD
LQW	TBD	TBD	TBD	TBD

Abbreviations: **WWH** - Warmwater Habitat; **EWH** - Exceptional Warmwater Habitat; **CWH** - Coldwater Habitat; **SSH** - Seasonal Salmonid Habitat; **MWH** - Modified Warmwater Habitat; **LWH** - Limited Warmwater Habitat; **LRW** - Limited Resource Water; **PWS** - Public Water Supply; **BW** - Bathing Waters; **PC** - Primary Contact; **SC** - Secondary Contact; **ONRW** - Outstanding National Resource Water; **SRW** - State Resource Waters; **SHQW** - Superior High Quality Waters; **GHQW** - General High Quality Water; .**LQW** - Limited Quality Waters.

[1]Estimated from ODNR (1960).
[2]Estimated from ODNR (unpublished)
[3]USEPA (1991a) estimate.
[4]All publicly owned lakes and reservoirs except Piedmont Reservoir.
[5]Lakes and Reservoirs and not specifically given a primary contact recreation use in OAC, but this use is assumed.
[6]Antidegradation Waters are an additional classifications recently developed; initial stream classifications will be made during summer 2000

MWH-A; and impounded, MWH-I), Limited Resource Water (LRW), and the now defunct Limited Warmwater Habitat (LWH) designations. Each of these use designations is defined in the Ohio WQS (OAC 3745-1). Table 2-1 lists the size of waterbodies for each aquatic life and non-aquatic life use assigned to Ohio surface waters.

Water quality standards constitute the numerical and/or narrative criteria that, when achieved, will presumably protect a given designated use. Chemical-specific criteria serve as the "targets" for wasteload allocations conducted under the TMDL (Total Maximum Daily Load) process. This is used to determine water quality-based effluent limits for point source discharges and, theoretically, load allocations for nonpoint source BMPs (Best Management Practices). Whole effluent toxicity limits consist of acute and chronic endpoints (based on laboratory toxicity tests) and are based on a dilution method similar to that used to calculate chemical-specific limits. The biological criteria are used to directly determine aquatic life use attainment status for the EWH, WWH, and MWH use designations as is stated under the definition of each in the Ohio WQS. The aquatic life uses are briefly described as follows:

***EWH* (Exceptional Warmwater Habitat)** - This is the most protective use assigned to warmwater streams in Ohio. Chemical-specific criteria for dissolved oxygen and ammonia are more stringent than for WWH, but are the same for all other parameters. Ohio's biological criteria for EWH applies uniformly statewide and is set at the 75th percentile index values of all reference sites combined. This use is defined in the Ohio WQS (OAC 3745-1-07[B][1][c]).

WWH (Warmwater Habitat) - WWH is the most widely applied use designation assigned to warmwater streams in Ohio. The biological criteria vary by ecoregion and site type for fish and are set at the 25th percentile index values of the applicable reference sites in each ecoregion. A modified procedure was used in the extensively modified HELP ecoregion. This use is defined in the Ohio WQS (OAC 3745-1-07[B][1][a]).

MWH (Modified Warmwater Habitat) - This use was first adopted in 1990 is assigned to streams that have had *extensive* and irretrievable physical habitat modifications. The MWH use does not meet the Clean Water Act goals and therefore requires a Use Attainability Analysis. There are three subcategories: MWH-A, non-acidic mine runoff affected habitats; MWH-C, channel modified habitats; and MWH-I, extensively impounded habitats. The chemical-specific criteria for dissolved oxygen and ammonia are less stringent (and the HELP criteria are less stringent than other ecoregions) than WWH, but criteria for other parameters are the same. Biological criteria were derived from a separate set of modified reference sites. The biocriteria were set separately for each of three categories of habitat impact. The MWH-C and MWH-I subcategory biocriteria were also derived separately for the HELP ecoregion. The MWH-A applies only within the WAP ecoregion. This use is defined in the Ohio WQS (OAC 3745-1-07[B][1][d]).

LRW (Limited Resource Waters) - This use is restricted to streams that cannot attain even the MWH use due to extremely limited habitat conditions resulting from natural factors or those of anthropogenic origin. Most streams assigned to this use have drainage areas <3 sq. mi. and are either ephemeral, have extremely limited habitat (with no realistic chance for rehabilitation), or have severe and irretrievable acid mine impacts. Chemical-specific criteria are intended to protect against acutely toxic or nuisance conditions. There are no formal biological criteria. This use is defined in the Ohio WQS (OAC 3745-1-07[B][1][g]) and was formerly known as the Nuisance Prevention use designation, which is being phased out of the WQS.

LWH (Limited Warmwater Habitat) - This use was adopted in 1978 to act as a temporary "variance" mechanism for individual segments that had point source discharges that were not capable of meeting the 1977 Clean Water Act mandates. The process of phasing this use designation out of the WQS has been underway since 1985. Chemical-specific criteria were varied for selected parameters, otherwise the criteria for the remaining parameters were the same as for the WWH use. In 1985 all of the LWH segments were placed in a "reserved" status pending a Use Attainability Analysis for each segment.

SSH (Seasonal Salmonid Habitat) - This use designation was introduced in 1985 and is assigned to habitats that are capable of supporting the passage of Salmonids between October and May. Another use designation applies during the remaining months. Several tributaries to Lake Erie are so designated. This use is defined in the Ohio WQS (OAC 3745-1-07[B][1][e]).

CWH (Coldwater Habitat) - This use includes streams that are capable of supporting cold water aquatic organisms and/or put-and-take Salmonid fishing. This use is defined in the Ohio WQS (OAC 3745-1-07[B][1][f]).

HWH (Headwater Habitat) - This would apply to very small waters, typically less than 3 sq mi and is currently under development.

Table 2-2. General differences in ecological and other characteristics among the SRW, SHQW, and GHQW tiers.

Attribute	SRW	SHQW	GHQW
Endangered & Threatened Species	Multiple species, large populations, include most vulnerable	Present; smaller populations; may be less vulnerable species	Absent, or if present, small populations or low vulnerability
Declining Species	> 4 declining fish species/segment, large populations	2-4 declining fish species/segment, moderate populations	< 2 declining species, typically small populations
IBI, ICI	High mean scores, very high max scores	Lower mean scores, fewer high max scores or if more higher scores few other attributes	Lower mean scores, few or none very high
Vulnerability	Little effluent, high vulnerability	May be more effluent, moderate vulnerability	Lower vulnerability, for vulnerable components Director can still deny antidegradation application
QHEI	High percentage QHEI scores > 80	Fewer QHEI scores > 80, many above 70	Few or no QHEI scores > 80, fewer above 70
Multiple Attributes	High co-occurrence of above attributes	Lower co-occurrence or individual attributes more marginal	Little co-occurrence, individual attributes often marginal if present

Total Miles/Acres of Waters in Ohio

There are various estimates of the total miles of streams and rivers in Ohio. The Ohio Department of Natural Resources estimates 43,917 total miles of perennial and intermittent (*i.e.*, streams that are either dry during or do not flow part of the year) streams and rivers in Ohio (Ohio DNR 1960). U.S. EPA (1991a) has estimated that Ohio has 61,532 total miles of streams (29,113 perennial; 29,602 intermittent; and 2,818 ditches and canals). This estimate is from a computer-digitized map of U.S. streams and rivers produced by the USGS (1:100,000 scale Digital Line Graph [DLG] method). The U.S. EPA version of this map is known as Reach File 3 (RF3). Ohio EPA has adopted the U.S. EPA estimate of *perennial* stream miles to promote consistency between 305(b) reports produced by all states. The origins of the discrepancies between the various estimates of stream and river mileage mentioned above will be more closely examined in future 305(b) reports. However, the most likely sources of the differences between the Ohio DNR and U.S. EPA estimates are the large number of small, minor tributaries that appear on the DLG maps and differing estimates of segment lengths. Not all of the perennial streams in Ohio have been assigned an aquatic life use designation nor have all of the existing uses been confirmed with ambient biosurvey information using the previously discussed procedures.

Many miles of small streams (primarily watersheds less than 5 sq. mi. in area) in the Ohio database have not been designated. The precise difference between the U.S. EPA estimate of perennial stream miles and Ohio EPA's estimate of named or designated streams is due to the inclusion of undesignated streams in RF3 by USEPA and discrepancies in total lengths of individual streams between the two estimates. Use designations will continue to be reviewed and updated for named streams and assigned to unnamed streams as each is encountered within the schedule and resources assigned to the 5 Year Basin Approach.

Antidegradation

Besides the previously described aquatic life use designations, antidegradation classifications are also assigned on a stream and/or segment specific basis. The attributes necessary to assign the antidegradation tiers are described in the Ohio WQS (OAC 374—1-05, Anti-degradation Policy), explained in a draft Ohio EPA DSW fact sheet (Ohio EPA 1999a-Draft) and will be summarized briefly here.

Ohio EPA has drafted revisions to the State's antidegradation policy[1] which incorporate a level of protection between the minimum antidegradation policy required under the Clean Water Act and the maximum protection afforded by federal regulations. The most stringent application of antidegradation is to allow absolutely no lowering of water quality in waters designated as Outstanding National Resource Waters. The minimum requirement allows for a lowering of water quality to the established water quality standards applicable to the water body

1. Authority under 6111.12

if a determination is made that the lowering of quality is necessary to accommodate important social and economic development. The agency is proposing two intermediate levels of protection for certain ecologically important water bodies in the State that will permanently reserve a portion of the unused pollutant assimilative capacity, thereby assuring that future generations will enjoy a higher water quality than the minimally acceptable standard: 1.) State Resource Water[1] (SRW) and 2.) Superior High Quality Water (SHQW).

The process of assigning to tiers to an initial group of Ohio waters is ongoing in consultation with Ohio DNR. The most stringent requirements will for streams assigned to the SRW tier related to the co-occurrence of factors such as the strong populations of endangered, threatened, and declining aquatic species, high mean biological index scores, excellent and intact habitat, and vulnerability to increase pollutant levels (Table 2-1). The SHQW tier would have fewer of these attributes and fewer co-occurring ones, but would still be considered more vulnerable than GHQW streams and deserving of more protection. The assimilative capacity of GHQW would still be subject to an “antidegradation review” and the lowering of water quality or habitat could still be denied without substantial social and economic benefits for Ohio citizens.

Huron Erie Lake Plain (HELP)

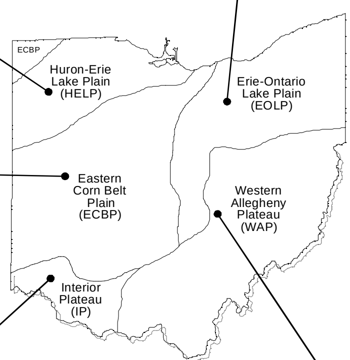
Use	Size	IBI	MIwb	ICI
WWH	H	28	NA	34
	W	32	7.3	34
	B	34	8.6	34
MWH-C	H	20	NA	22
	W	22	5.6	22
	B	20	5.7	22
MWH-I	B	30	5.7	NA

Erie Ontario Lake Plain (EOLP)

Use	Size	IBI	MIwb	ICI
WWH	H	40	NA	34
	W	38	7.9	34
	B	40	8.7	34
MWH-C	H	24	NA	22
	W	24	6.2	22
	B	24	5.8	22
MWH-I	B	30	6.6	NA

Eastern Corn Belt Plains (ECBP)

Use	Size	IBI	MIwb	ICI
WWH	H	40	NA	36
	W	40	8.3	36
	B	42	8.5	36
MWH-C	H	24	NA	22
	W	24	6.2	22
	B	24	5.8	22
MWH-I	B	30	6.6	NA



Interior Plateau (IP)

Use	Size	IBI	MIwb	ICI
WWH	H	40	NA	30
	W	40	8.1	30
	B	38	8.7	30
MWH-C	H	24	NA	22
	W	24	6.2	22
	B	24	5.8	22
MWH-I	B	30	6.6	NA

Western Allegheny Plateau (WAP

Use	Size	IBI	MIwb	ICI
WWH	H	44	NA	34
	W	44	8.4	34
	B	40	8.6	34
MWH-C	H	24	NA	22
	W	24	6.2	22
	B	24	5.8	22
MWH-A	H	24	NA	30
	W	24	5.5	30
	B	24	5.5	30
MWH-I	B	30	6.6	NA

Statewide Exceptional Criteria

Use	Size	IBI	MIwb	ICI
EWH	H	50	NA	46
	W	50	9.4	46
	B	48	9.6	46

Map 2-2. Ohio Biocriteria.

Table 2-3. Array of parameters available for watershed intensive monitoring activities.

Biological

Fish Community Data: IBI, MIwb
Macroinvertebrate Community Data: ICI
Bacteriological: Fecal coliform, streptococcus, E. coli

Physical

Qualitative Habitat Evaluation Index: QHEI; Zig/Zag Pebble Count; Riffle Stability Index, Secchi Tube Transparency, Temperature, Flow, Rosgen Stream Classification

Chemical: Conventional Parameters: pH, Dissolved Oxygen, Conductivity, TSS, TDS, Nutrients (Total Phosphorus, Nitrate, Nitrite, TKN, Ammonia)

Chemical: Metals (Water Column, Sediment, Effluent, Tissue)

Chemical: Inorganics and Organics(Water Column, Sediment, Effluent, Tissue)

Toxicity Testing - (Effluents, Instream), Acute and Chronic Tests

Biomarkers

Methodology For Assessing Use Attainment

This section describes the process used by the Ohio EPA to assess the attainment/non-attainment of designated uses. The Ohio EPA monitors and assesses surface water resources in Ohio using an “ecosystem” approach. This includes the use of an array of “tools” including water chemistry, physical and habitat assessment (Table 2-3), and the direct sampling of the resident biota. In addition, direct threats to

1. The existing SRW definition is being phased out and part of the process will be to move these waters to the appropriate new tier.

Table 2-4. Decision criteria for determining use attainment based on biological data.

Non-Attainment

A.] Neither ICI, IBI, nor MIwb meets criteria for ecoregion
OR
B.] One organism group indicates a severe toxic impact (poor or very poor category) even if the other indicates attainment.

Partial Attainment

A.] One of two or two of three indices do not meet ecoregion criteria (and are not in the poor or very poor category)

Full Attainment

A.] All indices meet ecoregion criteria

human health including fish tissue contamination, bacteriological threats, and drinking water contaminants are also monitored. Ohio has a number of “designated uses” and two of these were assessed for this report: aquatic life uses and recreation. Although there is no fish consumption use in the Ohio WQS we also track where we find elevated levels of fish tissue contaminants that is used by us as an indicator of aquatic and potential human risks and by the Ohio Department of Health in their issuance of consumption and contact advisories (see Appendix A). The method for determining attainment status based on the biocriteria (Map 2-2) is summarized in Table 2-4. The criteria values for the water chemistry values are too voluminous to list here (Ohio WQS 1999) but can be obtained from Ohio EPA’s web site at:

http://chagrin.epa.state.oh.us/rules/3745-1.html

The criteria for bacteriological assessments are summarized in Table 2-6 for bathing waters and Table 2-5 for primary and secondary contact recreation. The contaminant values used to identify elevated levels of tissue contamination are listed in Table 2-7.

Primary Intensive Survey Design

Although efforts are continually made to access and share data with others in Ohio (see next section), the backbone of the data used in this report is from our intensive watershed surveys. A biological and

Table 2-5. Besides bathing waters there are two other categories of recreational uses that we assess in streams in rivers. Data for waters of less frequent public contact (most inland streams) are sampled much less frequently than bathing waters and the data are considered more as screening level indicators of potential problems.

Primary Contact - Suitable for full body contact recreation (e.g. swimming or canoeing). To qualify as a primary contact recreation use, a stream must have at least one pool of 100 square feet greater than a depth of three feet.
Secondary Contact - Suitable for partial body contact recreation (e.g. wading).

The are two criteria used to evaluate recreational use attainment: fecal coliform bacteria and E. coli. A stream segment must meet at least one of these criteria to be in attainment of its use designation.

Use	Fecal coliform	E. coli
Primary Contact Recreation	Min. of five samples within 30 day period not to exceed 1,000 per 100 ml (A) and not to exceed 2,000 per 100 ml in more than 10% of the samples during any 30 day period (B)	Min. of five samples within 30 day period not to exceed 126 per 100 ml (A) and not to exceed 298 per 100 ml in more than 10% of samples taken during any 30 day period (B).
Secondary Contact Recreation	Not to exceed 5,000 per 100 ml in more than 10% of the samples taken during any 30 day period (B).	Not to exceed 576 per 100 ml in more than 10% of samples taken during any 30 day period (B).

Table 2-6. Recommendations issued by the Department of Health for posting advisory signs at beach areas is based upon the E. coli or fecal coliform bacteria content of water samples collected. Evaluation of water sample results is based on the “bathing waters” standards for recreational use as specified in rule 3745-1-07 of the Ohio Administrative Code.

The standard for E. coli content indicates:

1. The geometric mean based on not less than five samples within a 30-day period shall not exceed 126 E. coli colonies per 100 ml of water; and
2. E. coli content shall not exceed 235 E. coli colonies per 100 ml of water in more than 10% of the samples taken during any 30-day period.

The standard for fecal coliform indicates:

1. The geometric mean based on not less than five samples within a 30-day period shall not exceed 200 fecal coliform colonies per 100 ml of water; and
2. Fecal coliform content shall not exceed 400 fecal coliform colonies per 100 ml of water in more than 10% of all samples taken during any 30-day period.

Data for bathing waters in Ohio is available online

water quality survey, or “biosurvey,” is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. This effort may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful of sampling sites or a much more complex effort including entire drainage basins, multiple and overlapping stressors, and tens of sites. Each year Ohio EPA conducts biosurveys in 6-10 different study areas with an aggregate total of 350-400 sampling sites.

Table 2-7. Concentrations of fish tissue contaminants considered: (1) not elevated, (2) slightly elevated, (3) moderately elevated, (4) highly elevated, or (5) extremely elevated.

Parameter	Not Elevated	Slightly Elevated	Moderately Elevated	Highly Elevated	Extremely Elevated
Aldrin	30	131	568	1135	> 1135
Arsenic	150	656	2838	5676	> 5676
Cadmium	500	2188	9459	18919	> 18919
Chlordane	500	2188	9459	18919	> 18919
DDT, DDD, DDE	500	2188	9459	18919	> 18919
Dieldrin	50	220	1000	1999	> 1999
Endosulfan	6000	26250	113514	227027	> 227027
Endrin	300	1313	5676	11351	> 11351
Heptachlor	500	2188	9459	18919	> 18919
Heptachlor Epoxide	13	57	246	492	> 492
Hexachlorobenzene	800	3500	15135	30270	> 30270
Lead	86	375	1622	3243	> 3243
Lindane	300	1313	5676	11351	> 11351
Methoxychlor	5000	21875	94545	189189	> 189189
Mirex	200	875	3784	7568	> 7568
Methylmercury	50	220	1000	1999	> 1999
PCBs (total)	50	220	1000	1999	> 1999
Selenium	2500	10938	47927	94545	> 94545
Toxaphene	250	1094	4730	9459	> 9459

Ohio EPA employs biological, chemical, and physical monitoring and assessment techniques in biosurveys in order to meet three

major objectives: 1) determine the extent to which use designations assigned in the Ohio Water Quality Standards (WQS) are either attained or not attained; 2) determine if use designations assigned to a given water body are appropriate and attainable; and 3) determine if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or best management practices. The data gathered by a biosurvey is processed, evaluated, and synthesized in a biological and water quality report. Each biological and water quality study contains a summary of major findings and recommendations for revisions to WQS, future monitoring needs, or other actions which may be needed to resolve existing impairment of designated uses. While the principal focus of a biosurvey is on the status of aquatic life uses, the status of other uses such as recreation and water supply, as well as human health concerns, are also addressed.

The findings and conclusions of a biological and water quality study may factor into regulatory actions taken by Ohio EPA (e.g., NPDES permits, Director's Orders, the Ohio Water Quality Standards [OAC 3745-1]), and are eventually incorporated into Water Quality Permit Support Documents (WQPSDs), State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and this, the Ohio Water Resource Inventory (305[b] report).

Hierarchy of Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators comprised of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are

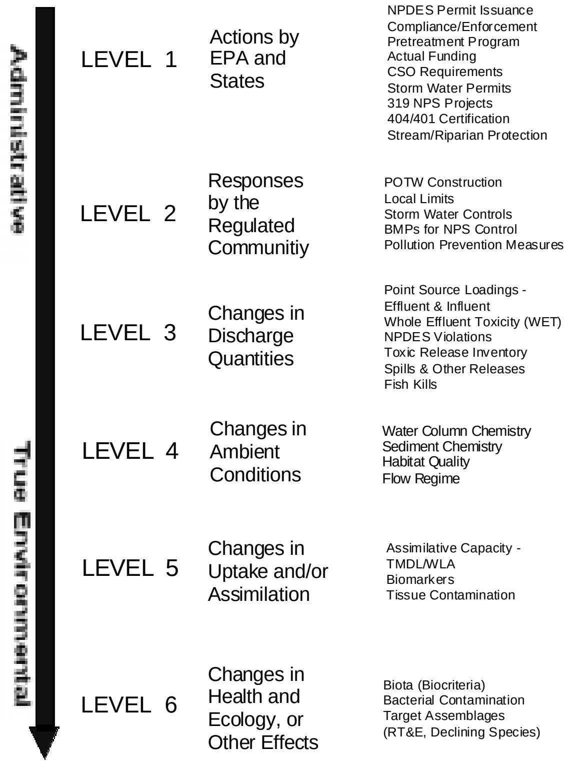


Figure 2-2. Hierarchy of administrative and environmental indicators which can be used for w quality management activities such as monitoring and assessment, reporting, and the evalua of overall program effectiveness. This is patterned after a model developed by U.S. EPA (19

judged objectively on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures. This integrated approach is outlined in Figure 2-2 and includes a hierarchical continuum from administrative to true environmental indicators. The six "levels" of indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation); and, 6) changes in health, ecology, or other effects (ecological condition, pathogens). In this process the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). Thus, the aggregate effect of billions of dollars spent on water pollution control since the early 1970s can now be determined with quantifiable measures of environmental condition.

Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. Stressor indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. Exposure indicators are those which measure the effects of stressors and can include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. Response indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices which comprise Ohio's biological criteria. Other response indicators could include target assemblages, i.e., rare, threatened, endangered, special status, and declining species or bacterial levels which serve as surrogates for the recreational uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators within the roles which are most appropriate for each.

How Causes and Sources of Impairment Were Assessed: "Multiple Lines of Evidence"

As mentioned above Ohio EPA uses "multiple lines of evidence" to ascribe causes and sources of impairment. Ohio's intensive survey program is "applied" and not "experimental" in nature although its foundation is based on an extensive and rigorous ecological foundation. Cause and source associations are not based on an experimental "cause and effect" analysis, but rather are based on associations with stressor and exposure indicators whose links with the biosurvey data are based on previ-

ous research or experience with analogous impacts. The reliability of the identification of probable causes and sources increases where many such prior associations have been identified.

Table 2-8. Different definitions of cause/source magnitude codes between USEPA and Ohio EPA.

Magnitude Code	USEPA Definition	Ohio Definition
High	A cause/source makes a major contribution to impairment if it is the only one responsible for non-support or pre-dominates over other causes of non-support. Sites with partial impairment may only have an M code.	The primary cause(s)/source(s) of full or partial impairment in a stream segment. Any impairment in a waterbody will have at least one cause/source with an H magnitude code.
Moderate	A cause/source makes a major contribution to impairment if it is the only one responsible for partial support or pre-dominates over other causes of partial support or is one of multiple causes of non-support.	The secondary cause(s)/source(s) of full or partial impairment in a stream segment. For example, biological response signatures may clearly indicate that toxics are the primary cause, however, habitat conditions would likely contribute to levels of impairment if toxic impacts were abated.
Slight	A cause/source is one of multiple causes of partial or non-support and is judged to contribute relatively little to this nonattainment.	Tertiary causes/sources of partial and non-support may contribute to the partial or non-attainment in the absence of the other stressors.

The process is analogous to making a medical diagnosis in which a doctor relies on multiple lines of evidence concerning a patient's health. Diagnoses are based on previous research that experimentally or statistically linked symptoms and test results to specific diseases or pathologies. Clearly, the doctor does not "experiment" on a patient, but relies on previous experience in interpreting the multiple lines of evidence (test results) to generate a diagnosis, potential causes or sources of the malady, a prognosis, and a strategy for alleviating the symptoms of the disease or condition. The ultimate arbiter of success is the eventual recovery and the well-being of the patient.

While there have been criticisms of misapplying the metaphor of ecosystem "health" compared to human patient "health" (Suter 1993; e.g., concept of ecosystem as a super-organism) here we are referring to the process for identifying biological integrity and cause/source associations not whether human health and ecosystem health are analogous concepts.

In the analogy we are suggesting here, water chemistry samples are analogous to various diagnostic tests (e.g., a blood sample) that may clearly identify a health problem, but that cannot provide a positive indication of the well-being of a patient. A serious water quality standard violation for a toxic parameter, for example, is likely to be a good indicator of impairment; however, the lack of a violation in no way confirms the presence of biological integrity. Direct measures of health that integrate all of the factors that could affect ecological integrity are essential for an accurate picture of an ecosystem's condition. The inclusion of biosurvey data, based on biocriteria, into a broad, integrated intensive survey program, is the best way to achieve goal of protecting and restoring aquatic life. Our work has shown that the inclusion of biosurvey data in ambient monitoring efforts can boost the detection of aquatic life use impairment by approximately 35-50% over that obtained with a simplified water column chemistry approach alone (i.e., measuring exceedences of a suite of routinely monitored chemical parameters; Ohio EPA 1990a).

Judgement and Statistical Inference.

Much of the initial inference about the causes and sources of an impaired stream segment are inferred from a biologists impressions formed over years of sampling aquatic life in many different types of streams and settings. Sometimes the impacts are obvious and straightforward (acid mine streams with no fish, concrete channels), but often they are more complex. Certain stressors are well known because of their pervasiveness throughout the ecosystem. Milton Trautman in compiling data for the fishes of Ohio (1981) sampled the fish communities in thousands of locations throughout Ohio over 50 years and compiled data collected by others well back into the 1800s. He documented the strong association between siltation, sedimentation, habitat destruction, and the decline of the fish fauna of Ohio. Many of the associations we have shown statistically, he had shown from the associations in land use changes and stream alterations based on extensive data collections over 100 years and the early writings of Ohio settlers and naturalists (Trautman 1981). The introduction to his book is a must read for anyone wanting to understand the patterns we are now seeing in Ohio's streams and rivers.

Most of the patterns we observe in our monitoring data emerge clearly from analyses of our large biological, chemical, and habitat databases. These statewide and regional analyses help us form the associa-

Table 2-9. Hierarchy of assessments for biological, habitat, chemistry, and toxicity data for making 305(b) attainment and non-attainment decisions. Darkest highlighted rows are ones used the most by Ohio EPA in this report. Lightly shaded categories of data are used occasionally and unshaded categories are never used by themselves (for listing).

Level	Technical Components	Spatial/Temporal Coverage	Data Quality[2]
	Biological Surveys		
4[1]	Generally two assemblages, regional reference conditions, multimetric index (Ohio EPA data, Other Professionals using Ohio EPA methods)	Monitored during 1-2 sampling seasons, broad coverage of sties	High precision and sensitivity, professional biologist performs survey and assessment
3	Single assemblage the norm, some biotic index, perhaps supplemented with historical records. (Professional surveys for other purpose or using other methods that deviate somewhat from Ohio EPA methods, e.g., seining)	Monitoring of targeted sites during a single season, sampling may be spatially limited	Moderate precision and sensitivity; professional biologist performs survey or provides training for survey; professional biologist performs assessment
2	One assemblage, usually invertebrates (SQM, Other QA/QC Volunteer Methods)	Limited sampling for site specific studies	Low to moderate precision and sensitivity; professional biologist may provide oversight
1	Visual observation, reference conditions not used	Limited sampling, extrapolation from other sites	Unknown or low precision and sensitivity
	Habitat Assessment		
4	Quantitative measures of instream parameters, channel morphology and floodplain characteristics; landuse data quantified; habitat reference data available (EMAP procedure)	see biosurvey	High precision and sensitivity; professional scientist performs survey and assessment
3	Visual habitat assessment with SOPs, may be supplemented with quantitative measurements of selected parameters; typically conducted with biosurvey; landuse data quantified; habitat reference data available (QHEI, pebble counts)	see biosurvey	Moderate precision and sensitivity; professional scientist performs survey or provides training for survey
2	Visual observation and assessment of habitat characteristics; use of land use maps for characterizing watershed condition; reference condition pre-established by professional scientist	see biosurvey	Low precision and sensitivity; professional biologist may provide oversight and training.
	Chemical Assessment		
4	All of the following: Water quality sampling using composite or series or grab samples (diurnal coverage)	Broad spatial (multiple sites) and temporal (long term) coverage of site with sufficient frequency and parametric coverage to capture acute events, chronic conditions, and other potential P/C impacts	High data quality - data able to detect impairment and to differentiate a gradient of environmental conditions
3	Any one of the following: Composite or a series of grab water sampling used (diurnal coverage) Calibrated models (calibration data < 5 years old)	Broad spatial (multiple sites) and temporal (long term) coverage of site with sufficient frequency and parametric coverage to capture acute events	Moderate to high data quality
2	Any one of the following: Water sampling using grab sampling Rotating basin surveys involving multiple visits or automatic sampling Synthesis of existing of historical information on fish contamination levels Screening models based on loadings data (not calibrated or verified)	Bimonthly or quarterly sampling during key periods Short period of record over a period of days or multiple visits over a season	Low to moderate data quality
1	Any one of the following: Water sampling using grab sampling Water data extrapolated from an upstream or downstream station where conditions are homogeneous Data > 5 years old BPJ based on land use, location of sources	Low spatial and temporal coverage	Unknown or low

[1]Level of information refers to rigor of bioassessment (1=lowest, 4=highest)

[2]Refers to ability to differentiate quality along a gradient of environmental conditions.

ions we use in assigning causes and sources of impairment in specific waterbodies. This process has occurred elsewhere and has been referred to as "Ecoepidemeology."

Each cause and source of impairment associated in each waterbody has a code (H, M, or S) that identifies primary causes/sources of impairment (H), those of secondary influence (M) and those of minor influence (S) at the time the water was sampled. This is similar to the original intent of these codes in the 305(b) process and deviates somewhat from a change in USEPA guidance that altered these codes to reflect a severity of impairment. Ohio felt that the biological assemblages are the best way to examine severity of impairment along a gradient of ecological condition and retained the original intent of the codes. Table 2-7 summarizes the different approaches.

Water Quality Parameters Without Criteria

For water quality parameters without aquatic life criteria in the Ohio WQS (mostly nutrients, conventional substances, and naturally occurring metals), ambient results are compared to values from a set of "least impacted" regional reference sites or from associations between biological indices and ambient values of parameters. "Background" expectations have been derived in Ohio for nutrients and other water column parameters (Ohio EPA 1999b) and sediment parameters (Table 2-10).

Data Quality

The quality categories assigned to the monitoring data used in this assessment generally follow U.S. EPA guidelines (2-9). The classification of data collection methods reflects the rigor of the data used and the resultant accuracy of the aquatic life use assessment. The most rigorous data is from an "intensive" survey that includes water chemistry (effluent, water column, sediment), bioassay, physical habitat, and *both* fish *and* macro-invertebrate data. For the few waterbodies where only water chemistry data was available only impairment, not attainment was tracked.

The comparatively "narrow" focus of water chemistry data provides less confidence about aquatic life use attainment status than the broader-based biological community measures. Similarly, the confidence in the aquatic life use assessments is further increased when data from both fish and macroinvertebrates are available (particularly in complex situations) than when data from only one organism group is available (see Table 2-9). Toxicity testing (acute and/or chronic bioassays) results alone were not used to assess use attainment status nor were volunteer monitoring data, the results of "opinion" surveys, or unsubstantiated or anecdotal information. Such information, however, can be quite useful for indicating areas of potential impairment, in assigning causes and sources of impairment, or for suggesting when conditions may be changing.

The assessments in this report relied primarily on monitored level data. The location of biosurvey sites sampled from 1994 to 1998 across Ohio are illustrated in Map 2-3. The top panel illustrates aquatic life sites and the bottom panel sites sampled for bacteriological data, where data was available electronically through STORET.

Comprehensive Watershed Coverage

Comprehensive monitoring coverage is often cited as a goal of the USEPA in relation to 305(b) results and as a basis for TMDL decision making. Indeed, the National Academy of Sciences, in a report on the state of surface water monitoring in the U.S (National Academy of Sciences 1977), listed three important deficiencies in monitoring programs. One of these was a lack of coordination between different agencies, boards, and institutions involved in surface water monitoring and water quality management. Differing reasons and objectives for monitoring are partly responsible for the lack of ease in sharing and using other agencies' data. However, other reasons include barriers such as incompatible data base management techniques and a lack of standardization of field methods. Even with such cooperation maximized however, the coverage would not approach 100%.

In actuality it is not possible or even advisable, from a resource perspective, to sample all of the waters of the state directly. Our study design has shifted towards a stratified design in small streams and watersheds while keeping a more place specific approach towards sampling larger waters. This approach is both cost efficient and environmentally protective.

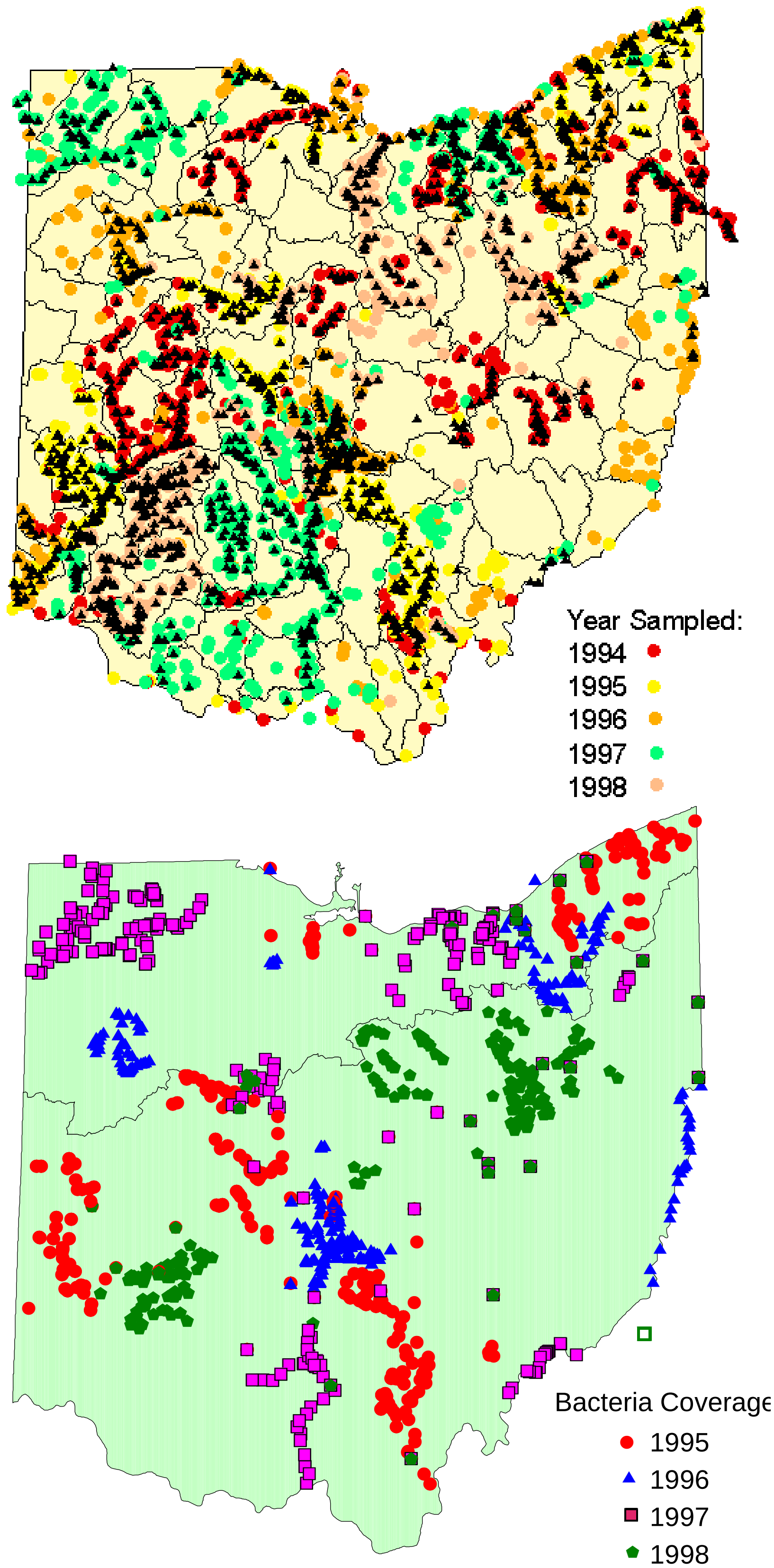
Random vs. Stratified Sampling

In a purely random approach to monitoring as has been done in USEPA's EMAP and in Ohio in a Regional EMAP design (see Ohio EPA 1996b) a random draw of sampling points is taken for a particular subpopulation of streams (e.g., streams < 10 sq mi drainage), however gaining access to these randomly chosen sites can be time consuming. This design, however, maximizes the power to draw conclusions about that subset of streams. Selection of sites in our stratified design begins with the drainage of the watershed to be studied. This drainage is then halved and sites are set at every

stream of that drainage size; these in turn are halved and each stream of that smaller size is sampled down until some threshold size is reached (e.g., 2 or 3 sq mi drainage depending on watershed). This design ensures us of coverage in all subwatersheds of the larger basin but is not arbitrary. Given the regular road grid that covers most of Ohio (typically mile squares) we concluded that sampling near bridges should not substantially bias our results. Our experience over the past 20 years and participation in a random study in the early 1990s gives us empirical confidence in that conclusion.

With this stratified monitoring design we can still make conclusions about populations of interest (streams < 10 sq mi drainage), but also about subwatersheds as well, moving us closer to comprehensive coverage. With this design we can estimate 100% coverage in a watershed. Our need is to be able to have the resources to monitor most of the states watersheds over a five year period to ensure both comprehensive and timely coverage. Our current schedule effectively places some watersheds on a 10-15 year cycle. The gaps illustrated in Map 2-3 illustrate the watersheds that are sampled on a 10-15 year cycle.

The majority of impairments to small watersheds are nonpoint source in origin. The solution to these will be most likely be watershed or regional solutions, not in most cases site specific solutions. Thus watershed efforts to restore riparian would broadly target the watershed not just sampled sites which formed the basis for a watershed-wide estimate of status and limiting factors. This underlies the concept of listing impaired watersheds for our TMDL list, not just segments. A focus on waterbody segments alone would most likely



Map 2-3. Data coverage for the last five year of aquatic community sampling (top) and four years of bacteriological sampling (bottom).

ensure that un-monitored waters will remain impaired.

Data needs will likely vary by watershed across the state and will be important to identify data gaps that we need to fill. It is likely that the gaps will not be in the "listing" arena (i.e., are streams attaining goals) rather there will be more data gaps related to identifying impact types and tracking implementation of restoration activities. Although mandated for point source controls (e.g., self monitoring requirements for effluents) it will be important to devise ways of measuring implementation of BMPs in watersheds and other interim measures that may measure incremental progress with these BMPs (e.g., pebble counts in sediment impaired waters).

Training

Data to be used in the 305(b) and therefore 303(d) listing process will require strict quality control. Ohio EPA has provided some training to scientists outside of the agency, this would need to increase if data sharing, for such purposes were desired to increase. Biological data from other agencies has been used in this report for a number of years and includes fish community data collected by the Ohio DNR - Division of Natural Areas and Preserves, Ohio DNR - Division of Wildlife, the Ohio Department of Transportation (ODOT), and the Ohio State University Museum of Zoology (OSUMZ). Ohio EPA is planning to provide guidance for acceptance of data for various uses in the 305(b) and 303(d) process over the next year or so. Previous 305(b) reports (e.g., Ohio EPA 1996b) provide some caveats to the use of existing data and discusses a hierarchy of bioassessment types to demonstrate the relative capabilities of each of eight different possible sampling approaches.

The level of bioassessment *should* play an important role in the consideration and establishment of policy on the use of biosurvey information relative to its integrated use with chemical-specific and toxicity information (Yoder 1991a; Table 2-9). Certain simple types of biomonitoring approaches are inappropriate for classifying complex environmental problems; similarly a reliance on water chemistry data (exposure indicators) to the exclusion of biosurvey data may also be inappropriate. In regards to monitoring applications, water chemistry, bioassay, and biosurvey data have each been portrayed as an equal leg of a three-legged stool. However, this analogy is inadequate (Karr 1989) and obviously there will be situations in which one or two of the tools will yield more information than the others. The ability to effectively use more "outside" data in the 305(b) and 303(d) process is dependent on resources to coordinate, facilitate, computerize, and QA/QC such data in an ongoing fashion. Effort would also be needed to maintain an ongoing training program to ensure high quality data drives potentially costly restoration actions.

Volunteer Monitoring

U.S. EPA has recently been encouraging the use of ambient data col-

lected by "volunteers" (U.S. EPA 1990a). For lotic systems this includes the qualitative sampling of macroinvertebrates and using a picture key to identify organisms and rate the sample on a scale from poor to excellent. For lakes it usually includes taking turbidity measurements using Secchi disks and observational information. The obvious and attractive advantages of this data are that it can generate substantial interest among the public about surface water resources and the attributes of these waters that are being protected by state agencies. It can also provide information at little or no cost to the government. However, environmental agencies need to be aware of the limitations of this approach, both technically and logistically, prior to depending on this as a major source of monitoring information. Data collected by volunteers can be useful to state agencies in waterbodies of special interest (*e.g.*, State Scenic Rivers) or in waterbodies where the state is unlikely to conduct monitoring. Although it is not used in listing or delisting waters in the 305(b) report it is useful for screening potential problem areas, especially in a watershed context and in narrowing down potential sources of impairment. To be useful in this context however, it is important the data be in electronic form with accurate geographical location information.

Resolution of 305(b) Data

The assignment of causes and sources in the Waterbody System (WBS) is necessarily broad in comparison to the detailed assessments contained in the Technical Support Documents completed by Ohio EPA for each Five-year Basin study area. The delineation of WBS segments frequently does not coincide with "boundaries" of change in the ambient results. As such, the detailed information in these and other Ohio EPA documents supersede the information reported here. However, it is the analysis of the site specific information that provides the basis for the assignment of causes and sources in the 305(b)

Table 2-10. Use support decisions for primary contact and secondary contact recreation uses in Ohio streams and rivers based on the two criteria (A and B) listed in Table 2-4 for Fecal coliforms and E. coli.

Use	Primary Contact	Secondary Contact
Full Support	Both Geometric mean and maximum (90th percentile) criteria are met	Maximum (90th percentile) criterion is met
Partial Support	Geometric mean met, but maximum (90th percentile) criteria is not.	Not Applicable
Non-Support	Both criteria are exceeded	Maximum (90th percentile) criterion is exceeded

report. Subbasin boundaries are referenced in Map 2-4 and major streams (>100 sq. mi. drainage area) are illustrated in Map 2-5.

Recreation Uses

Recreation uses, as impaired by bacterial contamination were also examined for this report. Three levels of contact use exist for various Ohio waters. The precision of the indicators, due to typically low sample sizes and uncertainty about the link between surrogate bacteria values (e.g., fecal coliform counts) and risk from disease causing pathogens, is typically much less robust than for aquatic life use assessments. Even so this data can provide very useful indicators of problem segments especially where they coincide with aquatic life concerns.

Bathing waters are those waters that have defined swimming areas and are typically located on inland lakes and the Lake Erie shoreline. The Ohio Department of Health, some local health departments and the Ohio DNR Division of Parks and Recreation monitor these waters in relation to the criteria for bacterial contaminants listed in Table 2-6. Between Memorial Day and Labor Day, selected public beaches are sampled for bacteria content by testing the water for either E. coli or Fecal Coliform bacteria. Sample results are used to generate a geometric mean (average) which is evaluated against the standards for recreational waters as specified in the Ohio Administrative Code. When the geometric mean exceeds the standards, ODH makes recommendations for the posting of beaches with signs advising against swimming and also list them on their web site:

http://www.odh.state.oh.us/ODHPrograms/BEACH/sample.htm

Here in this document we track contamination by bacteria in waters in relation to the primary and secondary contact use (see Table 2-5). This data is typically collected too infrequently to report regular contact advisories for stream and rivers. Rather, we use it as an indicator of contamination that can illustrate chronic sewage bypasses, urban runoff, and agricultural runoff. Although this data will be used in future TMDL efforts for listing

Table 2-11. Concentrations of total metals in sediment considered: (1) not elevated, (2) slightly elevated, (3) moderately elevated, (4) highly elevated, or (5) extremely elevated.

Parameter	Not Elevated	Slightly Elevated	Moderately Elevated	Highly Elevated	Extremely Elevated
Aluminum	< 14015	14015-21175	21176-35495	35496-156463	> 156463
Arsenic	< 12.5	12.5-18.2	18.3-29.5	29.6-52.1	>52.1
Barium	< 127	127-186	187-304	305-540	> 540
Cadmium	< 0.567	0.567-0.854	0.855-1.428	1.429-2.576	> 2.576
Chromium	< 19.9	19.9-28.8	28.9-46.5	46.6-81.9	>81.9
Copper	< 22.5	22.5-31.9	32.0-50.6	50.7-87.9	> 87.9
Iron	< 29200	29200-40100	40101-61900	61901-105500	>105500
Lead	< 32.2	32.2-47.5	47.6-78.1	78.2-139.0	> 139.0
Manganese	< 1565	1565-2426	2427-4148	4149-7592	> 7592
Nickel	< 30.9	30.9-44.5	44.6-71.7	71.8-126.0	> 126
Zinc	< 106	106-146	147-226	227-386	> 386

waters, the data itself is usually inadequate for generating a TMDL, but rather will initiate a more detailed monitoring program where a problem is likely that will be used to calculated a TMDL for bacteria.

To accomplish the screening for this report, fecal bacteria counts and E. coli counts are aggregated by waterbody segment for each year and classified as full supporting, partially supporting, or not supporting recreation uses according to the decision process in Table 2-10 as outlined by USEPA (1999) using Ohio's water quality criteria values.

Data Problems

As illustrated in Map 2-3 the data coverage is less complete for bacterial assessment than for aquatic life. Fewer data, in general are collected, but in addition we have lacked resources to have all data, especially those analyzed by contract labs, entered and uploaded to STORET so it would be available for this assessment. The lack of data related to this in certain parts of the state (e.g., southwest Ohio) is evident on the map illustrating sampling station coverage (Map 2-3)

Fish and Sediment Contamination

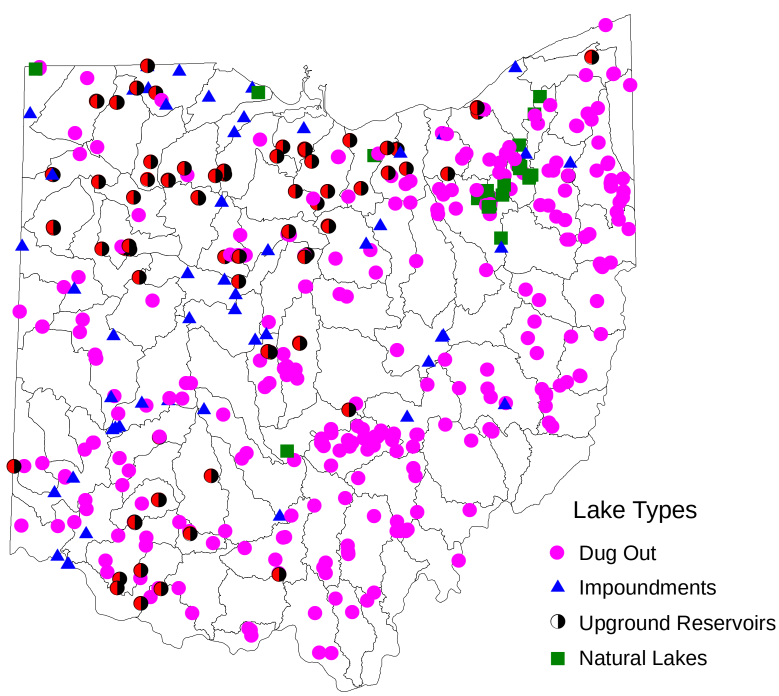
Table 2-11 lists the contaminants in tissue that were used to categorize contaminant levels in the fish of Ohio streams and rivers. Data from 1994 to 1998 were used for this report and were analyzed by waterbody segment. The parameter that showed the highest elevated levels were used to categorize contaminant levels for each waterbody assessed. Because fish are mobile the data was extrapolated to the entire waterbody (generally between 5-15 miles in length). Waterbodies that have Ohio Department of Health Issued consumption advisories are also tracked (waterbody, restricted versus no consumption).

Lakes, Ponds, and Reservoirs

An LCI use attainment flow chart is presented in Appendix B of this report. Using this revised procedure, all lakes meeting the criteria of "partial" and "impaired" use attainment meet the US EPA definition of having an "impaired" condition.

Impairment of a use, either "partial" or "impaired" condition, does not necessarily mean that the lake cannot be used for that activity, nor that a public health hazard exists. Both partial use and impaired use lakes represent high priority lakes in need of more intensive study to determine the severity of the problem, to identify problem causes and sources, and to develop lake and watershed restoration alternatives (i.e., Section 314 Phase I Diagnostic and Feasibility projects). Conversely, lakes judged to have full use attainment need to have lake and watershed protection plans developed and implemented to insure that the higher quality water resource is maintained over time.

A complete listing of Ohio's 446 public lakes is provided in Appendix C of this report. Private lakes and public lakes less than 5 acres surface area are not included in this volume due to a general lack of information. For the purposes of this report, public lakes are defined as those lakes/ponds/reservoirs, including upground reservoirs, where: (1) public access to the water is either owned, man-aged or leased by a public entity (i.e., federal, state, county, or municipal government agencies; park districts; conservation districts), or (2) the lake water is regulated by the Ohio EPA as a primary or secondary public drinking water supply. For the purposes of the CWA Section 314 program, "Significant Public Lakes" are defined as those public



Map 2-5. Ohio's publically owned lakes by lake type.

lakes that are freely open to the public for recreation. Significant public lakes are eligible for possible funding under the Clean Water Act Section 314 Clean Lakes Program, which is administered in Ohio by the Ohio EPA, Division of Surface Water. For this 2000 update, 345 (112,281 acres) of Ohio's 446 public lakes greater than 5 acres were identified as "Significant Public Lakes." Significant Public Lakes are listed in Appendix C as recreational use lakes.

For the State of Ohio Water Inventory, stream impoundments not locally recognized as lakes (e.g., low head dams) are classified under impounded stream segments. Two-hundred seventy-nine (62.6%) of Ohio's 446 public lakes are dammed impoundments, 86 (19.3%) are upground reservoirs, 57 (12.7%) are dug-out lakes, and 24 (5.4%) are natural glacial lakes (Map 2-5). Three lakes are more than 5000 acres: Grand Lake St. Marys, Auglaize County (12,700 acres); Mosquito Creek Reservoir, Trumbull County (7,850 acres), and Indian Lake, Logan County (5,104 acres). An additional 27 lakes range between 1,000 and 5,000 acres. Together, the 30 lakesmore than 1000 acres represent 84,336 (71%) of the total acres of public lake water in Ohio. A large number of public lakes (282) are from 5 and 50 acres in size, but these lakes represent only 3.9% (4,657 acres) of the total acres of public water.

Water Quality Assessment Process in Lakes

In general, prior to 1989 the overall condition of Ohio's lakes was not well known. However, from 1989 to 1995 the Ohio EPA has sampled 141 (31.6%) of its 446 public lakes. Partial funding for this monitoring effort was provided by the US EPA Section 314 Clean Lakes Program. The most extensive lake data now available are for water and sediment chemistry, parameters related to nutrient enrichment (total phosphorus, chlorophyll-a), Secchi disk turbidity, and fecal coliform bacteria. Little quantitative information is available for biological communities in lakes (including fisheries, benthos, and macrophytes). Since 1989, samples for plankton analysis have been collected for most of the 141 lakes, but species have not been enumerated except for a few select lakes. As part of a cooperative effort by three State agencies (Ohio Department of Health, Ohio EPA, and Ohio DNR), samples of fish tissue (fillets) have been analyzed for PCB and select heavy metals for more than 50 public lakes. Measured loadings of sediment, nutrients, and toxics from lake watersheds are known for only a few of Ohio's public lakes. Detailed loadings studies have been conducted for the four Section 314 Phase I Diagnostic studies at Winton Woods Lake, Indian Lake, Sippo Lake, and Dillon Reservoir.

Passage of the 1987 amendments to the Clean Water Act required each State to expand assessment of lake water quality beyond the concept of nutrient enrichment (i.e. trophic state) to include topics such as violations of water quality standards, attainment of designated uses, and identification of lakes threatened by nonpoint and point sources of pollution. In order to comply with these new federal mandates, the Ohio EPA developed a multiparameter lake assessment process called the Ohio Lake Condition Index (Ohio LCI, Davic and DeShon 1989). The Ohio LCI, as revised in 1992 (Ohio EPA 1992), is used in this 305(b) to assess the overall ecosystem condition of Ohio's public lakes. The revised LCI uses information gathered from 14 different parameters to allow a holistic assessment of the overall condition of the lake ecosystem. The revised LCI is found in Appendix B

One of the requirements of the 305(b) process is for States to classify according to trophic state of their public lakes. For this report, a modification of the original nutrient enrichment trophic concept of Naumann, and the algal biomass concept of Carlson was used to classify the "trophic state" of the surface water of Ohio's lakes. Following the procedures used in the 1982 Ohio 305(b) lakes report (Youger 1982), total phosphorus, chlorophyll-a concentrations, and secchi disk measurements were converted to Carlson Trophic State Index (TSI) values (Carlson 1977). Calculation formulas from Reckhow and Chapra (1983) are as follows:

Secchi Disk TSI = 60 - 14.41 ln (SD meters)

Chlorophyll-a TSI = 9.81 ln (Chl-a ug/l) + 30.6

Total Phosphorus TSI = 14.42 ln (TP ug/l) + 4.15

Carlson TSI values for total phosphorus and chlorophyll-a provide a method to quantify the open water "nutrient enrichment" concept of Naumann, and the "algal biomass" concept of Calson (1977). Lakes were considered assessed for trophic classification if approved data were available for summer chlorophyll-a (July, August, September) or spring total phosphorus (April, May, June).

Recent declines in CWA Section

Table 2-12. Lakes sampled by Ohio EPA from 1996-1999.

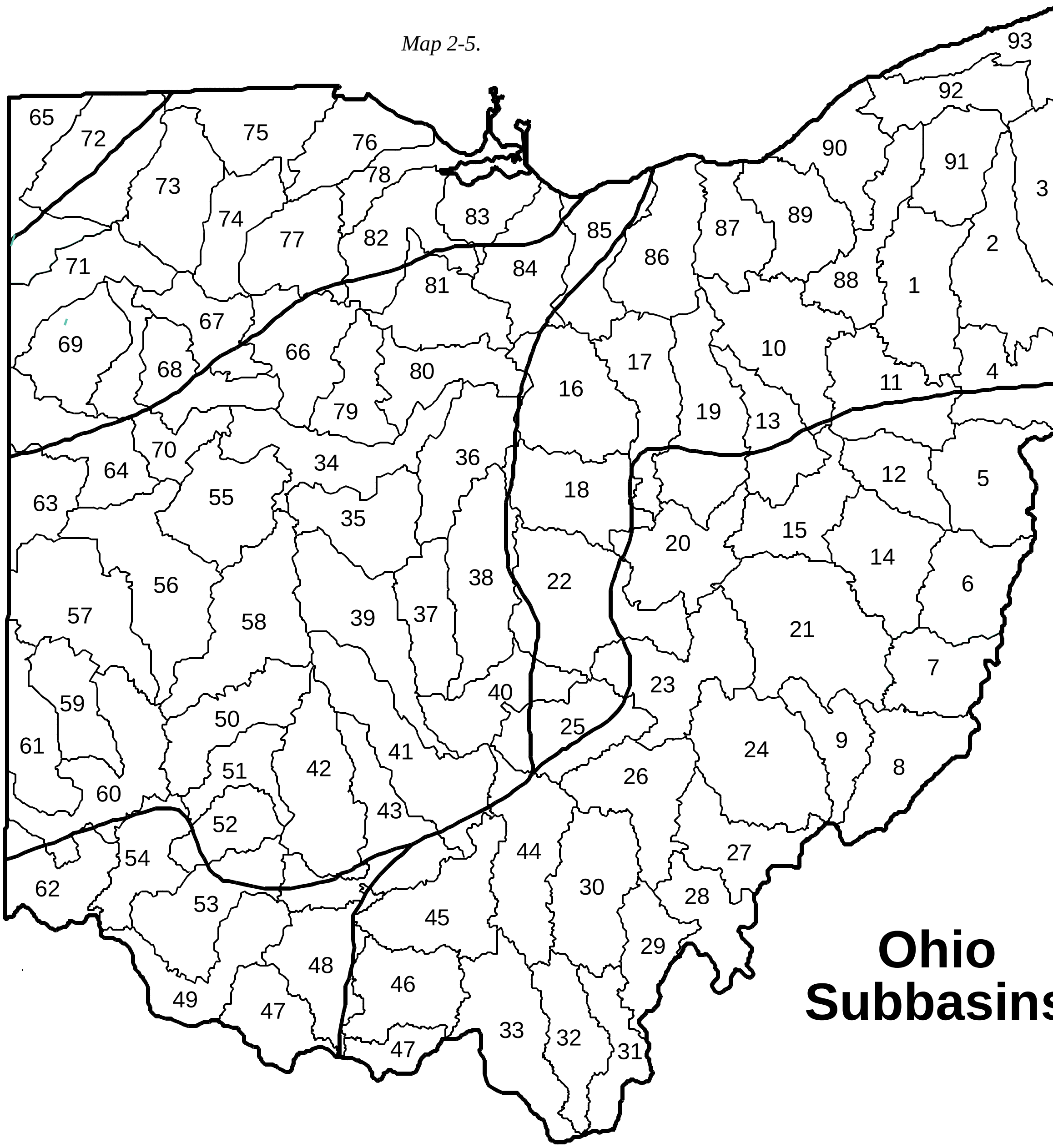
Year	District	Lake	Year	District	Lake
1996	SWDO	Lake Isabella Rush Run Lake Whitewater Lake Sharon Woods Lake	1998	SWDO	Ceasar Creek Lake William Harsha Lake (East Fork)
	NWDO	Lost Creek Reservoir Findlay Reservoir # 2 McComb Reservoir #2 Paulding Reservoir		NWDO	Pleasant Hill Reservoir Clear Fork Reservoir Charles Mill Reservoir
	SEDO	Piedmont Lake St. Clairsville Reservoir #1 Caldwell Lake Wolf Run Reservoir		SEDO	Piedmont Lake Clendening Lake
	CDO	Westerville Reservoir Alum Creek Lake Thoreau Pond Hoover Reservoir Shrock Lake		CDO	None
	NEDO	Summit Lake Nesmith Lake Mogadore Reservoir		NEDO	Long Lake (intensive)
1997	SWDO	Grant Lake Rocky Fork Lake Sardinia Reservoir Mt. Orab Reservoir #1 Mt Orab Reservoir #2	1999	SWDO	Indian Lake Lake Loramie
	NWDO	Nettle Lake Harrison Lake Lake Sue Lake Lavere		NWDO	Grand Lake St. Marys
	SEDO	Hammertown Lake Pike Lake Ross Lake Lake White Jackson City Reservoir		SEDO	Blue Rock State Park (Cutler Lake) Wills Creek Reservoir
	CDO	Deer Creek Lake Lake Choctaw Madison Lake Hargus Lake		CDO	None
	NEDO	Findlay Lake (intensive)		NEDO	Sippo Lake

314 funding have greatly reduced monitoring over the past several years. The most recent data included here is only a partial review of the available. Limited resources for lake assessments have been focused on lake specific assessments that are incorporated into Ohio EPA Technical Support Documents rather than statewide summaries (e.g., 1996 Lake Volume III of the 305(b); Ohio EPA 1996c). These summaries can be found in TSDs at the web site:

http://chagrin.epa.state.oh.us/document_index/psdindx.html

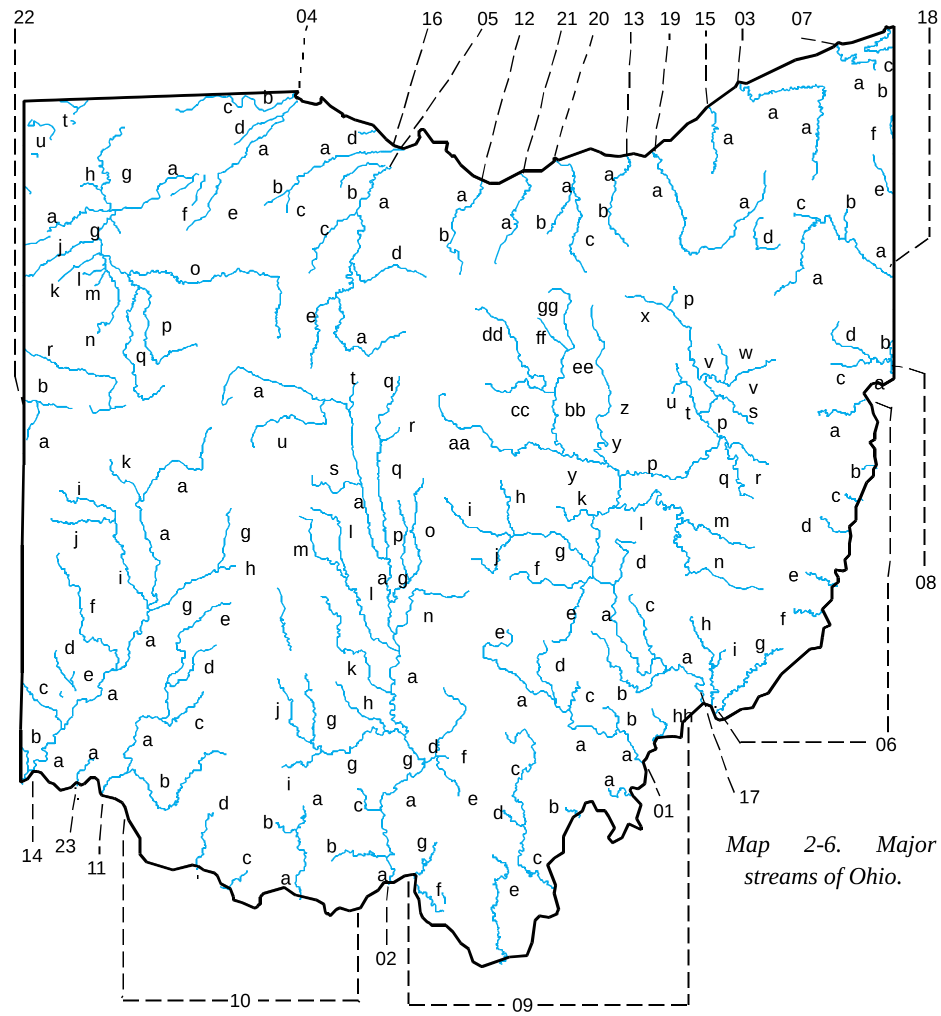
Some of these are also summarized in Appendix K. Lakes that were sampled by Ohio EPA from 1996 to 1999 are listed in Table 2-12.

Map 2-5.



Key to Map 2-5: Subbasin names

1 - UPPER MAHONING RIVER
2 - LOWER MAHONING RIVER
3 - PYMATUNING CREEK
4 - LITTLE BEAVER CREEK
5 - CENTRAL TRIBS (YELLOW CREEK AND CROSS CREEK)
6 - CENTRAL TRIBS (SHORT CREEK AND WHEELING CR.)
7 - CENTRAL TRIBS (MCMAHON, CAPTINA, SUNFISH CR.)
8 - LITTLE MUSKINGUM RIVER
9 - DUCK CREEK
10 - UPPER TUSCARAWAS RIVER
11 - NIMISHILLEN CREEK;
12 - CONOTTON CREEK
13 - SUGAR CREEK
14 - STILLWATER CREEK
15 - LOWER TUSCARAWAS RIVER
16 - BLACK FORK, CLEAR FORK, ROCKY FORK, MOHICAN R
17 - LAKE FORK, JEROME FORK, MUDDY FORK, MOHICAN R
18 - KOKOSING RIVER
19 - KILLBUCK CREEK
20 - UPPER MUSKINGUM RIVER AND WAKATOMIKA CREEK
21 - WILLS CREEK
22 - LICKING RIVER
23 - MIDDLE MUSKINGUM RIVER
24 - LOWER MUSKINGUM RIVER
25 - UPPER HOCKING RIVER
26 - MIDDLE HOCKING RIVER
27 - LOWER HOCKING RIVER
28 - SE TRIBS (SHADE RIVER)
29 - SE TRIBS (LOWER RACCOON CREEK AND LEADING CREEK)
30 - SE TRIBS (UPPER RACCOON CREEK)
31 - SE TRIBS (LITTLE INDIAN GUYAN CREEK)
32 - SE TRIBS (SYMMES CREEK)
33 - SE TRIBS (LITTLE SCIOTO RIVER AND PINE CREEK)
34 - UPPER SCIOTO RIVER (AND LITTLE SCIOTO RIVER)
35 - SCIOTO RIVER (MILL CR.,BOKES CR., FULTON CR.)
36 - UPPER OLENTANGY RIVER
37 - LOWER OLENTANGY RIVER
38 - BIG WALNUT CREEK
39 - BIG DARBY CREEK
40 - WALNUT CREEK;
41 - MIDDLE SCIOTO RIVER (INCLUDING DEER CREEK)
42 UPPER PAINT CREEK
43 - LOWER PAINT CREEK (N. FK. AND ROCKY FK.)
44 - SALT CREEK;
45 - SCIOTO RIVER (SUNFISH CR.,BEAVER CR.)
46 - LOWER SCIOTO RIVER (AND SCIOTO BRUSH CREEK);
47 - SW TRIBS (EAGLE CREEK AND STRAIGHT CREEK)
48 - OHIO BRUSH CREEK
49 - SW TRIBS (WHITEOAK CR.,INDIAN CR., BEAR CR.)
50 - UPPER LITTLE MIAMI RIVER
51 - CAESAR CREEK
52 - TODD FORK
53 - EAST FORK LITTLE MIAMI RIVER
54 - LOWER LITTLE MIAMI RIVER
55 - UPPER GREAT MIAMI RIVER
56 - GREAT MIAMI RIVER AND LORAMIE CREEK
57 - STILLWATER RIVER
58 - MAD RIVER
59 - TWIN CREEK
60 - MIDDLE GREAT MIAMI RIVER
61 - FOURMILE CREEK
62 - LOWER GREAT MIAMI RIVER AND WHITEWATER R.
63 - WABASH RIVER
64 - ST. MARYS RIVER
65 - ST. JOSEPH RIVER
66 - BLANCHARD RIVER
67 - LOWER AUGLAIZE RIVER
68 - OTTAWA RIVER
69 - LITTLE AUGLAIZE RIVER
70 - UPPER AUGLAIZE RIVER;
71 - UPPER MAUMEE R. (INCLUDING GORDON CREEK);
72 - TIFFIN RIVER
73 - UPPER MIDDLE MAUMEE RIVER;
74 - LOWER MIDDLE MAUMEE RIVER
75 - LOWER MAUMEE RIVER (AND OTTAWA RIVER)
76 - LAKE ERIE TRIBS MAUMEE R. TO PORTAGE R.
77 - UPPER PORTAGE RIVER
78 - LOWER PORTAGE RIVER
79 - TYMOCHTEE CREEK
80 - UPPER SANDUSKY RIVER
81 - MIDDLE SANDUSKY RIVER
82 - LOWER SANDUSKY RIVER
83 - LAKE ERIE TRIBS SANDUSKY R. TO VERMILION R.
84 - VERMILION RIVER
85 - HURON RIVER;
86 - BLACK RIVER
87 - ROCKY RIVER
88 - UPPER CUYAHOGA RIVER
89 - LOWER CUYAHOGA RIVER
90 - LAKE ERIE TRIBS (CHAGRIN RIVER)
91 - UPPER GRAND RIVER
92 - LOWER GRAND RIVER\
93 - ASHTABULA RIVER AND CONNEAUT CREEK.



Map 2-6. Major streams of Ohio.

Key To Map 2-6
01 - Hocking River Basin
a - Hocking River
b - Federal Creek
c - Sunday Creek
d - Monday Creek
e - Rush Creek
02 - Scioto River Basin
a - Scioto River
b - Scioto Brush Creek
c - Sunfish Creek
d - Salt Creek
e - Saltlick Creek
f - Middle Fk. Salt Creek
g - Paint Creek
h - N. Fk. Paint Creek
i - Rocky Fk. Paint Creek
j - Rattlesnake Creek
k - Deer Creek
l - Big Darby Creek
m - Little Darby Creek
n - Walnut Creek
o - Big Walnut Creek
p - Alum Creek
q - Olentangy River
r - Whetstone Creek
s - Mill Creek
t - Little Scioto River
u - Rush Creek
03 - Grand River Basin
a - Grand River
04 - Maumee River Basin
a - Maumee River
b - Ottawa River
c - Ten Mile Creek
d - Swan Creek
e - Beaver Creek
f - Turkeyfoot Creek
g - Tiffin River
h - Mud Creek
i - Powell Creek
j - Flatrock Creek
k - Blue Creek
l - Prairie Creek
m - Town Creek
n - Little Auglaize River
o - Blanchard River
p - Ottawa River
q - Auglaize River
r - St. Maryís River
s - St Josephs River
t - W. Br. St. Josephs River
u - Nettle Creek
v - Fish Creek
05 - Sandusky River Basin
a - Sandusky River
b - Muddy Creek
c - Wolf Creek
d - Honey Creek
e - Tymochtee Creek
06 - Central Tribs Basin
a - Yellow Creek
b - Cross Creek
c - Short Creek
d - Wheeling Creek
e - Captina Creek
f - Sunfish Creek
g - Little Muskingum River
h - Duck Creek
i - E. Fk. Duck Creek
07 - Ashtabula Creek Basin
a - Ashtabula River
b - W. Br. Ashtabula River
c - Conneaut Creek
08 - Little Beaver Creek Basin
a - Little Beaver Creek
b - N. Fk. L. Beaver Creek
c - W. Fk. L. Beaver Creek
d - M. Fk. L. Beaver Creek
09 - Southeast Tribs
a - Shade River
b - Leading Creek
c - Raccoon Creek
d - Little Raccoon Creek
e - Symmes Creek
f - Pine Creek
g - Little Scioto River
10 - Southwest Tribs
a - Ohio Brush Creek
b - W. Fk. Ohio Brush Creek
c - Straight Creek
d - Whiteoak Creek
11 - Little Miami River Basin
a - Little Miami River
b - E. Fk. L. Miami River
c - Todd Fork
d - Caesar Creek
12 - Huron River Basin
a - Huron River
b - West Fork Huron River
13 - Rocky River Basin
a - Rocky River
b - W. Fk . Rocky River
14 - Great Miami River Basin
a - Great Miami River
b - Whitewater River
c - Indian Creek
d - Four Mile Creek
e - Sevenmile Creek
f - Twin Creek
g - Mad River
h - Buck Creek
i - Stillwater River
j - Greenville Creek
k - Loramie Creek
15 - Chagrin River Basin
a - Chagrin River
16 - Portage River Basin
a - Portage River
b - M. Br. Portage River
c - S. Br. Portage River
17 - Muskingum River Basin
a - Muskingum River
b - Wolf Creek
c - Meigs Creek
d - Salt Creek
e - Moxahala Creek
f - Jonathan Creek
g - Licking River
h - N. Fk. Licking River
i - Raccoon Creek
j - S. Fk. Licking River
k - Wakatomika Creek
l - Wills Creek
m - Slat Creek
n - Leatherwood Creek
o - Seneca Fork
p - Tuscarawas River
q - Stillwater Creek
r - L. Stillwater Creek
s - Connotton Creek
t - Sugar Creek
u - S. Fk . Sugar Creek
w - Nimishillen CreekÌ
x - Chippewa Creek
y - Walhonding River
z - Killbuck Creek
aa - Kokosing River
bb - Mohican River
cc - Clear Fork
dd - Black Fork
ee - Lake Fork
ff - Jerome Fork
gg - Muddy Fork
18 - Mahoning River Basin
a - Mahoning River
b - Mosquito Creek
c - Eagle Creek
d - W. Br.Mahoning River
e - Yankee Creek
f - Pymatuning Creek
19 - Cuyahoga River Basin
a - Cuyahoga River
20 - Black River Basin
a - Black River
b - W. Br. Black River
21 - Vermilion River Basin
a - Vermilion River
22 - Wabash River Basin
a - Wabash River
b - Beaver Creek
23 - Mill Creek Basin
a - Mill Creek

Streams and Rivers

Aquatic life use support in this report is based on “current” assessments of 8,232 miles of streams and rivers (Table 3-1). This is 28.3% of the 29,113 miles of perennial streams miles or 13.4% of the 61,532 total stream miles estimated to exist in Ohio by the U.S. EPA (see Section 2). Although our sampling strategy is a generally focused rather than probabilistic one (but see background), our coverage on larger rivers is extensive (Figure 3-1). We have assessed greater than 90% of rivers of greater than 1,000 sq mile drainage (65.9% considering only “current” data) and greater than 50% (47.4% “current”) of all streams not considered headwaters (i.e., > 20 sq mi; Figure 3-1). The decline in our coverage of larger waters and a shift to small waters is clear when comparing the data considered current in 1996 (solid line) versus this 2000 cycle coverage (dashed line) in Fig 3-1.

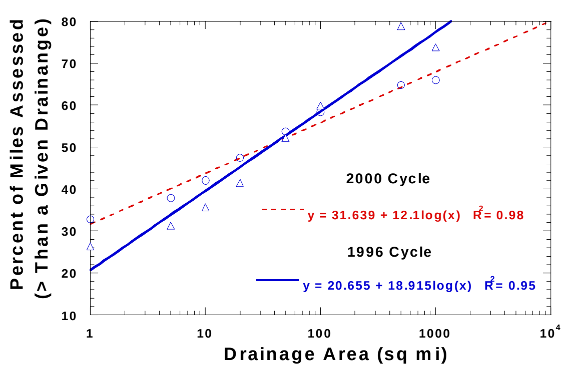


Figure 3-1. This graph illustrates the proportion of named streams monitored and still considered current as of the 2000 assessment cycle (dashed line) and as of the 1996 assessment cycle (solid line).

Concern with database biases related to extrapolation from small sample sizes decreases with increasing stream size. Results of our REMAP probabilistic sampling in small streams of the ECBP ecoregion were in close agreement with intensive survey results from similar size streams from this region. Our concern with bias in small streams, where we sample a small proportion of the total miles is reduced with our application of a stratified sampling design for these waters (see section 2).

Stream and river surveys in Ohio during the 1970s and 1980s revealed widespread impairment from inadequately treated municipal and industrial wastewater. Only 34.6% of streams and rivers fully supported aquatic life use criteria based on monitoring data collected prior to 1988 (Fig. 3-2). Ohio’s goal is for 80% of stream and river miles to fully meet the applicable aquatic life goals and standards (called “uses”) by the year 2010. The statistics reported here indicate that just over one-half (54.6%) of the streams and rivers that have been monitored and data is considered current by Ohio EPA are fully supporting their applicable aquatic life use designation (Figure 3-2). This means that more than one-half of Ohio's streams and rivers harbor good or exceptional quality assemblages of aquatic life. Statistics for the most recent two-year reporting cycle alone (representing data collected in 1997-98) showed 52.3% of streams and rivers meeting uses (dotted line on Figure 3-2) which is a break in the trend of increasing attainment that has been observed since 1994. There are multiple factors that are responsible for this change.

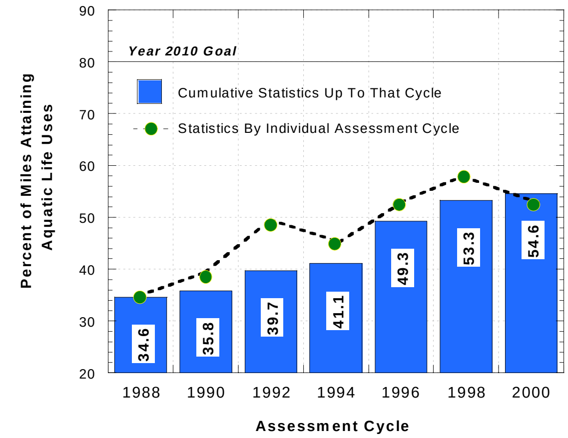


Figure 3-2. This bar chart summarizes the aquatic life use attainment statistics cumulatively up to each two-year cycle from 1988 to 2000. Statistics for each assessment cycle alone are illustrated by the dotted line. The individual 2000 cycle reflects data collected in 1997 and 1998, the 1998 cycle data collected from 1995 and 1996, etc.

Almost all of the improvement noted in these statistics since 1988 is the result of the abatement of the point source impacts dating from before the 1970s and 1980s that were the original impetus for the Clean Water Act. Reducing the effects of these sources was amenable to the type of permitting and funding assistance that was widely available in the 1980s. The remaining point and nonpoint source impacts present greater challenges and thus a leveling off of the comparatively rapid rate of restoration seen between 1988 and 1998 was expected. An increasingly greater proportion of the remaining impair-

Table 3-1. Aquatic life use attainment in Ohio streams and rivers based on our entire data base (1988 through 2000 assessment cycles), the post-1988 assessment cycles, and the individual 1988, 1990, 1992, 1994, 1996, 1998, and 2000 assessment cycles. Data Represent monitored and evaluated level data, except for the combined 1988-2000 cycles and combined 1988-1998 cycles, where only monitored level data was used to exclude older, less pertinent data from combined statistics.

Miles/%	Fully Supports	Fully Supports, But Threatened	Partially Supports	Does Not Support	Total
1988-2000 Assessment Cycles - Monitored Level Data					
Miles	3,857.2	631.8	1,690.8	2051.8	8,231.8
%	46.86	7.68	20.54	24.93	
	Total Full Support 54.53%		Total Impaired 45.47%		
1988-1998 Assessment Cycles - Monitored Level Data					
Miles	2,846.9	669.6	1,375.2	1711.4	6,603.2
%	43.11	10.14	20.80	25.90	
	Total Full Support 53.25%		Total Impaired 46.75%		
2000 Assessment Cycles - Monitored and Evaluated Level Data					
Miles	1,524.7	195.9	712.1	857.8	3,290.6
%	46.34	5.96	21.64	26.07	
	Total Full Support 52.29%		Total Impaired 47.71%		
1998 Assessment Cycles - Monitored and Evaluated Level Data					
Miles	1,394	333.9	620.6	660.7	3,009.4
%	46.32	11.10	20.62	21.96	
	Total Full Support 57.42%		Total Impaired 42.58%		
1996 Assessment Cycles - Monitored and Evaluated Level Data					
Miles	986.2	273.9	423.5	696.1	2,379.9
%	41.44	11.51	17.80	29.25	
	Total Full Support 52.95%		Total Impaired 47.05%		
1994 Assessment Cycles - Monitored and Evaluated Level Data					
Miles	544.3	220.3	462.2	457.7	1,684.8
%	32.31	13.08	27.44	27.17	
	Total Full Support 45.39%		Total Impaired 54.61%		
1992 Assessment Cycles - Monitored and Evaluated Level Data					
Miles	620.3	208.8	428.9	405.6	1,663.8
%	37.28	12.55	25.78	24.38	
	Total Full Support 49.84%		Total Impaired 50.16%		
1990 Assessment Cycles - Monitored and Evaluated Level Data					
Miles	213.7	157.8	224.5	346.9	943.0
%	22.66	16.73	23.81	36.79	
	Total Full Support 39.40%		Total Impaired 60.60%		
1988 Assessment Cycles - Monitored and Evaluated Level Data					
Miles	2,036.4	359.4	1,475.8	3,052.8	6,924.5
%	29.41	5.19	21.31	44.09	
	Total Full Support 34.6%		Total Impaired 65.40%		

ment is associated with nonpoint sources, which includes polluted runoff (such as sediment, nutrients, and toxic chemicals), habitat modification and destruction, and alteration of flow regimes, that have always been present during the past 20 years, but in which there has been comparatively little progress in abating. Other factors contributing to the decline includes a shift to monitoring a larger number of small streams, spatial bias in where monitoring is conducted each year, and formerly attaining streams and rivers which have since become impaired (see trend summary later in the chapter). Data collected during the late 1980s and early 1990s reflected the substantial investments made to improve point source discharges of wastewater, particularly from municipal treatment plants.

Attainment and Stream Size

Stream waterbodies have been categorized by drainage area (sq. mi.) at the lower end of each stream and river segment. This permits the examination of aquatic life use support by stream size. The severity of impairment varied according to stream and river size (Fig. 3-3). Severity is greater where non-attainment (i.e., all indices show impairment) is large in relation to partial impairment (at least one index meeting criteria) The lowest non-attainment and partial attainment was in large rivers where we have observed the greatest improvement from WWTP abatements. Only 12.2% of these miles were in complete non-attainment. The greatest severity is generally found in headwater streams (Fig. 3-3). Although this is partly an artifact of sampling design (fewer sites sampled with both fish and macroinvertebrates) a good portion of this is related to the greater susceptibility to the direct effects

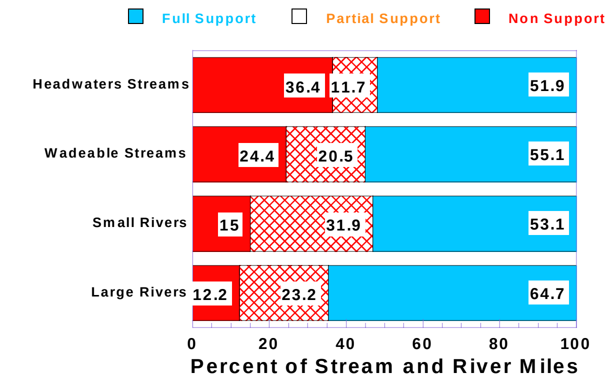


Figure 3-3. This graph illustrates the proportion aquatic life status by four categories of stream size: headwater (< 20 sq mi), wadeable streams (20-200 sq mi), small river (> 200 - 1000 sq mi), and larger river (> 1000 sq mi).

of nonpoint sources (*e.g.*, hydro-modification, runoff), habitat destruction, and general watershed modifications. Full use attainment varied little with stream size when examined in the 1996 report but is clearly higher in the large river category now (Fig 3-3). This is mostly related to abatement of the effects of large WWTPs in Ohio.

Aquatic Life Use Attainment by Use Category

Aquatic life use support also varied with the designated aquatic life. The EWH and CWH aquatic life uses had the greatest proportion of fully supporting and threatened stream and river miles (Table 3-2). These uses are the most sensitive aquatic life uses (*e.g*, habitats for intolerant fauna) and although they are resilient when impacts are abated (due to exceptional stream habitat) they are also susceptible to nonpoint source impacts such as habitat degradation and siltation. The high resource value of these streams makes them priorities for protection and restoration (see 'Threatened Streams and Rivers' later in this report).

Table 3-2. Use support summary by aquatic use for Ohio streams and rivers. Data are monitored level, 1988-2000 assessment cycles.

Aquatic Life Use		Fully Supports	Fully Supports, But Threatened	Partially Supports	Does Not Support	Total
EWH	Miles	869.4	156.6	280.8	92.5	1399.5
	%	62.1	11.2	20.1	6.6	
WWH	Miles	2,573.9	388.8	1,213.8	1,484.1	5,660.6
	%	45.5	6.9	21.4	26.2	
CWH	Miles	167.4	22.7	32.2	18.5	241.0
	%	69.5	9.4	13.4	7.7	
MWH	Miles	75.1	0.0	61.4	113.7	250.2
	%	30.0	0.0	24.6	45.4	
LRW	Miles	68.0	13.2	68.9	156.6	306.9
	%	22.2	4.3	22.5	51.0	
None	Miles	91.6	50.5	32.5	186.2	360.9
	%	25.4	14.0	9.0	51.6	

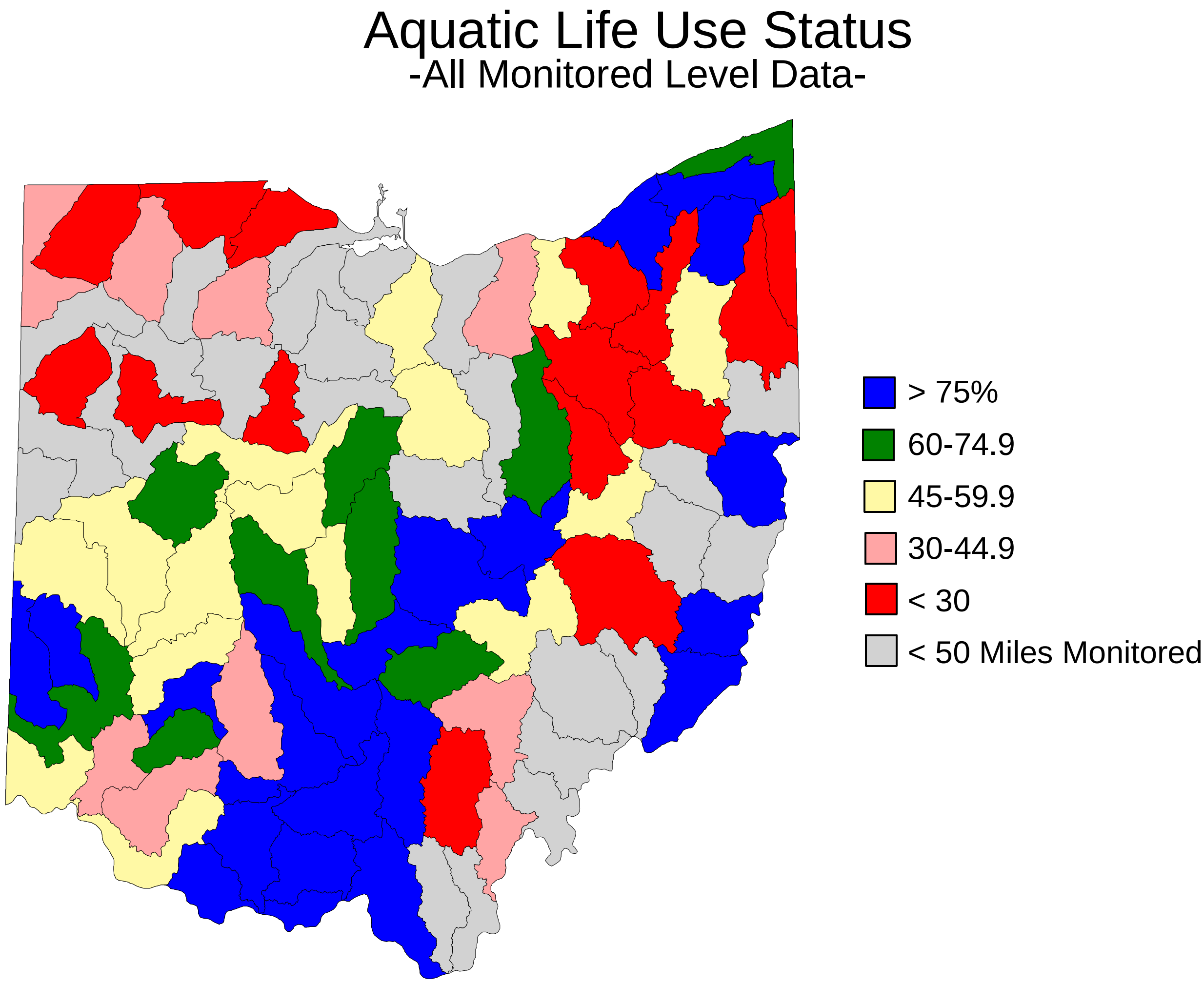
The more limited resource streams (MWH, LWH, and LRW aquatic life uses) have the least proportion of their miles supporting uses even though criteria for these waters are less stringent than WWH, CWH, or EWH waters. This condition likely reflects the intensity and magnitude of human activity (e.g., agricultural and industrial) around these waters.

Geographic Patterns in Aquatic Life Use Attainment

The degree of impairment is not homogeneous across Ohio, but varies based on severity of human activities as well as natural changes in the biota with factors such as ecoregion. Map 3-1 illustrates the attainment status for existing current aquatic life uses by subbasin in Ohio.

We see a general gradient of increasing impairment with increasing agricultural intensity from southeast to northwest Ohio as well as more severe impairment near urban and old industrial centers (Toledo, Cleveland, Youngstown, Akron/Canton). Some of the subbasins with greater than 75% attainment are in heavily agricultural subbasins (e.g., Twin Creek in western Ohio), however in these watersheds certain natural features (high base flow streams) and avoidance of modification of riparian areas reduces agricultural effects.

A similar pattern is evident in use statistics summarizes by Ohio EPA District Office. Although not "eco-



Map 3-1. Map illustrating aquatic life use attainment status in Ohio subbasins based on monitor-level data (data that is considered current and meets QA/QC standards).

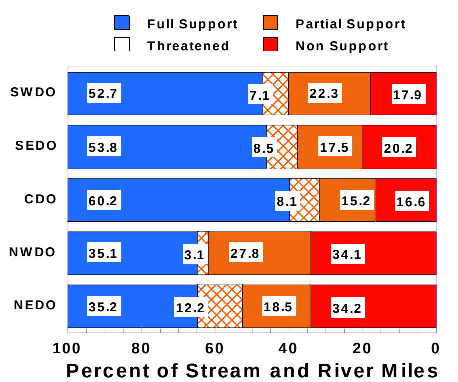


Figure 3.-4. This graph illustrates the proportion aquatic life status by Ohio EPA District Office.

logical” boundaries, these statistics are use full for setting regional priorities in water resource management.

Stream Specific Data

Aquatic life attainment statistics by stream or stream reach are listed in Appendix D. This appendix is only available in electronic (Adobe.pdf format) because of its great size. Anyone interested in printed portions of certain pages and without access to a computer with INTERNET capabilities can contact the Division of Surface water for printouts:

Dennis Mishne 614-836-8775 or
Ed Rankin 614-836-8772

Forecasting Use Attainment

Numerous Ohio stream and river segments have been reassessed following the implementation of point source controls to meet water quality standards in the 1980s. One benefit of the monitoring approach employed by Ohio EPA is the ability to forecast water quality changes into the future. A major challenge facing the Ohio EPA water programs is the goal of achieving full support of aquatic life uses in 80% of Ohio's streams and rivers by the year 2010 (Ohio 2010 Goal). In order to determine if existing programs are likely to achieve this goal, we attempted to look ahead based on past observations. The previous rate of restoration, projected from reassessment results observed between 1988 and 1998 (Figure 3-5) was an accumulating addition of approximately 2.2% restored miles per year (range: 0.9-3.8%/year). This has largely been the product of point source abatement efforts that took place in the 1980s. The 2000 results, however, deviated from that trend with full attainment declining 5.1% from the 1998 results to 52.3%. This is 9.4% less than the 61.7% that was predicted for the 2000 cycle by the 1998 forecast analysis. The annual rate of restoration has declined to 1.65% (percent miles restored per year; Figure 3-6). Because the proportion of point source related impairments is now small (8.7% of impaired waters in 2000), the most likely future pattern is one that levels out until more progress is evident in nonpoint source abatement. Even if progress is made on these sources, a longer recovery time supports the slowing of the rate of restoration in the revised forecast analysis (Figure 3-6).

Ohio 2010 Goals:

Aquatic Life Uses

2010 Goal:	**80%**
2010 Forecast:[1]	**60.0%**
2000 Forecast:	**61.7%**
2000 Actual:[2]	**52.3%**

[1] **Assuming Asymptotic Trend**
[2] **97/98 Water Years**

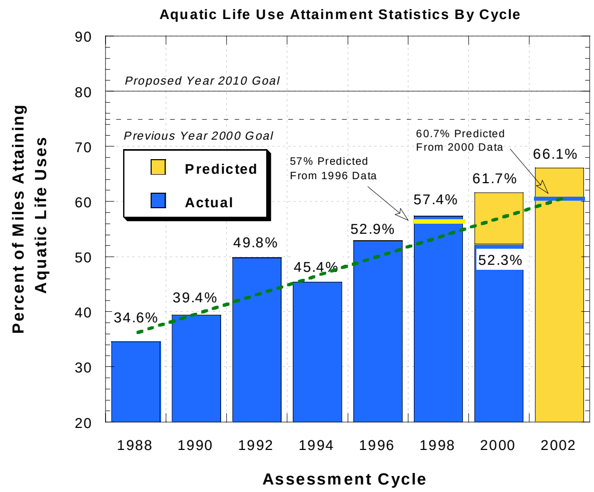


Figure 3-5. Aquatic life use attainment trend prediction based on 1988-2000 assessment cycles.

Causes of Decline

It is important to understand the basis for this trend assessment and to determine whether the observed results are a likely a changing slope or real trend or simply "noise" in the statistics. The data collected and used in calculating these statistics are the results of Ohio EPA's five-year basin approach which employs a targeted, intensive watershed survey design. This approach is driven by the need to provide site-specific information for a variety of water quality management purposes (e.g., is a particular treatment plant effective? is the designated aquatic life use appropriate? should we commit abatement resources to this water body? *etc*.). Comparisons of this approach to a random stream sampling design (1996 REMAP project) have shown that the intensive monitoring design that we employ provides a close approximation to such randomly derived results. As such, it provides a fair estimate of the condition of Ohio's rivers and streams using a subsample of assessed streams and rivers. Other unpublished work has shown that the variability in the statistics were linearly related to the miles sampled based on our intensive survey design (i.e., the variability in the estimate will increase linearly if monitoring effort declines). The concern is whether the decline in

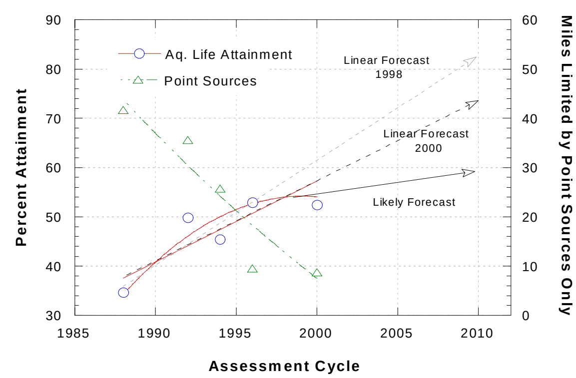


Figure 3-6. Trends in aquatic life use attainment (left y-axis) and in percent non-attainment related to point sources (right y-axis).

Table 3-3. Aquatic life use attainment statistics for the 2000 and 1998 assessment cycles by stream size ranges.

2000 Cycle			
Range	Status	Range	Status
≤ 30 sq mi	50.4%	> 30 sq mi	53.2%
≤ 50 sq mi	52.1%	> 50 sq mi	52.8%
≤ 100 sq mi	50.6%	>100 sq mi	54.5%
1998 Cycle			
Range	Status	Range	Status
≤ 30 sq mi	51.6%	> 30 sq mi	60.7%
≤ 50 sq mi	52.4%	> 50 sq mi	61.5%
≤ 100 sq mi	53.5%	> 100 sq mi	63.8%

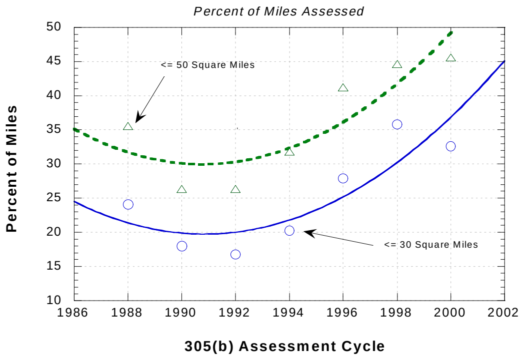


Figure 3-7. Percent of each assessment cycle monitors composed of streams < 30 and < 50 sq mi.

attainment statistics can be attributed to real changes in the environment, whether the rate of environmental change is within the range of expected deviation, or some combination of these factors.

Potential Factors: Stream Size

A recent shift toward including proportionately more small streams beginning in 1998 may have had an effect on the 2000 statistics. In general, the inclusion of smaller waters has increased over the past few 305b cycles, however, the 2000 cycle had a smaller percentage of very small streams (<30 sq mi) than the 1998 cycle (Figure 3-7). When statistics are calculated separately by stream size ranges for the 2000 results, small streams only had a minor effect on the overall statistics and were similar to the 1998 results for small streams (Table 3-3). The main difference between the 2000 and the 1998 results is in the statistics for *larger* streams. The effect of this factor was less than 1%.

Declining Trends

On average, in reaches where we have sampled during a previous assessment cycle, in addition to the 2000 cycle, there was a strong positive trend in attainment statistics when the earliest versus latest trends were examined or where the two most recent post-1988 cycles were examined for trends. In either case, where streams have been resampled, the percent of attaining waters did not exceed 53.2%. Approximately 16% of resampled reaches showed a decline as measured by both miles attaining and an increase in miles impaired. Situations where impaired miles increased, but attaining miles also increased or remained stable were excluded from this analysis because we have tended to monitor segments more completely and extrapolate data further than we did early in the 305(b)

Table 3-4 Aquatic life attainment statistics for stream waterbodies sampled during more than one assessment cycle. Data here represent earliest and latest cycles.

Fully Supports	Fully Supports, But Threatened	Partially Supports	Does Not Support	Total
Earliest Assessment				
1550.6	386.3	1284.0	2477.9	5698.8
27.2	6.8	22.5	43.5	
Latest Assessment				
2976.0	459.6	1571.1	1522.1	6528.9
45.6	7.0	24.1	23.3	

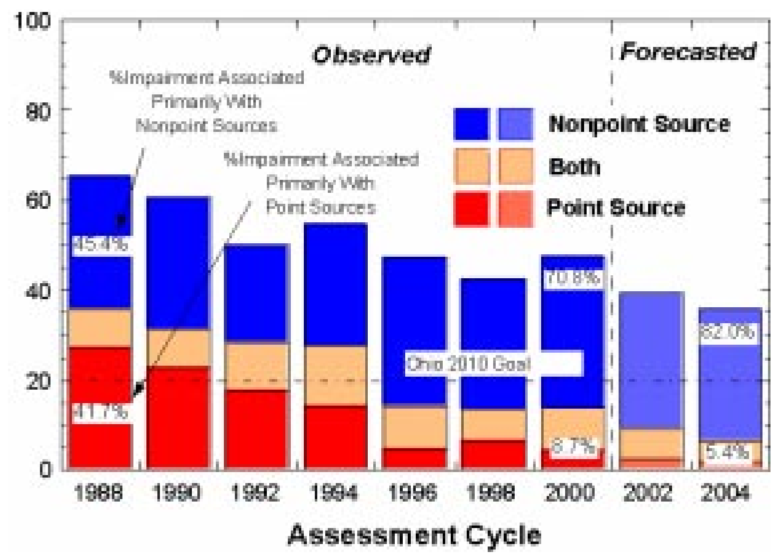


Figure 3-8. Trend in non-attainment of aquatic life uses in Ohio streams and rivers and illustrating the percent of non-attainment due to point sources, nonpoint sources, or a combination of point and nonpoint sources.

process. The total miles of decline, however, were 105.3 miles. If this total were added to the 2000 cycle attaining miles, the percent attaining aquatic life uses would have been 55.5%. Thus the contribution of this factor was 3.2% and was the larger of all the factors examined (Figure 3-9). However, even without this factor the statistics still represent a decline from 1998 and even more from the forecast analysis of 1998. Much of the decline in formerly attaining waters occurred in the Little Miami River and East Fork Little Miami River, both EWH designated rivers. It will be important to monitor future results to determine if similar high quality rivers with major point sources and relatively high proportion of effluent flow show similar patterns.

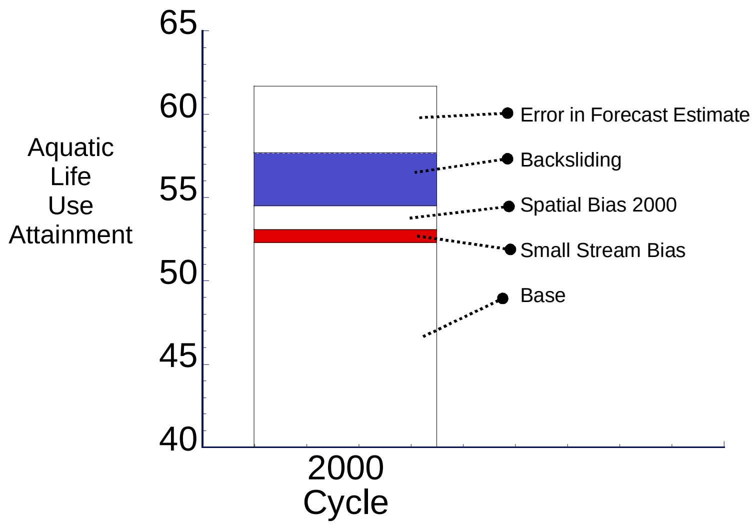


Figure 3-9. The attainment statistics for the 2000 assessment cycle and the estimated apportioning of deviation from the projected trend based on the 1988-1998 assessment data.

Spatial Bias: Postponing Scheduled Basin Assessments

The five-year basin approach assumes that watersheds will be regularly assessed and reassessed on a 5-10 year cycle. The resulting database forms the basis for the biennial 305b statistics and the forecast analysis. In 1998, the TMDL development commitment resulted in some previously scheduled watershed reassessments being postponed. This shift towards monitoring TMDL targeted watersheds could potentially induce a spatial bias to the results by: 1) providing proportionately more data from impaired watersheds; and, 2) not including watersheds with proportionately higher levels of full attainment. Point sources identified as major sources of impairment were not more prevalent in this assessment cycle than in previous cycles. An overall trend of their declining influence on aquatic life non-attainment continued (Figure 3-8) even with some site-specific examples of decline.

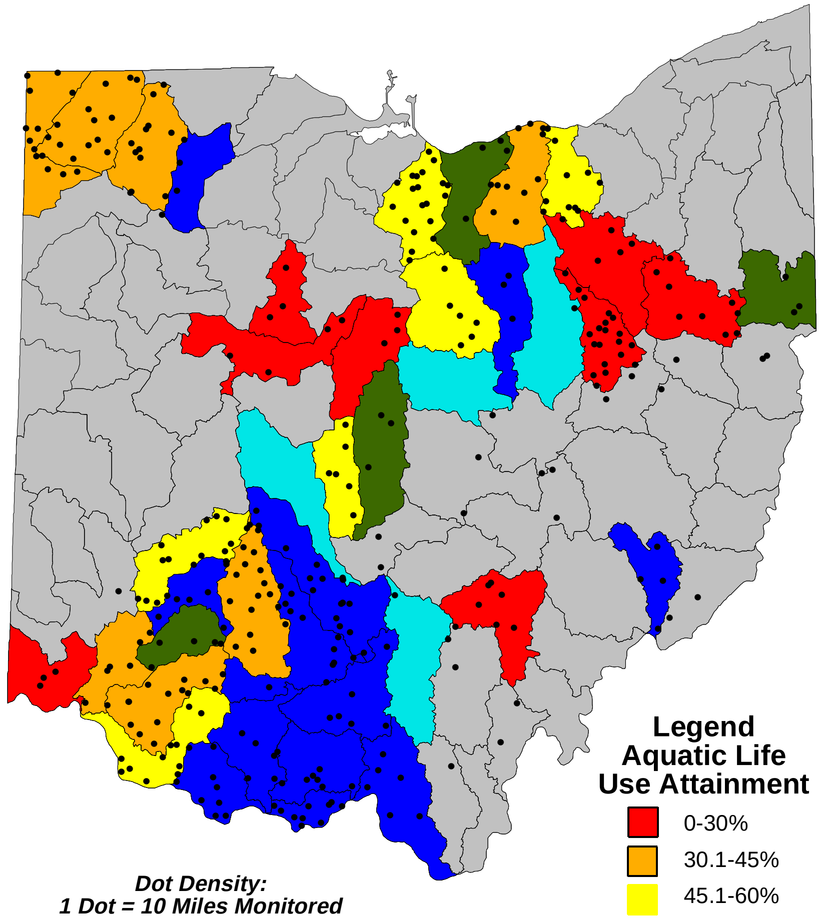
Map 3-2 illustrates the 2000 cycle aquatic life attainment statistics by subbasin where at least 25 miles were assessed. Four high quality subbasins (Big Darby Creek, Kokosing River, Salt Creek, Killbuck Creek), on the five-year schedule for 1997 and 1998 were not reassessed. To examine the potential effect of this exclusion on the 2000 statistics, previous assessment results were carried forward and used to recalculate the 2000 attainment statistics. The addition of these miles added 1.4% to the 2000 cycle aquatic life attainment statistics, from 52.4% to 53.8%.

Forecast Conclusions

All of the factors examined had potential effects on the 2000 statistics and the decline noted from 1998. Of these, declines in attainment status associated with point sources was the largest. However, even in the aggregate these do not explain all of the decline seen in the departure of the 2000 statistics from the forecast analysis (see Figure 3-5). It is likely, however, that the increase observed in 1998 had an upwards influence on the forecast analysis due in part to spatial bias in the 1995 and 1996 assessments. However, at the time it was not perceived as a potential problem (i.e., it was in the "correct" direction). Its affect was likely an inflation of the forecast analysis and the result that the 2000 statistics represented a more serious decline. A more reasonable interpretation is that the assumed trend of linear increase over the past decade is becoming curvilinear (see Figure 3-6) and that the progress in the late 1980s and through the early-mid-1990s has essentially been accounted for. This is supported by examining the changes in impairment where point sources are the sole major problem (Figure 3-8). These statistics have leveled off between the 1996 and 2000 cycles compared to the 1988 to 1994 cycles. It seems likely that the attainment statistics will level off to between 55-60% until the remaining sources of impairment are addressed.

Strategies To Increase the Rate of Restoration

Given that the current rate of restoration will increase the fully supporting fraction of streams to around 60% by the year 2010, what actions can Ohio EPA take to accelerate restoration enough to meet the Ohio EPA year 2010 goal of 80% full use support? Merely accelerating the rate of point source restoration *alone* will not achieve the goal. Clearly, new successes in controlling and abating other sources of impairment will be needed to attain the Ohio 2010 goal (i.e., full implementation of the TMDL program). Another factor that needs to be considered in projecting the rate of restoration is the role of increasing threats to full support of aquatic life use criteria. The most rapidly increasing threats are those related to urban and suburban development, watershed level modifications (*e.g.*, wetlands losses), and hydromodification. Increasing threats from nonpoint sources could erode gains made through point source abatement and result in a slowing in the rate of restoration. This would be an unanticipated deterrent to attaining the Ohio EPA year 2010 goal.



Map 3-1. Aquatic life use attainment status in streams and rivers sampled during the 1997 and 1998 water year (the 2000 305(b) assessment cycle. Aquamarine subbasins are high quality watersheds scheduled for monitoring for the 1997-1998 field years, but in which no substantial monitoring was performed.

Recreation Uses in Streams and Rivers

Compared to aquatic life uses there is comparatively less information available about recreational use attainment/non-attainment In addition, resource constraints have limited entry of all data into a national system, as was done in previous 305(b) cycles. Thus while the analyses here represent all electronically available data, they do not represent total coverage throughout Ohio. This also precludes any meaningful trend analysis at this time. The data coverage on Map 3-3 illustrates some of the gaps in coverage over the past several years (e.g., extreme southwest Ohio).

Ohio rivers and streams are assigned the recreational uses Primary Contact Recreation (PCR) or Secondary Contact Recreation (SCR). Primary Contact Recreation streams and rivers are deep enough for full human body immersion activities such as swimming. Secondary Contact Recreation streams are only deep enough to permit wading and incidental contact (*e.g.*, canoeing), and as such, the fecal coliform bacterial criteria are less stringent than for PCR.

Table 3-5. Recreation use support summary for Ohio streams and rivers.

Use Support	Miles	Percent of Assessed	Percent of Total
1988			
Full	2,320.7	48.9	7.8
Partial	160.9	3.4	0.6
Non-Support	2,265.2	47.7	7.8
All Data			
Full	1,466.3	54.0	5.0
Partial	249.9	9.2	0.9
Non-Support	998.8	36.8	3.4
2000 Cycle			
Full	804.5	52.4	2.8
Partial	154.9	10.1	0.5
Non-Support	576.7	37.5	2.0

[1] Perennial streams on the basis of USEPA (1991a) estimates

The principal criteria for assessing whether the PCR and SCR uses are supported are fecal coliform bacteria counts. A total of 2,715 miles of rivers and streams (where data was electronically available and considered current) were assessed over the past 5-10 years. The 2000 assessment cycle data for bacteria data encompasses four water years (1995-1998) because this data was not assessed for the 1998 305(b) cycle. Because most data collection efforts are not intensive for this parameter the confidence in the accuracy of the data is less than that for aquatic life use studies. In many cases the frequency of sampling is low and the results are considered a rough indicator of potential bacterial problems. Because of this the data has much more value in identifying spatial patterns in contamination than in identifying precise bacterial loads or health risks at any given site or reach.

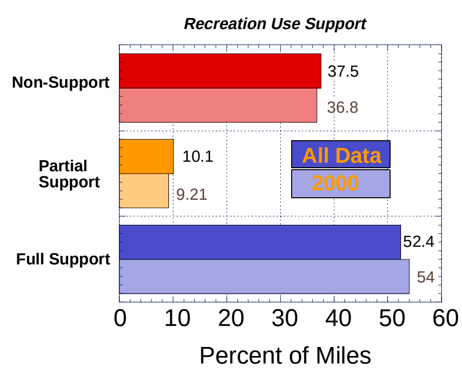


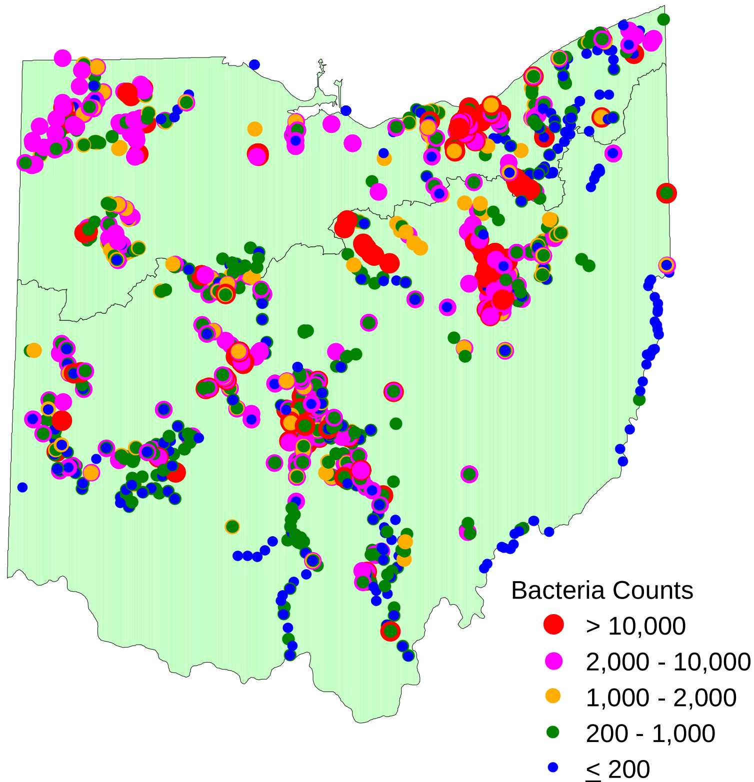
Figure 3-10. Recreation use support summary for Ohio streams and rivers for all current data and data from the year 2000 assessment cycle (water years 1995-1998).

The observed improvements in recreation use support compared to pre-1988 data (Table 3-5) are attributable to improvements in municipal wastewater treatment. The actual trend is greater than portrayed by the statistics of Table 3-5

because the pre-1988 data was assessed with less stringent criteria. More detailed trend assessment are limited because of the incomplete current database.

The remaining, non-supporting stream and river miles are a result of: (1) urban runoff and combined sewer overflows; (2) unresolved WWTP treatment problems; (3) unsewered areas; and, (4) livestock and agricultural runoff. The urban influence is clearly illustrated on Map 3-3.

This data will require more attention in future 303(b) cycles because of the intention to use it to list streams for the TMDL process. We will likely examine the screening criteria prior to the next required 303(d) listing in April 2002 based on research ongoing at USEPA and other investigators.



Map 3-3 Fecal coliform bacteria counts across Ohio from 1995-1998. Data gaps indicate areas where data was not available electronically.

Fish Tissue Contamination

The degree and extent of contaminated fish tissues in rivers and streams is of great importance to the citizens of Ohio. Besides serving as a human health risk indicator, contaminated tissue is a useful indicator for identifying streams and rivers affected by toxic substances and for tracking pollution abatement efforts in such waters.

Ohio's fish tissue sampling program historically had been small in scope (approximately 50 sites/year pre-1988, 100 sites/year 1989-1993). However, in 1993, Ohio EPA, in cooperation with Ohio DNR, initiated a statewide monitoring effort for fish tissue contaminants (approximately 600 samples/year). This effort is continuing. The analysis of fish tissue contaminants is in a dynamic state right now with more risk-based criteria being added to the analyses by the Ohio Department of Health over the past several years. Increases in miles of stream listed under varying risk categories is somewhat related to the addition of these new changes in criteria, not necessarily increased contamination. In fact, for some parameters where we have the most data (e.g., PCBs) the proportion of samples with higher contaminant levels have generally decreased over time (Figure 3-12). In addition, little mercury data was collected prior to the early to mid 1990s with the general result of widespread elevated concentrations in tissue. This also increased the statistics, but does not indicate an increasing trend of contamination. We use these ODH risk levels only as a screening tool here to identify stream segments where toxic compounds may be a problem.

On the basis of data collected from 1992 to 1999 (1994-2000) assessment cycles), 2.97% of the monitored stream and river miles (Table 3-6) had fish samples with low or non-detectable ("not-elevated") concentrations of PCBs, pesticides, metals, or other organic compounds. Definitions of concentrations considered elevated are listed in Table 2-7. 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 23.7% 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.

Table 3-6. Summary of miles of elevated levels of tissue contaminants in fish for Ohio streams and rivers

Contaminant Level	Miles	Percent of Assessed	Percent of Total
Up to 1992 Cycle			
Not Elevated	796.6	38.3	2.8
Slightly - Moderately Elevated	620.7	29.9	2.1
Highly-Extremely Elevated or Partial Advisory	574.4	27.6	2.0
Highly-Extremely Elevated and All Species Advisory	87.0	4.2	0.3
Totals	2,078.8	100	7.1
1994 - 2000 Cycles			
Not Elevated	109.2	2.97	0.4
Slightly - Moderately Elevated	2,668.0	72.53	9.2
Highly-Extremely Elevated or Partial Advisory	872.0	23.71	3.0
Highly-Extremely Elevated and All Species Advisory	29.1	0.79	0.1
Totals	3,678.4	100	12.6
2000 Cycle			
Not Elevated	61.9	2.2	0.2
Slightly - Moderately Elevated	2004.5	70.2	6.9
Highly-Extremely Elevated or Partial Advisory	778.6	27.3	2.7
Highly-Extremely Elevated and All Species Advisory	10.5	0.4	0.03
Totals	2855.5	100	9.8

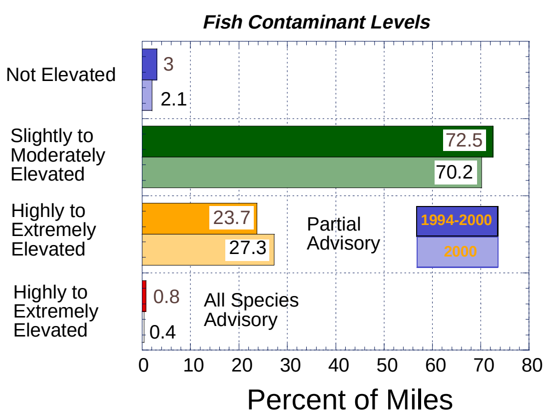


Figure 3-11. Elevated concentrations of contaminants in fish tissue for Ohio streams and rivers for the 1994 to 2000 assessment cycles and from the year 2000 assessment cycle (water years 1995-1998).

Health advisories for all species have been issued for 0.4% 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 relatively recently collected in Ohio.

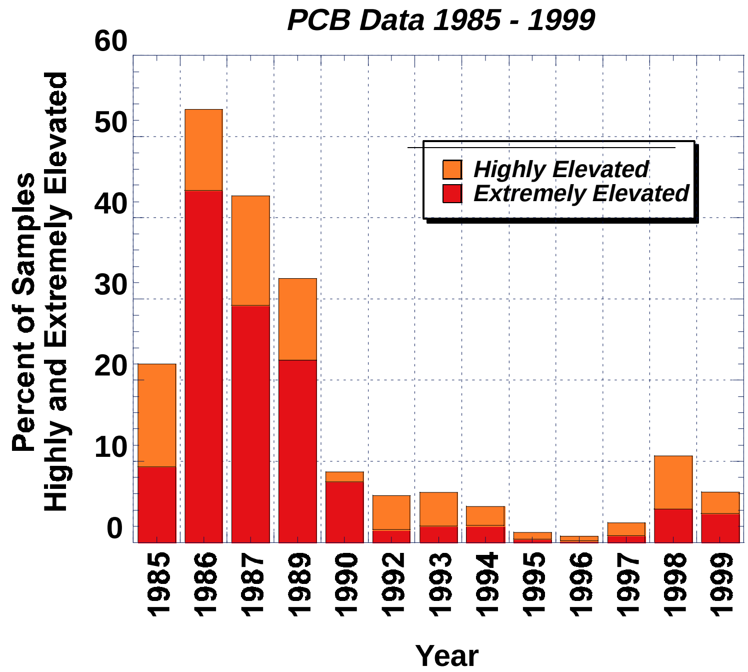


Figure 3-12. Percent of fish tissue samples collected with highly and extremely elevated PCB concentrations.

3.2 Lake Erie

Lake Erie is one of Ohio's greatest resources. Recently a "State of the Lake" report dealt with management and management goals for the lake in a broad sense. The results of this report are available on-line at:

http://www.epa.state.oh.us/oleo/

Here we examine the attainment status of several specific designated uses that apply to Lake Erie.

Aquatic Life

Data on the aquatic life use attainment status of the Lake Erie nearshore had not been substantially updated for a decade or more until now. Over the past five years Ohio has been developed biological criteria ("biocriteria") based on fish and macroinvertebrate communities in the nearshore of Lake Erie (summarized here) as well as in the Lake estuaries or "Lacustruaries" at the mouths of the rivers to Lake Erie (in final development, to be summarized in 2001). Along the Lake Erie nearshore areas 84.1% of the miles were full attaining the aquatic life use criteria, but all were considered threatened, mainly because of the uncertainty related to exotic species effects on the ecosystem.

Table 3-7. Degree of use support along the Lake Erie nearshore area

Designated Use	Fully Supports	Fully Supports, But Threatened	Partially Supports	Does Not Support
Aquatic Life		185.1 84.1%	10.6 (4.9)	24.2 (11.0)
Recreation		229.2[1]		
	Not Elevated	Slightly to Moderate Elevated	Highly - Extremely Elevated or Partial Advisory	Highly - Extremely Elevated or Partial Advisory
Fish Consumption			229.2 (100)	

[1] Based on data from the State of the Lake Report

Fish Consumption

Lake Erie has a fish consumption advisory for channel catfish over 16" long (see Appendix A, ODH Web Site:

http://www.odh.state.oh.us/Resources/Brochures/fishcons2000.pdf.

As a result the entire shoreline is considered partially supporting fish consumption activities

Lake Erie Fish Community IBI

The biological criteria developed for the Lake Erie nearshore do not reflect pristine or even least-impacted conditions, but rather the best attainable at the present time as defined by the best sites along the nearshore. In Lake Erie, three factors affect fish community structure; lake wide trophic changes as a result of nutrient enrichment, habitat loss primarily in the form of wetland destruction or diking and shoreline modifications, and localized environmental impacts from industrial and municipal discharges. Of principal significance is the predominant effect of lake wide trophic changes and associated species losses. These changes have resulted in most sites scoring as fair (best attainable at present) with few good and no exceptional values attained. Four of the nine sites that clearly fall into the good range are from the shorelines of the Lake Erie Islands. Island sites score better, in

part, due to their distance from lacustruaries and associated impacts. Habitat was also an important factor for island sites. The principal habitat type encountered around the islands was boulder - rubble strewn shorelines with high levels of substrate texture. It was observed in this study that the greater the habitat texture the greater the relative abundance and number of species. Breakwater sites, at the mouths of lacustruaries, had habitat textures similar to island sites, but failed to reach the levels attained at island sites. This was due to lacustruaries experiencing environmental stress from higher loads of pollutants. Beaches were the area of lowest substrate texture and tended to score lower than other habitat types (in the absence of other environmental stresses). Examples of localized pollution impacts were found in the Maumee Bay and Cuyahoga River areas where in spite of the fact that habitats were highly textured breakwaters, IBI values remained in the poor range. The only site in this study that fell in the very poor classification was just east of the Maumee Bay area. This site was a rip-rapped beach in an area where extensive settling of organic debris and urban waste was occurring. The dominant species at this site was goldfish, a highly tolerant fish.

None of the lake or lacustuary sites in this study attained an integrity level of exceptional and only a few attained the good level. This was reflective of the widespread and pervasive nature of environmental impacts in the region. Many species were missing (Trautman 1981, Hartman 1972) and trophic dynamics were radically changed (Regier and Hartman 1973, Stoermer et al. 1987). Five of the 20 most abundant species were non-indigenous species. Ninety three species were recorded and the average relative abundance of individuals (number per kilometer) was 687. At the good - fair integrity interface, similarities, between Lake Erie and its lacustruaries begin to diverge. In the lake proper, environmental impacts are more widely dispersed and less intense, where as in the lacustruaries they can be very intense, and are always more concentrated and localized. In the lake only, seventy three species were recorded and the average relative number of individuals (number per kilometer) was 934. Integrity levels of fair dominated the lake results (59%), poor to very poor (24%) comprised the next largest classification, and good (17%) the least. In the lacustruaries eighty seven species were recorded and the average relative number of individuals (number per kilometer) was 552. Poor to very poor IBI scores dominated the results (71%)

Lakes, Ponds, & Reservoirs

Table 3-8 summarizes use attainment status for the exceptional warmwater habitat aquatic life use (*i.e.*, default use for all publicly owned reservoirs), public water supply, fish consumption, and recreation in Ohio's public lakes, ponds, and reservoirs. Use attainment/non-attainment was derived using specified parameters of the Ohio EPA Lake Condition Index (LCI) following guidelines described in Davic and DeShon (1989) and Appendix B of this report. The paucity of long-term monitoring data limits the analysis to the present status of those few publicly owned lakes that have been recently monitored. Appendix K summarizes the results for those few lakes we could assess in some detail in Technical Support Documents (TSD:

http://chagrin.epa.state.oh.us/document_index/psdindx.html

Table 3-8. Use attainment summary (acres) for the Ohio lakes, ponds, and reservoirs.

Designated Use	Fully Supports	Threatened	Partially Supports	Does Not Support
Aquatic Life	641 (0.8%) -	51,921 (66.4%)	24,094 (30.8%)	1,519 (1.9%)
Recreation	641 (0.8%)	51,921 (66.4%)	24,094 (30.8%)	1,519 (1.9%)
Fish Consumption	28,682 (31.5%)	62,385 (54.4%)	12,800 (14.1%)	0.0
Public Water Supply	1,392 (1.8%)	39,292 (50.1%)	31,044 (39.6%)	6,768 (8.6%)

In the mid 1990s, Ohio significantly increased the number of lakes assessed for fish consumption (through ODNR fish collection efforts), although efforts and resources for aquatic life, recreation (REC), and water supply use (PWS) support assessment have dwindled. Recreation and Public Water Supply uses represent data reported in the 1996 305(b) report (Ohio EPA 1996c). It should be noted that both of these uses (REC, PWS) include non "health-related" metrics in the LCI (e.g., volume loss) and thus impairment is not necessarily indicative of a health risk, but is a broader estimate of the integrity of these uses.

Fish Contamination

Fish tissue samples from 61 monitored lakes showed little or no contamination with the exception of slight to moderately elevated mercury concentrations (Table 3-8). As for streams and rivers, new risk numbers for mercury have caused a large shift in the tissue statistics compared to the 1994 report, although for lakes these changes are limited to moderate contaminant levels or less.

Few lakes have impaired aquatic life uses, although most have stressors present that are thought to threaten aquatic life. A higher proportion of lakes have some LCI metrics related to recreation and public water supply that categorizes them as being partially supported (34.1% and 30.6%, respectively). Our assessment methodologies, based on the Ohio Lake Condition Index (LCI), are quite stringent and a classification of partial use may indicate a minor problem, such as low summer hypolimnetic dissolved oxygen. The LCI is extremely useful in identifying water resource problems for managers to improve lake condition and for classifying extremely high quality lakes that meet all the stringent conditions of the LCI. The nonsupport category of designated uses is the suitable identifier of more serious impairment in lakes. The recreation use is the most impaired use, however, only 11.6% of lakes are not supporting the use. The major causes of nonsupport of designated uses in lakes, ponds, and reservoirs are volume loss due to sedimentation, aesthetics, nuisance growths of aquatic plants, and nutrient and organic enrichment. The sources of these impacts are generally nonpoint in origin and include agriculture, urban runoff, and septic systems. As for streams and rivers, abatement of nonpoint sources is a key for improvement in lake conditions in Ohio.

Ohio River

Assessment of the Ohio River focused on the level of support for the following designated uses: warmwater aquatic life use, public water supply, fish consumption, and recreation (Table 3-9). Detailed analyses of water quality and ecological condition can be found in the ORSANCO 2000 305(b) report (ORSANCO 2000) and Sanders (1993, 1994). ORSANCO (2000) reported that the Ohio River was fully attaining aquatic life uses in 411.5 (98.8%) miles of the 416.6 monitored miles (of 450.9 total miles). Only 5.1 miles were impaired and these partially supported the aquatic life use.

All of the Ohio River met is Public Water Supply use (Table 3-9), however, 198.7% of the miles that border Ohio had an impaired contact recreation use. Combined sewer overflows and other wet weather events (e.g., urban runoff) are the primary source of the bacterial contamination, which is worse at high flows.

The Ohio River throughout its Ohio border has a consumption advisory for mercury (as does Ohio statewide), thus is partially supporting the fish consumption "use" in all 450.9 miles. The river also has a "do not eat" consumption advisories for PCBs for carp and channel catfish over 17." ORSANCO also detected evaluated levels of dioxin.

Overall the Ohio River, despite remaining problems from bacteria delivered during rain events and persistent contamination in tissue has seen a substantial improvement in its ecological condition. Although it is an extremely altered system compared to its historical free-flowing state, the Ohio River provides substantially better fishing and boating opportunities than two decades ago when organic enrichment and toxic pollution severely impaired most of the river.

Table 3-9. Use attainment summary[1] for the Ohio River (Ohio waters only) in terms of river miles. For the aquatic life use partial support is divided into substantially supporting (Subs.), Moderately Supporting (Mod.), and Marginally Supporting (Marg.).

Designated Use	Fully Supports	Partially Supports	Does Not Support	Not Assessed
Aquatic Life	411.5	5.1[a]	0.0	34.3
Recreation	5.5	65.6	133.1	246.7
Fish Consumption	0.0	450.9	0.0	0.0
Public Water Supply	450.9	0.0	0.0	0.0

[a] These 5.1 miles are partially supporting (marginally; see ORSANCO 2000).

Table 3-10. Causes of use impairment in the Ohio River.

Cause	Miles Impaired	Partially Supports
Unknown	5.1	Aquatic Life
Pathogens	198.7	Recreation
Priority Organics, Metals	450.9	Fish Consumption

Causes and Sources of Non-support of Aquatic Life Uses in Ohio

The following chapter summarizes the principal sources and causes of aquatic life use impairment in Ohio. Here we examine trends in the major causes and sources of aquatic life impairment, forecast likely changes in causes and sources in the near future, and then discuss the various cause categories within the context of the principal source responsible for the impairment.

Much of what is presented here does not represent new knowledge. Trautman (1981) examined the various reasons why the fish populations throughout Ohio had declined or become threatened during the period 1750 through 1980. The introductory discussions of his book have not yet lost their relevance. In fact, much of the biological monitoring conducted by Ohio EPA since 1980 has, in part, extended the base of information presented by Trautman (1981). What we are able to bring to this discussion is an increasingly quantitative assessment of water resource integrity in Ohio and an understanding of what has changed since Trautman's observations. This report includes the usage of some types of data and analysis techniques that were not available before 1980.

> ***Causes*** of impairment are the "agents" that actually damage or impair the aquatic life in a stream, such as the toxic effects of heavy metals or acidic water. ***Sources*** of impairment are the origin of the agent. For example, an industry may discharge a heavy metal, a farm may erode topsoil, or a coal mine may be the source of acid water leaching into a stream.

Causes of aquatic life impairment are defined as the actual agents that affect the aquatic life use (*e.g.*, low dissolved oxygen, silt, habitat modification, etc.). Sources of impairment are the entities or activities from where the pollutant or effect originated (*e.g.*, municipal wastewater treatment plant, row crop agriculture, bank destabilization, etc.). For example, a source of heavy metals (a *cause* of impairment) may be a municipal wastewater treatment plant (WWTP) or an industrial operation (a *source* of impairment). Elevated nutrients (a cause) may lead to low dissolved oxygen (a cause) and originate from row crop production (a source). The extent (*miles* of stream or river impaired) of various causes and sources of impairment are listed in tables 4-1 and 4-2 for streams and rivers, tables 4-3 and 4-4 for lakes and reservoirs, and tables 4-5 and 4-6 for Lake Erie. Appendix C (electronic form only because of size) summarizes the causes and sources of impairment for each individual water body segment. The causes and sources of impairment listed for a particular waterbody are those that actually elicit a response from the biological, chemical, or physical indicators, and excludes "potential" causes and sources that presently evoke no apparent response in any of the indicators. For example, in a stream severely impaired by toxics (a cause), all of the *current* impairment may be attributable to toxics, though other causes and sources may be present. Other causes that might exhibit impacts in the absence or reduction of the toxic impairment are not indicated. As the stream recovers with the elimination or control of the toxic cause, other causes (e.g., siltation from nonpoint sources) may become apparent at which time they will be listed as a cause of impairment. It is also reasonable to expect that the severity of the impairment would be less as the more severe toxic cause is abated and the "lesser" siltation cause becomes evident.

The evaluation of causes and sources in this report increases in representativeness with stream size. We have current assessments on 47% of Ohio streams and rivers with > 20 sq mi drainage areas, 59.9% of streams and rivers with > 100 sq mi drainage areas, and 65.9% of rivers with > 1000 sq mi drainage areas (see Figure 3-1). Although proportionately fewer small streams have been monitored, many perturbations that affect these streams show distinct and consistent regional and ecoregional patterns that are characteristic of the major land and/or water uses in these areas. This is due to the greater similarity of watersheds that completely originate within the same ecoregion. Although the estimate of the proportion of streams and rivers impaired is approximate, the relative importance of various sources in these streams is nevertheless revealing. The 1994-1995 REMAP study in small streams of the ECBP ecoregion, however, suggests that intensive survey data may a close estimate of overall impairment if sample sizes are sufficient (see Preface of 1996 305[b] report).

Predominant Causes and Sources of Aquatic Life Impairment:

Causes

Ohio's streams and rivers are impaired by different causes and sources of pollution and other activ-

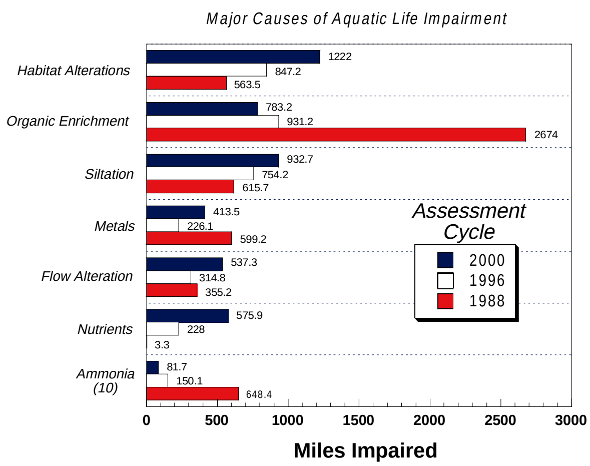


Figure 4-1. Changes in major causes of aquatic life use impairment in Ohio streams and rivers over the past three 305(b) assessment cycles: 1988, 1996, and 2000. These represent the water years 1980-87, 1993-94, and 1997-98.

ities. The pattern observed during the past decade has been one of: (1) a general lessening of point source related impairment; and, (2) an increase in nonpoint source related impairments. The latter is the result of the emergence of causes and sources which were "masked" as a major effect by the greater prevalence and severity of past point source impairments rather than a net increase in severity of nonpoint impairment. Thus, as point source problems are abated, other problems are becoming increasingly evident. The top seven major causes of impairment, based on current, monitored-level data, are habitat modifications, siltation, organic enrichment/low D.O., flow alteration, nutrients, metals, and ammonia (Table 4-1, Figure 4-1). Notable in the 2000 cycle is the continued, but slower rate of decline of point source related causes (dissolved oxygen, ammonia) and the predominance of nonpoint related causes such as habitat destruction, sedimentation, nutrients and flow alteration (4 of 5 top causes). River specific causes and sources of impairment are listed in Appendix C which also reports extent of impairment (miles)

Many of the non-point related causes that now predominate largely existed in the stream segments back in the 1988 cycle, but their effects were of lesser magnitude (M,S) or were totally masked by more severe organic enrichment or toxicity (metals/ ammonia). This also reflects the *relative* effectiveness of the programs to control point sources compared to the general lack of measures to control many habitat and sedimentation-related sources that predominate the emerging problems in these streams and rivers. The extent of these emerging problems, which may prevent Ohio from reaching its year 2010 goal of 80% of streams and rivers attaining aquatic life uses, argues for implementation of the TMDL approach Ohio is developing to deal with these problems. Appendix E summarizes the functions and benefits of riparian areas whose protection is essential if we are to deal effectively with habitat and sediment problems in Ohio. Because riparian areas are much less expensive to protect than restore, delaying their protection can be at a minimum more costly and at worst could preclude the full recovery of streams and rivers.

The term impaired can be misleading because the range of impact severity it includes is too wide. For example, an "impaired" segment can encompass a situation where fish and macroinvertebrates deviate slightly, but significantly from the biocriteria, which we would classify as "fair", or a situation where the communities are essentially eliminated by toxic impacts, which we would classify as "very poor." The use of the 305(b) terminology of "non-support" is linked to (1) the early, heavy reliance on chemical criteria to assess streams for "use support" and graded responses (i.e., excellent, good, fair, poor, very poor) are difficult to accurately derive, and (2) the strong link to the "regulatory" approach of USEPA and the assessment of whether point source permit conditions are being "violated." Since USEPA is encouraging more widespread of biosurvey data they should consider promoting an alternate "grading" system for evaluating aquatic life conditions (e.g., excellent, good, fair, poor, very poor), rather than the current "pass/fail" system in place (i.e., attainment/non- attainment). We have been reporting narrative ratings of stream health linked directly to our biological criteria since the 1998 cycle (reported by segment in Appendix C) and plan to go back to older data to generate this data to allow analysis of narrative trends.

Sources

The major sources of impairment (Table 4-2, Fig. 4-2) include hydromodification, agriculture, municipal (including CSOs) and industrial discharges, mining, and urban runoff. In the last full report (1996) point sources were the predominant sources, but it has now slipped to third behind hydromodification and agriculture. The actual change in miles between 1988 and 2000 cycles for major sources is illustrated in Figure 4-3. As mentioned above many of these sources were masked by formerly severe point source impairments. Although point sources have declined in relative importance they are still significant factors and in a few rivers they remain severe (e.g. Mahoning).

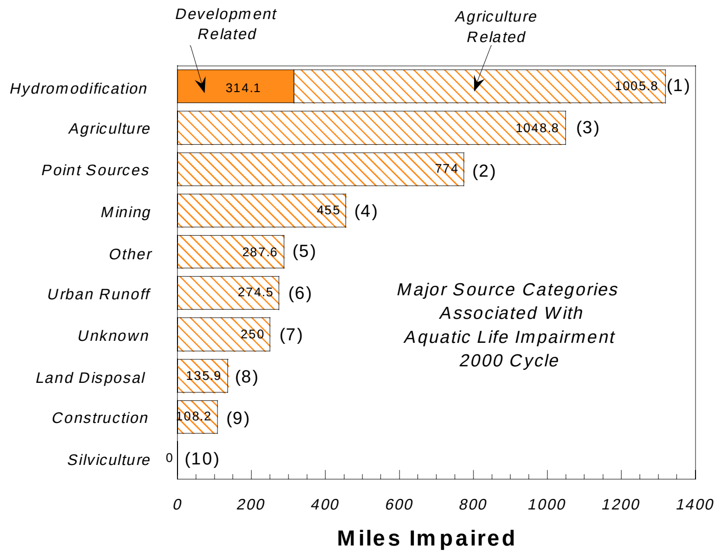


Figure 4-2. Major sources associated with aquatic life use impairment in Ohio streams and rivers and considered current for the 2000 assessment cycle (data collected as of 1998). Numbers in parentheses are ranks from the

Recent "booms" in the suburbanization of previously rural watersheds could also affect stream and river recovery by; (1) greatly increasing loadings to small, previously unimpaired waters, (2) approaching or exceeding maximum allowable loadings in some high quality streams (e.g., Little Miami River), and (3) adding to existing hydromodification and runoff problems from poor land development practices that are occurring in a near vacuum of riparian protection guidelines (see Appendix E). The 2000 cycle is the first where we distinguished between agricultural versus development related hydomodification. Urban/suburban development accounts for about 1/3 of these impaired miles (Figure 4-2). By itself this statistic is a bit misleading because while we have many streams in agricultural settings that achieve WWH and EWH aquatic life uses, few small streams in urban and heavily suburban areas meet these goals. Agricultural impairments are generally associated with encroachment on the riparian and direct alteration of habitats. These factors along with a high degree of impervious surfaces characterize development related impairments.

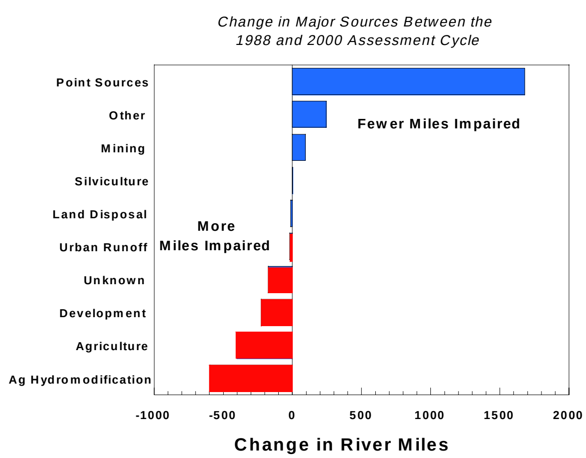
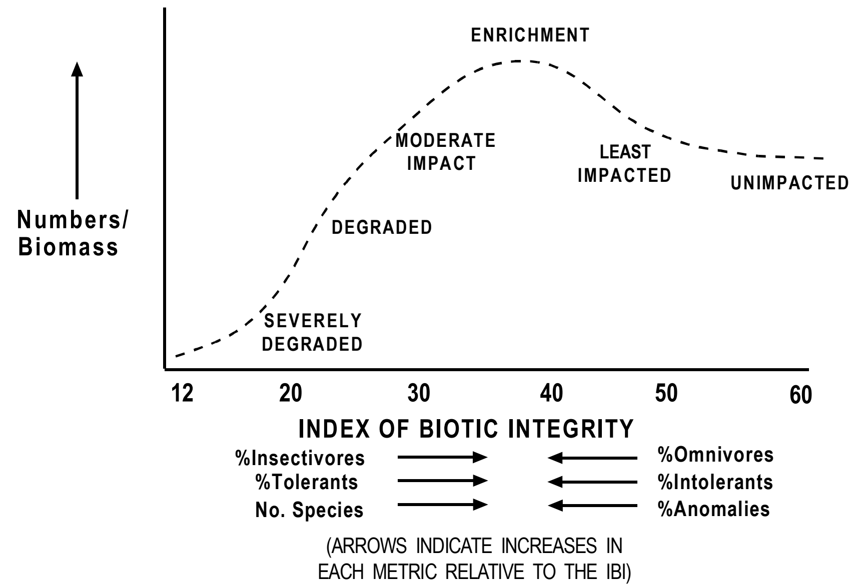


Figure 4-3. Change in major source categories associated with aquatic life use impairment in Ohio streams and rivers between the 1988 and the 2000 assessment cycles.

As discussed earlier, a move to a graded system of assessments for this report would provide a more detailed assessment of progress or backsliding on environmental quality.

In this section, references will be made to the type of effects various that various causes have on aquatic life. The characteristics of many classes of impacts on aquatic life are predictable, and often offer diagnostic insight into the source or cause of a pollution problem (Yoder 1991b). Yoder (1991b) discussed some patterns in the biological data that were related to classes of impairment along a gradient of increasing severity of impact (Figure 4-4). This figure outlines the conceptual model of the response of aquatic life to environmental perturbations. Identification of the relationship between general impact types and this model has provided insights into the mechanisms through which different classes of pollutants act.

Specific discussions of the causes and sources responsible for impairment, or threatened impairment, in lakes, ponds, and reservoirs are covered in Volume III of the 1996 report. Since a relatively small number of lakes were added to the 305(b) assessment for 2000 the discussion in the 1996 report remains valid. Throughout this discussion, however, many of the same causes and sources that affect streams and rivers, especially those originating from nonpoint sources, also apply to lentic systems.



Degraded (Very Poor)	Severely Degraded (Poor)	Impact (Fair)	Moderate Enrichment (Good)	Least Impacted (Excellent)
Community Characteristics				
No community organization - few or no species, very low numbers, only most tolerant, high % anomalies	Poorly organized community - few species, low numbers, tolerant species only, many anomalies	Reorganized community - tolerant species, intolerants in very low numbers, omnivores predominate	Good community organization - good numbers of sensitive species, some intolerants	Highly organized community - insectivores, top carnivores, intolerants predominate, high diversity
Chemical Conditions				
Acutely toxic chemical conditions	Low D.O. with chronic toxicity	Low D.O. , nutrient enriched, no recurrent toxicity	Adequate D.O. , no acute/chronic effects, elevated nutrients	No effects evident, background conditions, good D.O.
and/or	and/or			
Habitat Conditions				
Total habitat loss, extremely contaminated sediments	Servere habitat degradation, severe sediment contamination	Modified stream channel, heavy siltation, canopy removal	Good habitat, no significant channel modifications	Excellent habitat, no modifications evident
Examples of Perturbations				
Toxic discharges, dessication, acid mine drainage, severe thermal conditions.	Municipal and industrial discharges, intermittent acute impacts	Municipal sewage, combined sewrs, heavy agricultural	Minor sewage inputs, most are agricultural nonpoint affected areas, moderate thermal increase	No perturbations evident.

Figure 4-4. Conceptual model of the response of the fish community as portrayed by the Index of Biotic Integrity and other community metrics with narrative descriptions of impact types and corresponding narrative biological performance expectations.

Specific Selected Causes and Sources

Municipal Wastewater Treatment Plants

Ohio has hundreds of permitted municipal wastewater treatment plants (WWTP) that have discharges into Ohio surface waters. There are many smaller, unpermitted WWTP discharges. Of the NPDES permitted discharges, 223 are considered *major* discharges based primarily on effluent volume and other characteristics. The remaining discharges are termed "minors", of which a few are termed "significant minors." Although many major WWTPs serve large metropolitan areas (*i.e.*, Cleveland, Columbus, Cincinnati, Akron, Toledo, and Dayton) smaller cities are also served by major WWTPs.

The abatement of past WWTP impairments through upgraded treatment facilities is responsible for the greatest improvements in the integrity of Ohio surface water resources in the 1980s. Although this source is declining as a major responsible source there is still significant impairment to aquatic life uses remaining (Figure 4-2). For example, based on the 305(b) cycles through 2000, municipal WWTPs are the principal source of impairment in 550 miles of Ohio streams and rivers (14.7% of all impaired waters. For small WWTPs, poor operation and maintenance is often responsible for the remaining impairments. At the larger, major municipal WWTPs the periodic inability to adequately treat peak flows during storm events (most Ohio cities have combined storm and sanitary sewer systems) leads to plant bypasses, and significant combined and sanitary sewer overflow problems.

Organic Enrichment/Dissolved Oxygen

In examining the agents of impact related to inadequate municipal wastewater treatment, conventional compounds (*i.e.*, oxygen demanding substances) and unionized ammonia-N are the primary causes of aquatic life use impairment. The effects related to the impairment caused by these substances ranges from an altered diel dissolved oxygen regime and "subtle" shifts in aquatic community composition and function (*e.g.*, reductions of sensitive species, increases in omnivores, etc.) to seriously depleted dissolved oxygen, acutely toxic unionized ammonia-N concentrations, and aquatic communities with only a few tolerant species and high rates of external fish anomalies. These wide ranging impacts are lumped together as "organic enrichment/dissolved oxygen" causes, much of which is related to inadequate wastewater treatment. These were important influences in more than 865 miles of impaired or partially impaired streams and rivers (23.1% of all impaired miles).

Ammonia

Unionized ammonia-N concentrations are declining as a principal cause of impairment to aquatic life uses. Ammonia-N dropped from the 3rd leading major cause of impairment in 1988 to 10th in 2000, and now only affects 81 of the miles monitored. Although D.O. and ammonia have declined as WWTP related causes of impairment these are still important to track as treatment plants expand and/or reach the end of their design capacity. These causes are also associated with urban runoff and various bypasses into streams.

Industrial Discharges

Ohio has a large and diverse industrial manufacturing base. A byproduct of this activity, however, is the need to dispose of a variety of waste substances, some of which are toxic. Prior to the development of contemporary water quality regulations, large amounts of toxic substances were discharged untreated or poorly treated into Ohio's streams and rivers. With the passage of the Clean Water Act amendments of 1972 a permitting system (National Pollution Discharge Elimination System) was established to reduce and regulate the pollutants that an entity may discharge. The quality of many Ohio rivers (*e.g.*, Mahoning River, Black River, Cuyahoga River, Ottawa River) has been historically degraded (some quite severely) by the discharge of industrial pollutants. While there have been substantial improvements in industrial waste water treatment in Ohio (see Trend section for improving conditions in large rivers), there are still rivers and streams in that have poor and very poor biological performance which is related, at least partly, to industrial discharges or legacy pollutants (i.e., sediment contamination from past discharges).

Aquatic communities impacted by the toxic effects of industrial pollutants generally elicit a characteristic response which includes the following combination (see Figure 4-4); low species or taxa richness predominated by tolerant forms, very low abundance, high rates of anomalies on fish (*i.e.*, eroded fins, lesions, tumors, and deformities) and macroinvertebrates (deformed head capsules, etc.), and IBI and ICI scores in the poor and very poor ranges. This is a response signature of a complex mixture of toxic impacts that usually includes one or more industrial sources (Yoder 1991b). A map of locations where rates of anomalies greater than 5% (see Map 5-1) on fish shows that the occurrences are clustered near loca-

tions of heavy industrial development and impact.

Metals

Of the priority pollutants that impair aquatic life uses in Ohio surface waters and that are largely related to industrial sources, the heavy metals are responsible for approximately three times as many impaired miles as priority organics (high magnitude causes; Table 4-1). The subbasins most heavily impacted by heavy metals are those in the vicinity of major industries and large urban areas, especially in the Erie/Ontario Lake Plain ecoregion. Metals are discharged in both industrial and municipal effluents as well as in combined sewer overflows (CSOs) and urban runoff. There has been a declining trend, however, in the relative contribution of metals to statewide use impairment. Between 1988 and 2000, metals dropped from the fourth leading cause of non-attainment to sixth in terms of the proportion of miles impaired or partially impaired. Highly elevated and extremely elevated concentrations of metals in sediments are also clustered near cities that have or have recently had heavy industry (*e.g.*, Canton, Massillon, Youngstown, Cleveland, Lima, and Toledo). Rivers near large cities that do not have as extensive of a base of heavy industry (*e.g.*, Columbus and Dayton) generally have fewer sites with heavily contaminated sediment.

Priority Organics/Unknown Toxicity

Priority organic compounds and unknown causes of toxicity in streams and rivers are often associated with industrial processes. Recently there has been much emphasis on using whole effluent toxicity as a means to improve their control. Priority organics and unknown toxicity are most often found in regions with high population density and heavy industry such as the urban centers of the Erie-Ontario Lake Plain ecoregion. With the large number of complex and exotic chemicals now used in industry, it will be increasingly important to retain and increase our ability to identify toxic problem areas (*i.e.*, "hot spots") in surface waters. An integrated approach that incorporates instream assessments of aquatic communities, measures of whole effluent toxicity, traditional water quality and sediment chemistry measures, and some of the emerging diagnostic techniques (*e.g.*, biomarkers; see Section on Ohio EPA/U.S. EPA Biomarker research program), is the most cost effective and complete way currently available to *accurately* characterize areas where toxic pollution *is a problem*. More information on specific toxics problems is provided in Section 5.

Combined Sewer Overflows (CSOs)

Aquatic life use impairment caused by CSOs is often interactive with municipal, industrial, and/or urban runoff impacts. Aquatic life responses to the influences of CSOs may differ depending on whether toxics discharged into the sanitary sewer system enter the surface water body via the CSOs. Biological response signatures generally include very high macroinvertebrate densities combined with single digit ICI scores (Yoder 1991b). Fish community response signatures can include elevated anomalies combined with mid-range IBI and MIwb scores indicative of organic enrichment. If toxic substances enter via the CSOs, the response signature will tend to resemble those just described for complex toxic impacts. Physical impacts can include sewage sludge and solids deposits which are delivered to the stream or river during overflow events. This is often exacerbated by impoundments that are frequent on the rivers and streams in most Ohio cities.

CSOs are a major or moderate magnitude source of impairment in 248 miles of the streams and rivers monitored by Ohio EPA. Often, CSO impacts are masked by existing impacts from industrial effluents or, more frequently, by WWTP discharges. One example of this phenomenon is the Scioto River downstream from Columbus. In the late 1970s the full extent of the impact from the Whittier Street CSO (approximately 90% of all CSO flow and load in Columbus) and other CSO discharges could not be distinguished from the impacts from the two Columbus WWTPs. As the impact from these two WWTPs has lessened, the impact from these CSOs has become more apparent.

The impacts of CSOs and urban stormwater runoff must be considered beyond potential effects on the water column. The most important effects on aquatic life are the *cumulative* result of what each individual CSO and runoff event leaves behind, not merely what happens to water column chemistry during an event. In addition, many areas impacted by CSOs are simultaneously impacted by habitat modifications (*e.g.*, impoundments, riparian encroachment) and flow alterations. In Ohio, water withdrawals for public water supply purposes often occur just upstream

from the CSO discharge area, which leaves little flow for the dilution and dispersal of pollutants. In combination with the previously mentioned habitat modifications, this can result in an enrichment that is not unlike a lake eutrophication effect in the pools of the receiving stream or river. Thus evaluating the effects of CSO discharges is complex, site specific, and requires ambient monitoring and other information beyond water column chemistry alone. The new storm water regulations will lead to more focus on the effects of CSOs on waters in small to medium-sized cities.

Agriculture

Agriculture is one of the largest and most dispersed industries in Ohio. Although agricultural impacts often receive attention as a principal cause of aquatic life impairment, much of the degradation is directly linked to poor agricultural practices and not merely the presence of farming. Many of Ohio's exceptional warmwater streams and rivers (Big and Little Darby Creeks, Twin Creek, Stillwater River, Kokosing River, etc.) have watersheds with land use predominated by agricultural activities. These streams have remained essentially intact because *the adjacent riparian vegetation and stream habitat have not been extensively degraded or encroached upon*, at least to the degree that has occurred in other regions of the State. Streams and rivers that have an adequate riparian buffer zone (vegetated with *woody plants* in lieu of grass filter strips) and natural instream habitats that maintain connections with their floodplains possess the ability to "assimilate" the runoff from agricultural land use, provided it is not a limiting factor.

Agricultural activities that have the greatest impacts on aquatic life include riparian vegetation degradation and removal, direct instream habitat degradation via channelization and other drainage improvement activities, sedimentation and siltation caused by stream bank erosion (which is strongly linked to riparian encroachment), and land use activities that result in and/or accelerate rill, gully, and sheet erosion. Acute or even chronic effects on aquatic life from normal pesticide usage are rare in Ohio compared to the other agricultural causes of impairment. However, there is concern about the impacts of pesticides on public water supplies in the agricultural regions of Ohio. Agriculture (and its impacts) is the most intensive land use activity in the HELP ecoregion, followed by the ECBP and then the EOLP, IP, and WAP, the latter of which is the most heavily forested ecoregion of Ohio. Statewide, agricultural sources are second leading source directly responsible for impairment (major and moderate magnitude sources) directly in more than 1520 miles of streams and rivers, and indirectly, through hydromodification in another 1422 more (Table 4-2). Agricultural activities also threaten existing use attainment in 166.8 miles of streams and rivers and may be a potential problem in many more that have not yet been evaluated with monitored level information (Ohio EPA 1991, 1992). It is likely that the past estimates of impairment related to agricultural sources have been under estimated primarily because assessments have been directed to streams and rivers impacted by point sources and urban impacts. However, our shift to a stratified sampling design is more effective in getting relatively unbiased estimates of these effects in small waters.

Sedimentation and Siltation

Sedimentation resulting from agricultural activities is undoubtedly the most pervasive *single* cause of impairment from nonpoint sources. This cause is responsible for more major/moderate impairment (over 1493 miles of stream and rivers) more than any other cause except habitat disturbance, with which it is closely allied in agricultural areas. If the monitored level database was distributed equally across the state, sedimentation would likely be the leading cause of impairment in terms of stream and river miles.

Sediment deposition in both lotic and lentic environments is a natural process. However, it becomes a problem when it exceeds the ability of the system to "assimilate" any excess delivery. Sediment deposited in streams and rivers comes primarily from stream bank erosion and in runoff from upland erosion. The effects are much more severe in streams and rivers with degraded riparian zones. Given similar rates of erosion, the effects of sedimentation are much worse in channel modified streams than in more natural, intact habitats. In channel modified streams the incoming silt and sediment remains within and continues to degrade the stream channel, instead of being deposited in the immediate riparian "floodplain." This also adds to and increases the sediment bedload that continues to impact the substrates

long after the runoff events have ceased. Thus to successfully abate the adverse impacts of sediment we need to be concerned with what each event leaves behind and also what takes place in the water column during each event. We also need to protect natural stream connections with floodplains, that can assimilate some proportion of these sediments.

The effects of siltation on aquatic life are the most obvious in the ecoregions of Ohio where: (1) erosion and runoff are moderate to high, (2) clayey silts that attach to and fill the interstices of coarse substrates are predominant, and (3) streams and rivers lack the ability to expel sediments from the low flow channel which results in a longer retention time and greater deposition of silt in the low flow channel.

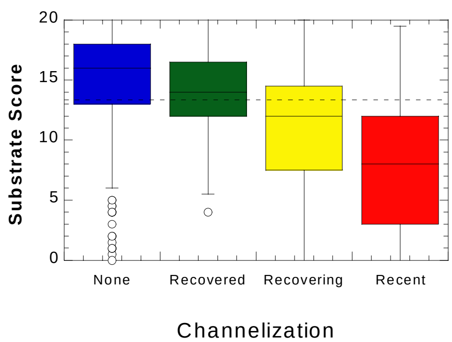


Figure 4-5. Substrates scores in streams with increasing degrees of channel modifications.

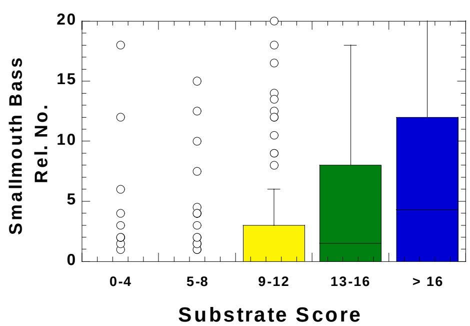


Figure 4-6. Relative number of smallmouth bass in wadeable streams versus substrate score as measured in the QHEI.

Nutrients delivered along with sediments can result in major shifts in the trophic dynamics of aquatic ecosystems (see Figure 4-4). In lakes, high rates of sedimentation reduce lake volume and habitat, increase turbidity, and contribute to accelerated eutrophication.

Trautman (1981) believed that siltation was the most pervasive pollutant in Ohio. He related the reduction of many fish species in Ohio to deforestation, an increase in the intensity of farming, and the resultant increased silt load from each. For some species, the reduction in the distributional range is especially striking. See the 1996 305(b) report for a more detail assessment of this pattern. In contrast to the sensitive species, there has been an expansion of the distribution of some species tolerant to turbidity, degraded habitats, and nutrient enrichment. Carp, uncommon in high quality streams, have greatly increased their distribution near (1) urban/suburban population centers, (2) impoundments, and (3) areas with excessive nutrient enrichment (see 1996 305(b)).

The tight link between sedimentation, habitat degradation, and biological effects is illustrated nicely in Figures 4-5 and 4-6. These data show a clear link between channelized streams and poorer (finer, embedded, silt covered) substrates in wadeable Ohio streams (Figure 4-5). This is likely, in most cases, a result of these streams becoming disconnected from their floodplains through the entrenchment of stream channels. Fine substrates in these waters accumulate in the low flow channels instead of being stored in bars or expelled to floodplains. The negative biological effects of this are clear also. Figure 4-6 illustrates the association of smallmouth bass abundance with the substrate score of the QHEI. It is clear that degraded substrates are essentially devoid of populations of this popular sport species.

Aquatic communities are not only indicators of acceptable environmental conditions for themselves, but also indicate that the water resource is of an acceptable quality for wildlife and human uses. Aquatic organisms have the ability to integrate and reflect the total of all disturbances in a watershed. While individual disturbances themselves may seem trivial, the aggregate result of these individual impacts emerges as a degraded and declining fauna on a major watershed scale. The key to halting and eventually reversing these trends first lies in recovering degraded

riparian zones and natural stream habitat morphology, properly managing watersheds for local impacts (includes land use activity setbacks, wetland preservation and restoration), and minimizing silt and sediment runoff from *all* upland land use activities, not just agriculture alone. There are encouraging signs of progress, especially related to agriculture. Recently, a 200 million dollar bond project was created (The Ohio Lake Erie CREP) which is a local, state, federal, and private partnership to create 67,000 acres of riparian Area and upland practices to reduce sediment pollution in Lake Erie and its watersheds.

(http://www.dnr.state.oh.us/odnr/soil+water/crephome.htm)

This will be accomplished through installation of filter strips, riparian buffers, wetlands, hardwood trees, wildlife habitat, and field windbreaks.

Nutrient and Organic Enrichment

Another major impact from agricultural activities is organic enrichment from excessive nutrients delivered via runoff from fertilizer and organic wastes from livestock operations. The resulting impacts include a wide range of problems including severely depressed dissolved oxygen levels to indirect problems caused by greatly overstimulated algal production. The aquatic community changes caused by nutrient enrichment and organic enrichment/low dissolved oxygen are summarized in Fig. 4-4.

We completed a study of the relationships among habitat, nutrients and aquatic life in 1999 (Ohio EPA 1999b). Because aquatic life criteria for nutrients do not exist, our goal was to derive interim guidelines for nutrient levels in streams that would support various aquatic life goals. Some conclusions of this study include:

1.) Headwater streams are important to the assimilation of nutrients and sediment in runoff. The aggregate condition of headwater streams is correlated with the quality of water an aquatic life resources in larger streams, and reflects the integrity of the watershed as a whole.

2.) Wooded riparian buffers are a vital functional component of the stream ecotone and are instrumental in the detention, removal and assimilation of nutrients from or by the water column.

3.) The management of nonpoint sources of pollution and determining the assimilative capacity of a lotic system (i.e., TMDLs) needs to include more than dilution dynamics alone. Residual effects of nutrients and sediment are most manifest in measures of biological community performance (e.g., IBI or ICI).

4.) Reference (REF) total phosphorus (TP) and nitrate-nitrogen (NO3-N) concentrations differed between ecoregions with the highest background concentrations occurring in the Huron/Erie Lake Plain (HELP) and Eastern Corn Belt Plains (ECBP) ecoregions, lowest in the Western Allegheny Plateau (WAP) ecoregion, and intermediate in the Erie-Ontario Lake Plane (EOLP) and Interior Plateau (IP) ecoregions.

4.) Reference (REF) TP and NO3-N concentrations typically increased with stream size, especially so in large rivers.

5.) Degradation of biological communities (i.e., biological integrity less than WWH criteria) was not observed until median nitrate-N exceeded 3-4 mg/l. This result, however, may be con-founded by nitrate-N concentrations that remain elevated following high stream flows after flows returns to normal.

6.) Biological community performance in headwaters and wadable streams was highest (i.e., Index of Biotic Integrity [IBI] or Invertebrate Community Index [ICI] values 50-60) where TP concentrations were lowest. The association between increasing TP concentration and decreasing IBI or ICI scores was statistically significant.

7.) The lowest TP concentrations were also associated with the highest quality stream habitats (i.e., Qualitative Habitat Evaluation Index [QHEI] scores >60-70). The correlation of low TP with high quality lotic habitat is thought to be the result of TP being sequestered by the well organized, diverse and trophically dynamic aquatic assemblages that are typically associated with high quality habitat.

8.) Habitat characteristics appeared to have some of the strongest effects on the aquatic biota and should be a major consideration in developing nonpoint source pollution abatement strategies

Agricultural Related Habitat Modification

The modification of natural stream channels for agriculture drainage has undoubtedly resulted in some the most irretrievable impairments to aquatic life uses in Ohio. Habitat modification was the *single most predominant* major cause of impairment in 1222 miles of streams and rivers (Table 4-1, Figure 4-1). Our intensive survey work and the results of the REMAP probabilistic sampling in the ECBP indicate that, especially for small waters, habitat alteration is widespread in Ohio, often affecting 40% or more these steams in certain areas of the state. (e.g., Huron/Erie Lake Plain

(HELP) and northern rim of the E. Corn Belt (ECBP) ecoregions). The streams of the HELP ecoregion have nearly all been deepened and straightened at least once to promote the subsurface drainage. This was accomplished largely in an area that once was a vast woodland swamp called the "Black Swamp." This activity has proceeded since the late 19th century and has had obvious and significant impacts on the indigenous biota, habitat, and water quality in the Maumee River drainage. Karr *et al.* (1985) reported that 44% of the fish species that once existed in Maumee River basin have either declined (26 species) or been extirpated (17 species), much of which is related to habitat loss.

Stream channelization reduces and eliminates pool depth, reduces habitat heterogeneity, increases the retention time for sediment in the stream channel, and reduces the retention time for water remaining in the channel. Streams channelized under the auspices of the Ohio Drainage Law (ORC 6131) are subject to routine "maintenance" activities which include herbicide application, tree removal, sand bar removal, and the snagging and clearing of accumulated woody debris. Although the latter are an important source of instream cover, it is believed to reduce the capacity of the channel to carry excess water. In addition, miles of stream are literally lost when streams are changed from sinuous, meandering channels to straight channels.

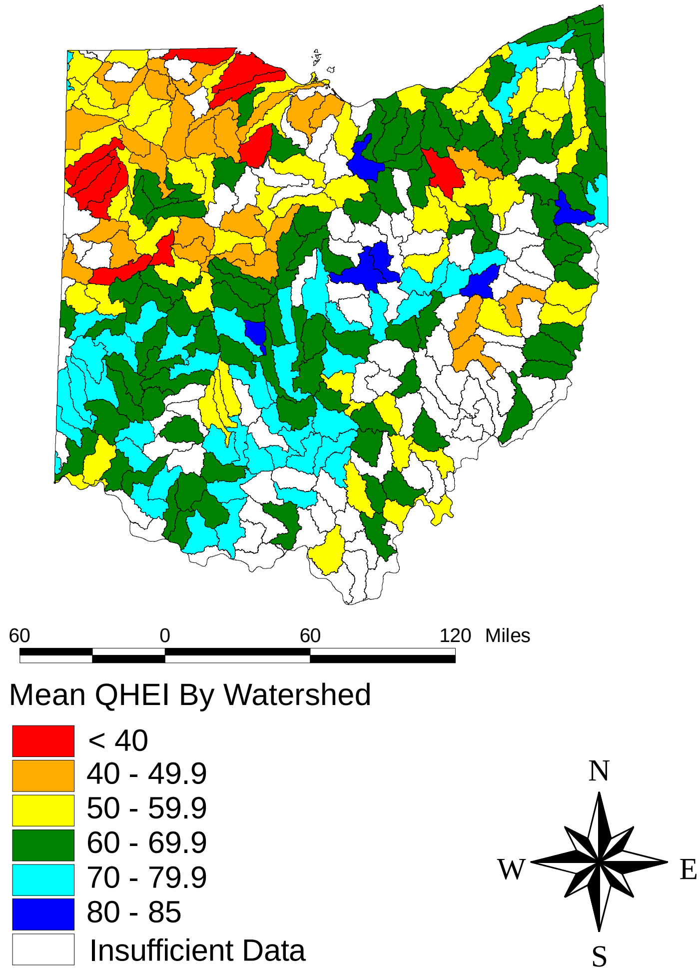
In much of the HELP ecoregion productive row crop agriculture would not be possible unless sub-surface drainage is maintained. The intensity of agricultural activities in some areas, however, greatly exacerbates the negative effects of stream modification. Frequently, agricultural activities encroach on streams and rivers to the extent that the woody riparian buffer is reduced or eliminated. This results in destabilized stream banks, channel widening, and the eventual need for channel modifications. An inadequate riparian buffer also allows excess nutrients and sediments to runoff directly into streams (the effects of which were previously described).

Despite the negative effects of channel modifications, Ohio EPA has recognized that channel maintenance will likely keep certain streams, particularly those in the HELP ecoregion, in a permanently altered condition. These modifications will effectively prevent the attainment of the WWH biocriteria. Thus the Modified Warmwater Habitat (MWH) use designation was devised as a middle ground between the unattainable WWH use and the Limited Resource Waters (LRW). The MWH use also recognizes the reality of the Ohio drainage laws, the need for sub-surface drainage to support existing agricultural land uses, and the unlikelihood of any successful attempts to restore the original habitat in these waterbodies in the near future.[1] The total miles of stream designated as MWH thus far (889.9 miles up from 134 miles in the 1992 report) is only 3.7% of the total designated stream miles.

1. Natural stream restoration techniques and research ongoing at OSU on controlled drainage systems hold promise for moderate the effects of agricultural drainage

In the ecoregions of Ohio other than the HELP, stream modification for sub-surface drainage is less widespread. Surface flooding is generally a more prevalent issue in these areas and workable alternatives to channelization are more likely to become available. The "need" for channel modifications in these areas is nearly always the result of adjacent land uses encroaching too closely to the stream or river channel. As the land use encroaches the "problems" with both direct and indirect by-products of the natural stream dynamics increase. Consequently, increasing external maintenance is needed to preserve the encroaching land use. This is a problem that is not unique to agriculture, but includes virtually every land use activity that occurs near Ohio streams and rivers. This may be one of the fastest growing water resource problems in the state.

Alternatives (*e.g.*, diking, avoidance, set backs, etc.) must be more vigorously pursued especially considering the environmental consequences of degraded habitat to aquatic communities (See Fig. 4-5). Maintaining and restoring good habitat quality is critical to maintaining diverse and functional assemblages of aquatic life in



Map 4-1. Mean QHEI by watershed in Ohio

Ohio's streams and rivers. Intact aquatic habitats achieve higher biological index scores and are better able to resist and recover from point and nonpoint sources of pollution (Rankin 1989). Fortunately, there is a growing awareness that naturally stable stream channels, with a natural morphology are both ecologically and economically sound. ODNR is promoting the construction of naturally stable channels as an alternative to traditional drainage and flood control channel projects. In the long term, such an approach will benefit both aquatic life and streamsize landowner. Information on these techniques can be obtained in a series of ODNR stream management fact sheets:

http://www.dnr.state.oh.us/odnr/water/pubs/fs_st/stfs03.html.

More Riparian Functions

Good quality riparian buffer zones also provide critical habitat for many species of non-aquatic wildlife and can act as corridors of migration for both aquatic and terrestrial species. Without these woody corridors, populations of these species could become isolated and become more prone to extirpation. This has certainly occurred for many populations of both aquatic and non-aquatic organisms in Ohio. Certain bird species are dependent on treed riparian areas for successful breeding. For example, the acadian flycatcher (Empidonax virescens) is a riparian zone "indicator" that requires approximately a 400-500 feet width of wooded area to nest successfully. The distribution of this bird species is correlated with the width of the wooded riparian zone along the mainstem. Such indicators, when used in combination with aquatic community information, provide a robust assessment of the health of the lotic ecosystem. It is this type of information that continues to reinforce the concept that streams and rivers must be protected as an ecosystem that includes the adjacent riparian zone beyond the wetted channel. Several publications provide useful information on protecting and restoring wooded riparian zones in Ohio (ODNR 1991, USDA 1991).

Other Land Use and Habitat Impacts

While much of the habitat degradation in Ohio streams and rivers is related to agricultural land use, many other activities contribute as well. Map 4-1 illustrates average habitat quality in subbasins across Ohio as measured by the Qualitative Habitat Evaluation Index (QHEI; Rankin 1989). Although this map shows agriculture impacts on habitat, it also illustrates that habitat impacts related to suburban development, sewer line construction, dam construction, hydrological alterations, construction activities, mining, and silviculture are widespread.

Habitat degradation in urban and suburban areas often results when construction activities encroach on the stream channel and riparian vegetation is removed, and when channels are deepened and widened to increase channel capacity to more quickly disperse flood waters. Because of the high proportion of urban areas with impermeable surfaces, streams and rivers may experience increased fluctuations in flow especially when flow retention

basins are poorly designed or not present. Such streams are usually characterized by a tolerant assemblage of organisms that can withstand the altered flow hydrograph, habitat modifications, and organic enrichment from urban runoff that results in increased algal production. This latter consequence takes place as the result of the combined effects of riparian vegetation removal, altered channel morphology, lack of flows during the summer months, and an excess of sediment and nutrients.

Construction Activities

Construction activities have historically had significant effects on sedimentation largely through the comparatively vast amount of runoff that can originate from exposed soils without adequate erosion controls. This runoff can be several times greater than what is typical for other land uses. Recent stormwater regulations will require NPDES permits for certain construction activities on properties down to 1 acre (vs. 5 acres under previous regulations). Most activities will fall under general permits. These general permits will implement generic Best Management Practices (BMPs). The Ohio DNR, Division of Soil and Water has available training materials that demonstrate successful approaches to control of construction related runoff. A video training course "Keeping Soil on Construction Sites: Best Management Practices" is available from:

Ohio Federation of Soil &
Water Conservation Districts
Building E-2
Fountain Square
Columbus, Ohio 43224
(614)-265-6610

Suburban development is one of the fastest growing threats to streams in Ohio. This not only includes the direct impacts just described, but far field effects on larger mainstem rivers due to the export of sediment from construction sites located in the upper sections of tributaries. The most common habitat impairments that result from the export of clayey silts and sediment is the increased embeddedness of cobble and gravel substrates. This serves to eliminate interstices on which many benthic organisms and species of fish directly depend. This threat is the most serious in the streams and rivers designated as Exceptional Warmwater Habitat (EWH), State Resource Waters, and state scenic rivers.

In the Interior Plateau ecoregion a by-product of increasing suburban development additionally includes the routing of interceptor sewer lines to serve the expanded development. This has a devastating effect on the small, headwater streams of this ecoregion, particularly the high gradient streams in Hamilton and western Clermont Counties (Ohio EPA 1992).

Dams and Other Flow Alterations

The alteration of the hydrologic regimes of Ohio streams and rivers through dam construction, water withdrawals for public water supply purposes, canals, deforestation, and changes in landuse (*e.g.*, urbanization), have had, and continue to have profound effects on Ohio streams and rivers. The most popularly understood effect of dams is the interruption in migration patterns of fish species. However, other impacts of dams include habitat changes that eliminate obligate rheotactic species (*e.g.*, darters, some minnows, some suckers), alteration of the dissolved oxygen and temperature regimes downstream from dams (Robison and Buchanan 1988), and gravel starvation downstream of impoundments (Hill *et al.* 1991). This phenomenon is evident in several Ohio streams and rivers downstream from municipalities where low head dams deter the recovery of previously modified channels. This also has negative ramifications on the ability of these streams and rivers to assimilate organic wastes from CSOs and urban runoff.

Hubbs and Pigg (1976) estimated that reservoirs in Oklahoma were a major proportion of the "hazard" to threatened fishes in that state. Dams on large, mainstem rivers generally have much greater impacts on system wide ecological integrity than dams located on headwater streams because: (1) they block access to more area of a basin or subbasin, (2) they are generally large and affect more river miles, and (3) large rivers are fewer in number than small streams (see Figure 2-1). Fortunately, in Ohio, most of the large reservoirs are on medium

sized rivers and streams. However, navigation and low head dams are prevalent on Ohio's large rivers and have some of the same effects described above.

Water withdrawals can also have deleterious effects on streams and rivers depending on the timing and magnitude of the withdrawals. Regulations related to water withdrawals have focused on maintaining “minimum” flows required to protect some sensitive life stage of an aquatic organism (*e.g.*, spawning, young-of-the-year rearing areas, etc.). Recent work (Hill *et al.* 1991), however, indicates that protecting for minimum flows only may not adequately protect aquatic resources. Hill *et al.* (1991) discuss the importance of high flow events (within a regime of natural flows) for maintaining and creating diverse habitat conditions. They provided a list of seven possible watershed changes that occur when natural flood flows are reduced:

“(1) valley floors no longer flood; (2) local water tables are no longer recharged; (3) stream bar and channel areas no longer become inundated and scoured; (4) sediment accretes on bars and channel edges; (5) side channels and backwater areas become disconnected from the main channel or abandoned by the mainstem as they fill in; (6) tributary channel confluences with mainstems locally aggrade and push out into the main channel; and, (7) the ratio of pools to riffles is significantly altered.”

Although this research was primarily directed rivers of the western U.S., many warmwater streams and rivers in Ohio exhibit some of the negative attributes described above as a result of man-induced flow changes. Most at risk to these types of hydrological changes are EWH and other high quality streams and rivers. EWH waters such as Big Darby Creek contain strong populations of threatened and endangered species of fish, mollusks, etc. These species occur precisely because of the presence of the specific habitat types that would undoubtedly be changed if large quantities of water were withdrawn during high flows. Unfortunately, the reduction and loss of sensitive species in many other parts of the state indicates that water withdrawals from EWH streams would likely result in the reduction or loss of such species. This adds a new consideration to the siting of new surface water supplies including upground reservoirs. The attenuation of peak flows due to water withdrawals is not unlike the previously discussed effects of dams in deterring downstream channel recovery.

Interceptor Sewer Construction

The elimination of wastewater flows from small, package WWTP discharges to small, headwater streams has generally been accomplished by the regionalization of those flows. This option has been viewed as more desirable than upgrading and operating the small package WWTPs. The consolidation of sanitary wastewater flows into a single location not only eliminates many pollution problems, but eases the administrative burden in tracking compliance.

In 1990, the Ecological Assessment Section was requested to evaluate a proposed interceptor sewer project in the Taylor Creek subbasin in western Hamilton County. Numerous small package WWTPs, many of which are poorly operated, and home aeration system and septic tank discharges, impact the headwaters of the subbasin. The 1990 sampling was limited to nine locations in the Taylor Creek watershed and adjacent Bluerock Creek. The findings of this sampling revealed some moderate degradation to the fish and macroinvertebrate communities at sites that were in the closest proximity to the package WWTPs. However, FULL attainment of the WWH use designation was found at four of the eight Taylor Creek subbasin locations (Ohio EPA 1990c). In addition, the physical habitat was essentially intact and easily capable of supporting the WWH use.

The Permit to Install (PTI) application submitted by the Hamilton Co. Metropolitan Sewer District (MSD) was denied. The design of the project included a network of nearly 19 miles of interceptor sewers that were designed to convey sanitary wastewater flows by gravity. This design necessitates the excavation and modification of many miles of stream beds. The PTI was denied on the basis that it would damage habitat and permanently prevent the attainment of the WWH use designation, particularly the biological criteria. Detailed information on the streams in this area and these projects in summarized in Ohio EPA (1992a, 1992b). Ohio EPA used the results of this study to help formulate policy guidance for reviewing PTIs for interceptor sewer projects.

Resource Extraction

Coal mining is the principal resource extraction activity in Ohio and is of major economic importance in the southeast part of the

state. Although other forms of resource extraction are also scattered across Ohio (*e.g.*, sand and gravel extraction, clay mining, limestone quarrying, and salt mining) none have as extensive of an impact on water resource quality. Coal mining occurs primarily in the W. Allegheny Plateau ecoregion and is principally responsible for a variety of environmental perturbations. Most of the well-known problems are associated with low pH related to acidic surface mine runoff, particularly from unreclaimed and abandoned mines (Table 4-1). Mine related chemical impacts in the portions of the WAP ecoregion with a sandstone geotype are extensive. Several studies have attempted to inventory abandoned mine lands and their respective impacts on chemical water quality (Ohio DNR 1974; USDA 1985). Clearly, severe impairment of the resident biota exists in the highly acidic and heavily silted streams. However, much less is known about the *severity* of impairment to the biota in watersheds with less intensive mining and in areas with limestone geotypes. This lack of reliable and comprehensive information initially lead to the erroneous assignment of aquatic life use designations (*i.e.*, the now defunct Limited Warmwater Habitat use designation) in the 1978 water quality standards. These are being addressed via the Five-year Basin Approach as the opportunity arises to monitor these streams. Two recent examples are the biological and water quality surveys of the Hocking River mainstem and selected tributaries, the Southeast Ohio River tributaries, and the Raccoon Creek watershed (Ohio EPA 1991b, 1996; 1991c; 1997). In the field year 2000 we are survey the Duck Creek and Little Muskingum River watersheds.

Many impacts from mining are nontoxic *per se* and are more related to increased sedimentation and periodic acidification from uncontrolled and abandoned mine lands runoff, mine shaft discharges, and direct stream channel modifications from relocations and encroachment on riparian zones. The absolute extent of mining impacts in the WAP ecoregion is likely underestimated by this report. Many impacts are presumed to be chemically severe and essentially irreversible. Thus, as a result, comparatively little effort has been expended on comprehensive biological characterizations, except through the Five-year Basin Approach.

Acid Mine Effected Lakes.

Another requirement of the 305(b) report is for States to identify those lakes in which water quality has deteriorated as a result of high acidity that may be due to acid mine drainage. The Ohio LCI assessment uses the Acid Mine Drainage (M) parameter to identify lakes that are potentially impacted by acid mine chemicals such as low pH, high iron, sulfates, and manganese.

Only three of Ohio's 446 public lakes that have been assessed for potential acid mine effects show impaired chemical conditions: Friendship Park Lake, Jefferson Co.; Essington Lake, Perry Co.; and Lake Hope, Vinton Co. For the most part, lakes potentially affected by acid mine drainage in Ohio are found only in the unglaciated Western Allegheny Plateau ecoregion of southeast Ohio where extensive resource extraction (coal mining) occurs.

High Quality Waters

Although reports such as this emphasize the identification of problems in surface waters, Ohio possesses many high quality waters that exceed the minimum criteria for the Clean Water Act goal use (*i.e.*, WWH). More than 3,050 miles of the designated streams and rivers are assigned the Exceptional Warmwater Habitat aquatic life use. This comprises 10.5% of the U.S. EPA estimate for perennial streams and 12.7% of all Ohio streams and rivers that have a designated aquatic life uses.

Table 4-7. State designated scenic rivers in Ohio.

River	Year Designated	
Big[1] and Little Darby Creeks	1984	82
Chagrin River and tributaries	1979	49
Grand River and tributaries	1974	56[2]
Little Beaver Creek and tribs	1974	36[2]
Little Miami River	1969	105
Maumee River	1974	43
Olentangy River	1973	22
Sandusky River	1970s	65
Stillwater R.& Greenville Cr.	1980	83
Upper Cuyahoga River	1974	25

[1]Nature Conservancy has designated Big Darby Creek as a “Last Great Place” on earth because of its unique ecosystem.
[2] Part of this length designated as “Wild” river.

Ohio has a nationally reputed scenic rivers program and currently has 12 rivers designated (Map 4-2, Table 4-7). As a part of this program, citizen volunteer groups carry out monitoring in these rivers annually to act as an early warning system for potential impacts and to involve citizens in the protection of these streams. This data is summarized in annual reports that compare the results of the citizen volunteers to reference sites. Copies can be obtained from:

Ohio Department of Natural Resources
Division of Natural Areas and Preserves
Fountain Square Court
Columbus Ohio 43224
(614/265-6453)

Their web address is:

http://www.dnr.state.oh.us/odnr/dnap/

Map 4-2. Location of Designated Scenic River in Ohio.

The Ohio EPA ambient biological survey approach, which is the principal basis for this report, provides information that is useful for illustrating the distribution of rivers and streams with high quality water and aquatic community assemblages throughout Ohio. Map 4-3 shows the distribution of exceptional index scores for fish and macroinvertebrates. These streams and rivers are those that have essentially intact physical features, which provides habitat for some of the highest quality aquatic assemblages in Ohio. Many of the watersheds in which these streams and rivers are located contain or are near conspicuous geomorphological features such as escarpments, glacial boundaries, and outwash valleys. Habitat ravaged areas, such as much of northwest Ohio, are generally lacking in exceptional fish communities, although exceptional macroinvertebrate communities,

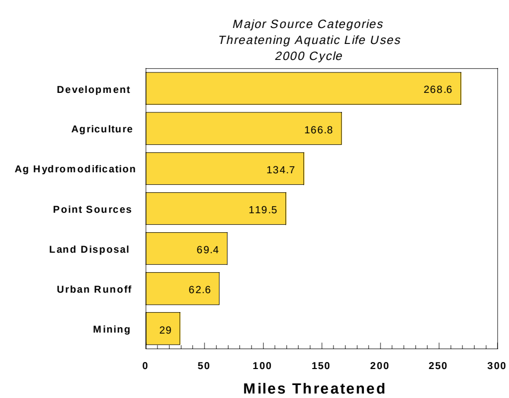
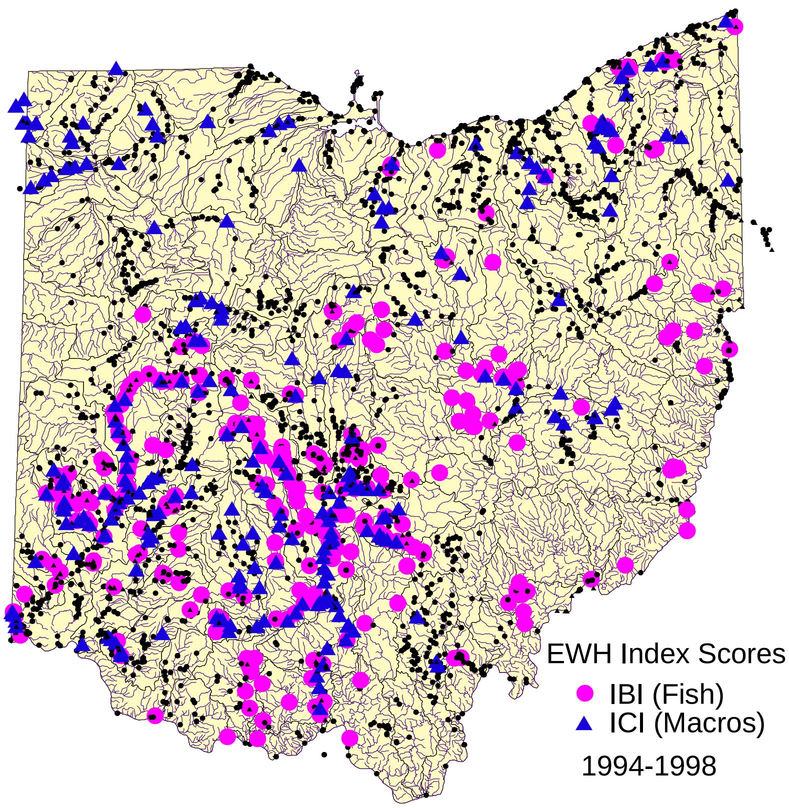


Figure 4-7. Major sources threatening aquatic life use attainment in Ohio streams and rivers and considered current for the 2000 assessment cycle (data collected as of 1998).

which more strongly reflect chemical water quality than habitat, are found at a few sites in this region. Exceptional streams are important because they are also the rivers and ment of land use activities is a continuing and even increasing problem along certain of these rivers and streams.



Map 4-3. Location of EWH biological index scores (IBI or ICI) of 50 or more collected in Ohio streams and rivers from 1994 to 1998.

streams that afford the highest quality recreational opportunities for Ohioans.

Portions of several of the larger rivers in Ohio historically have had poor to very poor water quality (*i.e.*, Tuscarawas River, Scioto River, Great Miami River), but have recently demonstrated FULL or PARTIAL attainment of the EWH use designation. The protection, enhancement, and continued maintenance of physical habitat and riparian zone integrity is essential to achieving and maintaining the full potential of these and other streams and rivers that are still water *quality* limited. Unfortunately, encroach-

Threatened and Restorable High Quality Streams and Rivers

Although Ohio has made significant progress in restoring waters polluted by inadequately treated wastewater many high quality waters are threatened or impaired by nonpoint sources of pollution. Here we summarize information on those high quality waters that are (1) currently fully supporting their aquatic life uses, but are considered imminently threatened by some activity in their watershed that may cause a loss of this use, or (2) currently have impaired or partially impaired aquatic life uses considered restorable over a short period (i.e., < 10 years) or are impaired by an activity considered responsive to existing management options.

By focusing on such waters, Ohio can concentrate effort and funds on waters (1) that are of high ecological and recreational quality, (2) where dollars spent on removing identified threats can save typically more costly restoration dollars, and (3) where restoration of high quality can be achieved for minor costs. Incremental increases in siltation or loss of aquatic habitat can be insidious. Nearly imperceptible, gradual insults to stream habitat can create a situation where expectations for stream quality slowly decline with time. Although the status of streams and rivers in Ohio seems static and little changed it must be remembered that only 150 years ago Europeans had little permanent effect on most Ohio waters. Today less than half of those waters we have monitored are achieving goals for biological integrity scaled to the present landscape. The historical data that exists exhibits a pattern of species loss and ecological integrity over time (Trautman 1981). A focus on maintaining the highest quality waters and restoring the streams with the greatest ecological potential will (1) inspire public steward-

ship and high expectations for such waters, and (2) enhance the constituency for restoration of more severely impaired streams. Such factors are recommended components of the draft TMDL process in Ohio.

Identification of Threatened Waters

Threatened waters are defined as waters currently fully attaining their designated aquatic life use, that have some activities that are imminent threats to maintaining that use. Often, stream waterbodies that are threatened already have some portion of the segment impaired or partially impaired. Threatened waters are also disproportionately comprised of EWH or CWH streams: 11.2% and 9.4%, respectively, of these uses have threatened segments versus 6.9% for WWH streams and none for MWH streams. This is because of the sensitivity of these waters to the predominant threats of siltation and habitat destruction. The primary threats to high quality streams are physical in nature and include direct habitat modifications, such as riparian removal, or other disturbances to the riparian areas of streams, bank erosion, and siltation from agricultural or urbanization adjacent to the stream or along tributaries. The influence of tributaries to high quality streams is often underestimated as a source of impairment or a threat to those high quality waters. Thus, protection strategies for high quality waters need to consider these factors.

The most restorable high quality streams include those with high quality habitat, but which have some minimal impairment or partial impairment and a nonpoint-related cause and source that is considered readily restorable (e.g., riparian removal versus unreclaimed strip mine). A preliminary ranking of stream restorability, based on the QHEI, stream gradient, and confirmed aquatic life use is listed in Appendix F and discussed in the next section.

Restorability of Aquatic Life

There are several major factors that determine how quickly a stream can recover to reference conditions, either through natural conditions or with human intervention. These factors include both site specific factors and larger scale (reach or watershed level) factors than can act to limit or accelerate recovery. We have proposed a method to rank streams by there restoration ease and potential (Appendix F).

The major factors in this ranking include site and segment scale habitat quality, river scale habitat quality, watershed scale habitat conditions, stream gradient or energy (i.e., energy needed to restore degraded habitat conditions), and specific “high influence” habitat attributes that may limit achievement of biological attainment of biocriteria. The “density” of data used to create these rankings varies by stream and watershed and rankings based on few data points (i.e., where certainty is lower) are identified.

Narrative restorability categories are listed below:

Least Restorable: Essentially None
Low
Low-Moderate
Moderate
Moderate - High
High
Very High
Most Restorable: Extremely High

Stream segments classified as LRW or MWH, on the basis of a biosurvey, are considered the least restorable conditions. Here an aquatic life use attainability study has been performed and Clean Water goals are currently considered unattainable. Typically such streams are kept in a modified state through channel maintenance to promote agricultural or urban drainage or flood control. Conversely, EWH streams generally have higher restorability ratings. This rating is current used by the Division of Environmental Funding and Assistance in their rating system for prioritizing funding requests and may become an important component of other priority setting processes related to stream protection and restoration. It may also prove a useful tool for setting TMDL priorities.

Table 4-1. Relative assessment of major, moderate, and minor causes of impairment (i.e., miles[1]) that result in partial and non-attainment of aquatic life uses or threaten the current full attainment status of aquatic life uses in Ohio streams and rivers during the 1988 through 2000 305(b) report cycles. *Data reflects monitored-level information only.*

Cause	Magnitude				Previous Rank				
	Major	Moderate	Minor	Threatened	98	96	94	92	88
Habitat alterations	1221.95	262.50	65.52	246.19	1	2	3	3	5
Siltation	932.76	560.29	124.86	297.82	3	3	2	2	3
Organic enrichment/DO	783.29	266.52	77.11	105.09	2	1	1	1	1
Nutrients	575.91	508.56	146.57	225.31	6	5	9	13	16
Flow alteration	537.35	292.61	116.43	59.07	5	4	6	6	6
Cause Unknown	443.80	60.7	45.8	0.50	7	7	8	8	7
Metals	354.41	256.49	78.32	24.40	4	6	4	5	4
pH	164.14	23.48	5.90	7.15	8	8	7	7	8
Priority organics	111.62	98.76	50.40		9	10	10	9	9
Unionized Ammonia	81.74	24.63	26.20	3.50	10	9	5	4	2
Pathogens	66.13	100.67	74.15	58.69	11	12	19	-	-
Turbidity	48.93	10.70			22	21	-	-	-
Suspended solids	43.48	43.19	65.65	22.18	12	11	20	20	-
Iron	34.03	28.25			-	-	-	-	-
Aluminum	24.60	26.80			-	-	-	-	-
Natural Limits (Wetlands)	23.80	0.50	2.50		23	-	-	-	-
Salinity/TDS/chlorides	22.50	37.00	8.29		14	14	14	15	15
Oil and grease	21.60	18.00	10.65	2.00	13	13	12	12	10
Thermal modifications	18.55	0.46		27.73	17	15	16	-	-
Total toxics	7.56	22.53	1.00	1.20	18	20	-	-	-
Other inorganics	7.35	11.40	23.70		19	25	13	11	12
Pesticides	4.40	66.36	82.85	26.22	16	16	11	14	11
Filling and draining	4.00			0.30	21	22	21	19	-
Noxious aquatic plants	3.61	24.37	6.20		-	-	-	-	-
Chlorine	2.40	7.90	1.90	7.00	20	19	18	17	13
Taste and odor	2.00				15	18	17	18	14
Low Nutrients	1.20				-	-	-	-	-
Nonpriority organics		7.20	12.30		22	-	-	-	-

Table 4-2. Relative assessment of major, moderate, and minor sources (i.e., miles[1]) which cause impairment of aquatic life uses in Ohio rivers and streams during the 1988 through 2000 305(b) report cycles. Data reflects monitored-level information only. Major, moderate, and minor impacts refer to the high, moderate, and slight magnitude codes specified by the U.S. EPA guidance for the 305(b) report.

Source	Magnitude			
	Major	Moderate	Minor	Threatened
Point Source	777.04	263.50	22.90	119.50
Industrial Point Sources	67.99	12.70		2.10
Major Industrial Point Source	93.41	18.40	4.00	18.20
Minor Industrial Point Source	24.85	7.75	0.50	5.25
Municipal Point Sources	161.37	49.80	5.60	3.00
Major Municipal Point Source	239.80	102.45	18.94	41.55
Minor Municipal Point Source	135.36	76.87	34.52	56.45
Package Plants (Small Flows)	13.42	17.00	8.00	15.55
Combined Sewer Overflow	191.68	57.72	0.60	
Sanitary Sewer Overflow	8.50		3.00	3.70
Domestic Wastewater Lagoon	3.60			
Agriculture	1048.76	471.45	81.10	166.80
Nonirrigated crop production	970.12	409.95	89.47	90.17
Irrigated crop production	2.30			
Specialty crop production		2.60	1.20	
Pasture land	204.97	101.12	70.54	21.93
Range land				13.20
Range Grazing - Riparian	23.30	6.00	1.30	54.20
Range Grazing - Upland	11.00	62.00	5.70	
Feedlots (Confined Animal Feeding Oper.)	15.70	1.60		8.89
Confined Animal Feeding Operations (NPS)	8.85	3.30		
Aquaculture	2.90			
Animal holding/management areas	21.30	12.20	0.50	
Manure lagoons				2.00
Silviculture		8.40		1.50
Harvesting,restoration,residue managem't		5.40		1.50
Road construction/maintenance		3.00		
Silviculture Point Sources			0.80	
Construction	108.17	140.11	3.00	209.61
Highway/road/bridge/sewer line	17.30	25.50	7.50	23.10
Land development/Suburbanization	86.87	114.41	18.50	192.61
Sewer Line Construction	2.20	4.30		3.50
Urban Runoff/Storm Sewers (NPS)	274.53	228.74	18.91	62.58
Non-industrial Permitted	12.20	12.75		
Industrial Permitted	13.70	19.25		
Other Urban Runoff	247.93	185.51	54.01	62.58

Table 4-2 continued.				
Mining	454.95	24.35	58.40	28.95
Surface Mining	185.74	21.21	50.90	16.95
Subsurface mining	14.01	13.15	8.49	
Dredge mining				3.50
Petroleum activities	10.20			
Mine tailings	9.10		1.00	8.50
Acid Mine Drainage	242.00			
Land Disposal	135.87	165.87	3.50	69.38
Sludge	3.20			
Wastewater	3.80			
Landfills	22.95	25.57	5.90	6.10
Industrial land treatment	10.28	2.60		
Onsite wastewater systems (septic tanks)	93.44	127.83	47.11	63.28
Hazardous waste	8.90		6.00	
Septage disposal				
Hydromodification - Agriculture	1005.80	415.74		134.66
Hydromodification - Development	305.13	167.93	2.70	59.00
Channelization - Agriculture	769.49	340.35	13.32	43.49
Channelization - Development	112.21	110.13	9.50	5.50
Dredging - Agriculture	2.50	19.20	0.50	
Dredging - Development	8.30	3.00	0.50	
Dam construction - Agriculture	11.44	2.00		
Dam construction - Development	53.66	7.00	4.00	27.80
Upstream Impoundment	38.76	16.25	6.20	
Flow regulation/modification - Ag	35.52	188.14	17.30	
Flow reg./mod. - Development	78.50	14.25		
Habitat Modifications o/than Hydromod.	38.20	4.02		
Removal of riparian vegetation - Ag	274.00	69.63	8.50	68.65
Removal of riparian vegetation - Dev	40.70	35.91	17.30	26.35
Streambank destabilization - Ag	219.25	86.10	11.93	62.32
Streambank destabilization - Dev	24.33	28.78	2.50	13.75
Drainage/filling of wetlands - Ag	3.80			
Drainage/filling of wetlands - Dev	0.80			
Marina(s)	3.00	2.00	8.80	
Other	287.61	232.31	8.00	29.28
Atmospheric deposition		2.20		
Waste storage/storage tank leaks	2.80	2.20		2.10
Highway maintenance and runoff		14.40	1.90	6.00
Spills	46.95	54.77	46.10	2.00
Contaminated sediments	36.06	97.17	20.70	4.40
Natural	181.45	85.27	36.30	
Recreational activities				1.50
Upstream impoundment	13.11		17.70	7.50
Groundwater Loadings	0.10			
Other	8.64			
Source Unknown	250.04	31.10	48.30	0.50

Table 4-3. Relative assessment of major, moderate, and minor causes of impairment (i.e.,acres[1]) that result in partial and non-attainment of aquatic life uses or threaten the current full attainment status of aquatic life uses in Ohio lakes, ponds, and reservoirs during the 1988 through 2000 305(b) report cycles. *Data reflects monitored-level information only.*

Cause	Major	Moderate	Minor	Threatened
Cause Unknown	-	-	690	-
Unknown toxicity	-	-	3590	-
Pesticides	124	1562	5091	4783
Priority organics	-	79	2040	2275
Nonpriority organics	-	72	708	2264
Metals	577	1672	1384	8344
Iron	-	-	1350	-
Unionized Ammonia	37	152	100	5046
Chlorine	-	32	-	130.
Other inorganics	85	480	447	5113
Nutrients	23,926	2655	5239	26546
pH	-	154	1269	9
Siltation	12868	15713	1505	8731
Organic enrichment/DO	8744	3519	822	30346
Salinity/TDS/chlorides	100	1794	-	2759
Thermal modifications	900	272	62	2784
Flow alteration	-	88	690	8100
Other habitat alterations	-	12756	732	1661
Pathogens	-	94	79	922
Radiation	-	-	17	16
Oil and grease	-	1868	679	7882
Taste and odor	539	55	144	355
Suspended solids	5104	1675	1274	1072
Noxious aquatic plants	5138	777	516	3587
Filling and draining	30	11	79	327
Turbidity	19471	4616	44	3508
Exotic species	63	53	51	9
Low Nutrients		19		5350

Table 4-4. Relative assessment of major, moderate, and minor sources (i.e., miles[1]) which cause impairment of aquatic life uses in Ohio lakes, ponds, and reservoirs during the 1988 through 2000 305(b) report cycles. Data reflects monitored-level information only.

Source[1]	Major	Moderate	Minor	Threat
Point Source				43
Industrial Point Sources		6590	14569	12698
Major Industrial Point Source		100		
Municipal Point Sources	1190	21949	1613.50	10360
Major Municipal Point Source				180
Minor Municipal Point Source	121			
Package Plants (Small Flows)			985	581
Combined Sewer Overflow	193	1717	1458	2453
Sanitary Sewer Overflow	201		14	3110
Agriculture	11548	59	20	13713
Nonirrigated crop production	19483	3810	364	18083
Irrigated crop production	0	785	2432	240
Specialty crop production		18747		110
Pasture land	63	4179	5346	9016
Range land	7	927	5174	2977
Feedlots (Confined Animal Feeding Oper.)	14171	2207	6597	4792
Aquaculture			31	
Animal holding/management areas		60	690	1206
Silviculture	0	1744	239	177
Harvesting,restoration,residue managem't			182	333
Forest management			127	308
Road construction/maintenance			25	120
Construction	88	722	1325	1147
Highway/road/bridge/sewer line			704	2687
Land development/Suburbanization	297	1045	48	6668
Urban Runoff/Storm Sewers (NPS)	152	276	1479	2916
Non-industrial Permitted	241	2067	2004	1267
Industrial Permitted		183	100	2160
Other Urban Runoff	618	1964	832	1837
Mining	85			313
Surface Mining	85	539	227	3568
Subsurface mining	185		26	
Petroleum activities			1529	5009
Mine tailings			44	9
Acid Mine Drainage				900
Land Disposal				16
Sludge		12700	157	6
Wastewater				6
Landfills		40	957	2948
Industrial land treatment			157	
Onsite wastewater systems (septic tanks)	4249	940	15640	24211
Hazardous waste			10	5
Hydromodification - Agriculture		13		
Channelization - Agriculture		12821		96
Dam construction - Development				88
Flow reg./mod. - Development	900	180		
Removal of riparian vegetation - Ag		121		
Other	34			16
Atmospheric deposition		5385	1406	2580
Waste storage/storage tank leaks	80.00			
Highway maintenance and runoff				2010
Spills		3773	195	3229
Contaminated sediments	204	2404	1512	4526
Natural	648	13252	211	9014
Source Unknown	325			221

[1]Identification of summary source codes have not yet been implemented in lake assessments as they have for streams and rivers. “1000” level codes are not summary statistics, but are generic identification of soruces. This will be changed for the 2001 assessment effort,

Table 4-5. Relative assessment of causes of impairment (i.e., miles[1]) causing partial and non-support of designated uses along the Ohio Lake Erie shoreline. Major, moderate, and minor impacts refer to the high, moderate, and slight magnitude codes specified by the U.S. EPA guidance for the 305(b) report.

Cause	Magnitude			
	Major	Moderate	Minor	Threatened
Priority organics			0.50	
Nutrients	25.07	1.70		
Siltation	18.58			
Organic enrichment/DO	5.05			
Other habitat alterations	4.10	12.29		
Exotic species				27.80
Priority organics			0.50	

Table 4-6. Relative assessment of sources of impairment (i.e., miles[1]) causing partial and non-support of designated uses in Ohio Lake Erie shoreline. Major, moderate, and minor impacts refer to the high, moderate, and slight magnitude codes specified by the U.S. EPA guidance for the 305(b) report.

Source	Magnitude			
	Major	Moderate	Minor	Threatened
Point Source	12.29	3.28	2.20	
Industrial Point Sources		12.29	1.70	
Municipal Point Sources		3.28	0.50	
Major Municipal Point Source	12.29		1.70	
Combined Sewer Overflow		3.28	0.50	
Agriculture	17.83			
Nonirrigated crop production	17.83			
Urban Runoff/Storm Sewers (NPS)		3.28		
Non-industrial Permitted		3.28		
Industrial Permitted		3.28		
Other Urban Runoff			3.28	
Hydromodification - Development	4.10	12.29		
Habitat Modifications o/than Hydromod.	2.40			
Streambank destabilization - Dev	1.70	12.29		
Other	0.75			185.20

5. Toxics & Human Health

Although toxic compounds effect many fewer waters than they did a decade ago they are still a concern in surface waters in certain areas. The river miles, shoreline miles of Lake Erie, and acres of lakes, ponds, and reservoirs not meeting aquatic life uses due to toxic impacts are summarized in Table 5-1. We are conducting a new assessment of Lake Erie nearshore areas and lacustruaries centered on newly developed biological criteria. This assessment is not complete however and information on these important waters won't be complete until 2001.

A listing of waterbodies with toxic or public health concerns are listed in Appendix G for segments with fish tissue contamination, Appendix H for segments with sediment contamination, Appendix I for segments with high proportions of fish with external abnormalities, Appendix J for areas with elevated fecal coliform counts (streams and rivers only), and Appendix A for segments with fish consumption advisories. Many of these data are also presented here in map and graph form and form much of the basis for this discussion.

Toxicity due to ammonia-nitrogen is the leading cause in terms of the most miles of impairment due to non-priority toxics in Ohio rivers and streams. Toxicity due to heavy metals are the leading cause of non-attainment due to *priority* toxic substances in Ohio (Table 4-1). The toxic causes (major magnitude) of partial and non-attainment in Ohio are minor compared to the remain-

Table 5-1. Miles monitored for and impaired by toxics as a major cause of impairment of aquatic life use in Ohio rivers and streams, lakes, ponds, and reservoirs, and Lake Erie.

Waterbody Type	Size Monitored	Size Impaired
Streams/ Rivers	6,560	1,192
Lakes, Ponds, Reservoirs	85,379	733
Lake Erie nearshore	219.9	0
Lacustruaries	TBD	TBD

Individual waterbodies with elevated metals in bottom sediments are listed in Appendix H. The definitions of highly elevated and extremely elevated metals in sediment is based on deviations from Ohio reference site data (see Table 2-11).

The analysis of background conditions at least impacted reference sites provides; (1) the range of sediment concentrations at some of the same sites that are the prototypes for aquatic community performance expectations, (2) the ability to provide a framework or reference for

ing causes of impairment (Figure 5-1). It is clear that impairment is dominated by nonpoint source-related causes

Sediment Contamination

In-place contaminants, which consists primarily of heavy metal and organic contaminants, are a major source of impairment in only 36 miles of streams and rivers, but a moderate influence in 97 more. This is still less than the 187.9 major influenced miles recorded back in 1988. Many of the rivers and streams impaired by toxics in sediments are located within and downstream from the larger municipal and industrial areas of Ohio.

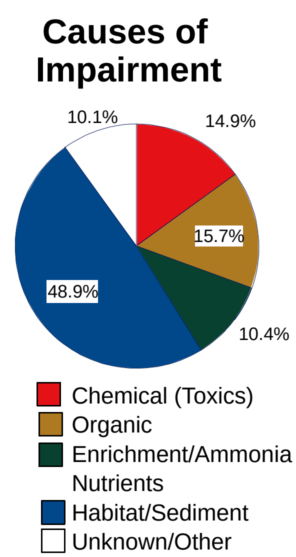


Figure 5-1. Major causes of aquatic life impairment in Ohio streams and rivers.

interpreting concentrations in lieu of toxicity based criteria, and (3) the ability to consider ecoregional differences in the interpretation of sediment chemistry results. Examination of sites that have high sediment metals concentrations in combination with biological community condition can provide information about threshold concentrations that are associated with impaired community performance. This work is incorporated into the framework used to interpret biosurvey results and in the assignment of causes and sources of impairment.

Fish abnormalities

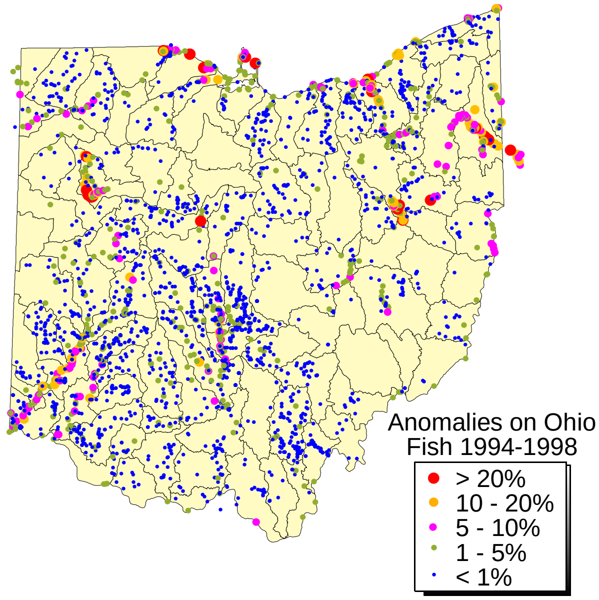
One important component of the biosurveys is the identification of external abnormalities (*i.e.*, deformities, eroded fins, lesions, and tumors) on fish. Information is also being recorded about macroinvertebrate anomalies (*e.g.*, head capsule, mouthpart, and antennae deformities).

Redhorse With Deformed Spine

External abnormalities in fish are strongly correlated with toxic conditions in streams and rivers and provide a useful diagnostic tool when used in combination with other community data dimensions. A discussion of the association of high rates of external abnormalities with the complex toxic impact type in Ohio was provided in the 1990 Ohio Water Resource Inventory (Yoder 1990) and elsewhere (Yoder 1991b).

Channel Catfish With Lesion

At the reference sites a very low incidence (*i.e.*, <0.1-1.0%) of external abnormalities is generally found. As chemical pollution and other stresses increase, the rate of external abnormalities generally increases reaching >10-50% in extreme cases. As gross pollution was abated in the late 1980s, intermediate and sensitive species (*e.g.*, redhorse spp.) reinvaded areas where they were previously absent. In some situations sublethal and marginal conditions continued to occur making these sensitive fish susceptible to moderate to high rates of external abnormalities. In the remaining grossly impaired areas many of the abnormalities are grotesque. Examples included even tolerant species (*e.g.*, carp, white suckers, bullheads) with no fins remaining, grossly deformed skeletal features, and eroded, deformed, and branched barbels. The last five years, 1995-1999, have shown the lowest rates of anomalies since we began recording them in the early 1980s (Figure 5-2).



Map 5-1. Anomalies on fish in Ohio streams and rivers collected from 1994 to 1998.

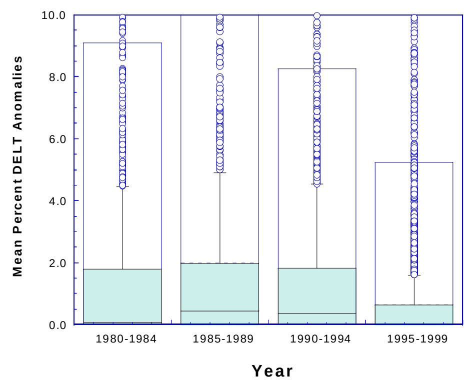


Figure 5-2. Median percent anomalies in all fish samples collected in four five-year periods up to 1999. The 1980 - 1984 period may underestimate anomalies because anomaly data was not yet collected at all sites early in this period.

Map 5-1 illustrates the rate of anomalies by stream site in Ohio from 1994-1998. The data illustrated on this map are also summarized in Appendix I.

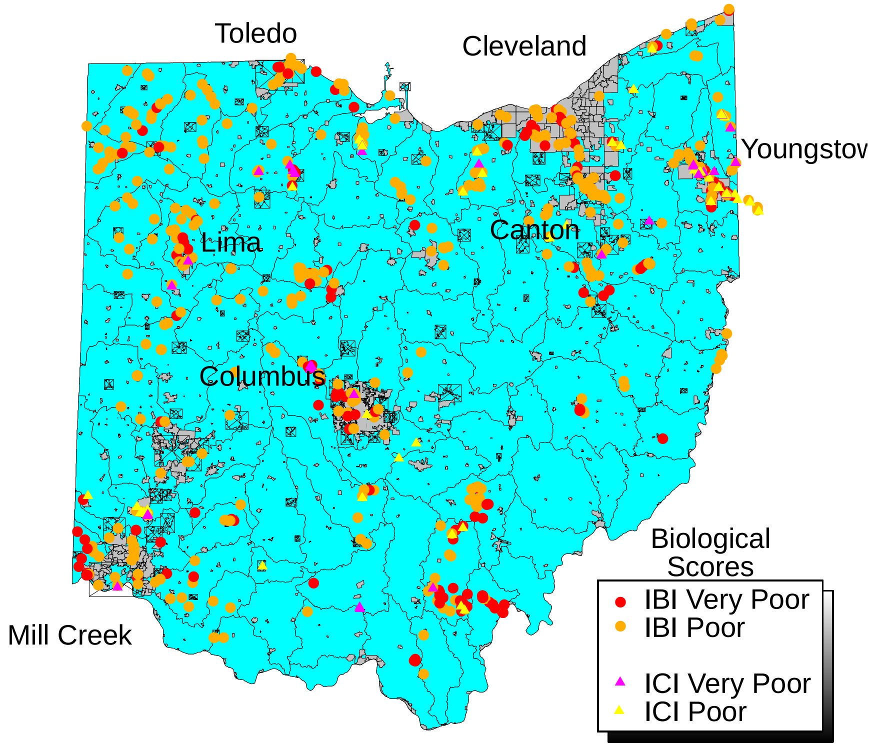
What is apparent from Map 5-1 is that the highest rates of residual abnormalities are found in urban

areas that contain or contained heavy industry. On this map point size increases with percent of external abnormalities. Although rates have declined there are still high rates in the lower Cuyahoga River (downstream from Akron), the Tuscarawas River (Massilon), the Mahoning River (Youngstown), Nimishillen Creek (Canton), the Ottawa River (Lima), the Ottawa River (Toledo), and the Little Scioto River (Marion) (also see Appendix I).

Areas that show the highest rates of external abnormalities are likely to be the areas of greatest risk to human health as well, especially where tumors, deformities, or other developmental problems indicate exposure to toxic compounds.

High rates of abnormalities are also associated with very poor biological performance (*i.e.*, biological index results near minimum values). Map 5-2 illustrates fish and/or macroinvertebrate results that score in the poor and very poor range. These locations are generally located in some of the same areas as the other indicators of toxic conditions (*e.g.*, elevated metals in sediment) for the reasons discussed above. This pattern includes the areas of Ohio that contain concentrations of heavy industry (*e.g.*, steel making, rubber and plastic, petroleum refineries, glass making, electroplating).

Habitat conditions can “push” fish communities into the poor range, however, it take generally takes toxic impacts to impair them to the very poor range. Although there are many fish sites rated “poor” away from urban areas, the preponderance of very poor sites are within the urban centers where toxic impacts are more likely a component of the stressors (Map 5-2).



Map 5-2. River and stream sampling stations in Ohio with poor or very poor fish and/or macroinvertebrate community performance based on data collected from 1994-1998.

Fish Kill Information

Fish kills can be useful indicators of waterbodies with chronic spill problems. An absence of reported fish kills alone, however, does not ensure satisfactory conditions. Streams that have infrequent or no reported fish kills may be severely impacted and have a predominance of tolerant species.

Map 5-3 (right map) illustrates the distribution of fish kills across Ohio since 1990 where electronic locational data was available. Although this distribution is fairly widespread there are clusters in the agricultural and western areas of the state and comparatively fewer in the southeast. An examination of the identified causes of reported fish kills (Figure 5-2) indicates that many of the causes are manure and fertilizer related. This pattern of kills also seems to be associated with the distribution of permitted

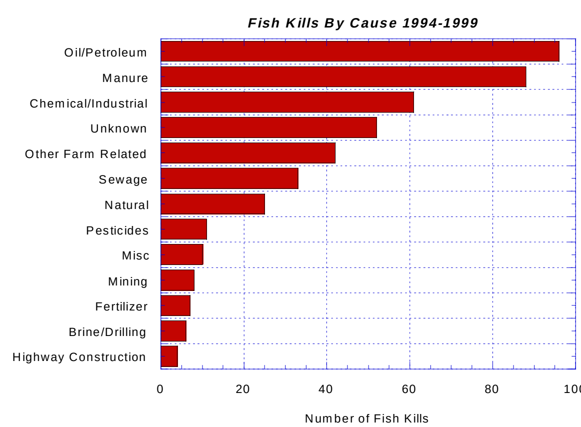
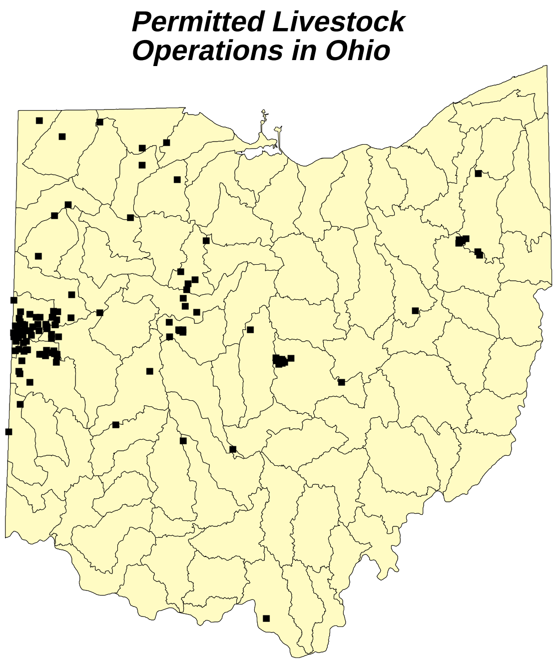
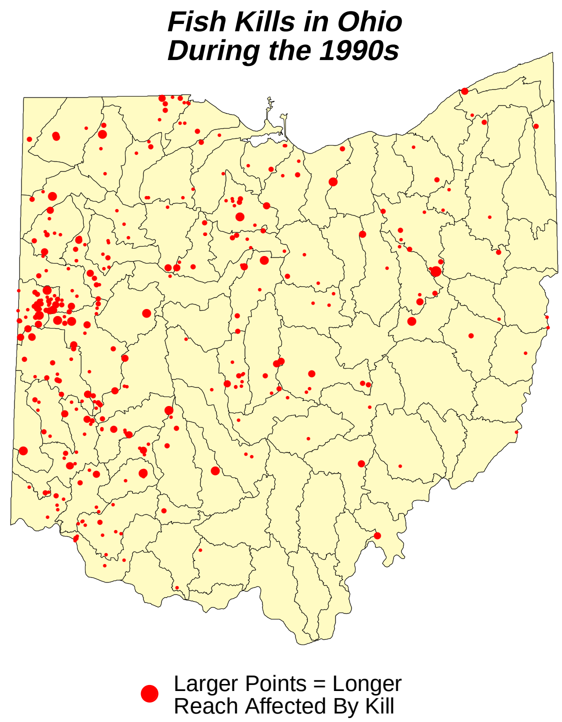


Figure 5-2. Number of fish kills reported in Ohio from 1994-1999 by reported cause category.





Map 5-3. Left: Location of permitted livestock operations in Ohio (greater than 1000 animal units). Right: Fish kills in Ohio in the 1990s where electronic locations are available.

livestock operations in Ohio (Map 5-3, left).

Besides the toxic impacts discussed above other types of pollution can also affect human health. Highly elevated and extremely elevated fecal coliform bacteria counts in Ohio streams and rivers during 1994-1998 are listed by waterbody in Appendix J. These impacts have direct effects on the recreational uses of these waterbodies and are another indicator of problems from spills, improper treatment of sewage, uncontrolled runoff, and combined sewer overflows.

Information on water quality (*i.e.*, high fecal coliform counts) advisories at public bathing beaches is limited to Lake Erie and state park beaches and is available from the Ohio Department of Natural Resources and the Ohio Department of Health. Postings are typically due to elevated levels of fecal coliform bacteria in excess of the bathing waters standard (200 ct./ 100 ml).

Fish Consumption and Human Body Contact Advisories in Ohio

There are three types of fish consumption advisories in Ohio:

1. *Do Not Eat* - Check the Appendix prepared by ODH or the web site of ODH first to find out if your catch is listed on this list. These fish have higher levels of contaminants, and should not be eaten.

2. *Meal Advice* - These fish have low levels of contaminants, but are safe to eat - provided the trimming, cooking, and meal frequency advice is followed.

3. *Statewide advisory for sensitive populations*. At present, this is for women of child bearing age and young children (age six and under) only. They are advised to eat not more than one meal per week of fish (any species) from any Ohio body of water, and not more than one meal a month, or one meal every two months if specified in the following table. This precaution pertains only to these sensitive populations. Anyone else should follow the consumption guidelines per species and per body of water.

4. *Dermal Advisory* - Another advisory is issued that cautions against dermal (skin) contact: The waters and/or sediments in these areas have high levels of contaminants. It is recommended that a person not swim or wade in these water body sections.

There are presently 61 fish consumption and/or primary contact advisories (Appendix A) in Ohio waters (12 Do Not Eat; 43 Meal Advice; and 5 Dermal Contact) plus the Statewide advisory for sensitive

populations. See Appendix F. or the ODH web site for more information.

Summary

Toxic impairments have substantially declined in Ohio over the past twenty years. Fox example the total miles attributed to toxic causes decline from 1,010 miles to 823 miles and as a proportion from 16.4% to 14.9% of impairments. If ammonia is considered a “toxic” compound the change is even more substantial with the miles attributed to ammonia declining from 633 miles to 81.

Our ability to detect toxic impacts of certain types is very good. The solutions to deal with some of these remaining impacts (e.g., CSOs, hazardous waster) will remain a challenge for the foreseeable future. In addition we need to continue looking for new, “unknown” toxic impacts that may be more difficult to detect. Toxic impacts will remain a high priority for the agency because of their risk to human and environmental health. As with other type of pollution impacts, pollution prevention if usually the best alternative to pursue. Pollution prevention measures to keep nonpoint related toxic stressors out of the water really start with avoidance of areas adjacent to streams that where runoff potential is high. These are also the ecologically most sensitive areas as well in most cases. In addition, areas adjacent to streams (e.g., floodplain forests, riparian areas) also provide economic reasons for avoidance. For example, it is clear that protecting these natural floodways reduces downstream flooding and enhances the quality and reduces treatment cost related to drinking water. Thus a focus on avoidance of these areas at all levels of government would provide substantial economic and environmental advantages for Ohio citizens.

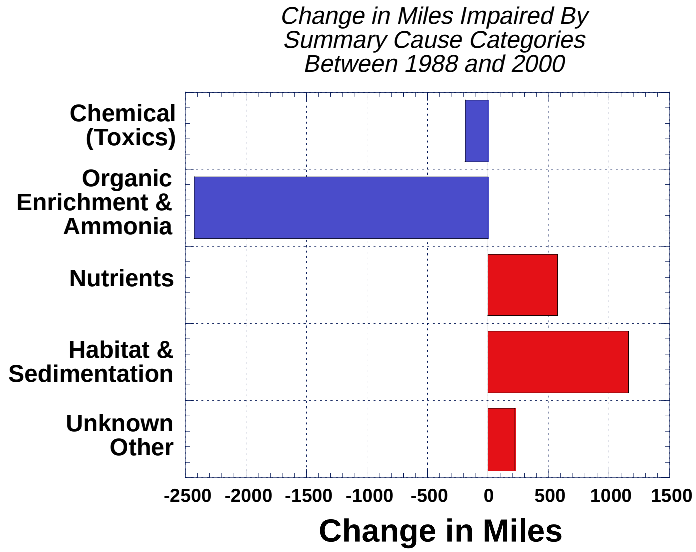


Figure 5-4. Change in miles impaired associated with various summary cause categories between monitored-level data in the 1988 cycle and the 2000 assessment cycle.

This section summarizes some selected programs in Ohio that are important in either protecting high quality waters, dealing with threatened areas or restoring impaired waters. In relation to threatened and impaired waters we expect the TMDL process to be an important tool for focusing all these efforts effectively in Ohio. The challenge for all program areas is to rise above programmatic barriers to focus on our common goals in the Agency's and Division's strategic plans of protecting, restoring, and enhancing water resource quality across Ohio.

Ohio EPA Nonpoint Source Assessment

Nonpoint source (NPS) pollution refers to water pollution that results from a variety of human land use practices. As a result, NPS pollution is controllable by implementing land management practices that protect and/or restore water quality as well as consider economic, social and political interests. These practices are often referred to as best management practices (BMPs).

The Ohio Environmental Protection Agency (Ohio EPA) is the designated state water quality management agency responsible for administering the Clean Water Act (CWA) Section 319 program in Ohio. In a broad context, NPS pollution control is a part of the Ohio EPA surface water quality program. However, NPS pollution control is administered as a distinct program because of the manner in which the federal CWA addresses the issue. Under CWA Section 319, the Ohio NPS Program emphasizes education, technical assistance, financial incentives and voluntary actions as opposed to regulatory mandates or permits. The success of the Ohio NPS Program to date is attributed to the fact that it is a program based on innovation, voluntary compliance, is geographically focused and involves a multitude of local, state and federal agencies working toward a common water quality goal.

Throughout Ohio, federal, State and local agencies are implementing NPS pollution control projects. The majority of these projects are implemented at the local level with technical support from federal and state agencies. These projects represent an investment of approximately $22 million of federal, state and local funds being used to address NPS water quality issues. Each year, DSW applies for and receives CWA Section 319 funding from U.S. EPA for NPS implementation and demonstration projects in Ohio. Education, innovation, cost-sharing and voluntary compliance with locally developed watershed management plans are the cornerstones of Ohio's NPS program.

The Ohio NPS program relies heavily on watershed management plans to address water quality problems. These plans emphasize: identification of the nature, extent, and cause of water quality problems; development of an implementation plan; implementation of BMPs; education and evaluation. The watershed management plans are developed locally with input and support from Ohio EPA, Ohio Department of Natural Resources (ODNR), Natural Resources Conservation Service (NRCS) and other agencies.

Ohio EPA's role in NPS pollution control is:

1.) identify adverse water resource impacts and threats caused by NPS pollution,

2.) document water resource improvements resulting from implementation of BMPs,

3.) provide education and financial incentives to implement NPS pollution controls,

4.) sustain a viable voluntary program for managing NPS water quality problems,

5.) maintain effective communication and coordination with all agencies, groups and individuals interested in NPS pollution controls, and

6.) secure and administer available federal funds and encourage local efforts in watershed management

A Guide to Developing Local Watershed Action Plans in Ohio

This guide is designed to assist citizens, citizen organizations, businesses and local governmental agencies start planning and implementing watershed projects.

The Guide describes how to:

1.) find the information and resources needed to create and implement a local watershed action plan;

2.) address multiple causes of water quality and habitat degradation in a watershed; and

3.) involve stakeholders from both inside and outside of government in a process of prioritizing problems and developing integrated solutions to them.

The Guide is a publication of the Division of Surface Water at Ohio EPA. It was written in cooperation

with the U.S.D.A. Natural Resources Conservation Service, the Ohio Department of Natural Resources, The Ohio State University Extension, Maumee Valley Resource Conservation and Development, Inc., and the Miami Valley Regional Planning Commission.

Livestock Waste Management

DSW formed a new unit in 1997 to address livestock waste management issues. This unit will handle all Ohio EPA surface water permits required by livestock operations (e.g. PTIs). In addition, the unit will respond to complaints and enable DSW to conduct additional inspections and provide better compliance assistance at larger operations. The state is also reviewing its current strategies for dealing with CAFOs.

Other NPS Efforts: Ohio Watershed Network

The purpose of the Ohio Watershed Network is to improve and protect Ohio's water resources through the creation of a statewide information and education network in support of local watershed protection efforts.

The project objectives are as follows: 1.) To provide training and other educational opportunities in organizational development and watershed management principles to new and existing watershed partnerships. 2.) To create a statewide information network using electronic and traditional media to facilitate communication and collaborative learning among watershed groups and their agency partners. 3.) To establish a library and electronic catalog of information and education resources about and for local watershed partnerships.

Ohio's Ground Water Quality

Ground water quality monitoring and data analysis of ground water quality data is summarized in the 2000 305(b) report as required in section 106(e) of the Clean Water Act. Programs to monitor, evaluate, and protect ground water resources in Ohio are carried out by various state, federal and local agencies. The Ohio Environmental Protection Agency (Ohio EPA) is the designated agency for monitoring and evaluating ambient ground water conditions and assessing ground water contamination problems for the State of Ohio. Within Ohio EPA, the Division of Drinking and Ground Waters (DDAGW) carries out the above functions, as well as coordinating various ground water monitoring efforts with other state programs through the State Coordinating Committee on Ground Water. The 2000 305(b) Ground Water Report provides DDAGW the opportunity to enhance our characterization of state-wide ground water quality through improved efforts in data quality and analysis, as well as meeting the 305(b) reporting requirements.

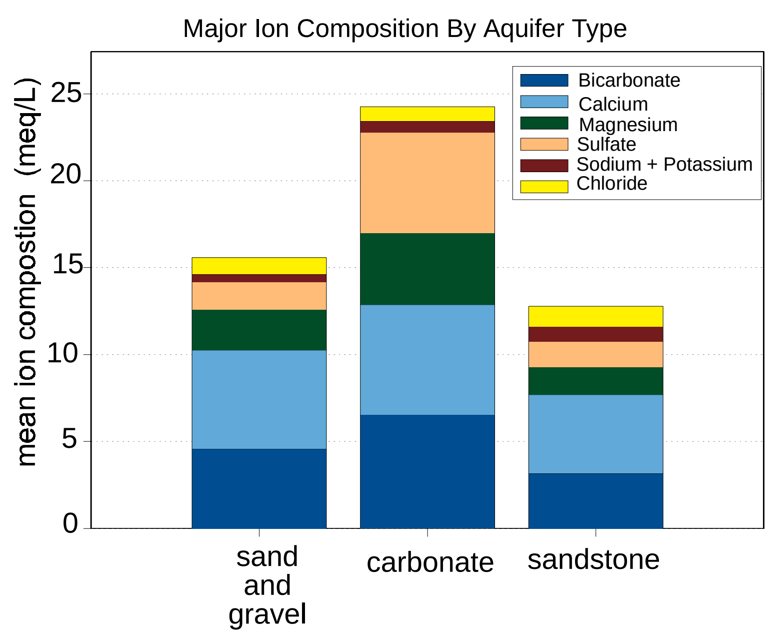


Figure 6-1

Characterization of the three major aquifer types in Ohio is consistent with U.S. EPA's request to assess water quality for selected aquifers or hydrogeologic settings within the State. The four summary tables: Major Sources of Ground Water Contamination; Summary of State Ground Water Protection Programs; Ground Water Contamination Summary; and Aquifer Monitoring Data; requested by U.S. EPA, however, are presented on a statewide basis. Currently we do not have sufficient locational information to associate contamination sites with aquifer types or hydrogeologic setting.

Two main databases are used to characterize Ohio's ground water quality in the 2000 305(b) Report.

The Ambient Ground Water Monitoring Network is the DDAGW program created to monitor "raw" (untreated) ground water. This program's goal is the collection, maintenance, and analysis of ground water quality data to measure changes in the quality of the State's major aquifer systems. The second database is the public water system (PWS) compliance data, which is compiled from information on treated (processed) ground water; thus these two data sources compliment one another.

Water quality from three main aquifer types are characterized in this report with supporting geochemical data for each aquifer type. The first aquifer is the sand and gravel aquifer system, which is superimposed on the bedrock of the eastern and southwestern portions of the state. These are Ohio's most productive and sensitive aquifers, forming thin bands of permeable unconsolidated material filling old river valleys cut by glacial meltwater and preglacial streams. The second is the sandstone aquifer system, found throughout the eastern portion of Ohio. These aquifers are characterized by gently dipping strata of sandstone, shales, and other units which yield moderate to high volumes of water, although in the southeast the yields may drop to low production levels due to the presence of interbedded shales, coals, and clays. The third major aquifer type is the carbonate bedrock, found in the western half of the state. These carbonates can be thick (up to 600 feet), and yield over 500 gallons of water per minute in fractured zones with solution channels.

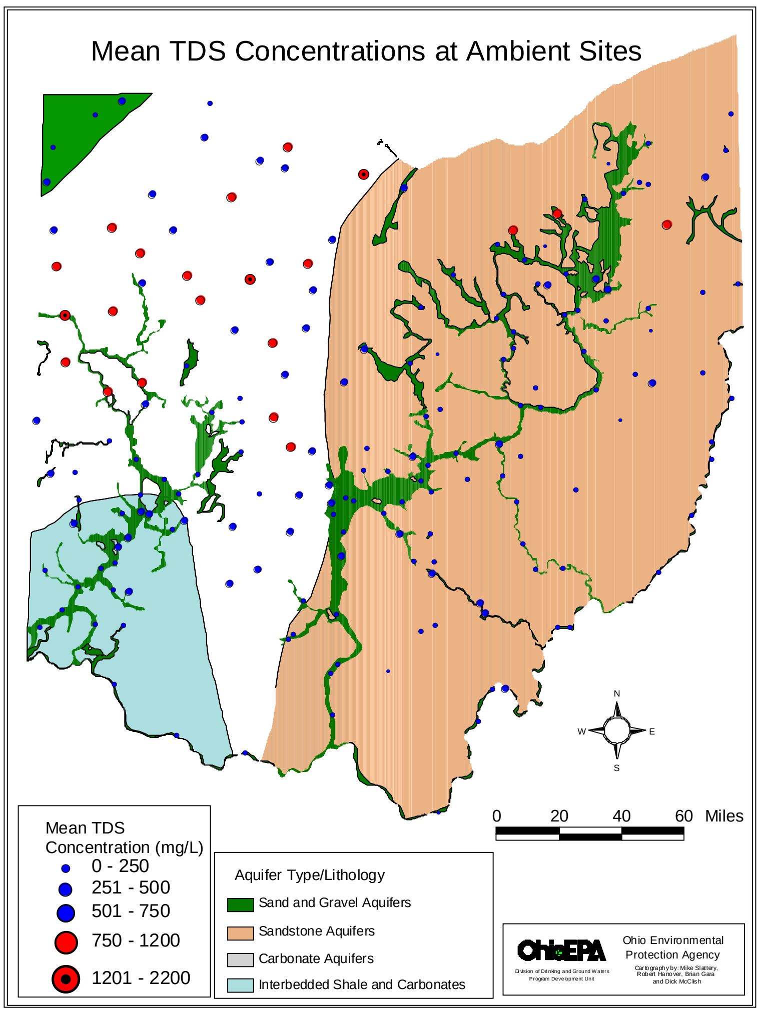


Figure 6-2

Ground water quality across the state is generally of high quality, and distinct water types are associated with each aquifer type. Figure 1 shows the mean major ion composition for the three major aquifer types in Ohio. The sand and gravel aquifer waters consist of a calcium-bicarbonate type water, while the carbonate waters are of the calcium-bicarbonate-sulfate type; these waters also have the highest total dissolved solids of the three aquifers. The sandstones are of the calcium-sodium-bicarbonate type.

As suggested by Figure 6-1, the carbonate system exhibits the greatest mean concentrations for sulfate, calcium, and magnesium, but also for TDS, alkalinity, strontium, iron, fluoride, hardness, and specific conductance. These higher concentrations may be related to longer residence times relative to the other aquifer settings, as well as availability of soluble gypsum and halite in evaporative sequences and other soluble secondary minerals found in fractures. Relative differences in ground water chemistry between aquifer types across the state is illustrated in Figure 6-2, which shows the mean TDS concentration at each Ambient site by graduated symbol size. The high TDS concentrations in the carbonate system are clearly visible in this figure. The association of higher TDS with the sand and gravel units than the sandstone is attributed to the rock composition associated with the

aquifers. The sand and gravel aquifers are dominated by carbonate rock debris deposited by glacial process, and consequently the.

Ohio's Source Water Assessment and Protection (SWAP) Program

Ohio's Source Water Assessment and Protection (SWAP) Program is an innovative program to protect Ohio's streams, rivers, lakes, reservoirs, and ground waters used for public drinking water from future contamination. Building on existing environmental assessment and protection programs, the SWAP Program will identify drinking water protection areas and provide information on how to reduce the potential for contaminating the waters within those areas. By focusing assessment and protection efforts on source waters, the Ohio EPA hopes to ensure the long term availability of an abundant supply of safe drinking water for existing and future citizens of Ohio.

The 1996 amendments to the Safe Drinking Water Act expanded the concept of source water protection developed through the WHP Program to all public water systems, including those based on rivers, lakes and reservoirs. The 1996 amendments added Section 1453 which requires every state to develop and submit a SWAP program to the U.S. EPA and to complete a source water assessment of every public water system. Specifically, the amendments require three steps to be taken for each public water system:

1.) Delineate the area to be protected (the SWAP area), based on the area that supplies water to the well or surface water intake;

2.) Inventory potential significant contaminant sources within the SWAP area; and

3.) Determine the susceptibility of each public water supply to contamination, based on information developed in the first two steps.

The SWAP process is currently underway in Ohio.

Division of Emergency and Remedial Response (DERR)

The DERR vision is to become distinguished as an economically self-sufficient multi-media team that administers a stream-lined, multi-faceted Emergency Response and Site Remediation Program as well as an exceptional, proactive Chemical Emergency Preparedness and Prevention program.

The Division's mission within the Ohio EPA is to prevent, respond to, remove and cleanup releases or threats of releases of hazardous waste, hazardous substances and pollutants through compliance monitoring, emergency response, enforcement, and voluntary actions.

The Division is comprised of 4 major environmental program areas: the Chemical Emergency Preparedness and Prevention Program, the Voluntary Action Program, the Remedial Response Program, and the Emergency Response and Special Investigation Program.

Prevention of pollution activities and Preparedness for handling releases of contaminants encompass the following programs:

Cessation of Regulated Operations (CRO) - this program is focused toward implementing rules that prevent environmental contamination that arise from closing industrial facilities. House Bill 98 is the authority for this program.

Spill Prevention Control and Countermeasures (SPCC) - this program is developing state rules under ORC 6111.03 to refine a program that helps industry prevent spills at our 54,000 oil production and storage facilities. The SPCC works with industry to identify where spills may occur and the proper methods of protection; thus preventing releases of contaminants from reaching Ohio's streams and rivers.

Polychlorinated Biphenyls (PCBs) - this program oversees the phaseout of PCBs from the environment by working with stakeholders to establish incentives for entities to prevent PCB spills through improved regulatory compliance and the phasing out of PCB containing equipment and processes.

Right-to-Know (RTK) - this program is named based on the Emergency Planning and Community Right-to-Know Act (EPCRA) which was enacted by Congress in 1986 in response to a concern that emergency responders and the public were not aware of the types and quantities of hazardous chemicals stored in their communities. Chapter 3750 is Ohio's equivalent to the EPCRA. It provides for a 3-tiered emergency planning and response hierarchy comprised of local fire departments, local emergency planning districts, and the State Emergency Response Commission (SERC).

Radiological Safety - under Chapter 4937 of the Ohio Revised Code, which required the creation of the Utility Radiological Safety Board (URSB) which includes the Ohio EPA, the Radiological Safety program was established.

This Board oversees, assesses, and evaluates safety procedures related to Ohio's two Nuclear Power Plant utilities and that of the neighboring Pennsylvania Beaver Valley Nuclear Power Plant. The Ohio EPA is tasked with providing environmental sampling teams to determine when re-entry into an evacuation area is appropriate

should an accident occur which releases radioactivity to the environment.

Removal and Clean-up activities are encompassed by the following programs:

Voluntary Action Program - this program implements the cleanup activities created by Senate Bill 221 in 1994. Under this program, a person or organization may voluntarily investigate and remediate, if necessary, a piece of property according to standards the Ohio EPA has promulgated in rules. The person or organization uses the services of professionals and laboratories certified by the Ohio EPA to ensure quality work.

Remedial Response Program - includes the Technical Program and Support Section (TPSS) and the Contracts and Remedial Enforcement Section (CRES). These programs use enforcement of existing law and regulations to ensure that contaminated land, air, or water is remediated. Often this long-term cleanup involves both private citizens or organizations, or potentially responsible parties (PRP's), as well as both federal and state EPA's.

Office of Federal Facilities - this program oversees the remediation of all Department of Energy (DOE) and Department of Defense (DOD) sites in Ohio by the year 2000.

Emergency Response and Special Investigations activities are encompassed by the following programs:

Emergency Response Unit (ERU) - provides 24 hour/day 365 day/year statewide coverage for emergency responses to releases of petroleum or hazardous substances.

Special Investigations Unit (SIU) - conducts investigations into alleged environmental violations that potentially constitute criminal activities.

Site Investigation Field Unit (SIFU) - specializes in environmental sampling and investigation of potentially contaminated sites.

Unregulated Hazardous Waste

Site Evaluations
Two staff in the Ecological Assessment Section (EAS) are funded and tasked by the Division of Emergency and Remedial Response (DERR) to conduct biological and water quality investigations of surface water resources that are potentially impacted not only by unregulated hazardous waste sites on the state priority list, but also Department of Energy radioactive materials sites and Superfund sites as well. These studies may include fish and macroinvertebrate community assessments, fish tissue sampling, sediment and surface water contaminant monitoring, along with evaluations of physical habitat conditions. The information collected is used in assessing environmental impacts from hazardous waste sites and as resource information for performing Natural Resource Damage Assessments. These staff members are also involved with a biomarker research project, a discussion of which follows. If this research is successful, biomarkers could prove to be a valuable tool in identifying causes and sources of impact by creating strong links to specific classes of pollutants and hence to specific sources. Along with the standard biological community and habitat information this has the potential for use in assessing situations for natural resource damage claims.

Wetlands Assessment/401 Water Quality Certifications

The Ohio Comprehensive Wetlands Strategy
In February 1994, the Ohio Wetlands Task Force published its Report and Recommendations for wetlands in the State of Ohio. The task force, made up of representatives of business, agricultural, environmental and conservation groups, universities, federal, state and local government agencies was convened by Ohio EPA. The Task Force Report and Recommendations included a statement of goals and objectives and recommendations to meet these goals.

The goal of the Task Force was to provide the framework in which the State can actively preserve, protect, and enhance wetlands, their functions and values, and encourage a gain in wetlands acreage, in a manner that balances the ecological integrity of wetlands with responsible economic development. The Report consists of a series of recommendations on different wetland issues facing Ohio. Six primary objectives were established to guide the development of specific recommendations, including:

• develop mechanisms to improve coordination of existing federal, state, and local regulatory programs so that there is clarity, consistency, timeliness and effectiveness
• strengthen state/local cooperation within the context of state wetlands goals and objectives;

• improve the quality and availability of information about Ohio's wetlands and wetland programs;

• educate landowners, developers, local governments and the general public about the importance of, and techniques for, preserving wetlands;

• identify, initiate, and support mechanisms for public and private preservation, restoration, and creation of wetlands.

• create consistent, adequate and flexible funding mechanisms for implementation of the above goals and objectives.

Recommendations on how to carry out these objectives were made as specific as possible, so that they would be more easily implementable. Strategies were identified as short term (1 - 2 years), intermediate term (2 - 6 years), and long term. Some of the key recommendations to state government include the following:

• a biennial report on the status and trends of Ohio's wetlands should be produced. Data should be organized by hydrologic unit and will include information on the losses and gains of wetland acreage, regulatory permit statistics, information on mitigation and restoration efforts, and tracking the implementation of other Strategy recommendations;

• development of a state wetland restoration policy goal. The Strategy proposes an interim goal of a gain of 50,000 acres of wetlands and riparian ecosystems by the year 2000, and an overall goal of 400,000 acres to be restored or created by the year 2010;

• develop educational materials including a Private Landowners Wetlands Assistance Guide: Voluntary Options for Wetlands Stewardship in Ohio, Wetlands and Watershed Management, and a Guide to Existing Wetland Regulations;

• an array of suggestions were made to create consistent, adequate and flexible funding mechanisms in order to implement the recommendations of the Strategy.

Implementation of many of the recommendations of the Task Force is underway. Highlights of the implementation process include development of a coordinated wetlands program by Ohio EPA and the Ohio Department of Natural Resources (ODNR), described below. 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. These and other program developments are discussed below.

Ohio Wetlands Programs

The Ohio EPA and the ODNR have developed a common strategic plan for the wetlands programs in the State of Ohio. The strategy includes a vision statement, a mission statement, guiding principles and indicators of success to guide agency work over the next five years.

The vision that Ohio EPA and ODNR share for wetlands in Ohio is that the ecological functions and values of Ohio's wetlands will be optimized for the benefit of the people of Ohio based on a strong foundation of knowledge, public support and sound science. To do this requires common agency missions to effectively manage, restore, protect, and expand wetlands by developing an understanding of wetland resources; developing public support and understanding; and utilizing new and existing educational, regulatory, and incentive programs.

Six indicators of success have been developed to specifically guide the implementation of the strategic plan. They include enhanced coordination and timely decision making by Ohio EPA and ODNR, creating an inventory of high quality wetlands in the state, working toward a net gain in wetland acreage, and increasing outreach on new and existing wetland programs. Action plans have been developed to move ahead with these indicators of success.

National and Statewide Wetland Inventories

There are two inventories of wetland acreage in Ohio. The National Wetlands Inventory (NWI) was initiated by the U.S. Fish and Wildlife Service (U.S. FWS) in the late 1950's. To date all aerial photos used to produce the maps have been photointerpreted for Ohio. Maps have been produced for most of the State's land area, excluding a small portion of the central Ohio area.

In addition to the NWI, 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. For example, all woodlands in Ohio were identified from the Landsat imagery; any of those occurring on hydric soils are presumed to be wet woodlands. In 1994, NRCS personnel finalized a review of the draft maps for each county. This completed the first edi-

tion of the OWI. The wetland inventory will be used to help implement the Swampbuster provision of the U.S. Farm Bill. The inventory will also provide planning information for both wildlife management and water quality management.

Programmatic Developments Concerning Wetlands

Ohio EPA has received several wetlands program development grants and a watershed management grant from U.S. EPA. As a result, five projects are in progress including the development of water quality standards for wetlands, the development of rapid assessment techniques in conjunction with the development and testing of wetland environmental indicators, a pilot project to test 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. These program developments are discussed in more detail below.

Water Quality Standards for Wetlands

Ohio EPA protects water quality in streams, rivers, and lakes using water quality standards consisting of aquatic life use designations, numerical chemical and biological criteria, narrative criteria and an antidegradation policy. Ohio EPA currently meets some of the minimum federal requirements for wetland water quality standards by including wetlands in the definition of waters of the state and by applying the antidegradation policy to wetlands.

In order to fully extend the protection of the Clean Water Act to wetlands, Ohio EPA is developing wetland water quality standards. A wetland use designation has been drafted to protect the beneficial functions of wetlands. Narrative criteria to support the uses and an antidegradation policy specifically for wetlands have also been drafted. As recommended in the Ohio Wetlands Task Force Report and Recommendations, a series of meetings was held with a Technical Advisory Group to provide review and comment on the technical and ecological soundness of the first draft of the standards. A second draft of the standards is currently being reviewed by, and discussed with, a larger Public Advisory Group. It is anticipated that the standards will be promulgated in the Spring of 1997.

The draft wetland water quality standards propose that the quality of a wetland be objectively evaluated using a rapid wetland assessment method. 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.

The proposed rule will be used to evaluate requests for 401 water quality certifications, and other water program permits, and will do the following:

• acknowledge that all wetlands are not the same. Different wetlands have different functions and values and this is reflected in the wetland categories and the review criteria that will be established. The rules

are intended to protect wetlands that provide important functions while allowing reasonable use of areas that are less critical;

• codify the existing project review procedures so that the public will be informed of the decision making process and will be able to plan accordingly. For example, mitigation requirements for on-site verses off-site (including mitigation banks) will be specified.

• establish a sliding scale of mitigation requirements that will result in the replacement of wetlands that are destroyed.

• increase the effectiveness and efficiency of the 401 program.

Development of Ecological Indicators and Rapid Assessment Methods for Wetlands

While information has been compiled on the quantity of wetlands in Ohio, there is little information regarding their quality. Pollutants contained in agricultural and urban runoff, which have very significant effects on other surface waters in the state, undoubtedly act to degrade wetland quality, as do hydrological modifications in the watershed. Both chemical and biological criteria have been developed to support the water quality standards for rivers and streams. While wetlands are protected under the Water Quality Standards, the biological criteria and use designations were not developed for wetland

ecosystems and therefore often have limited applicability.

As described above, Ohio EPA is developing water quality standards for wetlands to rectify this situation. The full implementation of these standards depends on the collection of baseline water quality and biological data in representative reference wetlands.

To this end we are presently studying wetlands throughout Ohio to establishing reference wetlands and identifying potential indicators of wetland integrity and/or impairment. The goal is to develop biological criteria for wetlands using vascular plants, macroinvertebrates, and amphibians as indices of biotic integrity (IBIs) for eventual adoption into the state's water quality standards.

The IBI values will then be used to calibrate the Ohio Rapid Assessment Method for Wetlands to support regulatory decision making under the state's Wetland Antidegradation rule, which requires that wetlands be assigned to one of three categories based on the wetland's quality and functionality.

The initial objective of this study is to provide the reference data needed to implement the wetland water quality standards and wetland antidegradation rule. The pilot metrics developed from this study should enable Ohio wetlands to be assigned to one of the three regulatory categories. Generally, the study objectives are as follows:

1.) To develop pilot biological metrics that may be used to evaluate the function and ecological integrity of a wetland. These metrics will be based on the vegetation, macroinvertebrate, and amphibian data, and will form the basis for wetland biocriteria.

2.) To identify and describe reference wetlands in the Ohio's four main ecoregions: Eastern Cornbelt Plains, Erie/Ontario Drift and Lake Plain, Huron-Erie Lake Plain, and Western Allegheny Plateau. These reference wetlands will be used to develop biocriteria and will also be used as “goals” for wetland mitigation projects.

3.) To continue to assess whether the Ohio Rapid Assessment Method correlates well with the more in-depth measures of wetland quality, and to test and refine breakpoints between the wetland categories.

4.) To begin to assess the sensitivity of different methods in evaluating the relationship between wetland quality and the degree of disturbance.

The key part of Ohio's current regulatory program for wetlands is found in the wetland antidegradation rule. The wetland antidegradation rule categorizes wetlands based on their functions, sensitivity to disturbance, rarity, and irreplaceability, and scales the strictness of avoidance, minimization, and mitigation to a wetland's category. Three categories were established:

Category 1: Wetlands with minimal wetland function and/or integrity.
Category 2: Wetlands with moderate wetland function and/or integrity.
Category 3: Wetlands with superior wetland function and/or integrity.

In order to implement the wetland standards and antidegradation policy, wetlands must be assessed on their relative quality. Ohio EPA has developed a draft Ohio Rapid Assessment Method. The Ohio Rapid Assessment Method has proved to be a fast, easy-to-use procedure for distinguishing between wetlands of differing quality. It does not and was not, however, intended to substitute for direct, quantitative measures of wetland function (i.e., biocriteria).

Ohio began development of sampling methodologies and began sampling reference wetlands for biocriteria development in 1996. To date, Ohio has sampled 56 wetlands located primarily in the Eastern Cornbelt Plains Ecoregion located in central and western Ohio. These wetlands have included depressional emergent, forested, and scrub-shrub wetlands, flood plain wetlands, fens, kettle lakes, and seep wetlands. The wetlands being studied span the range of condition from “impacted” (i.e., those that have sustained a relatively high level of disturbance) to “least impaired” (i.e., the best quality sites available).

Based on the results to date (See Fennessy et al., 1998a 1998b; Mack et al., unpublished data), Ohio's research supports the use of vascular plants, macroinvertebrates, and/or amphibians as biological metrics in wetlands, and also the continued use and development of the Ohio Rapid Assessment Method as a rapid assessment tool.

This work has been funded since 1996 by several EPA Region 5 Wetland Program Development Grants.

Study Design

Fifty-seven wetlands were sampled during the 1996, 1997, 1998, and 1999 field seasons. The first two years of data laid the groundwork for standardizing sampling methodologies, classifying wetlands, identifying potential attributes and developing metrics using vascular plants, amphibians, and macroinvertebrates.

In 1996, Ohio EPA monitored a series of riparian forested across a

gradient of disturbance (i.e., least impacted to impaired) (Fennessy et al., 1998b). Estimates of the relative level of disturbance were made on a scale of 1 (most disturbed) to 10 (least disturbed), based on visual evidence of disturbances, review of aerial photographs of the wetland and the surrounding area, and interviews with staff from the Natural Resource Conservation Service and/or the landowner. In 1996 and 1997, Ohio EPA monitored 21 forested and emergent depressional wetlands. Relative disturbance was evaluated using a tiered flow chart to assign a relative disturbance score and also with the score from the Ohio Rapid Assessment Method (Fennessy et al., 1998a, Figure 2.2).

Ohio EPA found a good correlation between the scores of the Ohio Rapid Assessment Method score and level of disturbance a wetland site has experienced. Higher ORAM scores correlate well with lower levels of disturbance based on our model, as do lower ORAM scores with disturbed sites. In 1999, the ORAM score of the site was used as measure of the level of disturbance. So far, this appears to be a highly effective “x-axis” disturbance gradient for the development of IBIs for wetland plants.

Reference wetlands are sites or data sets from sites that typify a class of wetlands within a relatively homogeneous physiographic region. Reference sites should include wetlands that have been degraded or disturbed. Site selection in this study is made using an ecoregional approach and to reflect a gradient of disturbance (i.e., least impacted to impaired).

Lessons Learned for Macroinvertebrates and Amphibians

1.) Funnel traps consistently collected an average of ten more macroinvertebrate taxa than qualitative sampling using dip-nets. Funnel traps were much more effective in sampling amphibians and fish than sampling with dip nets.

2.) Qualitative sampling collected somewhat more Mollusca and Chironomidae taxa than funnel traps.

3.) Funnel traps collected more leech taxa, Hemiptera taxa, Coleoptera taxa, Odonata taxa, and Crustacea taxa than qualitative sampling.

4.) Hester-Dendy artificial substrate samplers were ineffective for sampling most wetland macroinvertebrates except oligochaetes, Chironomidae, and Mollusca.

5.) A 24-hour sampling period for funnel traps is preferred as it allows for the collection of nocturnal species that are infrequently collected by daytime sampling methods.

Floristic Quality Assessment Indexes

Ohio EPA has found that the FQAI score and subscores of the FQAI, e.g., percent coverage of plants with Coefficients of Conservatism of 0, 1, or 2, is a very successful attribute and metric for detecting disturbance in wetlands (Figures 4 and 5).

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 under development 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.

The Cuyahoga RAP Habitat Committee has identified the need for a method to identify potential wetland restoration sites. Now in Stage Two, the RAP is investigating the role of wetlands in remediation of the beneficial use impairments which were identified in the Stage One Report. Both the size of the watershed and the many characteristics which influence the potential for restoration success at a given site make it advantageous to automate these procedures with a GIS.

This project is taking a two-stage approach, namely:

- the development of criteria needed to select and prioritize sites where the potential for successful restoration is high (including such factors as soils, land use, topography, and riparian zone characteristics);

- the use of these criteria to systematically analyze (using the GIS) the placement of wetland restoration sites that will maximize water quality and habitat benefits.

This data will be used to identify those areas which have the most suitable characteristics and therefore the highest probability of success in a restoration program.

As part of the Ohio EPA’s watershed approach for managing water quality programs in a geographically organized manner, the Division of Surface Water (DSW) recently secured USEPA funds to develop a method 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. The results of this project will also be used to assist in the selection of watersheds for wetland mitigation banks and to develop watershed management plans for local watersheds. This project will also allow an assessment of the landscape function of wetlands. We will explore the relationship between wetland area, type and location (for example, headwater versus mainstem) and water quality attainment for incorporation into the Ohio Wetlands Status and Trends Report.

The relationship between the extent and spatial distribution of wetlands and the stream network will be systematically analyzed. Available data on the stream network, such as stream flow characteristics and water quality indicators (both chemical and biological) will also be included. The synoptic approach to cumulative impact assessment will be used as one means to structure data analysis (see Leibowitz et al. 1992). This approach was developed so that information on cumulative impacts to wetlands could be included in the Section 401 certification review process. It has wider application, including prioritizing wetland protection and restoration efforts.

Status and Trends Report

The development of a Status and Trends Report on Ohio's wetlands called for in the Ohio Wetlands Task Force Report and Recommendations will be used to track alterations to wetlands through the Section 401 water quality certification program and restoration effort. A computerized data base is being established to monitor wetland-related activities by hydrologic unit. This will include tracking losses and gains of wetland acreage, a chronology of application processing, information on regulatory permit statistics and information on mitigation and restoration efforts. This will also facilitate production of future 305(b) reports.

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. Wetlands are specifically included in the definition of waters of the state in the Ohio Revised Code 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.

Wetlands will retain their classification as State Resource Waters under the existing antidegradation rule until the new wetland water quality standards, which includes a new wetland antidegradation rule, is adopted.

Wetland restoration, creation and enhancement carried out as mitigation for wetland fills is currently done at a 1.5 to 1.0 in-kind ratio. Monitoring of water quality, sediment, vegetation establishment, and hydroperiod is required for a period of 5 years. In the third year of the monitoring period, Ohio EPA has the opportunity to make recommendations to enhance the successful establishment of the mitigation project in order to maintain and improve water quality. These monitoring requirements may be revised as part of the development of performance goals for mitigation wetlands.

The Ohio EPA responds to frequent citizen complaints of unauthorized placement of fill materials into wetlands and other waters of the state. Ohio EPA investigates the complaint and generally notifies the alleged violator of their responsibilities under federal and state law. Section 401 certifications are required for dredge and fill activities affecting both streams and wetlands.

The involvement of the Ecological Assessment Section in the evalua tion of proposed activities that require a 401 water quality certification has been substantial since the adoption of numerical biological standards for streams and the attendant field evaluation techniques. Use of these criteria is presently the only means by which Ohio EPA can protect lotic habitat quality statewide. Although Ohio EPA is occasionally requested to participate in the review of petitioned ditch projects performed under the Ohio Drainage Law (ORC 6131), no other means exists to protect aquatic habitat.

Specific examples of the use of biological criteria and habitat assessment in reviewing 401 certification applications have included stream channelization projects, surface mining, hydromodification (dam construction), and damage assessments for unauthorized activities. Biological criteria are especially useful in this process since habitat is a predominant factor in determining the ability of a lotic system to support a structurally and functionally healthy assemblage of aquatic life. Furthermore, by using the result of the work that supported the development of the Qualitative Habitat Evaluation Index (QHEI; Rankin 1989), the biological consequences of projects involving the degradation of lotic habitat can be predicted. This allows Ohio EPA to prevent unnecessary degradation of aquatic habitat and communities.

Mitigation Assessment and Development of Performance Goals

As part of Ohio EPA's long-term development of the wetlands program, performance goals for mitigation projects are being developed. Mitigation for approved wetland fills is allowed under the 401 program. It is essential in authorizing this practice that wetland mitigation projects successfully replace the functional values of the filled wetlands. Currently there is no means (at the state or federal level) to rapidly assess the functions of mitigation wetlands relative to natural wetlands. Performance goals will be used to define criteria for successful mitigation projects and allow an assessment of their performance. They can also serve to evaluate reasons for mitigation project failure and to suggest mid-course corrections, if necessary. Data gathered in the proposed wetlands biomonitoring program will be essential in defining the criteria for success.

One of the objectives of this project was to assess how well compensatory mitigation is working in Ohio by comparing a series of mitigation and natural (or reference) wetlands. All mitigation wetlands included in the study were permitted through the section 404/401 program. Quantitative measures were taken to assess plant community structure, wetland size and basin morphometry, and soil characteristics. Qualitative measures were taken on wildlife and buffer area characteristics. Identical measurements were taken on a population of reference wetlands for comparison. In all, 14 mitigation wetlands and 7 reference wetlands were visited but only those projects which were, at minimum, in their second growing season were included in the analysis. Reference wetlands were selected in the same Cowardin class (Cowardin et al. 1979) and hydrologic unit (as defined by USGS, 1988) as one or more of the mitigation wetlands. The final report on this project will be available in early 1997.

Lake Erie Programs

There are a number of efforts ongoing to evaluate the status of the Lake Erie nearshore. Some of these are summarized here.

Development of a Lakewide Management Plan (LaMP) for Lake Erie began in 1994. The original intent of LaMPs, as cited in the Great Lakes Water Quality Agreement, is to reduce the loadings of toxic pollutants that are causing the impairment of beneficial uses in the waters of the Great Lakes. However, it is widely felt that there a number of stressors, in addition to toxic chemicals, that impact the lake. These include habitat destruction, the invasion of exotic species, overfishing and others. Therefore, the Lake Erie LaMP will address these as well. Currently, an assessment of beneficial use impairments is underway as well as development of ecological objectives for the Lake.

As the Lake Erie LaMP progresses, data gaps will be identified and addressed allowing a much stronger data base against which to assess the water quality of the lake. Ongoing chemical and biological assessments of direct Lake Erie dischargers need to be continued to ensure that NPDES limits are protective of the environment and public health.

Ohio EPA has developed draft biological criteria for the Lake Erie estuary, harbor and nearshore areas. These are similar to those developed for Ohio's inland streams and rivers, but use metrics and evaluation tools appropriate for these areas. Three years of data collection and method development have been completed. It is expected that a fourth year will be needed to finalize the criteria.

Ohio EPA has spent considerable time during the past two years reviewing and commenting on the U.S. EPA Great Lakes Water Quality Guidance (GLWQG). The initial phase focussed on specifying numerical limits for pollutants in ambient Great Lakes waters to protect human health, aquatic life and wildlife. It also provided guidance to the Great Lakes States on minimum water quality standards, antidegradation policies and implementation procedures for the Great Lakes System. Ohio EPA is currently developing revised standards and implementation procedures. Ohio also hopes to use the Lake Erie LaMP to further address some issues of concern that the state has when using just the GLWQG.

Under the Great Lakes Governors Toxic Substances Agreement, an interagency work group has drafted a protocol for a uniform Great Lakes sport fish consumption advisory. Based on this protocol, Ohio has issued a revised fish advisory for Lake Erie. In some ways it is now more restrictive, and in often ways it is less restrictive. Either way, the advisory is now more risk based and provides a better guidance for consumers deciding when to eat their catch.

The invasion of exotic species in Lake Erie, particularly the zebra mussel, have significantly impacted the dynamics of the lake. Numerous studies are underway to better quantify these impacts and document any effect zebra mussels may have on the systematic processing of toxics in the lake. This includes investigating whether toxics are more available for uptake, whether toxics bioaccumulate more quickly at the top of the food chain, and whether the organisms may be altering the biological community to support less desirable species.

The state of Ohio has authorized an extensive fish tissue sampling program to be implemented across the state to provide better information on which to base the need for issuance of fish advisories. A number of Lake Erie tributaries are included in the sampling schedule.

RAPS

There are four Remedial Action Plans (RAPs) in Ohio: Ashtabula River (USEPA), Black River, Cuyahoga River, and Maumee River. Ohio EPA is responsible for ensuring RAPs are implemented in Ohio. These areas are the State's most polluted and environmentally impacted rivers which empty into Lake Erie. Ohio's Remedial Action Plan Program (GLIN) addresses the restoration of beneficial uses (GLIN) in Ohio's four Lake Erie Areas of Concern (AOC) (GLIN). As requested in the Great Lakes Water Quality Agreement, (IJC) the RAPs take an ecosystem approach and incorporate active public involvement.

Year after year, the same locations were identified as the most contaminated areas around the Great Lakes. The adoption and implementation of environmental laws and regulations significantly reduced the discharge of pollutants, but these areas continued to experience severe environmental degradation. In 1985, the Water Quality Board of the International Joint Commission (IJC) recommended the development of comprehensive remedial action plans (RAPs) to concentrate

Basic Tenants of the RAP Process in Ohio

Empowering the local communities with Ohio EPA as an equal partner.
Community participation promotes local ownership.
Participation of professional planners.
Top-down commitment.
Keeping RAP needs and accomplishments high profile.
Creating a separate identity.
Staff enthusiasm, dedication, and creativity.
Volunteer enthusiasm, dedication, and creativity.
Developing partnerships with existing programs.
Constant communication at all levels.
Extensive efforts to seek funding.
Setting milestones to encourage enthusiasm rather than unrealistic goals that generate frustration.
Strategic planning.
Numerous efforts to keep the public informed, aware and involved.
Keeping state and U.S. elected officials apprised of RAP efforts.

on the cleanup and restoration of these areas. New, creative, innovative, collaborative and wide-reaching approaches would be needed to achieve this goal. The eight Great Lakes states and Ontario agreed to the challenge and Ohio EPA took the lead for the program in Ohio.

Neither the State nor Federal Governments had sufficient resources, the historical knowledge, or even the authorities to restore all the impairments identified. Ohio EPA invited the local communities to become active participants in the decision-making involved with the RAPs. Initial public meetings on the RAP process and the outstanding environmental problems in each AOC were held in 1987. At those meetings, the local communities showed a great interest in taking a strong role in restoring their rivers.

Local committees have been created in each of the areas to coordinate the development and implementation of the RAP. Ohio EPA works with these committees as an equal partner in the RAP process. The local committees have been built with the intention of obtaining representation from all of the local agencies, organizations, and unaffiliated citizens with an interest or a stake in river remediation.

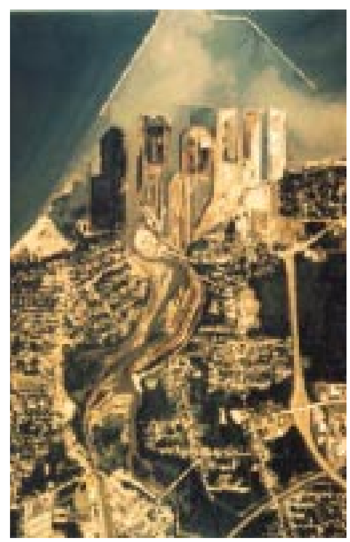
Each of Ohio's RAPs has been organized somewhat differently, depending on the unique characteristics of each AOC. These characteristics include: environmental problems in the AOC, sources and causes of the problems, available resources - both technical and financial, political climate, public interest, and the volunteer base. The ecosystem approach and the public involvement requirements of the RAP process have allowed us to be as flexible and innovative as we need to be to restore all beneficial uses to each AOC. With funding from U.S. EPA and the State, Ohio EPA has been able to support a full-time coordinator for each RAP. However, much cross-program technical assistance has been provided by staff from several divisions and districts. This agency-wide cooperation has been invaluable to the RAP program. Promotion of the concepts in the sidebar above by Ohio EPA have lead to an effective RAP program in Ohio.

Since 1988, Ohio EPA has been working toward completion of remedial action plans (RAPs) for Ohio's four Lake Erie Areas of Concern (AOCs). These include the lower Ashtabula, Cuyahoga, and Maumee rivers, and the entire Black River watershed. Also a requirement of the Great Lakes Water Quality Agreement, RAPs are to be developed through a systematic, ecosystem approach with a considerable amount of local community involvement. Considerable progress has been made on RAPs, and outlooks for each area are presented below. Much more detail is provide on web sites that summarize the beneficial use impairments, agreements. etc.

Ashtabula River

Web Site:
http://www.epa.gov/glnpo/aoc/ashtabula.html.

Since 1994, the Ashtabula River public/private partnership process has been very successful generating seed monies, completing relevant studies and making steady progress toward implementing its RAP. Futhermore, the partnership is committed to maintaining a high profile around the Great Lakes region. Much of the success in these areas may be attributed to the organizational structure of the partnership and its use of the combined expertise, knowledge, experience, networks and resources of its many partners. Research efforts into understanding the complex nature of the river ecosystem continue, and will help focus RAP actions in the future. A comprehensive community outreach strategy will continue to be employed to ensure public and



community involvement in the RAP.

Current priorities of the RAP Council and Partnership include

- conduct public outreach to various target groups about the RAP;
- complete and distribute the draft CMP/EIS for formal public review and comment in late 1997;
- develop and distribute a survey for 400 (more) registered county voters to poll community awareness and attitudes about river cleanup efforts and their willingness to pay for cleanup; and,
- hold a fish fry for Ashtabula Township Association members to raise awareness of the efforts to clean up the river and gain their support of same.

The RAP Council continues to look at other issues in the AOC as well, such as habitat enhancement and restoration. RAP members are presently discussing installation of low-tech inexpensive fish spawning structures in non-polluted river slips, as a mini-pilot project, prior to fullscale river cleanup.

Like the Cuyahoga River RAP, Ashtabula River stakeholders are actively pursuing designation of the Ashtabula River as an American Heritage River. The historical, cultural, economic and environmental significance of this river, as well as its past, present and future economic impacts on the nation, make it a worthy candidate for such recognition. Because of the perseverance and diligence of many stakeholders, the Ashtabula River "river of many fish" will once again teem with a diverse and healthy biological community

Black River

Web Site:
http://www.epa.gov/glnpo/aoc/blackriver.html

Properly managing urban, suburban and rural land use practices along the Black River through protection of the riparian corridor will improve the quality and productivity of this valuable natural resource. One area that will benefit from riparian protection once nonpoint source pollution is controlled is the lower 6-8 miles of the Black River (known as the lacustuary area). Within the Black River lacustuary area, the effects of point source pollution have been minimized to the level that the overall water quality and fish communities are on the verge of recovery. This is due to the closing of the USS/Kobe coke facil-

ity in the early 1990's and the upgrading of the Elyria Waste Water Treatment Plant. As a result, the overall water quality of this area (which includes the aquatic habitat) is nearing environmental recovery. If the local communities along the Black River continue to reduce the nonpoint source pollution nutrient loadings entering the lacustuary by protecting upstream riparian corridors, and do not encroach on the lacustuary's physical structure, algal abundance (feeding upon the nutrients) will decline, the re-establishment of aquatic vegetation will occur, and high quality fish communities with abundant sport fish species and rare and endangered species will return. In addition, to the benefit of the sports fishing industry and endangered fish species, this area of the Black River could be known as a unique high quality environment and attract visitors and recreationalists from throughout the Lake Erie area.

The Black River RAP and its community partners have been making a difference. Through the support of the Riparian Corridor Resolution, the Communications/Education Programs, the Black River RAP with its community partners have fostered a new and heightened awareness to protect this area is already occurring.

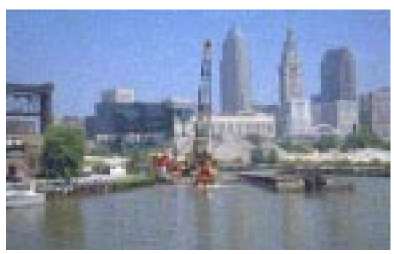
Cuyahoga River

Web Site:
http://www.epa.gov/glnpo/aoc/cuyahoga.html

The Cuyahoga River RAP process continues to address the issues and problems identified by the Stage One Report and Update. It has been very successful thus far in garnering resources and funding to undertake these projects and programs. Much of the success in this area is attributed to the organizational structure of the RAP and its use of a non-profit organization, the CRCPO.

Significant actions have been undertaken by the RAP and its partners to restore the beneficial uses of the Cuyahoga River. Research efforts into understanding the complex nature of the river ecosystem continue, and will help focus RAP actions in the future. Aggressive efforts have been made to develop a public and community involvement strategy that guides the outreach and education efforts of the RAP.

Current priority issues of the RAP



include several that are outgrowths of recent projects and studies. These include habitat restoration,

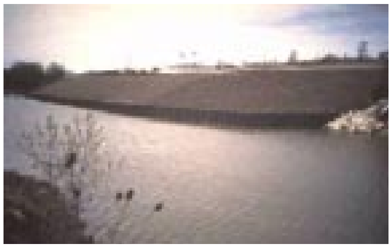
navigation channel dissolved oxygen/larval fish studies, urban stormwater management and comprehensive environmental education and community involvement.

The Cuyahoga River RAP team is also committed to pursuing designation of the Cuyahoga River as an American Heritage River. The historical, cultural and environmental significance of this river, as well as its past, present and future economic impacts on the nation, make it a worthy candidate for such recognition. Because of the efforts of dedicated agencies, organizations, local stakeholders and private individuals, the Cuyahoga River will never burn again!

Maumee River

Web Site:
http://www.epa.gov/glnpo/aoc/cuyahoga.html

The Maumee RAP process continues to address the 11 beneficial use impairments listed in the Maumee RAP Stage 1 Report (1990) and significant progress has been made in many of the impairment areas. Through the dedication and funding of TMACOG, Ohio EPA and numerous other partners through the years, the RAP is moving forward. It has taken a long time to gather the in-depth research and data necessary for implementation of a wide variety of projects, but a strong foundation has been laid. Active participation and public awareness within the Maumee AOC is currently driving many worthy projects that will eventually help lead to the completion of Stage 2. The involvement of all the action



groups and the wide array of partners in the creation of the Maumee RAP Strategic Plan (1997) has given renewed drive and focus to the RAP. The Maumee RAP has a positive outlook and is dedicated to the restoration of the waters of the Maumee Area of Concern to “fishable and swimmable” conditions.

Lake Erie Protection Fund

In 1990, Substitute House Bill 804 was signed into law establishing the Lake Erie Protection Fund. The intended use of these funds is to award grants that will help the State of Ohio protect and enhance its greatest natural resource ~ Lake Erie. This is accomplished through research, monitoring, demonstration and education projects concerning Lake Erie, its shoreline and watershed.

Of particular interest to the Lake Erie Protection Fund are projects which further the objectives of Ohio's state, national and international plans and commitments. Present, the Lake Erie license plate program, Erie...Our Great Lake credit card program, donations, and bequests.

Ohio Lake Erie Commission

The Ohio Lake Erie Commission has helped establish water quality and coastal area policies for the State of Ohio. The Commission has created an effective forum for public discussion on Lake Erie issues between Cabinet members, legislators, local communities and the general public. These issues include review of the Great Lakes Water Quality Initiative, revision of the Great Lakes Ecosystem Charter, adoption of a state Lake Erie research agenda and development assistance of Ohio's Coastal Management Plan.

The Ohio Lake Erie Commission is comprised of the directors of six state agencies whose respective programs focus on the management and wise stewardship of Lake Erie. The Commission agencies are: Ohio Environmental Protection Agency, and the departments of Natural Resources, Agriculture, Health, Transportation and Development.

Inland Lakes, Ponds, and Reservoirs

Created by Section 314 of the Federal Water Pollution Control Act in 1972, the Clean Lakes Program (CLP) actually began in 1975 when Congress funded the program. The CLPs purpose is twofold:

1.) Define the cause and extent of pollution problems in lakes, and

2.)Develop and use effective methods of restoring and protecting lake water quality.

To do this, state and local governments are given financial assistance (in the form of grants) for lake restoration projects that provide multiple public benefits (including water quality and recreational improvements).

Four phases of work are covered under CLP grants.

1.) Lake Water Quality Assessment (LWQA) Grants provides funding for monitoring at selected public lakes based on Ohio EPA's 5-Year Basin Plan.

2.) Phase I (Diagnostic/Feasibility Study) Grant funds are used to conduct a thorough analysis of a lake and its surrounding watershed. This study does three things: 1) determines the cause and extent of pollution, 2) evaluates all possible solutions, and (3) recommends the most suitable and cost-effective ways to clean up the lake.

3.) Phase II (Implementation) Grant funds puts the Phase I recommendations to work. Funds can be used for actual lake restoration work as well as to begin the implementation of management practices in the watershed.

4.) Phase III (Post-Implementation Monitoring) Grant funds are used to study how well the restoration methods and technologies work over a long period of time.

The Clean Lakes Program provides several opportunities to evaluate pollution impact. Lake Water Quality Assessment (LWQA) projects include monitoring of public lakes, and analysis lake water quality status and trends. Phase I studies are known as diagnostic/feasibility studies where lakes and their watersheds are analyzed for pollution impacts and pollution sources. A component of these studies is the development of feasible implementation actions to restore and protect the lake. Phase II is the implementation phase and Phase III involves follow-up monitoring to determine the overall successes. Each of these phases provides essential information about a lake to local lake users and residents. Because of reductions in 314 funding the monitoring and assessment of lakes in Ohio has substantially decline over the past 3 to 4 years.

Ohio River (ORSANCO)

Ohio is an original compact state of the Ohio River Valley Sanitation Commission (ORSANCO). ORSANCO, in cooperation with the compact states, performs most the water quality monitoring and reporting for the mainstem portion of the Ohio River. This includes the production of an Ohio River 305(b) report that is produced separately (ORSANCO 2000). ORSANCO recognizes the need for more integrated, site specific assessments and the inclusion of an expanded biological monitoring effort.

Division of Environmental Funding and Assistance (DEFA)

The Water Pollution Control Loan Fund (WPCLF) is a revolving fund designed to operate in perpetuity to provide low interest rate loans and other forms of assistance for water resource protection and restoration projects. In addition, specialized services are provided for small and hardship communities. Examples of projects which can be financed through the program are: publicly-owned wastewater treatment plant and sanitary sewer system construction projects, combined sewer overflow controls, sewer system rehabilitation and correction of infiltration/inflow; and, publicly and privately-owned septage receiving facilities, brownfields, landfill closure or remediation, on-lot septic system improvements, urban stormwater runoff, stream corridor restoration, forestry best management practices, development best management practices and agricultural runoff controls Using the WPCLF to fund water resource improvement projects has many advantages, including: P Loans at an interest rate below market rate provide significant cost savings. For example, loans at a 4.66 percent or a 2.2 percent interest rate (the rates in effect through March 31, 2000) are the equivalent of a 13 percent or a 28 percent grant respectively, when compared to the cost of a loan at 6.41 percent, and there are no bond issuance costs for the applicant.

Ohio EPA staff has extensive experience providing advice and assistance in identifying sound technical and financial solutions to water quality improvement needs. The types of assistance that can be provided include creating facilities planning information, reviewing projects for potential cost saving measures, providing technological, administrative and/or performance information, helping to develop user charge systems, and working with other funding programs.

Summary of Integrated Priority System

The Integrated Priority System (IPS) can be used to rate water quality improvements which address both point and nonpoint sources of impacts on water resources. The IPS can be used to rate projects, activities or actions. It does this by evaluating the effect of the activity on the human or aquatic life uses of water resources. The system does this by considering: 1) the potential uses of water resources; 2) the restorability of water resources to their potential uses or the protection of existing uses; and 3) the effectiveness of projects, activities or actions in addressing identified sources of impairment or threat. The IPS places the highest level of priority on projects, activities, or actions that protect human health. The IPS places a second level of priority on projects, activities, or actions which: 1) protect or restore the aquatic life uses of surface water resources, 2) protect or restore the ecological integrity of wetlands, or 3) protect or restore the quality of ground water resources for human use.

The IPS is not the same thing as the Project Prioritization System which is included in each year's WPCLF Program Management Plan. The IPS is an environmentally-based rating system, and is not intended to include other factors. One of the action items included in the Strategic Business Plan is the consideration of other relevant factors which, when combined with the IPS, will become the ranking system for projects using the WPCLF.

Economic Analyses

Ohio EPA conducts analyses of the financial capability of municipal and industrial dischargers to meet the terms and requirements of their NPDES permits. The results of an analysis may determine the need to issue a discharge specific variance from Ohio water quality standards if an entity were economically incapable of meeting discharge requirements. A summary of the process for evaluating municipal and industrial dischargers follows. The detailed procedure is described in Economic Evaluation Methodology (Ohio EPA 1991c).

Municipal Analysis

The evaluation of the financial capability of a municipal discharger is a three-part procedure; a screening review, a cursory review, and a detailed analysis. The initial screening review addresses the impact of the project on residential customers. The purpose of the screening review is to identify the obviously affordable projects, and to eliminate them from further analysis. When the cost of the project results in a household impact above the benchmark, a detailed analysis of the financial health of the municipality will be completed. This analysis determines if the project is likely to result in substantial and widespread economic and social impact. When the annual cost per residential customer is below the benchmark, a detailed analysis is generally not required. However, a cursory review of the general economic condition of the community will also be used to suggest the need for detailed analysis.

The focus of a detailed analysis is on the financial stability of the community, and on the changes projected to occur in the financial condition as a result of the project. To develop a comprehensive picture of the community, four general areas are considered: 1) socioeconomic factors; 2) financial factors; 3) debt factors; and 4) administrative factors.

Industrial Analysis

During the period covered by this report a two-part review process was in place for industrial dischargers to determine their ability to make expenditures necessary to meet effluent limitations. The initial screening review determined the impact on the industry and predicted the possibility of plant closure. The detailed analysis assessed the potential impact of a plant closure on the community. Two types of screening reviews would be completed depending on the type of financial data that was available. The analysis would be done at the plant level if information were available. If plant specific information was not available, the analysis would be at the level of the firm as a whole. Both analyses would be completed for a five year period to identify trends.

Expenditures for Water Pollution Control in Ohio 1991-1992

Capital expenditures for wastewater pollution control in Ohio were compiled for the period January 1991 through December 1992. This information was obtained from Permits to Install (PTI) that were filed with the Division of Water Pollution Control during that period. No figures were available for operation and maintenance costs. The total amount expended was $827.1 million statewide. Table 9-3 provides a break-down by major basin for 1991-1992. In some cases it was not possible to determine the basin where the expenditure took place. These are included under “Overlapping Basins”. Seven different types of pollution control activity were listed:

1)publicly owned treatment works (POTWs);
2)industrial treatment facilities;
3)industrial pre-treatment facilities;
4)on-site systems;
5)semi-public facilities;

6)sewers, pumps, and lift stations; and
7)other

Figures depicting the distribution of funds across these seven categories by major river basin are presented in Appendix H. Also included in Appendix H is a graph that indicates the level of total water pollution control expenditures in the years 1987-1988, 1989-1990 and 1991-1992.

Ohio Water Quality Standards

Antidegradation
Federal regulations require that state water quality standards (WQS) include an antidegradation policy. In very simple terms, Ohio's antidegradation rule (Ohio Administrative Code 3745-1-05) sets out additional requirements intended to keep clean waters clean. In practice, the rule applies in situations where there is a requested authorization to increase the discharge of pollutants to a surface water body or to otherwise significantly impact the physical habitat of a surface water body. 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. Revisions to the rule were subsequently made in 1997 to incorporate the requirements of the U.S. EPA Water Quality Guidance for the Great Lakes System and in 1998 to move provisions related to wetlands to a new rule (Ohio Administrative Code 3745-1-54).

The antidegradation rule spells out the applicability of the rule in permitting and provides criteria to consider in the review process. In all cases the existing uses of the water body 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).

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 existing uses) 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 National Resource Waters, 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 and Limited Quality Waters. The agency's decision will be public noticed and another public hearing held if significant public interest is evident.

All surface water bodies 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 surface 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.

General High Quality Waters - These include surface 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 lower-

ing 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 Hogwash, except that additional sources of pollution will not be permitted.

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.

Ohio EPA established an external advisory group in May 1998 to assist the agency in the review and revision of the antidegradation rule. This group met through April 2000 and provided recommendations to Ohio EPA. Ohio EPA is currently drafting revisions to the rule, taking into account the external advisory group recommendations. Revisions to the rule are expected to be proposed in early 2001.

Great Lakes Water Quality Initiative

U.S. EPA issued the “Water Quality Guidance for the Great Lakes System” regulation in March 1995 under the terms of the Great Lakes Critical Programs Act. This regulation, also known as the Great Lakes Water Quality Initiative (GLI), was developed with the joint cooperation of all Great Lakes states. The regulation requires that the Great Lakes states adopt provisions in their state programs that are as protective as the provisions in the GLI regulation. In Ohio, this requirement applies to the Lake Erie drainage basin, roughly the northern third of the state.

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 Lakes basin is needed to assure meeting environmental goals and preserving the economic foundation of the region.

Ohio EPA worked with an external advisory group in 1996 and 1997 to assist the agency with the adoption of the GLI requirements. Ohio rules incorporating the requirements of the GLI were adopted in Ohio Administrative Code Chapters 3745-1, 3745-2 and 3745-33 and became effective in October 1997. The rules include the following five GLI elements:

1)procedures for the calculation of water quality criteria for the protection of human health and revisions to existing human health criteria;

2)procedures for the calculation of water quality criteria for the protection of wildlife and new wildlife criteria;

3)revisions to existing procedures for the calculation of water quality criteria for the protection of aquatic life and revisions to existing aquatic life criteria;

4)new antidegradation requirements, applicable to discharges of bioaccumulative chemicals of concern, to maintain existing water quality where it is better than minimum requirements; and,

5)new procedures to convert the water quality criteria into wastewater discharge permit limits.

Since adoption of these criteria and procedures into state rules, they have served as the basis for water quality-based permits and other regulatory requirements.

Ohio NPDES Permitting Programs.

DSW issues NPDES permits that contain limits and conditions needed to meet State water quality standards and federal treatment technology standards. The permits identify discharge effluent limits, self-monitoring requirements, and other general compliance requirements and schedules. Permit issuance for “majors” is linked to a five-year basin program. This watershed approach to permit issuance is structured around a water quality monitoring program that evaluates chemical and aquatic life conditions in a comprehensive manner once every five years. Permit issuance occurs within two years

following the basin intensive surveys.

DSW issues general NPDES permits to similar types of dischargers who cause minimal impacts to water quality. The permits identify management practices, effluent limitations, monitoring requirements, and other general requirements. The permits also explain how a discharger may apply for coverage under the general permit and how to discontinue coverage. In order to be covered by a general permit, each facility must meet specific eligibility requirements that are presented in the general permits.

Ohio law and rules require that a Permit to Install (PTI) be obtained for modification, improvement or installation of any wastewater treatment or collection system. The law also requires an approval of plans for the disposal of industrial waste or sludge. The majority of the PTI application and plans for sewerage installation or improvement and industrial waste or sludge disposal are reviewed in the District, and sent to Central Office for issuance of the PTI or Plan Approval/Denial. The Central Office is responsible for program development and policy issues. Technical assistance and support to the regulated community and the public is a large part of the work completed by both offices

Sludge

The Division has five main initiatives in the sludge program. These are 1) activities relating to the pursuit of Section 503 delegation, 2) Section 503 compliance assistance through technical assistance to the regulated community and the Ohio EPA district offices, 3) public outreach through such activities as speaking at conferences and participating on the ad hoc sludge committee, 4) assessing current sludge management and disposal activities by collecting and evaluating data from annual sludge reporting efforts, and 5) taking the lead and coordinating the review of statewide marketing and distribution plan approval applications

Compliance Inspections, Monitoring and Enforcement

The Division of Surface Water conducts a compliance inspection program to address both major and minor dischargers in the State of Ohio as appropriate. The NPDES monitoring data that is generated by the dischargers and other permit and/or consent agreement requirements will be reviewed on a periodic basis to insure compliance with those requirements.

Enforcement

The Division of Surface Water staff works closely with the regulated community and local health departments to ensure that surface waters of the state are free of pollution. The regulated community with which DSW staff works includes wastewater facilities, both municipal and industrial, and small, unsewered communities experiencing problems with unsanitary conditions.

DSW staff provides technical assistance, conducts inspections of wastewater treatment plants, reviews operation reports, oversees land application of biosolids and manure from large concentrated animal feeding operations, and investigates complaints regarding malfunctioning waste water treatment plants and violations of Ohio's Water Quality Standards. DSW strives to ensure that permitted facilities comply with their National Pollutant Discharge Elimination System (NPDES) permits. DSW also assists small communities with inadequate means of waste water treatment seek alternatives to help abate pollution to waters of the state.

In cases which Ohio EPA is unable to resolve continuing water quality problems, DSW may recommend that enforcement action be taken. The enforcement and compliance staff work with Ohio EPA attorneys, as well as the Attorney General's Office to resolve these cases.

The Municipal Assistance Program

Operating an efficient wastewater treatment plant is a continuous and costly job. Proper training and equipment are necessary components, but support from state and local officials can help a facility comply with water quality regulations.

The Municipal Wastewater Assistance program, established by Section 104(g)(1) of the federal Clean Water Act, is a cooperative effort between state environmental agencies and communities to bring facilities into compliance and/or to maintain compliance.

The Ohio EPA steps out of its enforcement role to serve as a facilitator, providing innovative and cost effective methods of improving plant performance for communities wanting to achieve and maintain compliance. The program is directed at non-capital improvement type recommendations; however, it is sometimes necessary for capital expenditures to correct the performance limiting factor of the facility. Since the beginning of the program in 1984, Ohio EPA has worked with many communities that are now capable of operating effectively.

CSO Control

Combined sewers are built to collect sanitary and industrial wastewater as well as storm water runoff

and transport this combined wastewater to treatment facilities. When it rains, the volume of storm water and wastewater may exceed the capacity of the combined sewers or of the treatment plant, and a portion of the combined wastewater may be allowed to overflow untreated into the nearest ditch, stream, river or lake. This is a combined sewer overflow, or CSO. Ohio has about 1,600 known CSOs in 102 communities, ranging from small, rural villages to large metropolitan areas.

The primary goal of Ohio's CSO Strategy (March, 1995) is to control CSOs so that they do not significantly contribute to violations of water quality standards or impairment of designated uses. Through provisions included in NPDES permits, all CSO communities must implement short-term controls, the nine minimum technology-based controls. If these are not sufficient to meet water quality standards, a community may be required to implement more extensive long-term controls. In addition, communities must characterize their collection systems and overflows, evaluate the wet weather treatment capabilities of their wastewater plants, and conduct instream bacterial monitoring

Pretreatment

The pretreatment program regulates industrial facilities discharging wastewater to publicly owned treatment works (POTWs). These facilities, known as industrial users, discharge process wastewater often contaminated by a variety of toxic or otherwise harmful substances. Because POTWs are usually not specifically designed to treat these substances, pretreatment programs are needed to eliminate potentially serious problems that occur when these substances are discharged into public sewer systems.

The pretreatment program is mandated under the federal Clean Water Act and USEPA has delegated the program to Ohio for implementation. At Ohio EPA, the Pretreatment Unit is responsible for implementing the pretreatment program. Since local sewer control is best handled at the local level, Ohio EPA delegates program responsibilities to local governments, but also directly regulates industries when local government is unable to perform the role effectively or mandated to have an approved pretreatment program. The Unit's implementation philosophy is to work in partnership with local government, providing support and technical expertise, to help build capacity at the local level. At present, Ohio EPA oversees approximately 100 approved local pretreatment programs and directly permits approximately 150 industrial users discharging into non-approved POTWs

Sediment Management

Since May of 1995 DSW has been heading an inter-divisional sediment task force whose mission is to develop an Agency strategy to address sediment contamination/ management problems. The major activities of the task force have been in the areas of sediment criteria review and development, sediment collection standardization, and data management. Sediment task force members have also conducted sediment sampling which can be used to support criteria development, provided technical support to the Voluntary Action Program created for “brownfields” cleanups and redevelopment in Ohio, and created a database for sediment related literature. Future activities include finalizing standardized sediment methodologies guidance, conducting an Agency sediment training workshop, collecting and analyzing additional sediment samples, developing sediment benchmarks for metals using existing Ohio sediment data, and organizing Agency sediment data into a computerized form to make the data both accessible and easy to analyze. The task force also serves as the primary vehicle for providing technical review and comment on external documents from U.S. EPA, U.S. Army COE and others, and for providing technical assistance on sediment issues.

Storm Water: Phase I

In response to the need for comprehensive NPDES requirements for discharges of stormwater, Congress amended the CWA in 1987 to require the U.S. EPA to establish phased NPDES requirements for storm water discharges. To implement these requirements U.S. EPA published in the Federal Register on November 16, 1990 (40 CFR 122.26) initial permit application requirements for certain categories of stormwater discharges associated with industrial activity, and discharges from municipal separate storm sewer systems serving a population of 100,000 or more. The regulations covered 173 cities and 47 urban counties and an estimated 100,000 industrial sources nationwide. As a NPDES delegated state, Ohio EPA is currently implementing the federal stormwater program.

Municipal

On the municipal side, the regulations cover discharges of stormwater from municipal separate storm sewer systems. Large municipalities with a separate storm sewer system serving a population greater than 250,000 (e.g. Columbus) and medium municipalities with a service population between 100,000 and 250,000 (e.g. Akron, Dayton and Toledo) must obtain NPDES permits. Cincinnati and Cleveland are currently pursuing an exemption from the program. Application deadlines for large and medium

municipalities were November 16, 1992 and May 17, 1993, respectively.

Industrial
The list of stormwater discharges associated with industrial activity is extensive. All stormwater discharges associated with industrial activity that discharge to waters of the State or through a municipal separate storm sewer system are required to obtain NPDES permit coverage, including those which discharge through systems serving populations less than 100,000. Discharges of stormwater to a combined sewer system or to a POTW are excluded. Ownership of sources associated with industrial activity is not limited to the private sector and does include publicly owned sources.

Storm Water: Phase II

On December 8, 1999, USEPA promulgated the expansion of the existing National Pollutant Discharge Elimination System (NPDES) Storm Water Program by designating additional sources of storm water for regulation to protect water quality. This fact sheet will cover who will be affected by these regulations. All affected entities, unless otherwise specified, are required to obtain permit coverage by March 10, 2003.

The regulation affects four categories of storm water dischargers, including two classes of facilities for automatic coverage on a nationwide basis: small municipalities and small construction sites.

Small Municipalities
About 280 municipalities located in urbanized areas and that operate municipal separate storm sewer systems (MS4s) will be included in the program in the State of Ohio. Pollutants from MS4s include floatables, oil and grease, as well as other pollutants from illicit discharges.

The definition of MS4 does not include combined sewer systems. A combined sewer system is a wastewater collection system that conveys sanitary wastewater and storm water through a single set of pipes to a publicly-owned treatment works (POTW) for treatment before discharging to a receiving waterbody. During wet weather events, the capacity of the combined sewer system can be exceeded, resulting in an overflow, or CSO. Combined sewer systems are not subject to these regulations. These systems are addressed in the Ohio EPA CSO Control Policy (March 1995). If a municipality is served by both separate and combined sewer systems, only the separate portion of the system is regulated by this rule.

The regulations will also affect discharges from MS4s owned by the state or political subdivisions of the state or the United States. This includes runoff from highways, hospitals, prisons, military bases or universities which are located within the urban areas affected by this regulation.

Operators of small MS4s will be required to develop a storm water management program that implements six minimum measures, which focus on a Best Management Practice (BMP) approach. The BMPs chosen by the MS4 must significantly reduce pollutants in urban storm water compared to existing levels in a cost-effective manner.

The Six Minimum Control Measures
1.) Public Education and Outreach Program on the impacts of storm water on surface water and possible steps to reduce storm water pollution. The program must be targeted at both the general community and commercial, industrial and institutional dischargers.

2.) Public Involvement and Participation in developing and implementing the Storm Water Management Plan.

3.) Elimination of Illicit Discharges to the MS4.

4.) Construction Site Storm Water Runoff Ordinance that requires the use of appropriate BMPs, pre-construction review of Storm Water Pollution Prevention Plans (SWP3s), site inspections during construction for compliance with the SWP3, and penalties for non-compliance.

5.) Post-Construction Storm Water Management Ordinance that requires the implementation of structural and non-structural BMPs within new development and redevelopment areas, including assurances of the long-term operation of these BMPs.

6.) Pollution Prevention and Good Housekeeping for municipal operations such as efforts to reduce storm water pollution from the maintenance of open space, parks and vehicle fleets.

USEPA clearly endorses a watershed approach to storm water management as well as preventative measures such as policies and ordinances that:

- protect sensitive areas such as wetlands and riparian areas,
- minimize imperviousness,
- maintain open space, and/or minimize the disturbance of soils and vegetation.

The rule contains several mechanisms through which Ohio EPA may provide waivers from these requirements. A waiver can be issued if either of the following conditions are met:

The population of the jurisdiction within the urban area is less than 1,000 people and: The MS4 does not substantially contribute to the storm water pollution of a physically interconnected MS4 which falls under these regulations. Storm water controls are not needed based on wasteload allocations that are part of Total Maximum Daily Loads (TMDLs) that address the pollutants of concern. The population of the jurisdiction is under 10,000 people and Ohio EPA has: Evaluated all receiving waters to which the MS4 discharges. Determined that storm water controls are not needed based on a TMDL or equivalent.Determined that future discharges from the MS4 do not have the potential to result in exceedances of water quality standards.

Small Construction Sites
The existing Storm Water NPDES Program already regulates storm water runoff discharges on construction sites that disturb 5 or more acres of property. Phase II will require permit coverage for additional construction activities in Ohio that disturb between one acre and 5 acres. Pollutants of concern include sediments and erosion from these sites.

The final rule does allow owner/operators of these small construction sites to file for permit waivers if they can certify that either of the following are true:

The rainfall erosivity factor (“R” in the Revised Universal Soil Loss Equation-RUSLE) is less than five during the period when the construction activity will occur. Detailed information on the RUSLE can be found at the following website:

www.itc.nrcs.usda.gov/focs/RUSLE/userguid/ruslug1.html

NOTE: It is not expected that any construction sites within Ohio will qualify for the RUSLE exemption. “R” varies depending on geographic location and is dependent on the time of year that construction activity will occur and the amount of time a site will be left bare.

Construction will occur within an area where controls are not needed based on a TMDL for the local water body, or equivalent analysis.

Municipally Owned Industrial Facilities
Municipally-owned industrial facilities which have been excluded from Phase I must apply for permit coverage by March 10, 2003. These facilities include, but are not limited to, wastewater treatment plants that discharge at least 1 million gallons of water per day and construction sites larger than 1 acre.

TMDL Program

The Total Maximum Daily Load (TMDL) program, established under Section 303(d) of the Clean Water Act (33 U.S.C. 1313), focuses on identifying and restoring polluted rivers, streams, lakes and other surface waterbodies. A TMDL is a written, quantitative assessment of water quality problems in a waterbody and contributing sources of pollution. It specifies the amount a pollutant needs to be reduced to meet water quality standards (WQS), allocates pollutant load reductions, and provides the basis for taking actions needed to restore a waterbody.

Each State is required to submit a prioritized list of impaired waters to U.S. EPA for approval (the ì303(d) list). Ohio’s 1998 list of impaired waters indicates that 881 of 5000 waterbody segments are impaired or threatened; of the 326 watersheds in Ohio, 276 contain at least one listed segment. Along with the list, Ohio EPA has established a schedule for completion of TMDLs for all impaired waters in Ohio by 2013. The list of impaired waters and schedule are updated every two years.

Additional information on TMDLs is available on the U.S. EPA TMDL web site.

When the federal rules are finalized, they will direct the development of TMDLs. In addition, Ohio EPA has established an external advisory group on TMDL issues. Approximately 80 people are actively participating in the development of recommendations on how Ohio EPA should develop TMDLs; their recommendations are due to the Ohio EPA Director in June 2000. Meanwhile, Ohio EPA is moving forward on several TMDL projects. The Middle Cuyahoga River TMDL was completed in 1999. TMDLs are in various stages of development in the following watersheds:

TMDLs to be completed in late 2000:

Mill Creek (Cincinnati)
Sugar Creek
upper Little Miami River
Rocky River

TMDLs to be completed in 2001

upper Stillwater River
Bokes Creek
Mill Creek (Marysville)
Raccoon Creek

TMDLs and Pollutants vs. Pollution

The new federal regulations related to TMDLs make a distinction between "pollutants" and "pollution" and only require TMDLs be developed for pollutants. In this definition pollutants are essentially parameters such as chemicals or sediments which can be expressed as a concentration value (i.e., milligrams/liter). Pollution, as defined in the Clean Water Act, includes all anthropogenic alterations to the chemical, physical, and biological quality of water, not all of which can be expressed as concentration values.

There are several problems inherent with this distinction. First, whether or not a TMDL is required for an impaired water, Ohio is charged with restoring all uses to waters regardless of the cause or source of impairment. Second, the distinction is effectively an artificial one because for the most prevalent pollutant-specific causes of impairment (nutrients, organic enrichment/low D.O., and sediments) the effects are inseparably intertwined with habitat quality. A narrow focus on pollutants alone would, in most cases, not be successful in restoring impaired designated uses. Of the BMPs for which there exists a reasonable expectation of success in restoring impaired uses, riparian and instream habitat restoration promise the most complete approach to resolving this issue. The TMDL program will bring more scrutiny to the relationships and association between habitat, nutrients, and sediments. Successful implementation of TMDLs will require habitat restoration and/or enhancement in order to be successful.

The "letter" of the TMDL regulations deal specifically with pollutants with water quality standards (i.e., TMDL = WLA + LA + SF). However, the "spirit" of the regulation and the Clean Water Act in general is focused on the restoration of impaired waters based on designated uses. That habitat might be ignored belies the spirit of the Act and will lead to less than successful progress towards our Agency's 80% by 2010 goal for designated use restoration.

Other Habitat Efforts

The effects of habitat modification have been recognized by several agencies in Ohio. To that end, the Director of Ohio DNR issued a directive aimed at the protection stream habitats. Its purpose is:

"To ensure adequate consideration is given to the protection of streams and their associated natural resource functions. This directive applies to all DNR Divisions who construct, change or modify stream channels or provide assistance to citizens of the state on stream modification, restoration and protection."

Specifically, in relation to stream habitat the policy strives for:

- *protection of high quality streams and stream corridors;*
- *restoration of modified or degraded streams and stream corridors whenever possible;*
- *building in natural stream system features;*
- *development of departmental stream management recommendations that address the relationships among near-stream forested corridors, water quality, aquatic habitat, and land use best management practices;*
- *promoting breaching or removal of dams not currently in use or no longer serving their respective intended purposes;*
- *encouraging land uses which support the natural benefits of the floodplain;*
- *supporting farmland preservation and other land use planning strategies that benefit stream quality*

Such a policy has obvious direct benefits to the environment, plus many indirect benefits. Given the close relationship between successful management of pollutants via TMDLs and the restoration of impaired designated uses, this will have an important effect on how impaired waters are actually restored.

The Need for Innovative Solutions to Nonpoint Sources of Pollution

It is clear from the results of this report that Ohio, as well as other states across the country, need to determine and implement new innovations to reduce the harmful effects of nonpoint source runoff. Several efforts in Ohio are examples of this type of innovation that could result in reaching the goal of full support of aquatic life uses in 80% of stream miles by 2010.

Watershed Resource Restoration Sponsor Program

DEFA recently initiated an incentive-based program. WPCLF loan interest from any DEFA loan project for a wastewater treatment or collection system improvement may be utilized to fund an eligible stream restoration project at no additional cost to the loan applicant. Some examples of stream restora-

tion projects eligible for funds include:

- Land conservancy easements
- Stream bank re-stabilization
- Riparian restoration
- Dam modification
- Sediment remediation projects
- Source Water Protection Plans
- Watershed Implementation Plans
- Watershed Action Plans.

An important criterion for these projects is that they will provide, either by themselves or in conjunction with other projects being undertaken, complete protection or restoration of aquatic habitat sufficient to meet or protect the designated uses of the benefited water resources as defined under Ohio Water Quality Standards. The restoration project may be performed by the loan applicant or the funding may be directed to a third party sponsor (i.e. such as a park district, land conservancy, or a soil and water conservation district). We are encouraging watershed environmental groups/SWCDs/NRCS/Park Districts to get potential stream projects defined and pre-qualified by DEFA (submit description of project, assessment of stream restorability, cost, schedule, etc.) prior to planning a stream project with a pending loan applicant. The important parts of this effort are that: 1.) there is no additional cost to these efforts, 2.) they efforts focus on those impairment we have identifying as the both the greatest source of impairment and threat. (e.g., habitat), and 3.) they fill a void where little work has been done relative to the extensiveness of these impacts.

Ohio's Western Lake Erie Watershed Project: A Conservation Reserve Enhancement Program (CREP)

The Ohio Lake Erie CREP is a special conservation program tailored to meet the needs of the State. This voluntary program will improve the water quality of streams and increase wildlife habitat by reducing sediment pollution. Up to 67,000 acres may be enrolled over the next ten years, contingent upon the State of Ohio having funds available to match federal dollars. The Ohio Lake Erie CREP is a Federal-State agreement to commit environmentally sensitive agricultural land through the Conservation Reserve Program to a conserving use.

Since the Western Basin of Lake Erie is so shallow, it is readily affected by pollution from watershed activities. The Western Lake Erie Watershed is intensively cultivated and land use is approximately 85% cropland. Because of the large numbers of intensively cropped acres, this watershed transports much higher sediment than other agricultural watersheds of similar size.

The Ohio Lake Erie CREP has been designed to:

1) Reduce sediment loading to impaired streams and help restore designated uses of surface waters

2) Protect 5,000 linear miles of stream

3) Enroll 10 percent (Up To 67,000 acres) of the Western Lake Erie Watersheds farmed riparian areas

Throughout the project, the State will conduct water quality monitoring to evaluate and record progress in achieving these goals.

Exotic Species in Ohio Waters

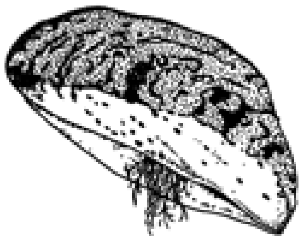
The introduction of exotic (non-native) species in Ohio surface waters is a form of "biological pollution" that has posed a serious problem for Ohio's indigenous aquatic fauna for more than 100 years. Non-native species such as carp and goldfish are well established in Ohio waters. These species have their highest populations in areas with moderate to high degradation of habitat or water chemistry. Several recently introduced exotic species have become the focus of special concern in Lake Erie.

Zebra Mussel

Zebra mussels (*Dreissena polymorpha*), which are native to southern and central Asia, are believed to have entered the Great Lakes in 1986 via the discharge of ballast water from ocean going ships. By 1989 the zebra mussel had spread throughout Lake Erie. Zebra mussels colonize quickly and have been reported at densities up to 30,000 individuals per square meter. The long term ecological effects of this species on fish and wildlife is unknown at this time. It is known to have economic impacts by fouling water intake systems in Lake Erie. This species could have beneficial effects as a food supply for certain species of fish and birds, and has apparently contributed to increased water clarity by filtering suspended particles while feeding. One result of the increased water clarity has been the return of some aquatic plants that had not been seen in Lake Erie for 30 years including the *Potamogeton pusillus*, or small pondweed (Ohio Sea Grant:

http://www.sg.ohio-state.edu/publications/nuisance/algae/tl-1295plants.html

It may also serve as an indicator of toxic pollution via its ability to concentrate certain pollutants. The effects of its large filtering capacity and high rate of colonization on other species in Lake Erie are



Zebra Mussel

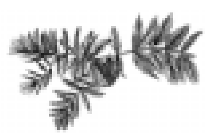
unclear at this time. Thus, it will be important to monitor the effects of the zebra mussel especially given the economic importance of Lake Erie to Ohio. The Ohio Division of Wildlife has funded research by the Ohio Cooperative Fishery and Wildlife Research Units to study the mussel's impact on walleye reef spawning. OSU Sea Grant has also funded a study of the feeding habits of the freshwater drum on zebra mussels. The Ohio Division of Wildlife will continue to assess the stock dynamics of walleye and yellow perch in Lake Erie, as it has in the past, which should enable the detection of significant impacts of zebra mussels (if any) on population stocks. In addition, the zebra mussel has been collected in the Ohio River which may threaten populations of native naiad mollusks in this drainage.

Round Goby, Ruffe, and Other Exotic Species

Besides the zebra mussel, other recently introduced exotic species may be of concern in Ohio. Two recent arrivals are the spiny water flea (*Bythotrephes cederstroemi*) and the river ruffe (*Gymnocephalus cernua*). The effects of the spiny water flea could result from its foraging on daphnia, rotifers, and copepods, which themselves are forage for young fish of such species as emerald shiners (*Notropis atherinoides*). It is unclear whether this species could disrupt the trophic relationships in Lake Erie or whether they will simply replace the zooplankton consumed as forage for fish. Yellow perch and walleye have been reported to consume spiny water fleas. In addition another species has reached Lake

Spiny Water Flea

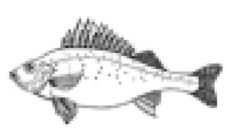
Ontario and could invade Ohio waters: *Cercopagis pengoi*, more commonly called the fishhook waterflea (see Twineline, July/ August 2000 - Vol. 22/No. 4; http://



Eurasian Watermilfoil

www.sg.ohio-state.edu/pdfs/JA00.pdf

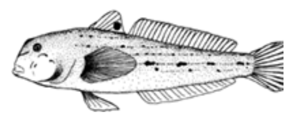
The river ruffe, like the zebra mussel, also arrived via the discharge of ballast water from ocean going ships. The concern with this species is that it could compete for forage with yellow perch. Because it reproduces earlier than yellow perch and has little or no sport or commercial significance, it would be an unsatisfactory replacement for yellow perch in Lake Erie. Because of its proportionately large spiny fins it does not seem to be a



Ruffe

preferred food item of most large predators.

Other recent exotic invaders of the Great Lakes are the tube-nosed goby and round goby. Both had been found in the St. Clair River between Lake St. Clair and Lake Huron. In 1993 Ohio EPA staff collected round goby in Lake Erie near the mouth of the Grand River. These species have the same Asian origins as the zebra mussel. These are small bottom dwelling fish species that also arrived via ocean freighter ballast water discharges. Because of its bottom dwelling hab-



Round Goby

itats, it may compete with the indigenous darter and sculpin species present in Lake Erie. The spread of this species and its possible interactions with sculpins and other species will be monitored over the next few years. Because the effects of each of these exotic species are unknown they are of special concern to both the ecological and economic interests of Lake Erie.

Biocriteria in Ohio's WQS

Ohio EPA first proposed biological criteria as part of its water quality standards regulations in November 1987 and reproposed them in October 1989. Following extensive interaction with interested parties the revised WQS were adopted in February 1990 and became effective in May 1990. A three volume set entitled Biological Criteria for the Protection of Aquatic Life contains the rationale, development, and field methods for deriving and using biocriteria in Ohio (Ohio EPA 1987a,b; 1989a,b). An addendum to Volume II (Ohio EPA 1989) and a revised Volume III (Ohio EPA 1989b) were produced in 1989. In addition, a detailed rationale for the development and application of the Qualitative Habitat Evaluation

Index (QHEI) was also produced (Rankin 1989). This issue has received national attention as evidenced by the first national workshop on biocriteria held December 1987. Since that initial effort U.S. EPA has produced guidance on Rapid Bioassessment (U.S. EPA 1989), national biocriteria program guidance (U.S. EPA 1990b), and a policy statement on biocriteria in April 1990. A technical guidance manual for developing and using biological criteria in wadeable streams is in progress. Efforts have also been initiated to develop biological criteria for lakes.

Policy Issues

A key policy debate involving biological criteria is the U.S. EPA policy of independent application. This policy requires that biological survey information, chemical-specific data, and bioassay results are evaluated independently with no single method being viewed as superior or preemptive of another. Others have proposed a weight-of-evidence approach in which the application of each tool is done on a more flexible case-specific basis. Ohio EPA has been much involved in this debate, particularly given the narrative language in the 1990 WQS that allows for a weight-of-evidence approach. This issue has yet to be resolved with U.S. EPA, Region V. We have suggested that the issue include a classification of the "strength" of the biological survey and underlying biological criteria development procedures as a way to regulate how much flexibility a state might be granted in the use of biological survey information (Yoder 1991a; see also Section 2, Table 2-7. pp. 31 of this volume). The real issue is not one of attempting to prove the superiority of one tool over another, but rather an issue of knowing the relative strengths of the particular assessment types for each tool and not extending the respective chemical-specific, toxicological, or biosurvey tools beyond their inherent abilities. Obviously there are biological survey techniques that have a comparatively low power of discrimination and assessment, as there are parallels for chemical-specific and bioassay techniques. We firmly believe that this concept must be part of the process, otherwise we risk basing decisions on the weakest information, jeopardizing the accuracy of decision making and the credibility of the institutions.

Based on analyses presented in the 1990 Ohio Water Resource Inventory (Ohio EPA 1990a) and elsewhere (Yoder 1991a, 1991b), there is little doubt that the addition of biological criteria and ambient biological monitoring significantly adds to the capability to detect and manage water resource impairments. For example, Ohio EPA (1987a) illustrates several examples of problem discovery and problem amplification, none of which would have been possible without an *integrated* chemical, physical, and biological approach to surface water monitoring. Aquatic life use impairments that we have identified and characterized during the past 12 years simply would not have been detected using chemical criteria and assessment tools *alone*. The identification of the three leading causes of aquatic life use impairment described by this inventory would not have been possible without this type of approach, including the use of numerical biological criteria derived using the regional reference site approach.

Stream Habitat Protection

It is evident from the data summarized in Section 4 that the Ohio EPA year 2000 goal of restoring water resource quality cannot be achieved by controlling point sources alone. While nonpoint sources and causes of impairment are often complex there is a physical "infrastructure" of streams and rivers that is basic and essential for the proper ecological functioning of these ecosystems. Ohio needs to work to protect and restore stream functions that support the aquatic life uses of these waters. Any approach should recognize: (1) the long-term ecological, recreational, and economic value of surface waters, and (2) the need for economic vitality in Ohio. Excepting those areas that Ohio wishes to maintain in a near pristine state for the enjoyment of future generations the challenge of stream habitat protection is to protect the environment while not unnecessarily burdening economic development. These efforts need to maximize long-term economic and ecological considerations over short-term economic gain that sometimes sacrifices environmental quality.

Work done near Toronto, Ontario has shown that instream ecological integrity depends on the existence of intact riparian areas and landuse (Steedman 1988). As landuse becomes more urban, ecological integrity usually declines; however, that decline can be forestalled and moderated with intact, healthy riparian areas along streams. As riparian area are reduced and removed, streams lose ecological integrity. Clearly, stream function is strongly keyed to the presence of intact riparian zones.

The functions provided by riparian areas include nutrient uptake and storage, erosion control and storage, habitat forming functions, shading, energy provision (i.e., leaves and woody debris), flood control, groundwater treatment (recharge) and storage, breeding and migrating bird and wildlife habitat, and recreation. These functions are discussed in more detail in Appendix B. Two recent books that deal with the threat of aquatic habitat destruction in the Unite States are: Restoration

of Aquatic Ecosystems (National Research Council 1992) and Entering the Watershed: A New Approach to Save America's River Ecosystems (Doppelt et al. 1993). Both of these volumes provide valuable insight into the extent of the damage to stream habitat and riverine-riparian ecosystems and suggests new directions for protecting these resources.

Division of Surface Water Strategic Plan

The Division of Surface Water (DSW) at Ohio EPA has developed a strategic plan that will focus the division's work towards the Agency's water quality goals. It contains key themes and strategies that will guide this planning process and direct the division's efforts. The plan presents the working draft of the strategies to pursue over the next 3-5 years. The plan will be central for preparing for the division's budgeting process, development of annual work programs, accountability agreements and grant proposals.

Existing goal and mission statements provide the context for the strategic plan. For example, the Agency Goal Statement for Water Quality is to: "Increase stream's achieving swimmable/fishable goals to 80% by the year 2010." The beginning of the Division of Surface Water Mission Statement is: "To protect, improve, and restore the integrity of all waters of the state." DSW has developed five "themes" to move us toward the goal and mission statements. These themes are:

1) The watershed approach will be the coordination framework for management of water resources. Partnerships, which span all levels of government and involve both public and private entities, are key to designing and implementing watershed goals.

2) The Division of Surface Water will maintain and build upon the successes of our monitoring and assessment program and other information management system components to produce the necessary environmental indicators of water resource quality and expand our universe of useful information. This work will be linked to the watershed geographic unit.

3) The Division of Surface Water will focus on process improvement to help achieve cost effective, integrated program elements that deliver environmental improvements.

4) The Division of Surface Water will develop effective communication with our external and internal customers regarding watersheds, water quality conditions, and our activities,

5) The Division of Surface Water will seek opportunities to develop effective legislation, regulations, and policies to improve the quality of the waters of the state.

The specific way these themes will affect our division is outlined in detail in the strategic plan which is found in the Appendix of this volume.

Lakes Program

Efforts since 1988 by the Ohio EPA and other agencies to assess the overall condition of Ohio's lakes should be continued and expanded. Additional data are needed on volume loss due to sedimentation, fish tissue and sediment contamination, and overall health of the biological resource (e.g. through development of biocriteria or assessment criteria for fish, plankton, macrophytes, etc.). More information is needed to determine the source(s) of the elevated levels of mercury that exist statewide in fish tissue and sediment. Besides continuing to obtain Section 314 Phase I and II grants for intensive monitoring of specific lakes, a state funded inland lake monitoring program needs to be initiated to collect baseline and long–term chemical, physical, and biological data for all of Ohio's 446 public lakes. More lakes need to be sampled more often to determine trends in resource condition. A select set of ambient lake stations needs to be established to determine long term trends of lake ecosystem condition, both by ecoregion and lake type. Resources directed to development of lake wetland habitat monitoring procedures and assessment criteria should also be given a high priority. The volunteer citizen monitoring program established by NEFCO and OLMS/CLIP should be continued and expanded. Resources should be made available to include chlorophyll–a and total phosphorus measurements along with Secchi depth as the minimum monitoring components.

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Acronyms used in the 2000 305(b) report.

Acronym	Meaning
AMD	Acid mine drainage
AoC	Area of Concern (IJC)
ADV	Area of Degradation Value
BAT	Best Available Technology
BPJ	Best Professional Judgement
BPT	Best Practical Technology
BMP	Best Management Practice
CFD	Cumulative Frequency Distribution
CIV	Community Index Value
CLIP	Citizen Lake Improvement Program
CSO	Combined sewer overflow
CWA	Clean Water Act
CWH	Cold Water Habitat
DLG	Digital Line Graph
DNR	Department of Natural Resources
ECBP	Eastern Corn Belt Plains
EOLP	Erie-Ontario Lake Plain ecoregion
EPA	Environmental Protection Agency
EWH	Exceptional Warmwater Habitat
FDA	Food and Drug Administration
GLISP	Great Lakes International Surveillance Plan
HELP	Huron-Erie Lake Plain ecoregion
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
IJC	International Joint Commission
Iwb	Index of Well-Being
IP	Interior Plateau ecoregion
LEH	Lake Erie Habitat
LRW	Limited Resource Water
MWH-I	Modified Warmwater Habitat (Impounded)
MWH-C	Modified Warmwater Habitat (Channelized)
MWH-A	Modified Warmwater Habitat (Mine Affected)
NASQAN	National Stream Quality Accounting Network
NPDES	National Pollutant Discharge Elimination System
NPSA	Nonpoint Source Assessment
NPSMP	Nonpoint Source Management Plan
OAC	Ohio Administrative Code
ODA	Ohio Department of Agriculture
ODH	Ohio Department of Health
ODNR	Ohio Department of Natural Resources
ODOT	Ohio Depart. of Transportation
ORC	Ohio Revised Code
OSUMZ	Ohio State Univ. Museum of Zool.
PAH	polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenols
POTW	publicly owned treatment works
PWS	Public Water Supply
QA/QC	Quality Assurance/Quality Control
QHEI	Qualitative Habitat Evaluation Index
RAP	Remedial Action Plan
RF3	Reach File 3
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SQM	Stream Quality Monitoring Program

SRW	State Resource Water
SSH	Seasonal Salmonid Habitat
TMACOG	Toledo Metropolitan Area Council of Governments
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WAP	Western Allegheny Plateau ecoregion
WRI	Water Resource Inventory
WQA	Water Quality Act of 1987
WQS	Water quality standards
WWH	Warmwater Habitat
WWTP	Wastewater treatment plant

Glossary

Acute - Acute involves a stimulus severe enough to rapidly induce a response; in toxicity tests a response observed in 96 hours or less typically is considered acute. An acute effect is not always measured in terms of lethality; it can measure a variety of effects[1]

Acute (Chemical) Criteria - Water quality standard in Ohio designed to protect the Limited Resource Waters (Nuisance Prevention) aquatic life use; this criteria is less stringent than the chronic criteria and is designed to protect aquatic life from rapidly induced stresses.

Aquatic Life Use - A designation assigned to a waterbody in Ohio based on the *potential* aquatic life that the water can sustain given the ecoregion potential; (See EWH, WWH, CWH, LRW, Designated use).

Aquatic Life Use Attainment - Defined as 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 that use.

Bioassay - The procedure of exposing test organisms, in a laboratory setting, to various concentrations of of suspected toxicants or dilutions of whole effluent to determine the lethality of the solution2 (See Whole Effluent Bioassay).

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 (taken from: Ohio EPA 1987; Karr et al. 1986).

Biosurvey - In field (ambient) sampling of resident biological organisms to assess biological integrity. For Ohio the accepted methods include pulsed-DC methods of electrofish-

ing for sampling fish and, for sampling macroinvertebrates, Hester-Dendy Multiple Plate Artificial Substrate Samplers and dip nets. Other synonyms: ambient (or instream) biological sampling, biosurveillance[2].

Channelization - General term applied to stream channel modifications, usually designed to improve drainage of fields and/or prevent flooding, which include channel straightening and widening and often is associated with riparian vegetation removal; these activities almost always result in degraded biological integrity via habitat loss and trophic disturbances.

Chemical Specific Approach - Traditional water quality approach of regulating point sources by setting surrogate water quality criteria (allowable concentrations of individual chemicals in the water), that if not violated instream, should protect aquatic life and maintain aquatic life uses.

Chronic - Chronic involves a stimulus that lingers or continues for a relatively long period of time, often one-tenth of the life span or more. Chronic should be considered a relative term depending on the life span of the organism. A chronic effect can be lethality, growth, reduced reproduction, etc.

Chronic (Chemical) Criteria - Water quality standard in Ohio that is designed to protect the Warmwater and Exceptional Warmwater aquatic life uses by preventing long-term stresses to organisms that would affect growth, reproduction. etc.,; this criteria is more stringent than the acute criteria.

Clean Water Act - An act of the US Congress, first passed in 1972, which provides the legal framework for reducing pollutants to America's waters. This report is required by a section (305(b)) of that report.

Combined Sewer Overflow (CSO) - Combined sewers are sewers with sanitary wastes and storm water runoff in the same pipes; a combined sewer overflow is the location where storm water and municipal wastes are discharged to streams during rainfall events when the increased amount of flow cannot be carried by the sewer system to the WWTP.

Conventional Pollutants - Refers to pollutants commonly discharged by municipal WWTPs as by-products of the treatment process such as ammonia, nitrite, dissolved oxygen, and chlorine. These may also be constituents of urban and agricultural nonpoint runoff.

Criteria - The conditions presumed to support or protect a designated use (*e.g.*, WWH or MWH)[2].

Degradation - A lowering of the existing water quality or biological condition in Ohio's surface waters.

Designated Use - The purpose or benefit to be derived from a waterbody, *e.g.*, drinking water, aquatic life[2].

Dilution Screening - Mass-balance analysis of pollutants discharged based on point source discharge flow, the critical low flow of the stream (*e.g.*, $Q_7$10), and the concentration of a parameter in the effluent. Predicted instream concentrations are compared to the criteria for a given value and examined for WQS exceedences.

Ecoregion - Regions of geographic similarity based on an overlay of maps of land-surface form, soils, land use, and potential natural vegetation; such regions are likely to contain similar aquatic communities.

Ecoregion Criteria - Biological index values that represent the base level of what minimally impacted communities should achieve in a particular ecoregion.

Effluent - Term given to the wastewater discharge of a WWTP or industry.

Electrofishing - Method of collecting fish by stunning them with electrical current from a gas-powered generator; the stun is temporary and fish are released unharmed after processing. Processing includes species identification, counting, weighing, and examining for external anomalies. These results are used to calculate the Index of Biotic Integrity (IBI) and the modified Index of Well-Being (Iwb).

Eutrophic - This refers to a highly "productive" body of water that has high concentrations of organic matter, nutrients, and algae.

Evaluated Data - This refers to data used in this report that originated from sources *OTHER* than intensive surveys of biological or chemical conditions; these sources include predictive modeling, the nonpoint source survey, citizen complaints, and chemical data > 5 yrs old.

Exceptional Warmwater Habitat (EWH) - Aquatic life use designed to protect aquatic communities of exceptional diversity and biotic integrity; such communities usually have high species richness, often support rare and endangered species and/or an exceptional sport fishery.

FDA action limit - The “safety” limits for concentrations of compounds in fish flesh that above which consumption of the flesh carries some risk of cancer or other health problem.

Fecal Coliform - A bacteria group that is present in the intestines of warm-blooded animals and is evidence of the presence of human or animal wastes.

Fish Consumption Advisory - In Ohio, a notice to the public warning about specific areas with fish tissue contamination by toxic chemicals that exceed FDA action limits; advisories may be species specific or community wide. The decision to issue 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

Hester-Dendy Multiple Plate Sampler - A sampling device for macroinvertebrates which consists of a set of square hardboard plates (approximately a surface area of one square foot) separated by spacers of increasing width. Aquatic macroinvertebrates colonize or reproduce on this device which is placed instream for six weeks during the summer. Counts of individuals and species are used in calculation of the Invertebrate Community Index (ICI). (See Invertebrate Community Index).

Impacted - This refers to the situation where there is suspected impairment based on the presence of sources (*e.g.*, nonpoint source survey). In such cases there is evidence that some changes or disturbance has occurred to the stream, but there is no quantitative data to establish whether aquatic life uses are actually being impaired.

Impaired - This refers to the situation where there is monitored level data that establishes a violation of some water quality or biological criterion, and hence, an impairment of the designated use .

Index of Biotic Integrity (IBI) - An ecologically-based index that uses fish community data and summarizes them as 12 ecological metrics that can be classified into three categories: species richness, species composition, trophic composition, and fish density and condition (Karr 1981; Karr *et al.* 1986).

Index of Well-Being (Iwb) - A composite index of diversity and abundance measures (density and biomass) based on fish community data (Gammon 1976; Gammon *et al*. 1981).

Invertebrate Community Index (ICI) - An index of biological condition based on ten metrics that measure various structural and tolerance components of macroinvertebrate communities in Ohio streams (DeShon *et al*., unpublished; OhioEPA 1987).

In-Place Pollutants - Refers to pollutants deposited in the sediments of a waterbody (*i.e.*, therefore they are "in-place").

LC50 - the concentration of some tested substance in a suitable dilutant at which 50% of the organisms die in a specified period of exposure.

Limited Resource Water (LRW) - An aquatic life use assigned to those streams with very limited aquatic life potential, usually restricted to mine drainage streams or very small streams (<3 sq. mi. drainage area) in urban areas with limited or no flow during the summer

Long List - List of all impaired waterbody segments for all causes and sources pursuant to Section 304(l) of the 1987 Water Quality Act (WQA).

Major Cause or Source - The primary cause or source for a stream segment not attaining its designated use.

Mass Balance Analysis - See dilution analysis

Medium ("Mini") List - List of all stream segments impaired by toxic substances, including ammonia, chlorine, and toxicity detected by whole effluent bioassays. This a subset of the long list and is pursuant to Section 304(l) of the 1987 Water Quality Act (WQA).

Metals - Specific class of chemical elements that have unique characteristics (such as conductance); some of the metals commonly found in water or sediment as pollutants include lead, copper, cadmium, arsenic, silver, zinc, iron, mercury, and nickel.

Moderate Cause or Source - A secondary or contributing (but not primary) cause or

source of impairment of a 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 (WWH); such streams are characterized by species that are tolerant of poor chemical quality (fluctuating dissolved oxygen) and habitat conditions (siltation, habitat simplification) that often occur in modified streams.

Monitored Data - This refers to chemical or biological data used in this report that originated from sources such as intensive surveys of biological or chemical conditions; chemical data must be less than 5 yrs old.

Named Stream - Streams large enough to be named on USGS 71/2 minute topographic maps and listed in the Gazateer of Ohio streams; there are approximately 22,000 miles of named streams in Ohio.

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

Non-conventional Pollutant - Toxic pollutants *other* than the common nitrogen compounds (ammonia, nitrite), 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, farms and mines that are usually delivered to waterbodies via rain runoff and water infiltration.

Point Source of Pollution - Any source of pollution that arises 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, for example, kg/day.

Priority Pollutant - One of the 126 toxic compounds (a subset of 65 classes of toxic compounds). (See 304(l))

QHEI (Qualitative Habitat Evaluation Index) - A qualitative habitat index designed as

a screening tool to help in assigning designated uses and as an aid in interpreting changes in aquatic communities.

Recreation Use - Ohio designated uses related to human body contact (*i.e.*, swimming, wading, canoeing).

Reference Site - A relative unimpacted biosurvey site that is used to define the expected or potential biological community within a region such as a ecoregion; in Ohio reference sites were used to calibrate the ICI and IBI.

Rheophilic - Organisms that are "current loving"; usually reserved for organisms that are obligate riffle dwellers.

Short List - A list of point sources that discharge one or more priority pollutants of a quantity sufficient to substantially impair the designated use(s) of the receiving waterbody segment; a subset of the medium list and is defined pursuant to Section 304(l) of the 1987 Water Quality Act (WQA)

Stream Miles - Ohio's method of indicating locations along a stream; mileage is defined as the linear distance starting from a streams terminus (*i.e.*, mouth) and moving in an upstream direction.

Storm Sewer - System to collect and remove rain runoff from communities and discharge it to nearby waterways.

Surrogate Measures of Biotic Integrity - Chemical parameters designed to protect aquatic life if they are not exceeded instream. Because they are indirect measures of aquatic community integrity, and mostly derived from laboratory toxicity tests, they are termed "surrogate" (*i.e.*, substitute) measures of biotic integrity.

Threatened Streams - These are streams that are currently meeting their designated uses but because of obvious trends (see urban encroachment) or qualitative data are thought to be declining in quality and may become degraded in the future without changes in current practices.

Toxic Substances - Any substance that can cause death, abnormalities, disease, mutations, cancer, deformities, or reproductive malfunctions in an organism.

Unnamed Stream - Small streams for which there are no names provided on USGS 71/2 minute topographic maps; there are approximately 22,000 miles of unnamed streams in Ohio.

Urban Encroachment - Increased development in a watershed, especially where it affects the floodplain, riparian zone, and runoff characteristics of a basin.

Use Designation - See "Designated Use".

Wasteload Allocation - The portion of a streams capacity to assimilate pollutants without violating water quality standards allotted to existing (or future) point sources (*e.g.,* WWTPs)[1]; *i.e.,* the loading (kg/day) of a pollutant allowed to be discharged by a source without violating water quality standards.

Waterbody/Waterbody Segment - A length of stream, based on Ohio EPA's mapping system (Division of Environmental Planning and Management), defined for analysis of water quality trends for this report. Each stream segment is approximately 10 miles in length; there are over 3800 stream segments currently defined for Ohio. Each lake is also a separate waterbody.

Water Quality Act of 1987 - A bill that re-authorized and amended the Clean Water Act and added some additional sections (e.g., see 304(l))

Water Quality Based Effluent Limits - Parameter by parameter effluent limits for individual point source dischargers based on water quality considerations (criteria) and not a technological approach such as mandating a specific type of technology to be used in treatment.

Water Quality Limited Segment - Any segment where it is known that water quality does not meet applicable water quality standards and is not expected to meet applicable water quality standards even after the application of "Best Practical Waste Treatment Technology" by publically owned treatment works and the application of "Best Available Technology Economically Achievable" by point sources other than publically owned treatment works[1].

Water Quality Standards - The rules set forth for establishing stream use designations and water quality criteria protective of such uses the surface waters of the state[1].

Whole Effluent Toxicity - The collective toxicity of an effluent to bioassay test organisms expressed as the LC50 and irrespective of individual chemical concentrations. The procedure includes exposing test organisms, in a laboratory setting, to dilutions of whole effluent[2] (See Whole Effluent Bioassay). For complex effluents with many compounds, whole effluent toxicity testing is a more realistic predictor of effects on the instream biota than parameter by parameter chemical testing.

305(b) - Section of the Clean Water Act that requires a biennial report to assess the progress of the Clean Water Act programs.

304(l) - Section of the Water Quality Act of 1987 that is intended to accelerate the control of toxic discharges from point sources.

307(a) - Section of the Clean Water Act that lists 126 compounds denoted as “priority” pollutants; these compounds have historically been the focus of the U. S. EPA water quality program with the reasoning that removal of these priority compounds will also remove the 65 classes of compounds (thousands of individual compounds of which the priority pollutants are a subset).

[1]Taken from : USEPA. 1987. OhioEPA User’s Manual for Wasteload Allocation, Water Quality Modeling

[2] Taken from: USEPA. 1987. Report of the National Workshop on Instream Biological Monitoring and Criteria. USEPA Office