MI/DEQ/WRD-12/001

# WATER QUALITY AND POLLUTION CONTROL IN MICHIGAN 2012 SECTIONS 303(d), 305(b), AND 314 INTEGRATED REPORT

Michigan Department of Environmental Quality
Water Resources Division
March 2012

This Integrated Report is available electronically on the Michigan Department of Environmental Quality, Water Resources Division, Web site at http://www.michigan.gov/deqwater under Water Quality Monitoring, Assessment of Michigan Waters.

**ACKNOWLEDGEMENTS**

Appreciation is extended to contributing staff members of various Michigan Department of Environmental Quality divisions and the Great Lakes Environmental Center for their assistance in the development of this Integrated Report.

Chapter heading images for Chapters 3 and 8 were provided by David Kenyon, Michigan Department of Natural Resources. The Chapter heading image for Chapter 1 was provided by Dawn Roush, Michigan Department of Environmental Quality. The title page image and Chapter heading images for Chapters 5 and 7 were provided by William Taft, Michigan Department of Environmental Quality. The Chapter heading image for Chapter 6 was provided by Seth Wright, Great Lakes Environmental Center. Chapter heading images for Chapters 4 and 10 were provided by Matthew Wesener, Michigan Department of Environmental Quality. Chapter heading images for Chapters 2 and 9 were provided by Kevin Goodwin, Michigan Department of Environmental Quality.

Report Compiled by: Kevin Goodwin, Sam Noffke, and Jason Smith
Surface Water Assessment Section
Water Resources Division

TABLE OF CONTENTS

**ACKNOWLEDGEMENTS** ..... i
**LIST OF TABLES** ..... v
**LIST OF FIGURES** ..... vii
**EXECUTIVE SUMMARY** ..... x

**CHAPTER 1 INTRODUCTION** ..... 11

**1.1 PURPOSE** ..... 11
**1.2 MICHIGAN'S WATERS** ..... 12

***1.2.1 Great Lakes, Bays, Connecting Channels, and Lake St. Clair*** ..... *13*
***1.2.2 Inland Lakes and Reservoirs*** ..... *14*
***1.2.3 Rivers*** ..... *20*
***1.2.4 Wetlands*** ..... *21*

**CHAPTER 2 WATER PROTECTION ACTIVITIES** ..... 23

**2.1 ABANDONED WELL MANAGEMENT** ..... 23
**2.2 AQUATIC NUISANCE CONTROL** ..... 24
**2.3 BEACH PROTECTION** ..... 24
**2.4 BIOSOLIDS** ..... 24
**2.5 COASTAL MANAGEMENT** ..... 25
**2.6 COMMUNITY WATER SUPPLY** ..... 25
**2.7 COMPLIANCE AND ENFORCEMENT** ..... 25
**2.8 CONSERVATION RESERVE ENHANCEMENT** ..... 26
**2.9 CONTAMINATED SEDIMENT** ..... 26
**2.10 DRINKING WATER CONTAMINATION INVESTIGATION** ..... 26
**2.11 ENVIRONMENTAL HEALTH** ..... 27
**2.12 DRINKING WATER AND WASTEWATER INFRASTRUCTURE FINANCIAL ASSISTANCE** .. 27
**2.13 GREAT LAKES** ..... 28
**2.14 GROUNDWATER DISCHARGE** ..... 29
**2.15 INDUSTRIAL PRETREATMENT** ..... 29
**2.16 INFRASTRUCTURE SECURITY** ..... 30
**2.17 INLAND LAKES AND STREAMS** ..... 30
**2.18 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM** ..... 30
**2.19 NONPOINT SOURCE CONTROL** ..... 31
**2.20 SEPTAGE** ..... 53
**2.21 SOIL EROSION AND SEDIMENTATION CONTROL** ..... 53
**2.22 SOURCE WATER ASSESSMENT** ..... 53
**2.23 WELLHEAD PROTECTION** ..... 54
**2.24 WETLANDS PROTECTION** ..... 54
**2.25 WATER PROTECTION PROGRAM SPECIAL INITIATIVES** ..... 56

***2.25.1 Aquatic Invasive Species*** ..... *56*
***2.25.2 Saginaw Bay Coastal Initiative*** ..... *58*
***2.25.3 Clean Water Act Section 404 Permit Program*** ..... *59*

**2.26 COST/BENEFIT ASSESSMENT** ..... 59

**CHAPTER 3 WATER QUALITY MONITORING** ..... 60

**CHAPTER 4 ASSESSMENT METHODOLOGY** ..... 63

4.1 INTRODUCTION ..... 63
4.2 DATA AND INFORMATION USED TO DETERMINE DESIGNATED USE SUPPORT ..... 63
4.3 DETERMINATION OF DESIGNATED USE SUPPORT ..... 65
4.4 DESIGNATED USES: AGRICULTURE, NAVIGATION, AND INDUSTRIAL WATER SUPPLY 66

*4.4.1 Assessment Type: No Specific Indicator or Assessment Method ... 66*

4.5 DESIGNATED USE: WARMWATER FISHERY AND COLDWATER FISHERY ..... 66

*4.5.1 Assessment Type: Physical/Chemical ..... 66*
*4.5.2 Assessment Type: Biological ..... 67*

4.6 DESIGNATED USE: OTHER INDIGENOUS AQUATIC LIFE AND WILDLIFE ..... 68

*4.6.1 Assessment Type: Physical/Chemical ..... 68*
*4.6.2 Assessment Type: Biological ..... 70*

4.7 DESIGNATED USE: PARTIAL BODY CONTACT RECREATION AND TOTAL BODY CONTACT RECREATION ..... 71

*4.7.1 Assessment Type: Pathogen Indicators ..... 71*

4.8 DESIGNATED USE: FISH CONSUMPTION ..... 73

*4.8.1 Assessment Type: Physical/Chemical ..... 74*
*4.8.2 Assessment Type: Other Public Health Indicators ..... 78*

4.9 DESIGNATED USE: PUBLIC WATER SUPPLY ..... 78

*4.9.1 Assessment Type: Physical/Chemical ..... 78*

4.10 ASSESSMENT UNITS AND DETERMINATION OF GEOGRAPHIC EXTENT ..... 79
4.11 ASSESSMENT UNIT ASSIGNMENT TO CATEGORIES ..... 80
4.12 IMPAIRMENT CAUSE AND SOURCE ..... 82
4.13 DELISTING CATEGORY 5 ASSESSMENT UNITS ..... 83
4.14 ASSESSMENT METHODOLOGY CHANGES ..... 84

CHAPTER 5 ASSESSMENT RESULTS: THE GREAT LAKES, BAYS, CONNECTING CHANNELS (ST. MARYS, ST. CLAIR, AND DETROIT RIVERS), AND LAKE ST. CLAIR ..... 85

5.1 TROPHIC STATUS ..... 85
5.2 WATER CHEMISTRY OF THE GREAT LAKES CONNECTING CHANNELS ..... 85
5.3 WATER CHEMISTRY OF SAGINAW BAY AND GRAND TRAVERSE BAY ..... 86
5.4 FISH CONTAMINANTS ..... 87
5.5 BEACHES ..... 89
5.6 DECAYING ORGANIC MATTER DEPOSITS ..... 89
5.7 DESIGNATED USE SUPPORT SUMMARY ..... 90

CHAPTER 6 ASSESSMENT RESULTS: INLAND LAKES AND RESERVOIRS ..... 94

6.1 TROPHIC STATUS ..... 94
6.2 FISH CONTAMINANTS ..... 94
6.3 BEACHES ..... 96
6.4 DESIGNATED USE SUPPORT SUMMARY ..... 96

**CHAPTER 7 ASSESSMENT RESULTS: RIVERS** ..... 99

7.1 BIOLOGICAL INTEGRITY ..... 99
7.2 WATER CHEMISTRY ..... 100
7.3 FISH CONTAMINANTS ..... 102
7.4 BEACHES ..... 103
7.5 DESIGNATED USE SUPPORT SUMMARY ..... 103

**CHAPTER 8 ASSESSMENT RESULTS: WETLANDS** ..... 116

8.1 DESIGNATED USE SUPPORT SUMMARY ..... 116

**CHAPTER 9 WATER BODIES NOT SUPPORTING DESIGNATED USES AND CWA SECTION 303(D) REQUIREMENTS** ..... 118

9.1 INTRODUCTION ..... 118
9.2 IMPAIRMENT CAUSE AND SOURCE ..... 118

*9.2.1 Great Lakes and Connecting Channels* ..... *119*
*9.2.2 Inland Lakes and Reservoirs* ..... *120*
*9.2.3 Rivers* ..... *121*
*9.2.4 Wetlands* ..... *122*

9.3 TMDL DEVELOPMENT ..... 122

*9.3.1 The TMDL Process* ..... *122*
*9.3.2 TMDLs Completed* ..... *123*
*9.3.3 TMDL Schedule* ..... *123*
*9.3.4 Changes to the Section 303(d) List* ..... *124*

**CHAPTER 10 PUBLIC PARTICIPATION IN THE IR** ..... 127

10.1 INTRODUCTION ..... 127
10.2 REQUEST FOR DATA ..... 127
10.3 PUBLIC NOTICE OF DRAFT ASSESSMENT METHODOLOGY ..... 127
10.4 PUBLIC NOTICE OF THE DRAFT IR ..... 127

**Literature Cited** ..... 133

LIST OF TABLES


Table 1.1 Michigan Atlas ..... 12

Table 1.2 Jurisdictional Control of the Four Great Lakes Bordered by Michigan ..... 13

Table 1.3 Michigan's Public Access Lakes and Cisco Lakes by County ..... 16

Table 4.1 Carlson's TSI Equations ..... 69

Table 4.2 Michigan Inland Lakes Trophic Status Classification Criteria ..... 70

Table 4.3 Overall Fish Consumption Designated Use Support Determination for Mercury Using Water Column and Fish Tissue Mercury Concentration ..... 77

Table 4.4 Examples of Assessment Unit Assignment to Categories Using a Multiple Category System With Three Designated Uses ..... 82

Table 5.1 Trophic Status of the Great Lakes Bordering Michigan ..... 85

Table 5.2 Designated Use Support Summary for the Great Lakes, Bays, and Lake St. Clair ..... 92

Table 5.3 Designated Use Support Summary for the Great Lakes Connecting Channels in Michigan ..... 93

Table 6.1 Trophic Status Summary of Michigan's Public Access Lakes ..... 94

Table 6.2 Designated Use Support Summary for Inland Lakes and Reservoirs in Michigan ..... 98

Table 7.1 Proportion of River Miles Supporting the Other Indigenous Aquatic Life and Wildlife Designated Use ..... 99

Table 7.2 Designated Use Support Summary for Rivers in Michigan ..... 106

Table 8.1 Designated Use Support Summary for Michigan Wetlands ..... 117

Table 9.1 Michigan Great Lakes and Bays Not Supporting Designated Uses Listed by Cause of Impairment ..... 119

Table 9.2 Michigan Great Lakes and Bays Not Supporting Designated Uses Listed by Source of Impairment ..... 119

Table 9.3 Michigan Connecting Channel River Miles Not Supporting Designated Uses Listed by Cause of Impairment ..... 119

Table 9.4 Michigan Connecting River Miles Not Supporting Designated Uses Listed by Source of Impairment ..... 119

Table 9.5 Michigan Inland Lake and Reservoir Acres Not Supporting Designated Uses Listed by Cause of Impairment ..... 120

Table 9.6 Michigan Inland Lake and Reservoir Acres Not Supporting Designated Uses Listed by Source of Impairment ..... 120

Table 9.7 Michigan River and Stream Miles Not Supporting Designated Uses Listed by Cause of Impairment ..... 121

Table 9.8 Michigan River and Stream Miles Not Supporting Designated Uses Listed by Source of Impairment ..... 121

Table 9.9 Michigan Wetland Acres Not Supporting Designated Uses Listed by Cause of Impairment ..... 122

Table 9.10 Michigan Wetland Acres Not Supporting Designated Uses Listed by Source of Impairment ..... 122

Table 9.11 Number of Assessment Units with TMDLs Completed and Approved in 2010 and 2011 ..... 123

LIST OF FIGURES


Figure 1.1 Ecoregions of Michigan ..... 20

Figure 2.1 Great Lakes Areas of Concern ..... 28

Figure 3.1 Five-Year Rotating Watershed Cycle ..... 62

Figure 4.1 Determination of Other Indigenous Aquatic Life and Wildlife Designated use Support Using Water Column Toxic Substance Concentration ..... 69

Figure 4.2a Determination of Partial Body Contact and Total Body Contact Designated Use Support Using Ambient *E. coli* Water Column Concentration for Michigan beaches ..... 72

Figure 4.2b Determination of partial body contact and total body contact designated use support using ambient *E. coli* water column concentration for Michigan streams and rivers (non-beaches) ..... 73

Figure 4.3 Determination of Fish Consumption Designated Use Support Using Water Column Mercury Concentration ..... 75

Figure 4.4 Determination of Fish Consumption Designated Use Support Using Fish Tissue Mercury Concentration ..... 76

Figure 7.1 Fish Consumption Designated Use Support Summary for Michigan Rivers ..... 107

Figure 7.2 Rivers Not Supporting the Fish Consumption Designated Use Based on Mercury in Fish Tissue ..... 108

Figure 7.3 Rivers Not Supporting the Fish Consumption Designated Use Based on Mercury in Water Column ..... 109

Figure 7.4 Rivers Not Supporting the Fish Consumption Designated Use Based on PCB in Fish Tissue ..... 110

Figure 7.5 Rivers Not Supporting the Fish Consumption Designated Use Based on PCB in Water Column ..... 111

Figure 7.6 Other Indigenous Aquatic Life and Wildlife Designated Use Support Summary for Michigan Rivers ..... 112

Figure 7.7 Rivers Not Supporting the Other Indigenous Aquatic Life and Wildlife Designated Use Based on Habitat Alterations ..... 113

Figure 7.8 Rivers Not Supporting the Other Indigenous Aquatic Life and Wildlife Designated Use Based on Mercury in Water Column ..... 114

Figure 7.9 Rivers Not Supporting the Other Indigenous Aquatic Life and Wildlife Designated Use Based on PCB in Water Column ..... 115

Figure 9.1 Section 303(d) Delistings ..... 125

Figure 9.2 Section 303(d) New Listings ..... 126

LIST OF APPENDICES

Appendix A1. Maps of 8-digit and 12-digit HUCs in Michigan-Lower Peninsula.

Appendix A2. Maps of 8-digit and 12-digit HUCs in Michigan-Upper Peninsula.

Appendix B. Comprehensive list of assessment unit designated use support.

Appendix C. TMDL groups.

Appendix D1. Section 303(d) list modifications-delistings.

Appendix D2. Section 303(d) list modifications-new listings.

Appendix E. Public comments.

Due to the extensive number of pages contained in these documents, all appendices are available electronically at http://www.michigan.gov/deqwater under Water Quality Monitoring, Assessment of Michigan Waters, Water Quality and Pollution Control in Michigan Sections 303(d), 305(b), and 314 Integrated Report.

LIST OF ACRONYMS

| | |
|---|---|
| ADB | Assessment Database |
| AIS | Aquatic Invasive Species |
| AOC | Areas of Concern |
| BCC | Bioaccumulative Chemicals of Concern |
| BEACH Act | Beaches Environmental Assessment and Coastal Health Act of 2000 |
| BMP | Best Management Practice |
| BPJ | Best Professional Judgment |
| BTEX | Benzene, Toluene, Ethylbenzene, and Xylene |
| CAFO | Concentrated Animal Feeding Operation |
| CAZ | Critical Assessment Zone |
| CMI | Clean Michigan Initiative |
| CSO | Combined Sewer Overflow |
| CWA | Clean Water Act |
| CWSRF | Clean Water State Revolving Fund |
| DDT | Dichlorodiphenyltrichloroethane |
| GIS | Geographic Information System |
| GLEC | Great Lakes Environmental Center |
| HCV | Human Cancer Value |
| HNV | Human Noncancer Value |
| HUC | Hydrologic Unit Codes |
| IR | Integrated Report |
| LaMP | Lakewide Management Plan |
| LHD | Local Health Department |
| LWMD | Land and Water Management Division |
| MDARD | Michigan Department of Agriculture |
| MDCH | Michigan Department of Community Health |
| MDEQ | Michigan Department of Environmental Quality |
| MDNR | Michigan Department of Natural Resources |
| mg/kg | Milligrams per kilogram |
| mg/L | Milligrams per liter |
| MS4 | Municipal Separate Storm Sewer System |
| MSU | Michigan State University |
| MTBE | Methyl tert-butyl ether |
| NHD | National Hydrography Dataset |
| ng/L | Nanograms per liter |
| NPDES | National Pollutant Discharge Elimination System |
| NPS | Nonpoint Source |
| NREPA | Natural Resources and Environmental Protection Act |
| P51 | Procedure 51 |
| PBB | Polybrominated Biphenyl |
| PCB | Polychlorinated Biphenyl |
| pg/L | Picograms per liter |
| SWQIF | Strategic Water Quality Initiatives Fund |
| TMDL | Total Maximum Daily Load |
| TSI | Trophic Status Index |
| USEPA | United States Environmental Protection Agency |
| ug/L | Micrograms per liter |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |
| WCMP | Water Chemistry Monitoring Project |
| WMP | Watershed Management Plan |
| WQS | Water Quality Standards |
| WRD | Water Resources Division |

## EXECUTIVE SUMMARY

The federal Water Pollution Control Act (PL 92-500), also known as the Clean Water Act (CWA), requires states to provide the United States Environmental Protection Agency (USEPA) with an assessment of the quality of their waters [Section 305(b)], a list of waters that do not support their designated uses or attain water quality standards (WQS) and require the development of total maximum daily loads (TMDLs) [Section 303(d)], and an assessment of status and trends of publicly owned lakes (Section 314). Similar to the 2010 reporting cycle, the Michigan Department of Environmental Quality (MDEQ) is fulfilling these CWA reporting requirements in 2012 through the submission of an Integrated Report (IR).

A primary objective of this IR is to describe attainment status of Michigan's surface waters relative to the designated uses specified in Michigan's WQS. Michigan's WQS are consistent with the Great Lakes Initiative, establish minimum water quality requirements by which the waters of the state are to be managed, and provide the primary framework that guides the MDEQ's water quality monitoring/assessment and water protection activities. To describe the attainment status of surface waters, each water body is placed in at least one of five reporting categories based upon the degree of designated use support, the amount of information known about the water body's water quality status, and the type of impairment preventing designated use support.

This IR includes a description of the scope of Michigan waters covered; a summary of MDEQ activities designed to protect and restore water quality; an overview of water quality monitoring in Michigan; a description of Michigan's current assessment methodology; summaries of monitoring results and designated use support in the Great Lakes (including connecting channels and bays), inland lakes and reservoirs, rivers, and wetlands; information regarding water bodies not supporting designated uses, including water bodies requiring the development of a TMDL [i.e., Section 303(d) listings]; and a summary of the public participation process used in the development of this IR.

With the biennial development of each Section 305(b) report, Section 303(d) report, or IR, Michigan continues to refine its data management and assessment methodology. Implementation of data management and assessment methodology changes initiated for the 2010 IR continued in the preparation of this IR. These changes advanced Michigan's mapping capabilities for Section 305(b) and Section 303(d) listings. As a result, listing information in the form of maps became available to the public in December 2009 via the Michigan Surface Water Information Management System (MiSWIMS) http://www.michigan.gov/miswims. The MiSWIMS serves as a valuable resource for those interested in additional detail in any specific listing decision throughout the state.

Detailed lists of designated use support are contained in this report (Appendix B) as well as designated use support summaries for Great Lakes (including connecting channels and bays), inland lakes and reservoirs, rivers, and wetlands (Tables 5.2, 5.3, 6.2, 7.2, and 8.1, respectively). Overall, many of Michigan's surface waters are impacted by polychlorinated biphenyls (PCBs) and mercury and consequently do not support the other indigenous aquatic life and wildlife designated use and/or the fish consumption designated use. Atmospheric deposition is considered to be the major source of these persistent bioaccumulative chemicals. Excluding PCBs and mercury, physical/chemical and biological assessments of inland lakes and rivers indicate designated uses are supported in a majority of water bodies.

# CHAPTER 1
# INTRODUCTION

## 1.1 Purpose

The federal Water Pollution Control Act (PL 92-500), also known as the CWA, requires states to provide the USEPA with an assessment of the quality of their waters [Section 305(b)], a list of waters that do not support their designated uses or attain WQS and require the development of TMDLs [Section 303(d)], and an assessment of status and trends of publicly owned lakes (Section 314). Similar to the 2010 reporting cycle, the MDEQ is fulfilling these CWA reporting requirements in 2012 through the submission of an IR. Where possible, Michigan's 2012 IR was developed consistent with the USEPA's "Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b), and 314 of the Clean Water Act" and supplemental guidance information for 2008, 2010, and 2012 IRs prepared by the USEPA dated October 12, 2006, May 5, 2009, and March 21, 2011, respectively (IR Guidance).

A primary objective of this IR is to describe attainment status of Michigan's surface waters relative to the designated uses specified in Michigan's WQS (available upon request or at http://www.michigan.gov/deqwater under DEQ Laws and Rules, Rules, Water, Part 4). Michigan's Part 4 Rules, WQS, initially promulgated in December 1973, were most recently revised and promulgated in January 2006 pursuant to Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA). Michigan's WQS are consistent with the Great Lakes Initiative, establish minimum water quality requirements by which the waters of the state are to be managed, and provide the primary regulatory framework that guides the MDEQ's water quality monitoring/assessment and water protection activities. To describe the attainment status of surface waters, each water body is placed in at least one of five reporting categories (see Section 4.11) based upon the degree of designated use support, the amount of information known about the water body's water quality status, and the type of impairment preventing designated use support. Additionally, the attainment status information described within this IR is used to help inform some of the outcomes associated with various goals identified within the WRD's Measures of Success. The Measures of Success are used to define the expected outcomes of water resource program issues geared toward having clean and safe water (http://www.michigan.gov/deq/0,1607,7-135-3313---,00.html).

The remainder of this chapter includes a description of the scope of Michigan waters covered in this IR. Chapter 2 summarizes MDEQ programs designed to protect and restore water quality. Chapter 3 contains an overview of water quality monitoring in Michigan. Chapter 4 details Michigan's current assessment methodology. Chapters 5, 6, 7, and 8 are more technical in nature and provide summaries of monitoring results and designated use support in the Great Lakes (including connecting channels and bays), inland lakes, rivers, and wetlands, respectively. Chapter 9 addresses all water body types not supporting designated uses, including water bodies requiring the development of a TMDL [i.e., Section 303(d) listings]. Chapter 10 includes information regarding the public participation process in the development of this IR.

**Data Management and Assessment Methodology Updates**

With the biennial development of each Section 305(b) report, Section 303(d) report, or IR, Michigan continues to refine its data management and assessment methodology.

Michigan underwent extensive data management and assessment methodology changes to prepare the 2008 IR. All data (i.e., records) were transferred from the Michigan developed Water Body System to the USEPA Assessment Database (ADB). Use of the ADB makes Michigan's IR listings compatible with the USEPA's national reporting system. During this database migration, records were georeferenced using the National Hydrography Dataset (NHD) and renamed using a 12-digit hydrologic unit code (HUC)-based naming convention. Michigan's assessment methodology underwent extensive revisions to ensure that all relevant designated uses were evaluated for all water bodies. A few changes were also made regarding data interpretation, which are explained in the 2008 IR.

The data management and assessment methodology changes implemented in the 2008 and 2010 IRs advanced Michigan's mapping capabilities for Section 305(b) and Section 303(d) listings. Listing information in the form of maps are available to the public via the MiSWIMS http://www.michigan.gov/miswims. The MiSWIMS is an interactive application that allows users to view and download surface water-related data and information collected by the MDEQ and Michigan Department of Natural Resources (MDNR).

Due to data management and assessment methodology changes, designated use support summary tables (e.g., Tables 5.2, 5.3, 6.2, 7.2, and 8.1) are not directly comparable to previous IRs. Similar to previous IRs, trends in designated use support are not discussed in this IR. Analysis of designated use support trends based on information presented in this and previous reports (e.g., change in number of river miles supporting designated uses) would be misleading. As assessment coverage increases and water bodies are evaluated for the first time or when more sophisticated and sensitive monitoring techniques are applied (e.g., low level PCB analysis), the proportion of supporting versus not supporting water bodies will change between reporting cycles. However, such a proportion change between reporting cycles may not constitute a real overall change in water quality.

## 1.2 Michigan's Waters

Michigan is blessed with a wealth of surface water resources, including Great Lakes and their connecting channels, inland lakes, rivers, and wetlands (Table 1.1). Most of Michigan also has an abundant supply of high quality groundwater.

Table 1.1 Michigan Atlas (all values are approximations).

| Topic | Number | Area | Length | Source |
|---|---|---|---|---|
| **State population** | **10 million** | | | **United States Census Bureau 2008 Estimate** |
| **State surface area** | | **96,760 $mi^2$** | | **Sommers, 1977** |
| **Great Lakes, Great Lakes bays, and Lake St. Clair** | | **42,167 $mi^2$ (~45% of total Great Lakes** | | **USGS NHD (1:24,000 scale)** |

| Topic | Number | Area | Length | Source |
|---|---|---|---|---|
| | | area) | | |
| **Inland lakes and reservoirs with surface area ≥ 0.1 acre** | **46,000** | **872,109 acres** | | **USGS NHD (1:24,000 scale)** |
| **Rivers and streams (including connecting channels)** | | | **76,439 mi** | **USGS NHD (1:24,000 scale)** |
| **Wetlands** | | **5,583,400 acres** | | **USFWS National Wetland Inventory** |

In general, the open waters of the Great Lakes have good to excellent water quality. The inland waters of Michigan's Upper Peninsula and the northern half of the Lower Peninsula support diverse aquatic communities and are commonly found to have good to excellent water quality. Many lakes and rivers in this mostly forested area of the state support coldwater fish populations. Lakes and rivers in the southern half of Michigan's Lower Peninsula generally have good water quality and support warmwater biological communities as well as some coldwater fish populations. The southern portion of the state contains Michigan's major urban areas with much of the rural land in agricultural production. Many of Michigan's rivers and lakes receive direct discharge of treated effluent from municipal and industrial sources as well as runoff from urbanized areas, construction sites, and agricultural areas. Sedimentation, nutrient enrichment, and toxic pollutant loading are problems associated with runoff that can impact surface water quality. Surface water quality is generally showing improvement where programs are in place to correct problems and restore water quality.

### *1.2.1 Great Lakes, Bays, Connecting Channels, and Lake St. Clair*

The Great Lakes contain 20 percent of the world's fresh surface water and are a unique natural resource. The protection of the Great Lakes is shared by the United States and Canadian federal governments; the states of Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, Pennsylvania, and New York; and the Canadian Provinces of Ontario and Quebec. Various Native American tribal organizations are also stakeholders and play a role in protecting Great Lakes water quality.

Michigan lies almost entirely within the watersheds of Lakes Superior, Michigan, Huron, and Erie (Table 1.2). The state maintains jurisdiction over approximately 45 percent (by surface area) of the 4 bordering Great Lakes (38,865 of a total area of 86,910 square miles). Significant Great Lakes bays include Grand Traverse Bay and Saginaw Bay. In this IR, the St. Marys, St. Clair, and Detroit Rivers (connecting channels) and Lake St. Clair are generally discussed in the Great Lakes Chapter (see Chapter 5). The term "connecting channels" used in this report is slightly different than the term "connecting waters" defined in Michigan's WQS. In this IR, the Keweenaw waterway (i.e., the Portage Lake ship canal, Portage Lake, Portage River, etc.) is reported as river miles and inland lakes. Michigan's WQS include the Keweenaw waterway in the "connecting waters" definition.

Table 1.2 Jurisdictional control of the four Great Lakes bordered by Michigan.

| Great Lake | Canadian* (miles$^2$) | United States* (miles$^2$) | Michigan† (miles$^2$) | Total* (miles$^2$) |
|---|---|---|---|---|
| Superior | 11,100 | 20,600 | 16,400 | 31,700 |
| Michigan | --- | 22,300 | 13,250 | 22,300 |
| Huron | 13,900 | 9,100 | 9,100 | 23,000 |

| | Canadian* | United States* | Michigan† | Total* |
|---|---|---|---|---|
| Erie | 4,930 | 4,980 | 115 | 9,910 |
| Total | 29,930 | 56,980 | 38,865 | 86,910 |

*Strum, 2000; †United States Census Bureau 2002 estimate

Generally, the open waters of the upper Great Lakes (Superior, Michigan, and Huron) have excellent water quality. Exceptions include a few impaired locations restricted to nearshore zones influenced by large, densely populated, and heavily industrialized areas. Great Lakes' water quality has benefited from pollutant control and remedial efforts in tributaries. These activities have reduced the discharge of conventional and toxic pollutants, including nutrients, persistent organic compounds, metals, and oils.

Aquatic Invasive Species (AIS) continue to have dramatic indirect and direct effects on the Great Lakes (see Section 2.25.1). AIS are responsible for increases in water clarity, loss of organisms and biodiversity, disruption of food webs, and impacts on economically important fish species (International Association for Great Lakes Research, 2002). Emerging research also shows that AIS cause changes in nutrient cycling and availability and contribute to increased plant and algae growth in many nearshore areas, such as Saginaw Bay and the western basin of Lake Erie.

The Great Lakes have problems with selected persistent bioaccumulative chemicals. Fish consumption advisories in the Great Lakes serve as reminders that certain pollutants, such as PCBs, chlordane, dioxins, and mercury remain elevated in the water column and fish tissue. The use of PCBs and dichlorodiphenyltrichloroethane (DDT) was banned in the 1970s and concentrations of these chemicals in Great Lakes fish have declined; however, concentrations in some species still require consumption advisories. Atmospheric deposition, tributary loadings, and the dynamic exchange and cycling between air, water, and sediment within the Great Lakes basins are the key factors influencing contaminant levels in Great Lakes fish.

### *1.2.2 Inland Lakes and Reservoirs*

Michigan has approximately 46,000 inland lakes (including lakes, ponds, and river impoundments) with a surface area of at least one-tenth of an acre or greater. Lakes with the largest surface area include Houghton (Roscommon County), Torch (Antrim and Kalkaska Counties), Charlevoix (Charlevoix County), Burt (Cheboygan County), Mullett (Cheboygan County), Gogebic (Gogebic and Ontonagon Counties), Manistique (Luce and Mackinac Counties), Black (Cheboygan and Presque Isle Counties), Crystal (Benzie County), Portage (Houghton County), and Higgins (Crawford and Roscommon Counties).

Michigan has 730 inland lakes that are deemed "public access lakes" (Table 1.3). The list of public access lakes includes lakes with a public boat launch and a lake surface area of at least 50 acres as well as a few recreationally important small lakes (less than 50 acres) that have public boat launches. There are 345 public access lakes located in the southern Lower Peninsula, 219 in the northern Lower Peninsula, and 166 in the Upper Peninsula. The average public access lake size is 341 acres in the southern Lower Peninsula, 1,342 acres in the northern Lower Peninsula, and 731 acres in the Upper Peninsula.

Michigan has 156 inland lakes that are deemed "cisco lakes." The cisco (*Coregonus artedi*) is a member of a trout and salmon (Salmonidae) subfamily that usually occupies the cooler and deeper niches of high quality freshwater inland lakes and many parts of the Great Lakes. In North America, cisco can be found from Alaska to New England. Ciscos are, or were, present in at least 156 lakes in 41 Michigan counties ranging from the Indiana border to Keweenaw County in the Upper Peninsula. The cisco is currently identified as a state threatened species

pursuant to the NREPA. Ciscos require relatively deep inland lakes with cool, well-oxygenated waters. During summer stratification, cisco are rarely found in waters above 20$^{o}$C or at dissolved oxygen concentrations less than 3.0 parts per million. This species is very sensitive to habitat degradation and has been extirpated from lakes where these minimum thermal and dissolved oxygen conditions are not met. In 2003, the MDNR initiated a study to assess the status of the cisco populations in Michigan. The intent of this ongoing study is to identify inland lakes in which populations are extant and increase awareness of this species so that protective best management practices (BMPs) are promoted.

Although Michigan's inland lakes generally have good to excellent water quality, some water quality issues remain. Of the public access lakes that do not meet WQS, the primary cause is fish consumption advisories for PCBs or mercury. A statewide mercury-based fish consumption advisory applies to all of Michigan's inland lakes, reservoirs, and impoundments. The majority of Michigan's public access lakes have moderate or low nutrient levels; however, nutrient levels are high enough in several lakes to warrant corrective action through the development and implementation of a TMDL. Many lakes with moderate to high nutrient levels are located in the southern Lower Peninsula where large population centers and fertile soils exist. Many lakes with low nutrient levels are located in the northern Lower Peninsula and Upper Peninsula where the population density is lower, soils are less fertile, and lakes tend to be larger and deeper. Contaminated sediments are also an issue in several inland lakes, and remediation efforts are being planned or have been undertaken.

Table 1.3 Michigan's public access and cisco lakes by county. *Indicates that the lake is a public access lake and a cisco lake. †Indicates that the lake is a cisco lake only.

| | | | |
|---|---|---|---|
| ALCONA | BARRY | CALHOUN | CHIPPEWA |
| Alcona Dam Pond | Baker | Duck | Caribou |
| Brownlee | Barlow† | Goguac | Carp |
| Cedar | Big Cedar† | Homer | Frenchmans |
| Crooked | Bristol | Lane | Hulbert† |
| Hubbard* | Carter | Lee | Monacle* |
| Jewell | Chief Noonday | Nottawa | Shelldrake Impoundment |
| North | Clear | Prairie | |
| Vaughn | Cloverdale | Upper Brace | CLARE |
| | Crooked | Wabascon | Arnold |
| ALGER | Deep | Warner's | Big Long |
| AuTrain Basin | Duncan | Winnipeg | Budd |
| AuTrain Lake | Fine | | Cranberry |
| Deer† | Fish* | CASS | Crooked |
| Fish | Gun | Baldwin* | Five |
| Grand Sable | Jordan | Belas | George |
| Kingston | Leach | Birch* | Lily |
| Nawakwa | Lime† | Bunker† | Little Long |
| | Little Cedar† | Chain† | Mud |
| ALLEGAN | Long (Hope Twp) | Christiana | Perch |
| Allegan | Long (Johnstown Twp)* | Curtis† | Shingle |
| Baseline | Long (Yankee Springs Twp) | Day† | Silver |
| Big | Lower Crooked | Dewey | Windover |
| Duck | Middle | Diamond | |
| Eagle | Payne | Donnell* | CLINTON |
| Green* | Pine | Driskels | Ovid |
| Hutchins | Thornapple | Fish | Park |
| Kalamazoo | | Harwood* | |
| Lower Scott | BENZIE | Hemlock | CRAWFORD |
| Miner | Ann* | Indiana† | Jones |
| Osterhout | Betsie | Juno/Painter | K.P. |
| Selkirk | Crystal* | Kirk* | Margrethe |
| Swan | Herendeene | Lewis† | Section One |
| Swan Creek Pond | Little Platte | Lime† | Shupac |
| | Lower Herring | Magician | |
| ALPENA | Pearl | Mill | DELTA |
| Beaver* | Platte | North Twin | Boney Falls |
| Fletcher Pond | Stevens | Paradise | Camp 7 |
| | Turtle | Round† | Corner |
| ANTRIM | Upper Herring | Shavehead* | Dana |
| Bellaire* | | South Twin | Pole Creek Lake |
| Benway | BERRIEN | Stone | Round |
| Birch | Paw Paw | Tharp† | Skeels |
| Clam | | | |
| Elk* | BRANCH | CHARLEVOIX | DICKINSON |
| Ellsworth | Archer* | Charlevoix* | Antoine |
| Intermediate* | Bartholomew† | Deer | Bass |
| Lake of the Woods | Cary | Hoffman | Carney |
| St. Clair | Coldwater* | Six Mile | Edey |
| Torch* | Craig | Susan | Hamilton |
| Wilson | East Long* | Thumb | Louise† |
| | George | Walloon* | Mary* |
| BARAGA | Gilead | | Norway |
| Beaufort | Kenyon | CHEBOYGAN | Pickeral |
| Big Keewaydin | Lavine | Black | Rock |
| King | Marble* | Burt* | Sawyer |
| Parent | Matteson | Douglas† | Silver |
| Prickett Dam | Morrison | Lancaster | Six Mile |
| Ruth | North | Long | |
| Vermilac | Oliverda | Mullett* | EATON |
| | Randall | Silver | Narrow |
| | Rose (Lake of the Woods) | Twin Central† | Saubee† |
| | Silver | Twin North† | |
| | South | Twin South † | |
| | Union | | |

Table 1.3 continued. Michigan's public access and cisco lakes by county. *Indicates that the lake is a public access lake and a cisco lake. †Indicates that the lake is a cisco lake only.

EMMET
- Crooked
- Larks
- Paradise
- Pickeral
- Round

GENESEE
- C.S. Mott Impoundment
- Fenton
- Holloway Reservoir
- Kearsley Reservoir
- Lobdell*
- Ponemah
- Thread

GLADWIN
- Lake Four
- Pratt
- Secord Impoundment
- Wiggins
- Wixom Impoundment

GOGEBIC
- Allen
- Bass
- Beatons
- Bobcat
- Chaney
- Cisco*
- Clark*
- Clearwater
- Crooked†
- Dinner
- Duck
- Eel
- Gogebic*
- Henry Impoundment
- Lac Vieux Desert
- Loon†
- Langford
- Little Oxbow
- Lake Pomeroy
- Marion
- McDonald

GOGEBIC cont'd
- Moon
- Moosehead
- Moraine
- Noorwood†
- Ormes
- Sunday
- Taylor*
- Thousand Island*

GRAND TRAVERSE
- Arbutus
- Bass
- Bass
- Boardman
- Bridge†
- Brown Bridge Pond
- Cedar
- Cedar Hedge*
- Dubonnet
- Duck*
- Fife
- Green*
- Long
- Silver
- Spider

HILLSDALE
- Baw Beese
- Bear*
- Bird
- Carpenter†
- Cub
- Diane
- Hemlock*
- Long (Reading Twp)*
- Long (Stubin Co., IN)
- Round
- Sand North†
- Sand Middle†
- Sand South†
- Wilson†

HOUGHTON
- Bob
- Boston
- Emily
- Otter*
- Pike
- Portage*
- Rice
- Roland
- Sandy
- Torch*

INGHAM
- Lansing

IONIA
- Long
- Morrison
- Sessions
- Woodard

IOSCO
- Floyd
- Foote Dam Pond
- Indian
- Londo
- Long
- Loon*
- Loud Dam Pond
- Round
- Sand
- Tawas
- VanEtten
- West Londo

IRON
- Bass
- Brule
- Buck
- Cable
- Camp
- Chicagon
- Deer
- Ellen
- Emily
- Fire
- First Fortune
- Gibson
- Golden
- Hagerman
- Hannah Webb
- Indian
- Iron
- James
- Kidney
- Little Smoky
- Long
- Mary
- Michigamme
- Norway
- Ottawa
- Perch
- Runkle
- Smoky*
- Stager
- Stanley
- Sunset
- Swan
- Tamarack
- Tepee
- Winslow

ISABELLA
- Coldwater*
- Halls
- Littlefield*
- Stevenson

JACKSON
- Brown†
- Center
- Clark
- Crispell
- Gilletts
- Grass
- Pleasant
- Portage
- Round
- South Lime
- Swain's*
- Vandercook*
- Vineyard
- Wampler's

KALAMAZOO
- Austin
- Barton
- Crooked†
- Eagle
- Eagle
- Gourdneck
- Gull*
- Hogsett
- Howard†
- Indian*
- Long
- Morrow Pond
- Paw Paw*
- Portage (Blue)
- Ruppert
- Sagmaw†
- Sherman
- Sugarloaf
- West
- Whitford

KALKASKA
- Bear
- Blue (Big)*
- Big Guernsey
- Cub
- East
- Indian
- Manistee
- North Blue†
- Pickeral
- Starvation
- Skegmog*
- Twin (Big)*

Table 1.3 continued. Michigan's public access and cisco lakes by county. *Indicates that the lake is a public access lake and a cisco lake. †Indicates that the lake is a cisco lake only.

KENT
- Bass
- Big Myers
- Big Pine Island
- Big Wabasis
- Camp
- Campau
- Campbell
- Lime
- Lincoln
- Murray*
- Pratt
- Reeds
- Ziegenfuss†

KEWEENAW
- Bailey
- Desor†
- Fanny Hoe*
- Gratiot
- Lac LaBelle
- Medora
- Ritchie†
- Sargent†
- Siskiwit†
- Thayer's

LAKE
- Big Bass
- Big Star
- Harper
- Idlewild
- Little Bass†
- Paradise
- Reed
- Wolf

LAPEER
- Big Fish
- Davidson
- Long
- Minnewanna
- Nepessing
- Otter

LEELANAU
- Cedar
- Davis
- Glen*
- Lime
- Little Glen
- Little Traverse*
- North Lk Leelanau*
- School
- South Lk Leelanau*

LENAWEE
- Allens
- Deep
- Devils
- Hudson
- Round
- Round
- Sand

LIVINGSTON
- Appleton*
- Baseline*
- Bass†
- Bennett†
- Bishop
- Chemung*
- Fish†
- East Crooked*
- Hiland
- Limekiln†
- Ore†
- Portage†
- Runyan†
- Sandy Bottom†
- Thompson
- West Crooked*
- Whitmore
- Woodland
- Zukey†

LUCE
- Bass
- Bodi
- Culhane
- Kaks
- Muskallonge
- North Manistique*
- Perch
- Pike
- Twin

MACKINAC
- Brevoort*
- Little Brevoort
- Manistique*
- Milakokia
- Millicoquins
- S. Manistique*

MACOMB
- Stony Creek Impoundment

MANISTEE
- Arcadia
- Bear
- Canfield
- Healy
- Manistee
- Pine*
- Portage

MARQUETTE
- Anderson
- Ann†
- Arfelin
- Bass
- Bass
- Big Shag
- Dead River Storage Basin
- Engmans
- Greenwood Reservoir
- Horseshoe
- Independence*
- Ives†
- Johnson
- Little
- Little Shag
- Michigamme
- McClure Storage Reservoir
- Mountain†
- Pike
- Pine†
- Rush†
- Silver†
- Sporley*
- Squaw
- Witch
- Wolf

MASON
- Bass
- Ford
- Gun
- Hackert (Crystal)
- Hamlin
- Lincoln
- Pere Marquette
- Pliness
- Round

MECOSTA
- Bergess
- Blue
- Chippewa
- Clear
- Hillsview
- Horsehead
- Jehnsen
- Martiny
- Mecosta
- Merrill
- Pretty
- Rogers Pond
- Round
- School Section
- Townline

MENOMINEE
- Long

MIDLAND
- Sanford

MISSAUKEE
- Crooked
- Goose
- Long
- Missaukee
- Sapphire

MONTCALM
- Baldwin
- Bass
- Clifford
- Cowden
- Crystal
- Derby
- Dickerson
- Halfmoon
- Horseshoe
- Little Whitefish
- Loon
- Montcalm
- Mud
- Muskellunge
- Nevins
- Rainbow
- Rock
- Tamarack
- Townline
- Whitefish
- Winfield

MONTMORENCY
- Atlanta
- Avalon*
- Avery
- Clear
- East Twin
- Ess
- Gaylanta
- Grass
- Lake Fifteen
- Long*
- McCormick
- Muskellunge
- Rush
- Sage
- West Twin

MUSKEGON
- Bear
- Big Blue
- Duck
- East Twin
- Fox
- Half-Moon
- Mona
- Muskegon
- North
- White
- Wolf

Table 1.3 continued. Michigan's public access and cisco lakes by county. *Indicates that the lake is a public access lake and a cisco lake. †Indicates that the lake is a cisco lake only.

NEWAYGO
- Baptist
- Benton
- Bills
- Blanch
- Brooks
- Croton Dam Pond
- Crystal
- Diamond
- Englewright
- Fremont
- Hardy
- Hess
- Kimball*
- Nichols*
- Pettibone
- Pickerel*
- Robinson
- Sand
- Woodland

OAKLAND
- Angelus†
- Big
- Cass*
- Cedar Island*
- Crescent
- Deer*
- Dickinson
- Dunham†
- Green†
- Hammond†
- Heron
- Kent
- Lakeville
- Long
- Loon*
- Lotus*
- Lower Pettibone
- Maceday*
- Middle Straits
- Oakland
- Orchard*
- Orion
- Oxbow†
- Pontiac
- Seven
- Silver†
- Squaw/Clear
- Tipsico
- Townsend†
- Union*
- Upper Proud
- Upper Pettibone†
- Valley
- White
- Wildwood
- Wolverine

OCEANA
- Crystal
- McLaren
- Pentwater
- Schoolsection
- Silver
- Stony

OGEMAW
- Au Sable
- Bush
- Clear
- DeVoe*
- George
- Grousehaven*
- Hardwood
- Horseshoe
- Lake George
- Peach
- Rifle
- Sage
- Tee

ONTONAGON
- Bond Falls
- County Line

OSCEOLA
- Big
- Diamond
- Hicks
- Rose
- Sunrise
- Todd
- Wells

OSCODA
- McCollum
- Mio Dam
- Pond
- Tea

OTSEGO
- Big
- Big Bass
- Big Bear
- Bradford
- Dixon
- Emerald
- Heart
- Manuka
- Opal
- Otsego
- Pickerel
- Twenty Seven

OTTAWA
- Crockery
- Macatawa
- Pigeon
- Spring

PRESQUE ISLE
- Big Tomahawk
- Emma
- Essau
- Grand
- Long
- Lost
- May
- Nettie
- Shoepac
- Sunken

ROSCOMMON
- Higgins*
- Houghton
- St. Helen

SCHOOLCRAFT
- Boot
- Colwell
- Dodge
- Gemini
- Gulliver*
- Indian*
- Island
- Kennedy
- McDonald
- Petes
- Ross
- Snyder

ST JOSEPH
- Big Fish
- Clear
- Corey*
- Crotch
- Fisher's
- Klinger*
- Long
- Long
- Palmer
- Pleasant*
- Portage
- Prairie River*
- Sand
- Sturgeon
- Tamarack†
- Thompson*
- Three Rivers Impoundment

TUSCOLA
- Caro Reservoir
- Murphy
- North

VAN BUREN
- Ackley
- Banksons
- Brandywine
- Cedar
- Clear
- Cora
- Eagle
- Eleven
- Fish
- Fourteen
- Gravel
- Halls
- Huzzy's
- Lake of the Woods
- Maple
- North Scott
- Round
- Rush
- Saddle
- School
- Section
- Shafer
- South Scott
- Three Legged
- Three Mile
- Upper Jeptha
- Upper Reynolds
- VanAuken
- Wolf†

WASHTENAW
- Big Portage
- Blind†
- Bruin*
- Cedar
- Crooked
- Ford
- Four Mile
- Green
- Half Moon*
- Joslin
- Mill
- Mud
- North
- Pickerel†
- South*
- Sugar Loaf
- Winnewanna

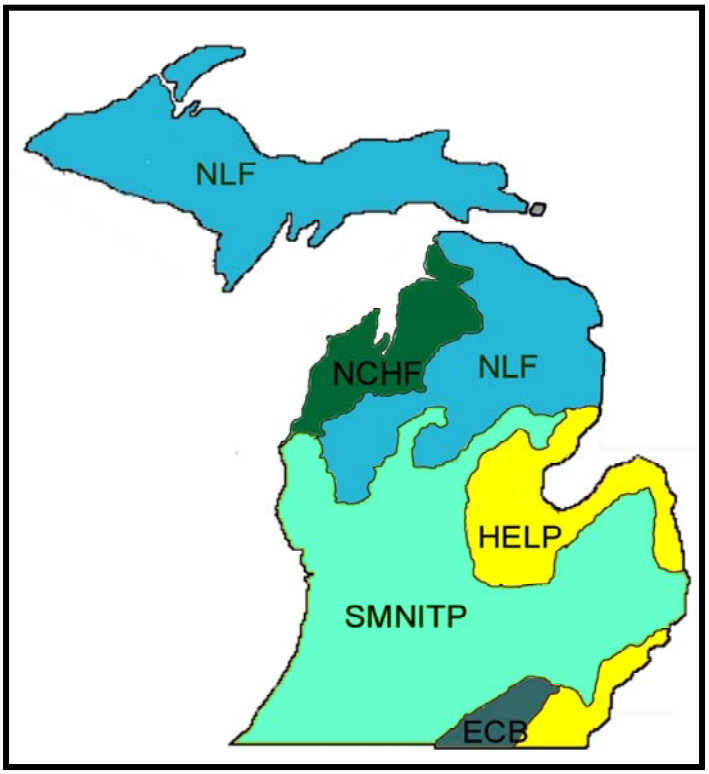
WAYNE
- Belleville
- Newburgh

WEXFORD
- Berry
- Cadillac
- Hodenpyl Dam Pond
- Long
- Mitchell

### *1.2.3 Rivers*

Michigan's rivers can be grouped by the distinct ecoregions through which they flow. Each of the five ecoregions in Michigan consists of areas that exhibit relatively similar geological landform characteristics (Omernik and Gallant, 1988). Factors used to delineate ecoregions include climate, soils, vegetation, land slope, and land use. This framework provides information on the environmental characteristics that tend to occur within each ecoregion. In order by size (largest to smallest area), the five ecoregions in Michigan are Southern Michigan/Northern Indiana Till Plains, Northern Lakes and Forests, North Central Hardwood Forests, Huron-Erie Lake Plains, and Eastern Corn Belt Plains (Figure 1.1).

Rivers in the Northern Lakes and Forests and North Central Hardwood Forests ecoregions tend to support coldwater fish within at least a portion of their systems. These rivers commonly have relatively small watersheds, high relief topography, substantial groundwater inputs, and are naturally low in productivity. Most rivers in the Northern Lakes and Forests ecoregion are perennial, often originating from lakes or wetlands. Although relatively free of sediment, surface waters in this ecoregion often have a characteristic brownish color because of elevated concentrations of dissolved organic material, including tannins and lignins. In the North Central Hardwood Forests ecoregion, river flow is highly variable. Flow is entirely intermittent in some portions of the ecoregion and entirely perennial in other areas. These rivers typically drain soils with much poorer nutrient content than in bordering ecoregions to the south.




**SMNITP** - Southern Michigan/Northern Indiana Till Plains
**NCHF** - North Central Hardwood Forests
**NLF -** Northern Lakes and Forests
**HELP** - Huron-Erie Lake Plains
**ECB** - Eastern Corn Belt Plains

Figure 1.1 Ecoregions of Michigan (Level III) (adapted from Omernik and Gallant, 1988).

Rivers in the Southern Michigan/Northern Indiana Till Plains ecoregion are generally of good water quality in the headwaters. This ecoregion is drained predominantly by perennial rivers. Such rivers are typically sluggish and are bordered, often extensively, by wetland tracts. Drainage ditches and channelized rivers have been a common solution to assist drainage of areas that are too wet for settlement and agricultural needs.

Upland features related to poor soil drainage heavily influence the rivers in the Huron-Erie Lake Plains and Eastern Corn Belt Plains ecoregions. Broad and nearly level lake plain is crossed by beach ridges and low moraines, which has resulted in the formation of poorly drained soils. More than half of the rivers in the Huron-Erie Lake Plains ecoregion are intermittent, and river flows are commonly runoff-dependent. In addition to the construction of numerous drainage ditches, the headwaters of many rivers are extensively channelized for quicker drainage and to improve upland field conditions. About half of the rivers in the Eastern Corn Belt Plains ecoregion are perennial and many have been channelized to assist soil drainage. This ecoregion is almost entirely farmland, and river quality is influenced by increased soil and water runoff from agricultural land uses.

### *1.2.4 Wetlands*

Michigan's aquatic resources include approximately 5,583,400 acres of wetlands, some of exceptional quality and rarity. About 15 percent of Michigan's land area is wetland. Several inventories of wetlands in Michigan have been undertaken by different agencies. At this time, however, no practical method has been developed to accurately track all wetlands gains and losses on a statewide basis. Sources of wetland loss include permitted activities; unpermitted activities (i.e., violations of Section 404 of the CWA and state law); agricultural and silvicultural practices, which are exempt under state and federal law; the loss of small, isolated wetlands that are not under state or federal jurisdiction; natural processes (e.g., beaver activity); and indirect effects (e.g., alteration of drainage networks due to urbanization). Wetland acreage may increase for some of the same reasons (e.g., changes in drainage pathways). However, most wetland gains are attributed to voluntary wetland restoration projects, pond construction, and mitigation for permitted impacts.

Estimates of wetland losses since European settlement range from 35 percent, based on the Michigan Natural Features Inventory presettlement inventory to 50 percent based on the United States Fish and Wildlife Service (USFWS) Status and Trends reporting. During 2006, the MDEQ, Wetlands Unit, then housed in the Land and Water Management Division (LWMD), contracted with Ducks Unlimited Great Lakes/Atlantic Regional Office to perform an update to the original National Wetland Inventory dataset that was completed in the late 1970s and early 1980s. The contract specifies updating the National Wetland Inventory dataset to the two most recent, statewide, aerial photography flights conducted in the state, that being the 1998 United States Geological Survey (USGS) Digital Ortho Quarter Quads data and the 2005 National Agriculture Imagery Program data. At the conclusion of this effort, the MDEQ will be able to readily quantify wetland gains/losses in the state over the last 30 years, which happens to be the same time period wetland regulations have been in effect.

The Michigan Natural Features Inventory published a preliminary assessment entitled, "Wetland Trends in Michigan Since 1800" (Comer, 1996), based on a comparison of original land surveys conducted by the General Land Office from 1816 to 1856 and Michigan Resource Information System land use/land cover maps. This publication includes a county-by-county estimate of historical wetland types and losses since pre-European settlement. In addition, the pre-European settlement maps have been digitized and are available for review in a Geographic Information System (GIS).

The Great Lakes Coastal Wetlands Consortium has recently completed a GIS-based inventory of Great Lakes coastal wetlands in cooperation with the Great Lakes state and provinces. This inventory is available through the Consortium's Web site at http://www.glc.org/wetlands.

Part 303, Wetlands Protection, of the NREPA requires the MDEQ to make a preliminary inventory of all wetlands in the state on a county-by-county basis. County wetland inventories are now completed for all 83 counties in the state, and have been made available to the public on the Internet at http://www.michigan.gov/deqwater under Wetlands Protection, Wetland Inventory Maps or by submitting a request for a large-format print to the MDEQ, LWMD. The county wetland inventories were produced by overlaying data from the following sources: the USFWS National Wetland Inventory maps, Natural Resources Conservation Service soil survey maps, and Michigan Resource Information System land use/land cover maps. County wetland inventories are intended to be used as planning tools that provide potential and approximate locations of wetlands and some information regarding wetland condition, but are not intended to be used to determine the jurisdictional boundaries of wetland areas subject to regulation.

## CHAPTER 2
## WATER PROTECTION ACTIVITIES

The MDEQ has a number of programs designed to protect and restore water quality. These programs establish WQS, provide regulatory oversight for public water supplies, issue permits to regulate the discharge of industrial and municipal wastewaters, provide technical and financial assistance to reduce pollutant runoff, ensure compliance with state laws, and educate the public about water quality issues. This chapter provides descriptions of Michigan's water quality protection programs and highlights several special initiatives and costs/benefits.

### 2.1 Abandoned Well Management

Unplugged abandoned wells threaten the quality of drinking water obtained from privately owned and publicly owned drinking water supply wells. The Resource Management Division has implemented a comprehensive Abandoned Well Management Program to coordinate statewide abandoned well location and plugging activities. Plugging abandoned wells protects the groundwater source aquifers that are used by nearly one-half of Michigan's citizens for drinking water. The goal of the Abandoned Well Management Program is to identify and properly plug as many abandoned wells as possible.

The WRD also administers an Abandoned Well Management Grants Program that is funded by the Clean Michigan Initiative (CMI). Abandoned well management grants target and fund the location and plugging of abandoned wells in community public water supply wellhead protection areas.

The MDEQ conducts training and public education/outreach activities to raise the level of public awareness concerning the environmental and public health threats associated with unplugged abandoned wells. Groundwater protection seminars that include abandoned well-related topics are sponsored for general audiences. Technical training programs covering abandoned well plugging techniques and requirements are conducted for registered water well drilling contractors, local health department (LHD) staff members, environmental consultants, and other state of Michigan departments.

The Michigan Department of Agriculture & Rural Development (MDARD) administers a cost share grants program, the "Farm*A*Syst" Program that can pay up to 90 percent of the cost for plugging abandoned wells on agricultural lands.

LHDs enforce abandoned well plugging requirements through field inspections and review of abandoned well plugging records that are submitted by registered well drilling contractors and property owners. The WRD conducts compliance and enforcement actions in cooperation with the Office of Criminal Investigations, the Michigan Department of Attorney General, and LHDs. Many successful enforcement actions have been taken in recent years.

## 2.2 Aquatic Nuisance Control

The MDEQ has the authority, under Part 33, Aquatic Nuisance Control, of the NREPA, to regulate the chemical control of nuisance aquatic plants, algae, and swimmer's itch. Each application for a permit must undergo a thorough review to assess the environmental impact to the water body and any human health and safety issues. A large majority of these treatments are carried out by commercial pesticide applicators licensed by the MDARD. The MDEQ works with the MDARD to assure those treatments and the applicators comply with the requirements of the permits and the pertinent laws. Program staff also review new chemical products proposed for use in Michigan waters, survey Michigan lakes to determine the composition of the native plant community and presence of exotic plant species, and seek to educate riparian property owners about the management of aquatic plants and a variety of related lake management issues.

## 2.3 Beach Protection

In Michigan, LHDs have jurisdiction to test and otherwise evaluate water quality at bathing beaches to determine whether the water is safe for bathing purposes. The LHDs advise beach owners when beaches should be closed and the local health officer may petition the county circuit court to close a beach if needed. Beach monitoring results collected by the LHDs and swimming advisories are made available to the public by the LHDs via the MDEQ's statewide beach monitoring Web site at http://www.deq.state.mi.us/beach. Signs are posted at bathing beaches stating whether or not the beach has been tested for *E. coli*. Since 2000, the MDEQ has provided grants to LHDs to support and augment beach monitoring throughout Michigan. These grants are funded by a combination of state CMI bond money and federal Beaches Environmental Assessment and Coastal Health Act (BEACH Act) funds. The BEACH Act authorizes the USEPA to award program development and implementation grants to eligible states, territories, tribes, and local governments. These annual grants support microbiological monitoring of coastal recreation waters, including the Great Lakes, which are adjacent to beaches or similar points of access used by the public. BEACH Act grants also support development and implementation of programs to notify the public of the potential exposure to disease-causing microorganisms in coastal recreation waters.

## 2.4 Biosolids

The treatment of municipal wastewater generates a residue called biosolids. Biosolids may be disposed of through incineration or landfilling, or they may be recycled. Because biosolids contain nutrients and can therefore have a beneficial use as fertilizer or soil conditioner, recycling is an effective alternative to incineration or landfilling. The MDEQ encourages the use of biosolids to enhance agricultural and silvicultural production in Michigan. However, if biosolids are not properly handled and enter surface water or groundwater, their associated chemical character could severely degrade water quality. To prevent such problems, the land application of biosolids is a regulated activity.

Under federal regulations, criteria for biosolids management have been established. National Pollutant Discharge Elimination System (NPDES) and state groundwater discharge permits require management of biosolids and other residuals from wastewater treatment facilities. Permittees are required to develop and obtain MDEQ approval of a Residuals Management Program. The MDEQ district staff members also inspect the facilities generating the biosolids and the land application sites.

## 2.5 Coastal Management

The Michigan Coastal Management Program in the Office of the Great Lakes, MDEQ, is one of more than 30 state coastal programs established under the authority of the Federal Coastal Zone Management Act of 1972 (PL 92-583). The National Oceanic and Atmospheric Administration provides annual funding to these state programs for protecting coastal land and water resources. A substantial portion of Michigan's annual funding is used for the MDEQ's administration of several State regulatory authorities that provide for the protection and management of coastal wetlands, shorelands, sand dunes, drowned river mouths, Great Lakes submerged lands, and other resources and habitats within Michigan's coastal zone Michigan's program also passes through a portion of its federal dollars as cost-share, Coastal Zone Management grants to local communities, nonprofit organizations, and other eligible groups. Coastal Zone Management grants support a variety of projects, including projects that directly support coastal watershed management and water quality improvement, such as community planning and zoning with an emphasis on resource protection, conservation planning, research, coastal habitat protection and restoration, resource inventories, GIS mapping, and public outreach and education.

The Michigan Coastal Management Program also administers Michigan's Coastal and Estuarine Land Conservation Program, a national program established in 2002. Under the Coastal and Estuarine Land Conservation Program, coastal states compete nationally for federal cost-share funding to acquire coastal habitats with significant conservation, recreation, ecological, and other values, and place them under permanent public ownership and protection. Local governments and state agencies nominate coastal habitat protection projects to the Michigan Coastal Management Program for Coastal and Estuarine Land Conservation Program funding. In turn, the Michigan Coastal Management Program submits up to three projects annually to National Oceanic and Atmospheric Administration for consideration in the federal competition.

## 2.6 Community Water Supply

The MDEQ oversees approximately 1,470 community water systems that furnish drinking water year-round to residential populations of 25 or more, to ensure that the USEPA's minimum standards for safe drinking water and Michigan Safe Drinking Water Act, 1976 PA 399, as amended (Act 399), requirements are met. Over the last decade, 99 percent or more of the population have been served by community water supplies meeting all health standards. Since 1998, the Drinking Water Revolving Loan Fund has provided low interest loans for projects designed to protect community water supply systems.

## 2.7 Compliance and Enforcement

The MDEQ, WRD, Enforcement Unit and Field Operations Division staff are responsible for conducting compliance and enforcement actions taken by the WRD. Field Operations Division staff conduct compliance inspections to ensure they are following the requirements of state water pollution control statutes and rules, surface and groundwater discharge permits, and violations of administrative or judicial orders. Other compliance and enforcement activities include response and investigation of complaints and the follow-up of corrective actions.

Enforcement action may be used to bring the entity into compliance as quickly as possible, restore any natural resource damages caused by the violation, assess appropriate penalties, eliminate financial gain that may have been realized as a result of noncompliance, and drive improvements in water quality. Enforcement actions are generally progressive in nature. They include any number of possible actions, including issuance of notices of violation, preparation of final orders of abatement, settlement via administrative consent orders, or referrals to the Michigan Department of Attorney General for civil or criminal litigation. The Enforcement Unit

serves as the WRD's liaison with the Michigan Department of Attorney General and also works with the USEPA and the United States Department of Justice on joint state/federal enforcement cases.

MDEQ staff collect effluent samples from NPDES facilities to evaluate compliance with permit limits. Additionally, the MDEQ conducts special studies to support water quality enforcement actions. These studies may include water, sediment, biological, and/or toxicity sampling, depending on the specific issue. Water quality monitoring in response to spills is also conducted. Monitoring activities to support enforcement actions are implemented as needed, and are always developed with input from Enforcement Unit and Field Operations Division staff.

### 2.8 Conservation Reserve Enhancement

The MDEQ works closely with the MDARD to implement the Conservation Reserve Enhancement Program, a federal-state-local conservation partnership designed to reduce significant environmental effects related to agriculture. The Conservation Reserve Enhancement Program is being implemented in four critical watersheds (Saginaw Bay, Macatawa River, River Raisin, and western Lake Erie basin) that have intense agricultural land use. The objectives of the program are to improve and protect water quality and to promote and enhance wildlife habitat by providing incentives to Michigan citizens for implementing conservation practices for a period of 15 years. Eligible conservation practices include grass plantings, filter strips, riparian buffer strips, field windbreaks, and wetland restoration. The MDEQ also supplied Section 319 and CMI funds for livestock exclusion, implementation of Natural Resources Conservation Service approved conservation practices, Conservation Reserve Enhancement Program technical assistance, and permanent conservation easements. The program has enrolled nearly 74,000 acres of the 85,000 acre goal in the priority watersheds.

### 2.9 Contaminated Sediment

The Contaminated Sediment Program consists of activities to coordinate and implement remediation at sites of environmental contamination that impact water quality. Sites range from current incidents of spills or losses of pollutants due to accidents or poor facility operations, to historic incidents where pollutants have been in the environment for many years. Some of these sites impact surface waters directly. Others may impact surface waters by the movement of contaminated groundwater, through treatment and permitted discharge of contaminated groundwater, or through discharges of contaminated groundwater to treatment facilities. The MDEQ staff members investigate sites of environmental contamination, make recommendations regarding proposed site remediation and treatment, evaluate treatment proposals and pollutant discharges from remediation systems, and provide other technical and project management support as necessary. As part of the CMI, $25 million was set aside for the investigation and remediation of contaminated sediments in Michigan lakes, rivers, and streams. Summaries of these projects are contained in the MDEQ's Consolidated Report (MDEQ, 2011).

### 2.10 Drinking Water Contamination Investigation

The MDEQ assists LHDs in conducting drinking water quality investigations in areas of known or suspected environmental contamination. Such technical assistance may involve monitoring design, analytical support, toxicological assessment, and/or health advisory notice development.

The MDEQ is also responsible for administering drinking water replacement activities. Administration is primarily accomplished through contracts awarded to local units of government and/or private well drillers to extend community water lines and to replace contaminated water

wells. Provision of bottled water, installation of treatment devices, and well abandonment is also addressed through this program.

The MDEQ also administers a statewide contract to monitor drinking water quality in wells adjacent to sites of environmental contamination and to replace contaminated water wells. Contaminated wells are replaced with water wells drilled to a deeper, protected aquifer, or the homes are connected to community water that is extended into the area.

### 2.11 Environmental Health

Working closely with LHDs, the MDEQ protects public health and the environment through administration of regulatory programs dealing with manufactured housing communities, campgrounds, and public swimming pools. The MDEQ also assures that suitable site conditions are present for proposed residential or commercial developments dependent on individual on-site sewage systems and wells, and regulates the proper collection and disposal of wastes by septic tank pump and haul operators.

### 2.12 Drinking Water and Wastewater Infrastructure Financial Assistance

The MDEQ, in conjunction with the Michigan Finance Authority, operates three revolving fund loan programs that can provide financial assistance to local units of government and public water suppliers for the construction of needed wastewater and drinking water infrastructure. These programs provide loan assistance at interest rates well below open market, with the intention of supporting the department's compliance programs and reducing the costs to be passed on to the users of water and wastewater systems. Debt service payments are returned to the funds and hence "revolved" as they are lent out again. The three programs are:

- Clean Water State Revolving Fund (CWSRF): The CWSRF has been in operation in Michigan since 1989 and to date has tendered 433 loans totaling over $3.7 billion. The CWSRF has played a critical role in the state's Combined Sewer Overflow (CSO) and Sanitary Sewer Overflow Control Programs, and will operate in perpetuity to provide assistance to wastewater system owners for ongoing capital improvement needs. In addition to financing Section 212 projects (Publicly Owned Treatment Works) the CWSRF can also fund Section 319 projects (nonpoint source [NPS] pollution control projects). The fund is capitalized by an annual federal grant and a required state match, with potential access to proceeds from the sale of Great Lakes Water Quality Bonds.

- Drinking Water Revolving Fund: The Drinking Water Revolving Fund has been in operation in Michigan since 1998 and to date has tendered 238 loans totaling over $691 million. Patterned after the CWSRF, the Drinking Water Revolving Fund continues to play a critical role in furthering the MDEQ's public water system program and ensuring the protection of the health of Michigan citizens who are served by public water supplies.

- Strategic Water Quality Initiatives Fund (SWQIF): The SWQIF program was created in 2002 and is capitalized solely by proceeds from the sale of Great Lakes Water Quality Bonds. The SWQIF can fund two specific kinds of projects that are not eligible under the CWSRF because the facilities constructed would not be in public ownership: (1) The on-site upgrade or replacement of failing septic tanks/tile fields; and (2) The removal of storm water or groundwater from sanitary or combined sewer leads. Through fiscal year 2011 the SWQIF has tendered 18 loans totaling over $22 million.

## 2.13 Great Lakes

The Great Lakes form a portion of the international boundary between the United States and Canada, and both countries have jurisdiction over their use. The first Great Lakes Water Quality Agreement between the two federal governments was developed in 1972 and established objectives and criteria for the restoration and enhancement of water quality in the Great Lakes system. A revised Great Lakes Water Quality Agreement was signed in 1978 recognizing the need to understand and effectively reduce toxic substance loads to the Great Lakes. The 1978 Great Lakes Water Quality Agreement adopted general and specific objectives and outlined programs and practices necessary to reduce pollutant discharges to the Great Lakes system. Under the 1987 Protocol that amended the 1978 Great Lakes Water Quality Agreement, the United States and Canadian governments identified 43 of the most polluted areas in the Great Lakes basin that had serious water quality problems known to cause Beneficial Use Impairments of the shared aquatic resources. These areas have been formally designated by the two governments as Areas of Concern (AOCs). Four AOCs were subsequently restored and delisted.

Ten AOCs are exclusively under Michigan jurisdiction: Clinton River, Deer Lake, Kalamazoo River, Manistique River, Muskegon Lake, River Raisin, River Rouge, Saginaw River/Bay, Torch Lake, and White Lake (Figure 2.1). The Menominee River AOC is shared with Wisconsin, and the Detroit River, St. Clair River, and St. Marys River are binational AOCs. The latter AOCs are managed jointly by a binational governance structure created under the Four Agency Letter of Commitment (also called the Four Agency Agreement) that was signed on April 17, 1998, by the Environment Canada, USEPA, MDEQ, and Ontario Ministry of the Environment.

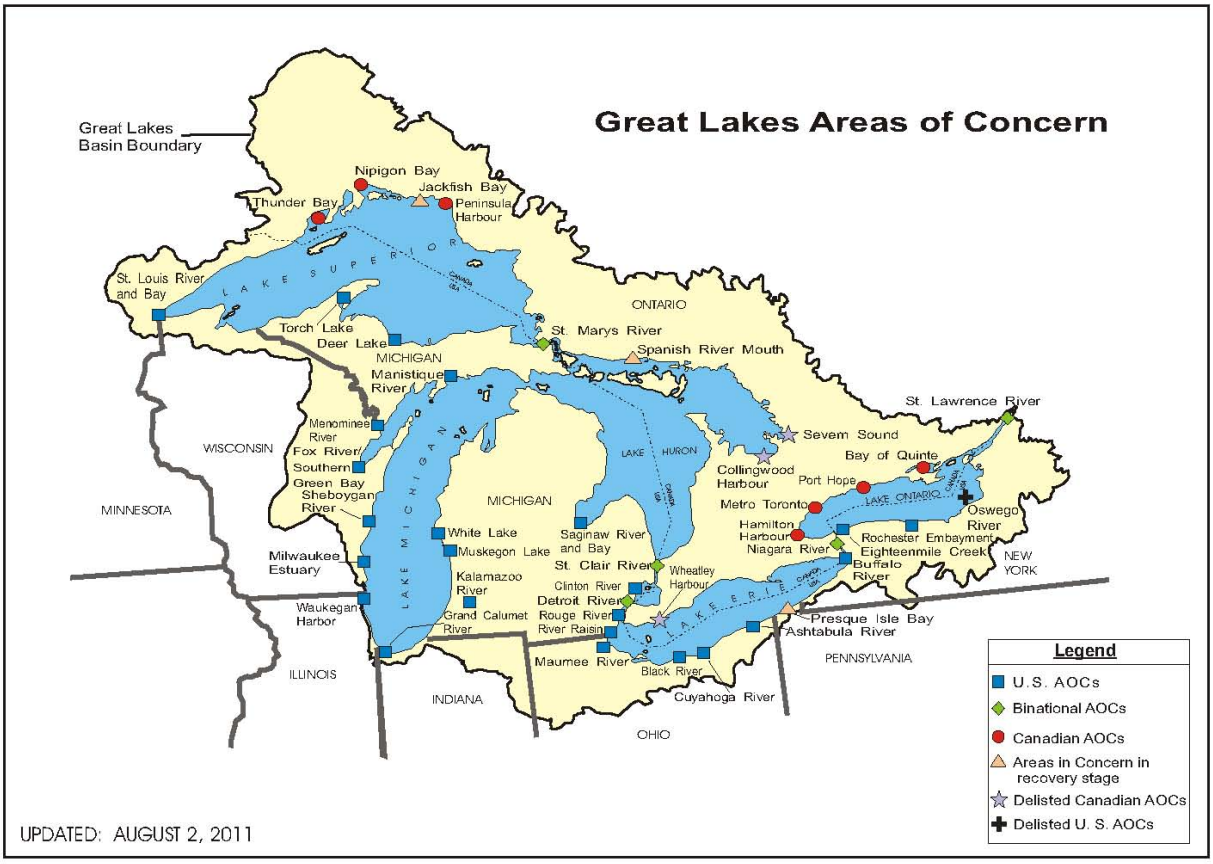



Figure 2.1. Great Lakes AOC (USEPA, 2010).

The 1987 Protocol called for cleanup of the AOCs through the development of Remedial Action Plans. Each Remedial Action Plan is required to identify problems that have led to Beneficial Use Impairments, identify actions needed to restore the beneficial uses, and provide documentation when beneficial uses are restored. Both federal governments play an active role in the implementation of the Remedial Action Plans. All of Michigan's 14 AOCs have completed Remedial Action Plans that are currently at various stages of implementation. Information regarding Michigan's AOCs and Remedial Action Plans is available at http://www.michigan.gov/deqwater in the AOC section under the Great Lakes, or from the Michigan Statewide Public Advisory Council at http://www.glc.org/spac/. A copy of the state's Guidance for Delisting Michigan's Great Lakes AOCs can be found at http://www.michigan.gov/deqwater in the AOC section under Great Lakes.

The 1987 Protocol required the development and implementation of Lakewide Management Plans (LaMPs) for each of the Great Lakes. The purpose of the LaMPs is to address critical pollutants and provide a strategy to protect and restore beneficial uses impacted in the open waters of each Great Lake. The USEPA, in cooperation with other government and nongovernment agencies, has developed LaMPs for Lakes Erie, Michigan, and Superior. Each LaMP includes an assessment of Beneficial Use Impairments, causes of the impairment, and recommendations on actions necessary to restore the beneficial uses. In undertaking the development of the LaMPs, the stakeholders recognized the need to address other water quality issues unique to each Great Lakes basin. The LaMPs were updated biennially, with the most recent updates completed in 2008.

A LaMP has not yet been developed for Lake Huron. Instead, the MDEQ, USEPA, Environment Canada, Ontario Ministry of the Environment, and Ontario Ministry of Natural Resources have formed the core of a Lake Huron Binational Partnership to coordinate environmental activities in the Lake Huron basin. A flexible membership is being promoted that is inclusive of other agencies and levels of government, tribes, nongovernment organizations, and the public on an issue-by-issue basis. The group developed a Lake Huron Binational Partnership Action Plan and has updated it biennially on the same schedule as the LaMPs.

### 2.14 Groundwater Discharge

The MDEQ's Groundwater Discharge Program regulates discharges to the ground through the development and issuance of permits and self-certifications. A "program review team" was established to develop and implement recommendations as needed for the Groundwater Discharge Program. Some specific program accomplishments include the conversion of the groundwater permit database into the NPDES Management System to increase permitting effectiveness, section procedure updates to consolidate and streamline groundwater permitting procedures, development and implementation of the Groundwater Expired Permit Initiative to address permits that expired prior to March 1, 2005, and review of the groundwater permit application to improve permit applications and decrease processing time.

### 2.15 Industrial Pretreatment

The MDEQ implements federal and state rules designed to limit pollution from industrial discharges to municipal wastewater treatment facilities. In 1983, the USEPA approved Michigan's pretreatment program and formally authorized the state of Michigan to oversee the program. To assure that pollutant discharges are controlled, many municipalities have been required to develop and implement local industrial pretreatment programs as a condition of their NPDES permit. Michigan operates under a two-tiered system: municipalities subject to industrial pretreatment program regulation with design flows greater than five million gallons per day must develop a federal local industrial pretreatment program, while municipalities subject to

industrial pretreatment program regulation with design flows less than or equal to five million gallons per day must develop a Michigan local industrial pretreatment program.

Municipalities developing industrial pretreatment programs are required to submit them to the MDEQ, WRD, for review and approval. Subsequent changes to an approved local industrial pretreatment program, as well as periodic reports of local program operations, must also be submitted for review. MDEQ field staff conduct periodic inspections of local industrial pretreatment programs to identify deficiencies and initiate actions necessary to assure effective operation. Information derived from inspections and reports submitted by the municipalities are entered into the NPDES Management System database.

### 2.16 Infrastructure Security

Due to terrorist attacks on September 11, 2001, and recent federal legislation and state authorizations, the MDEQ actively participates in numerous Infrastructure Security Program activities. The federal Public Health Security and Bioterrorism Preparedness and Response Act of 2002 requires drinking water systems to comply with requirements by certain dates as a part of the nation's homeland security efforts. The MDEQ plays a critical role in training and assisting the drinking water and wastewater system personnel to comply with the federal Infrastructure Security Program. The MDEQ helps to protect supply systems from malevolent acts by providing training to complete vulnerability assessments and emergency response plans, participating in water security tabletop exercises, and helping local units of governments to receive the Threat Advisory Notification System.

### 2.17 Inland Lakes and Streams

The Inland Lakes and Streams Program is responsible for the protection of the natural resources and the public trust waters of the inland lakes and streams of the state. The program oversees and regulates activities including dredging, filling, constructing or placement of a structure on bottomlands, constructing a marina, interfering with natural flow of water, or connecting a ditch or canal to an inland lake or stream.

The most common projects associated with inland lakes and streams regulated under Part 301, Inland Lakes and Streams, of the NREPA, include shore protection, permanent docks or boat hoists, beach sanding, and dredging or excavation. Other types of activities may also require permits.

### 2.18 National Pollutant Discharge Elimination System

Discharges to state surface waters from municipal, industrial, and commercial facilities must be authorized by permit under the NPDES Program. All Concentrated Animal Feeding Operations (CAFOs) in Michigan are also required to obtain an NPDES permit, except for those CAFOs that are granted a "No Potential to Discharge" determination by the MDEQ. The purpose of an NPDES permit is to control the discharge of pollutants into surface waters of the state to protect the environment. The USEPA delegated the program to Michigan, and the MDEQ has responsibility for processing NPDES permits. The maximum term for an NPDES permit is five years, after which they must be reissued.

The MDEQ reissues NPDES permits according to the five-year rotating watershed cycle, two years after the monitoring year (Figure 3.1). Under this approach, all of the permits in each individual watershed expire and are reissued in the same year. This approach allows the MDEQ to consider cumulative impacts of all dischargers on water quality in the watershed. Discharges to lakes, streams, and wetlands must not cause a violation of Michigan WQS. As part of the permit issuance process, limits are developed for pollutants to avoid a violation of

WQS and ensure compliance with the treatment technology regulations of the CWA. Draft permits are prepared containing pollutant limits and any appropriate special conditions. The draft permits are placed on public notice, allowing the opportunity for public comment.

The MDEQ was instrumental in amending the NREPA in 2004 to establish NPDES permit fees to assist in funding the NPDES Program.

Permits for regulated storm water discharges are also processed and issued by the MDEQ under the NPDES program. The Storm Water Program is also funded by fees collected from the dischargers. Under Phase I of the Storm Water Program, individual NPDES permits were issued to owners or operators of municipal separate storm sewer systems (MS4s) serving a population of 100,000 or greater. In 2003, the MDEQ promulgated rules to obtain the legal authority to implement Phase II requirements. As a result, owners or operators of MS4s serving populations less than 100,000 within urbanized areas were required to apply for NPDES permits by March 2003. Phase II permittees include cities, villages, townships, county road commissions, and county drain commissions, among others. A jurisdictional-based general permit, as well as the watershed-based general storm water permit, is used to provide permit coverage.

Michigan uses a general permit for industrial storm water discharges. The general permit requires the permittee to have a certified storm water operator and prepare and implement a Storm Water Pollution Prevention Plan. The applicability of this permit includes storm water discharges associated with industrial activity as defined in the federal regulations, and from special use areas (state- or federally-mandated secondary containment structures, areas designated on Michigan's List of Sites of Environmental Contamination pursuant to Part 201, Environmental Remediation, of the NREPA, and other activities subject to federal storm water regulation where storm water monitoring is necessary on a case-by-case basis). Monitoring is required only from the special use areas. Industrial storm water general permits and Certificates of Coverage are reissued on a watershed-basis with approximately one-fifth of the five-year permits reissued each year.

The MDEQ has continued implementation of the state's CSO Control Program, which has resulted in annual reductions of the volume of untreated combined sewage discharged to the surface waters of the state. Through implementation of the CSO Control Program, numerous CSO discharges are being eliminated at various locations around the state, while at other locations, treatment and disinfection of combined sewage discharges that comply with WQS and protect public health are being provided on an increasing basis.

### 2.19 Nonpoint Source Control

The NPS Program assists local units of government, nonprofit entities, and other state, federal, and local partners restore impaired waters; protect high quality waters, and reduce NPS pollution statewide. The basis for the program is watershed management; the MDEQ provides assistance and funding to develop watershed management plans (WMPs) and to implement NPS control activities in these plans. The NPS Program conducts or supports the following activities to accomplish these goals:

- Technical assistance to help organizations develop and implement Watershed Management Plans (WMPs), including BMP selection, land use planning activities, and engineering review of site plans.
- Information and education, including activities/tools created by the MDEQ and grantees, to educate people about NPS of pollution.
- Grants to develop and implement watershed management plans

- Compliance and enforcement, including response and investigation of complaints, follow-up requiring corrective actions, and occasionally participating in escalated enforcement actions.
- Monitoring and field investigations to identify NPS problems and evaluate the effectiveness of corrective or preventive actions.

Approximately 140 WMPs have been developed at the local level and most of these were developed by local watershed groups utilizing MDEQ grants. WMPs serve as guides for communities to protect and improve water quality. A list of MDEQ-approved WMPs that meet CMI and/or Section 319 criteria for implementation is available at http://www.michigan.gov/deqnps.

The NPS Program staff have identified a number of priority watersheds in which to focus pollution control activities to achieve the restoration and protection goals identified in the NPS Program Plan. The use of the words "threat" or "threatened" in this section does not imply that the water body is expected to not support one or more designated uses by the next reporting cycle; rather, the use of these words is consistent with USEPA guidelines contained in the *Federal Register* Vol. 68, No. 205, October 23, 2003, NPS Program and Grants Guidelines for States and Territories Section III.B.3. The following is a brief summary of the attributes and NPS threats in watersheds that will be a focus for restoration and protection activities:

***Lake Superior Basin***

- **Eagle River Watershed (HUC 040201030404)**

  The Eagle River watershed historically received waste products from the operation of stamp mills in the mid to late 1800s. The stamp mills separated copper from the rock, and the resulting waste product was termed stamp sand. Stamp sands were disposed of into the river system, and caused physical and chemical degradation. The MDEQ has secured funding to remediate several areas within this watershed, and is also conducting monitoring as part of the NPS National Monitoring Program for the next 10+ years. The MDEQ has been working with local organizations to continue remediation and monitoring efforts.

- **Carp Creek/Partridge Creek (HUC 0402010501)**

  Partridge Creek is a tributary to Carp Creek, which flows into Deer Lake; a Great Lakes AOC. In 1970, Partridge Creek was diverted from the city of Ishpeming's combined sewer system into underground mine workings to help alleviate flooding and CSOs. It has since been determined that the vented mixed water discharge to Carp Creek represents roughly 21 percent of the annual mercury load to Deer Lake and is the last known "controllable" source of mercury in the watershed. Removing Partridge Creek from the mine workings and post remedial monitoring to show the expected water quality improvements are the only remaining actions needed to potentially remove the Beneficial Use Impairment for fish and wildlife consumption and delist the AOC. Area stakeholders are working toward removing Partridge Creek from the mine workings while maximizing the amount of daylighted stream channel with restored natural channel functions.

- **Eastern Upper Peninsula Tributaries to St. Marys River (HUCs 04020203 and 04070001)**

  An 18-week monitoring project was completed in the summer of 2010 on the St. Marys River and Michigan tributaries to determine if an *E. coli* TMDL was needed for the sampled water bodies. The tributaries included the Charlotte (HUC 0407000101),

Waiska (HUC 04020203), Little Munuscong (HUC 0407000101), and Munuscong Rivers (HUC 0407000102), as well as several smaller tributaries in the Sault Ste. Marie, Michigan area. *E. coli* sampling results in the tributaries show widespread exceedances of the total body contact daily maximum WQS and total body contact 30-day geometric mean WQS with a lesser percentage of exceedances of the partial body contact daily maximum WQS. During this study the WQS was not exceeded at any of the 14 St. Marys River transects.

The St. Marys River is the Connecting Channel between Lake Superior and Lake Huron and is an important source of drinking water, recreation, sport fishery, shipping and commerce, and tourism, and is also an area of historical significance for Michigan. Emphasis needs to be placed on implementing BMPs to reduce *E. coli* contributions at high priority sites within the Sault Ste. Marie Area WMP and the Munuscong River WMP (currently under development). Emphasis is also needed for developing a WMP that identifies and prioritizes sources of *E. coli* in the remaining tributary watersheds to the St. Marys River.

***Lake Michigan Basin***

- **Little Lake and East Bass Lake (HUC 040301100302)**

  There are a number of lakes in Michigan that historically received waste products from the operation of sawmills over a century ago; and those include Little Lake and East Bass Lake within the Lake Michigan Basin. Sawmills operated along the lakeshore and disposed of the unwanted wood products (i.e., sawdust, bark, wood residues) in the lake. The disposal of these waste products has destroyed habitat and has caused a deterioration of overall water quality and the residing aquatic organisms. The Little Lake Watershed Council is in the process of being reorganized to include East Bass Lake, and the members are working with the MDEQ to foster a pilot project to determine the best course of remediation of these waste products. Also, the MDEQ has been working with this group to develop a CMI and Section 319 approved WMP.

- **Bear River, Little Traverse Bay (HUC 04060105-0101 through -0103)**

  The Bear River is the major tributary to Little Traverse Bay, a high quality oligotrophic embayment of Lake Michigan. This high-gradient river is impacted by urban storm water runoff as it flows through the steep topography of the city of Petoskey. The river's elevation drop in the last mile is the greatest in Michigan's Lower Peninsula. Sedimentation from stream bank erosion and road crossings are problems in the upstream reaches. The coldwater fishery has been impacted by hydrological changes from development and dams. A "Healing the Bear" initiative is sponsored by area organizations and has been successful at implementing several restoration and protection projects. Environmental issues in the Bear River are addressed through actions identified in the Little Traverse Bay WMP, which has been approved under both the CMI and Section 319 programs.

- **Lake Charlevoix (HUC 04060105-0201 through -0207)**

  Lake Charlevoix is a high quality oligotrophic lake and its largest tributary—the Jordan River—is a state designated Natural River. Lake Charlevoix is Michigan's fourth largest inland lake with the second longest shoreline and the fifth largest watershed, which also includes the Boyne River. The primary lake pollutants of concern are nutrients, with both nutrients and sediment being issues in the tributaries. The Lake Charlevoix Watershed Advisory Committee is one of the most active in northern Michigan and has excellent

participation by local governments. Area organizations have implemented numerous projects over the last several years as identified in the CMI approved WMP. Work is currently underway to update the WMP to meet Section 319 criteria with an expected plan completion date of 2012.

- **Grand Traverse Bay Shoreline Watersheds along West Bay and East Bay (HUCs 04060105-0702 through -0707)**

  The Grand Traverse Bay watershed is one of the premier tourist and outdoor recreation areas in the Midwest, primarily because of the high quality of its water resources. But this popularity has contributed to rapid population growth that threatens the oligotrophic waters of Grand Traverse Bay as well as the numerous small tributaries that flow from the shoreline watersheds bordering the bay. These small tributaries drain much of Traverse City—the largest city in northern lower Michigan—and portions of two of the three fastest growing counties in the state; Grand Traverse and Leelanau.

  The primary pollutants of concern for the bay are nutrients and pathogens. Several swimming beach areas have been identified as not meeting the state total body and partial body contact designated uses because of occasional elevated levels of *E. coli* and TMDL calculations are scheduled to be completed for these areas in 2015 and 2016. Nutrient inputs to the nearshore waters are a concern because of documented increases in the number and areal extent of macrophyte beds over the past decade. Sand sedimentation and thermal warming is the largest concern within the small tributary watersheds. In addition, Mitchell Creek has also been identified as not meeting the total and partial body contact designated uses because of occasional elevated levels of *E. coli* and a TMDL is scheduled for 2015.

  Recognition of the aesthetic, recreational, and economic value of the Grand Traverse Bay watershed's high quality waters, along with a concentration of many relatively affluent and well-educated residents, has resulted in the formation of numerous active environmental organizations and inland lake/river associations in the area. These organizations worked jointly with local governments and business representatives to develop a WMP that has been approved by the MDEQ as meeting both the CMI and Section 319 program requirements. The organizations have continued to cooperatively pursue the funding and effective implementation of many environmental protection actions. Significant work is underway to address storm water inputs from Traverse City, Suttons Bay, and Northport.

- **Boardman River Downstream from the Confluence of the North Branch and the South Branch (HUC 04060105-0504 through -0507)**

  This watershed includes the mainstream of the Boardman River—a blue ribbon trout stream and state designated natural river—and extends from the river's mouth at Grand Traverse Bay south and east about 20 miles to Supply Road. The watershed includes most of Traverse City west of Old Mission Peninsula. Deposition of sediment originating from road stream crossings, stream bank erosion, and construction, is the primary pollutant problem in the Boardman River. This watershed is covered by both the CMI approved Boardman River WMP and the CMI and Section 319 approved Grand Traverse Bay WMP. The local community is also developing a "Boardman River Prosperity Plan," which will not only update the Boardman River CMI plan to meet Section 319 program requirements, but will also incorporate economic planning projected out to the year 2050.

The Boardman River is currently receiving increased local attention as three major dams on the mainstream are slated for removal, providing a unique opportunity to educate the public on NPS pollution issues and potentially create large expanses of riparian buffers in the newly exposed bottomlands of the drained reservoirs. This will be the largest dam removal project in Michigan's history, and the largest wetlands restoration in the Great Lakes basin.

Kids Creek, which enters the Boardman River in Traverse City, is the most significant tributary within the boundaries of this watershed area. The indigenous aquatic life and wildlife designated use is not supported due to flow regime alterations, anthropogenic substrate alterations, and sedimentation/siltation. Sources of sediment are post-development erosion, urban runoff/storm sewers, and impervious surface/parking lot runoff. Significant work has been conducted implementing storm water BMPs in this watershed over the last several years and a multi-year hydrology study is underway to provide data needed for a TMDL calculation scheduled for 2013.

- **Glen Lake/Crystal River (HUC 040601040402)**

  The Glen Lake watershed includes portions of the famed Sleeping Bear Dunes National Lakeshore, the only national park in Michigan's Lower Peninsula, which comprises 40 percent of the land in the watershed. Glen Lake is oligotrophic with excellent water quality. The Crystal River is a coldwater stream that flows from Glen Lake to Lake Michigan through a large dune and swale wetland community, which is considered by the Michigan Natural Features Inventory and other management agencies as a globally rare ecological community. Furthermore, the Michigan Natural Features Inventory has stated that few, if any, higher quality and less impacted examples of a dune/swale community exist in Michigan. Partly as a result, the watershed is home to several species that are either of concern, threatened, or endangered at both the state and federal levels. Increasing development pressure threatens to degrade conditions in the lake through nutrient enrichment, in the river through sedimentation, and in the wetland areas associated with the groundwater-fed streams through the loss of habitat. The Glen Lake/Crystal River watershed is covered by a CMI and Section 319 approved WMP.

- **Betsie River from Dair Creek Downstream (HUC 04060104-0304 through -0307)**

  The Betsie River was the second river in Michigan to be designated a state Natural River and land use zoning covers building setbacks and vegetated buffers. The river is noted for its salmon and steelhead fishing throughout the main stem. Dair Creek is the most downstream of the two important tributaries that contain exceptional trout habitat and provide coldwater to the warmer lower Betsie River. Sediment, nutrients, and thermal inputs are the most significant pollutants of concern. Sources include road stream crossings, stream bank erosion at historical log roll away sites, construction sites, and riparian land uses. There is a CMI approved WMP for the Betsie River watershed, which includes Crystal Lake.

  Crystal Lake is a cold, oligotrophic lake that drains to the Betsie River through the Crystal Lake Outlet, an artificial channel built in 1873. Crystal Lake is Michigan's ninth largest inland lake with a surface area over 15 square miles, and the state's third deepest lake (behind only Torch and Elk Lakes), reaching a maximum depth of 190 feet. Part of the northern portion of the watershed is adjacent to the Sleeping Bear Dunes National Lakeshore. Bellows Beach, at the west end of Crystal Lake, is not meeting the total and partial body contact state designated uses because of occasional elevated

levels of *E. coli* from unknown sources and a TMDL is scheduled to be completed for this area in 2015.

- **Portage Lake, Manistee County (HUC 040601040405)**

  Portage Lake is a mesotrophic lake whose watershed drains to Lake Michigan through an outlet channel originally constructed in 1871, which lowered the lake level by several feet. Unlike many watersheds in Michigan's northern Lower Peninsula, there is very little state or federal public land in the watershed. Private land practices associated with forestry, agriculture, recreation, and commercial, industrial, and residential uses have had a significant impact on water quality. Nutrient enrichment and habitat loss are the primary environmental concerns. Dissolved oxygen levels in Portage Lake during the summer are typically below 2.0 milligrams per liter (mg/L) at depths greater than 40 feet, and reach near zero at depths of 60 feet.

  A CMI and Section 319 approved WMP has been completed for Portage Lake and plan implementation is being coordinated through the Portage Lake Watershed Forever committees with remarkable success. One of the most significant successes was when Onekama Township and the village of Onekama formed a joint planning commission and completed a joint master plan that was only the sixth such plan in Michigan. This "Onekama Community Master Plan" included all major elements and priorities of the WMP, enhancing the potential to successfully protect water quality throughout the watershed.

- **Bear Creek and Bear Lake, Manistee River Watershed (HUC 04060103-0501 through -0505)**

  The Manistee River supports one of Michigan's best coldwater fisheries and is particularly renowned for salmon. The Manistee River system's high water quality has resulted in the designation of two large areas under the state Natural River program, as well as federal designation of three distinct river reaches as Wild and Scenic rivers, one of which is Bear Creek. The primary pollutant of concern in Bear Creek is excessive sand bedload from sediment erosion, whereas nutrients are the main pollutants of concern for Bear Lake. Water quality protection efforts are coordinated through the Bear Creek Watershed Council and the Bear Lake Watershed Alliance. The Bear Creek watershed has a CMI approved WMP and efforts are currently underway to upgrade the plan to meet Section 319 criteria in 2012.

- **Big South Branch, Pere Marquette River Watershed (HUC 0406010104)**

  Often referred to as one of the finest trout streams in the Midwest, the Pere Marquette River is rather unique in Michigan for a river of its size in that it has remained free-flowing, with no dams on the mainstream. Partly because of its high water quality, the Pere Marquette River has been designated both a federal Wild and Scenic River and a state Natural River, which provide it special protection status. The Pere Marquette River has also been identified by the Nature Conservancy as one of only two watersheds in the northern Lower Peninsula (the Au Sable River is the other) that is a priority watershed for conservation action because of its high biological significance, ongoing threats, and opportunities for protective action.

  Some of the earliest watershed protection efforts in Michigan were taken in the Pere Marquette watershed, and the Pere Marquette Watershed Council remains active in implementing additional protection measures. Excessive sand bedload in the river from sediment erosion is the most significant water quality issue, although there are

signs of potential nutrient enrichment in some areas. The Pere Marquette River has a CMI approved WMP and a Section 319 update is expected to be completed by 2012. The Big South Branch of the Pere Marquette River has been identified as a priority subwatershed in the draft plan due to a mix of pollutant sources that should be addressed and a number of high quality areas needing protection efforts.

- **White River (HUC 04060101-07 through -09)**

  The White River watershed encompasses 344,166 acres in Newaygo, Muskegon, and Oceana Counties and is considered to be the southern-most major trout stream in the Lake Michigan drainage. The majority of the watershed is forested and nearly one-quarter of the watershed is included in the Manistee National Forest. The White River WMP identifies rising water temperature, sedimentation from runoff, and the loss of the naturally vegetated areas (primarily forested) as threats to the watershed.

  Many collaborative projects are currently taking place in the watershed with a variety of funding sources to address water quality concerns. The projects are directed through local groups such as the Land Conservancy of West Michigan, Muskegon County Conservation District, White River Watershed Partnership, and White Lake Public Advisory Council, as well as state and federal agencies. Projects include conservation easements, stabilizing erosive stream banks, replacing road stream crossings, and fish and wildlife habitat restoration.

- **Duck Creek (HUC 040601011008)**

  Duck Creek drains directly to Lake Michigan north of Muskegon. It is one of the remaining watersheds in the area that is not covered by a WMP. Based on Muskegon Conservation District data, this coldwater stream may be vulnerable due to temperature problems. With the planned expansion of the Michigan Adventure amusement park near Muskegon and the resulting land use changes, this watershed would benefit from the development and implementation of a WMP to protect existing high quality waters. The MDEQ staff have been working with the local community for the last three years to develop a proposal with planned participation by decision makers. A local entity recently received money from the West Michigan Strategic Alliance Green Infrastructure Program to look for opportunities to incorporate smart growth and low impact development in the area around Michigan Adventure.

- **Mona Lake (HUC 040601011011)**

  Mona Lake is a small, urbanized watershed near Muskegon. This watershed faces a mix of problems including sedimentation, excessive nutrients, pathogens, and invasive plants. The local watershed group has strong leadership, good community support, a working relationship with a wide variety of stakeholders, and a focus on finding innovative solutions.

- **Upper Muskegon River, from Butterfield Creek confluence north (HUC 0406010201 through 0202)**

  The Muskegon River is unique among large Michigan river systems (second largest) in that it blends coldwater stream reaches with other areas that have warmwater conditions. Consequently, it has many characteristics midway between those of coldwater and warmwater rivers, and therefore, supports a very diverse aquatic community. The area in the river's headwaters surrounding Higgins and Houghton Lakes, and immediately downstream, contains by far the largest acreage of biodiversity

priority areas identified by the Nature Conservancy in the entire Muskegon River watershed, particularly for aquatic species.

The varying aquatic characteristics within the watershed are dramatically represented by the stark differences between Houghton and Higgins Lakes, which are separated by only three miles. Houghton Lake is a shallow eutrophic lake, and though it is Michigan's largest inland lake with a surface area over 30 square miles, it has a maximum depth of only 22 feet and an average depth of just 7.5 feet. Conversely, Higgins Lake, Michigan's seventh largest with a surface area over 16 square miles, is a deep oligotrophic lake reaching a maximum depth over 130 feet and half the lake is over 50 feet deep. Higgins Lake was declared by National Geographic magazine as the sixth most beautiful lake in the world.

The primary pollutants of concern for the lakes are nutrients and *E. coli*, and for the river are nutrients, temperature, sediment, and hydrologic flow. A TMDL is scheduled for 2018 to address elevated *E. coli* levels that are not meeting the total and partial body contact designated uses at several Houghton Lake beaches. Butterfield Creek and the West Branch Muskegon River are both identified in the CMI and Section 319 approved Muskegon River WMP as critical areas because of temperature fluctuation, surface water runoff, and land use issues. A Section 319 subwatershed plan for the Upper Muskegon River area is being developed with an expected completion date of 2014.

- **Upper Grand River (HUC 04050004)**

The Upper Grand River watershed is the headwaters to Michigan's longest river and encompasses 700 square miles that include parts of 5 counties. Overall land use in the watershed consists of 44 percent agriculture, 12 percent residential, 3 percent commercial/industrial, 19 percent wetlands, and 22 percent of forested land, rangeland, urban green space, and water.

The Upper Grand River watershed has a number of designated use impairments. The North Branch of the Grand River and the Portage River fail to meet WQS for biota, dissolved oxygen, and *E. coli*. TMDL allocations were developed for these sections of the Upper Grand River and Albrow Creek in 2003 and 2007, respectively. In 2009, a sanitary sewer was installed in the community of Rives Junction, which should result in improvements to the Albrow Creek watershed.

Several areas in the watershed contain high quality habitat and natural lands that need to be preserved.

The Jackson County Conservation District has worked for several years with local communities to implement agricultural BMPs, educate citizens and farmers, restore wetlands, and produce Natural Resource Inventories in several communities to guide growth and protection efforts. They were recently awarded a grant to monitor dissolved oxygen, total suspended solids, and *E. coli* to help track progress made from past implementation activities.

This watershed is a priority for implementation projects that continue to address both the restoration and protection activities that have been identified in the WMP.

- **Upper Maple River (HUCs 0405000501, 0405000502, and 0405000505)**

  The Upper Maple River has a significant amount of agriculture with several CAFOs. Scattered among the many small towns and village are new homes on five- to ten-acre lots and occasional pockets of subdivision carved out of farm fields. There is little, if any, low impact development. Traveling downstream through the watersheds, the Maple River cannot maintain the current geomorphology, and cuts away at the banks redepositing sediment. Besides the development, the previous drain practices altered flows and increased sediment deposition. Impacts from agricultural drainage, water withdrawal, and failing septic systems need to be evaluated.

  There are multiple stretches of the Upper Maple River on the Section 303(d) list for biota and phosphorus. Phosphorus TMDLs were approved for Pine Creek and the Upper Maple River. An active watershed group includes the Clinton Conservation District and Clinton County Drain Commissioner. This watershed is a priority for continued support of implementation efforts, provided it extends throughout the watersheds and includes cooperative efforts between the MDEQ, county agencies, and local communities.

- **Red Cedar River (HUC 0405000404 and 0405000405)**

  The Red Cedar River includes both rural and urban areas. Urban land use is mainly located within several cities and surrounding townships and includes Michigan State University (MSU). Areas of the watersheds require restoration to address the impacts of urban development and agricultural practices in the rural areas. Prior to discharging to the Grand River, the Red Cedar River is characterized by heavy sedimentation deposition, urban debris, and high flow fluctuations. Pathogens have been identified as a pollutant impairing both the urban and rural areas. An active watershed group exists for the urban areas. There is a need to coordinate planning efforts between the urban and rural areas.

- **Sebewa Creek (HUC 0405000407)**

  This watershed includes both rural and urban areas and includes the Carrier Creek subwatershed. Biological surveys in the urban areas have identified poor macroinvertebrate populations. Areas of the watershed require restoration to address the impacts of urban development and agricultural practices in the rural areas.

  Low dissolved oxygen has been identified as impairing the warmwater fisheries designated use. An active watershed group exists for the urban areas and the Eaton Conservation District has recently been awarded a planning grant.

- **Rogue River (HUC 0405000604)**

  The Rogue River is a major tributary of the Grand River and its 167,625-acre watershed includes urban and rural areas with pastureland, crops, and forestland in portions of Kent, Montcalm, Muskegon, Newaygo, and Ottawa Counties. The Rogue River has the distinction of being one of Michigan's southernmost trout streams; however, the Rogue River WMP identifies rising summer water temperatures and sedimentation as threats to the watershed. The Lower Grand River WMP identifies the Rogue River as a priority for both restoration and preservation. Partnerships in the watershed are aimed to protect and restore the Rogue River watershed and address the impacts of development and other pressures due to its location in an urban area by working with local governments and educating citizens. In addition to an active local watershed group

and good community support, Trout Unlimited recently launched a new watershed-scale restoration project (Home Rivers Initiative) on the Rogue River.

- **Thornapple River (HUC 04050007)**

  The Thornapple River watershed, located in the southwestern portion of Michigan, includes 31 subwatersheds and is the largest subbasin of the lower Grand River watershed. The Thornapple River watershed extends from Potterville westward to the western portion of Barry County then north to its confluence with the Grand River in Ada. Though the prevalent land use in the watershed is agricultural, 17 of its streams are designated trout streams, including the main stem of the Coldwater River.

  Streams in much of the upper and middle portions of the watershed were historically channelized for agricultural purposes and are currently maintained as drains. Channelization affects the ability of several of the watershed's designated trout streams to support a coldwater fishery.

  Many collaborative projects are currently taking place in the watershed with a variety of funding sources to address water quality concerns. These projects are directed through local groups such as Barry-Eaton District Health Department, Barry County Conservation District, the city of Hastings, Trout Unlimited, Thornapple River Watershed Council, and Coldwater River Watershed Council as well as state and federal agencies such as the MDEQ and USFWS. Projects include a well and septic inspection ordinance, riparian protection ordinances, volunteer monitoring, ongoing dam removals, development of WMPs, and fisheries habitat restoration and protection.

- **Lake Macatawa (HUC 04050002)**

  Lake Macatawa, in southern Ottawa County and northern Allegan County, is a 1,780-acre drowned river mouth lake that discharges to Lake Michigan. The prevalent land use in the watershed is agricultural. Turbidity, color, settleable solids, suspended solids, and deposits are problems in the lake.

  Many collaborative projects are currently taking place in the watershed with a variety of funding sources to address water quality concerns. These projects are directed through the Macatawa Area Coordinating Council. The Macatawa Area Coordinating Council is an area-wide association, comprised of government units located adjacent to Lake Macatawa, which facilitates consensus building on public policy decisions that impact the greater Holland/Zeeland communities.

- **Kalamazoo River, downstream of Morrow Pond to Lake Allegan (HUCs 04050003-05 through -09)**

  The middle portion of the Kalamazoo River is the most critical area for the transport of nutrients to Lake Allegan; an instream impoundment. Lake Allegan has a TMDL for phosphorus that is currently in its implementation stage. Further BMPs are needed in both urban and agricultural areas to reduce phosphorus loadings. In addition, many areas of the mainstem of the Kalamazoo River remain undeveloped due to past industrial activities, which resulted in air and water pollution. As the Kalamazoo River becomes increasingly popular for recreation, it is critical that riparian areas be preserved for water quality protection.

- **Rabbit River (HUC 0405000308)**

  The Rabbit River is a tributary of the Kalamazoo River located primarily in Allegan County with a watershed that encompasses 187,200 acres. Land use in the watershed is primarily agricultural, but forested and urban areas are also represented. The Rabbit River WMP states that water quality threats and impairments are caused by sedimentation, nutrient inputs, and high-flow occurrences. The sources of sediment include stream banks, cropland, construction sites, and road crossings/road ditches. Nutrients enter the stream from agricultural production and residential area runoff. Damaging high flows result from uncontrolled storm water runoff due to development and past drainage practices.

- **Gun River (HUC 0405000307)**

  The Gun River watershed encompasses an area of 73,272 acres in Allegan and Barry Counties. The Gun River flows from Gun Lake through agricultural land into the urbanizing area of Otsego Township, Allegan County, where it joins the Kalamazoo River. The watershed has been significantly altered from its presettlement conditions, primarily due to agricultural development. Many of the forests have been cleared and the wetlands drained. Sedimentation and excessive nutrient inputs have resulted in areas of the watershed exhibiting degraded aquatic habitat, decline of biodiversity, and reduced fish populations. The MDEQ staff will focus efforts on restoration and protection of Fenner Creek (HUC 040500030702); a subwatershed of the Gun River watershed.

- **Augusta and Gull Creeks (HUCs 040500030505 and 040500030507)**

  The Augusta and Gull Creek subwatersheds within the Kalamazoo River watershed encompass a number of high quality streams and lakes including Gull Lake; a large, mesotrophic lake. While phosphorus levels in the watershed remain at acceptable levels, development pressure and CAFOs are concerns. Preservation of the riparian land is critical to provide an adequate buffer between agricultural operations and new development and water bodies. In addition, storm water discharges need to be managed through appropriate ordinances and control measures to prevent flashy flows and stream bank scouring.

- **Spring Brook (HUC 0405000306)**

  Spring Brook is a coldwater tributary to the Kalamazoo River immediately downstream of the city of Kalamazoo. A 1991 MDEQ biological survey conducted on Spring Brook indicated that this stream had the highest habitat quality for fish and other aquatic life of any coldwater stream of similar size that was sampled in southwestern Michigan. Brown trout of varying sizes were observed as well as high numbers and diversity of aquatic insects. A more recent biosurvey, conducted in 2004, found that approximately one mile of the riparian zone had been completely removed and replaced by subdivisions and lawns near Riverview Drive. A survey conducted farther upstream, at DE Avenue, found a largely unimpacted riparian zone and an excellent macroinvertebrate community. Pollutants associated with development including sediment, phosphorus, and thermal inputs are the primary threats to this watershed. Preservation and restoration of riparian buffers are needed in this watershed.

- **Black River (HUC 0405000202)**

  Sediment and nutrients are the largest pollutants of concern in the Black River watershed (Allegan and Van Buren Counties). The Two Rivers Coalition, a recently incorporated nonprofit organization, is a strong, proactive watershed group representing the Black River watershed (and the adjacent Paw Paw River watershed). The Two Rivers Coalition is a partner on a Section 319 NPS grant recently awarded to the Van Buren Conservation District, which will focus on wetland protection in the watershed.

- **Paw Paw River (HUCs 04050001-24 and -25)**

  The St. Joseph WMP indentified the Paw Paw River subwatershed as one of the highest priority (i.e., the top three critical areas) for preservation efforts based on: (1) a scoring system for percentage of wetland and forest cover as well as trout lakes and streams in the subwatershed; (2) the top three preservation subwatersheds form a contiguous land mass surrounded on all sides by urban and developing areas; (3) potential for regional cooperation; and (4) existence of a subwatershed WMP.

  The Paw Paw River has several designated trout streams. In particular, the east branch of the Paw Paw River is identified as a top quality, coldwater fishery. The mouth area of the watershed is impacted by urbanization, but there is a need for protection in the form of land use planning in the middle and upper portions of the watershed.

  The Two Rivers Coalition, a recently incorporated nonprofit organization, is a strong proactive watershed group representing the Paw Paw River watershed (and the adjacent Black River watershed). Sediment and nutrients are the largest pollutants of concern in the Paw Paw River watershed. The Two Rivers Coalition is a partner on a Section 319 NPS grant recently awarded to the Van Buren Conservation District, which will focus on wetland protection and restoration in the watershed.

- **Prairie River (HUC 0405000107)**

  Channelization and agricultural land drainage have been identified as a concern in the Prairie River subwatershed. A 2002 MDEQ biological survey indicated that macroinvertebrate communities rated “acceptable” (although nearly excellent) to “excellent.” Stream habitat was mostly “fair” with one station “good.” A 2007 MDEQ biological survey report indicated support of the coldwater fisheries designated use at the Bowers Road station. Another site farther downstream supported an abundance of warmwater fish taxa although, this segment is designated as coldwater. A watershed management planning grant has recently been initiated through the Branch County Conservation District.

- **Fawn River (HUC 0405000108)**

  Based on results of Soil and Water Assessment Tool modeling, the Fawn River watershed was identified in the St. Joseph River WMP as one of the top three critical subwatersheds for mitigation of agricultural impacts. Sediments and nutrients are the primary pollutants of concern. Recent MDEQ biological surveys indicated largely “excellent” macroinvertebrate populations, minimal disturbance of stream habitat despite abundance of agricultural land use, diverse stream habitat, wide-wooded floodplain, and “good” water quality. The LaGrange Soil and Water Conservation District in Indiana is pursuing a WMP grant for the Fawn River watershed.

- **Little Portage Creek (HUC 0405000109)**

  Biosurvey sampling conducted at a single station in 2005 resulted in a poor fish metric score, and an acceptable macroinvertebrate metric score. The total and partial body contact recreation designated uses are impaired, with an *E. coli* TMDL scheduled for 2012. Additionally the warmwater fishery designated use is impaired due to anthropogenic substrate alterations. There is local interest in developing a WMP.

- **Portage River (HUC 0405000105)**

  Biosurvey sampling conducted at a single station in 2005 resulted in an acceptable fish metric score, and an excellent macroinvertebrate metric score. The total and partial body contact recreation designated uses are impaired in Dorrance Creek, with an *E. coli* TMDL scheduled for 2018. The current WMP was developed by an MS4 group; however, it does not meet CMI or Section 319 criteria. There is local interest in upgrading the WMP to meet the aforementioned criteria.

- **Galien River (HUC 0404000102)**

  The Galien River is a priority due to the existing problems with pathogens with source areas covering a majority of the watershed. Other major pollutants threatening and impairing the watershed are sediment and nutrients. The Conservation Fund leads a local watershed group and is currently implementing a Section 319 NPS grant focusing on septic system awareness efforts, including a social indicators survey.

***Lake Huron Basin***

- **Lake Huron Coast - Duncan and Grass Bays (HUC 040700030103)**

  Located just east of the city of Cheboygan (Cheboygan County), the Duncan and Grass Bays area was identified as the most significant priority area to protect along the Lake Huron coast in the Northeast Michigan Coastal Stewardship Project completed in 2009. The area is a state designated environmentally sensitive area with high biological rarity, and includes shoreline ridge swale habitats, dune swale complexes, large tracts of public land, and extensive wetlands. Protecting adjacent land is a priority considering the high rate of population growth and development in the area, which contributes to sedimentation from construction site erosion as well as habitat loss and fragmentation. There is not a CMI or Section 319 approved WMP that covers this area, but there is local interest in developing one and funding is currently being sought.

- **Ocqueoc River - Silver Creek (HUC 040700030205)**

  Silver Creek is one of only two major tributaries to the Ocqueoc River and provides the majority of high quality, coldwater habitat within the Ocqueoc River system. Silver Creek is a designated trout stream home to native brook trout and used by steelhead and possibly salmon from Lake Huron. Sedimentation from eroding stream banks, road crossings, and livestock access is the most significant pollutant problem in Silver Creek. Temperature is also a concern given the importance of maintaining this coldwater tributary within the overall warmer waters of the Ocqueoc River watershed. A CMI and Section 319 approved WMP is used by the Ocqueoc River Commission to improve and protect the water resources. A significant project is underway in Silver Creek to implement a series of BMPs in a focused area to not only improve water quality in this important stream, but to also document the water quality improvements with comprehensive before and after environmental monitoring.

- **Devils River (HUC 04070003-0401 through -0404)**

  Devils Lake, located just south of the city of Alpena in the Devils River watershed of Lake Huron's Thunder Bay, ranked high in the Northeast Michigan Coastal Stewardship Project. The Devils River watershed contains an extensive wetlands complex threatened by development and subsequent sedimentation issues from construction sites and road stream crossings. Starlight Beach on Thunder Bay is not meeting the total and partial body contact designated uses because of elevated levels of *E. coli* from unknown sources. A TMDL is scheduled for 2017. This area does not have a CMI or Section 319 approved WMP, but funding is currently being sought to develop one.

- **Sturgeon (HUC 0407000401) and Pigeon Rivers (HUC 0407000403)**

  The Sturgeon and Pigeon Rivers are high quality, medium-sized, coldwater streams that drain into Burt and Mullett Lakes, respectively, in the Cheboygan River watershed. The Sturgeon River is one of the most pristine and high gradient streams in Michigan's Lower Peninsula and is one of the largest free-flowing trout streams in the state. The Pigeon River is also a high quality trout stream and flows through the Pigeon River Country State Forest. Sediment is the primary NPS pollutant of concern in both these rivers and several dam failures on the Pigeon River have negatively impacted macroinvertebrates and fish.

  Although there has been significant local interest in these rivers, neither one has a CMI or Section 319 WMP and historically they have received less attention than many other northern Michigan watersheds. However, as a result of a recent grant project, there is renewed focus on these rivers and one important effort is to establish a watershed coalition to coordinate long-term sustainability.

- **South Branch Au Sable River (HUCs 04070007-0101 through -0110)**

  The Au Sable River is a federally designated Wild and Scenic River and is often referred to as providing the finest brown trout fly fishing east of the Rocky Mountains. The Au Sable River watershed has also been identified by the Nature Conservancy as one of only two watersheds in the northern Lower Peninsula (the Pere Marquette River is the other) that is a priority watershed for conservation action because of its high biological significance, ongoing threats, and opportunities for protective action.

  The South Branch of the Au Sable River is a state designated Natural River that flows through the famed Mason Tract in the Au Sable State Forest. The primary pollutants affecting this world-class trout stream are sand bedload from stream bank and road crossing sediment erosion, as well as urban storm water runoff from the village of Roscommon. Actions to address water quality in the upper Au Sable River, which includes the South Branch, are coordinated through the Au Sable River Watershed Restoration Committee and the Upper Au Sable River CMI approved WMP. There is current local interest in evaluating storm water runoff from the village of Roscommon, and Roscommon County is pursuing the development of storm water management standards. This interest follows the recent successful implementation of numerous storm water runoff controls in the city of Grayling, which were designed to decrease Grayling storm water runoff to the Au Sable River by 80 percent.

- **Rifle River**

  The Rifle River is a state designated Natural River and is heavily used for recreation including fishing and canoeing. The Rifle River is threatened by sediment inputs from uncontrolled livestock access, gully erosion sites, stream bank erosion, and erosion from road stream crossings. Urban storm water discharges from the city of West Branch also pose a potential threat to this coldwater river. A watershed implementation grant has been completed for the Rifle River and the Rifle River Restoration Committee is currently active in implementation practices. This committee is well supported by the two resource conservation and development councils that cover the area.

- **Kawkawlin River**

  The Kawkawlin River has been identified as a critical watershed as part of the Saginaw Bay Coastal Initiative Program. The Kawkawlin River watershed drains to the southwestern portion of Saginaw Bay and provides important recreational opportunities. This area has, and continues to experience, problems with pathogens. Historically, the Kawkawlin River has also experienced impacts from elevated phosphorus levels (nuisance algae and duckweed). The local community is working on a watershed planning grant.

- **Pigeon River (HUC 0408010302)**

  The Pigeon River watershed is located in the "thumb" area of Michigan's Lower Peninsula in Huron County and very small portions of Tuscola and Sanilac Counties. Spanning approximately 145 square miles (92,799 acres), the watershed is part of the Eastern Coastal Basin in the larger Saginaw Bay Drainage Basin, and includes coastal shoreline along Saginaw Bay in Lake Huron. The Pigeon River originates as a series of agricultural drains and flows approximately 40 miles north to its confluence with Saginaw Bay. Over 190 miles of tributary channels have been established as county drains throughout the watershed. Approximately 8 miles are currently established as Inter-county Drains. Land use in the watershed consists of 82 percent agricultural, 5 percent urban, 10 percent forestland, and 3 percent wetland. Five main categories of causes of NPS pollution were identified in the Pigeon River WMP including streambank erosion, rill and gully erosion, tile outlets, road-stream crossing erosion, and livestock access. Failing septic systems are also a suspected source of pollution in the watershed. Reduction of phosphorus loadings from this watershed to the Saginaw Bay is a key goal identified in the WMP.

- **Pinnebog River (HUC 0408010303)**

  The Pinnebog River has been identified as a critical watershed as part of the Saginaw Bay Coastal Initiative Program. The Pinnebog River has been noted as having elevated phosphorus levels, and organic deposits have been a problem near the river mouth for the last several years. The local community has completed a WMP for this water body and is working to implement the WMP.

- **Cedar River (HUC 0408020102)**

  The Cedar River, a tributary to the Tittabawassee River, has stretches that are declared blue ribbon trout streams. The watershed is threatened by sediment inputs from uncontrolled livestock access, gully erosion sites, stream bank erosion, and erosion from road stream crossings. The watershed should be a focus for protection as it remains relatively undeveloped. The local community currently has two watershed grants to

implement BMPs and permanent conservation easements. Restoration of existing NPS pollution sites is important to maintain the high quality nature of this watershed.

- **Shiawassee River (HUC 04080203)**

  The Shiawassee River is a good quality warmwater stream that flows in a northerly direction from its genesis in Livingston and Oakland Counties and discharges into the Saginaw River and eventually into the Saginaw Bay of Lake Huron. The Shiawassee River watershed consists of mixed agricultural and urban land uses and covers 1,266 square miles or 742,400 acres. NPS program efforts to date have focused on the Mid-Shiawassee River watershed, which makes up the central portion of the watershed and is 227 square miles or 138,178 total acres in size.

  Portions of the Holly Drain (HUC 040802030203), a subwatershed to the Mid-Shiawassee River, are covered by an *E. coli* TMDL. In addition, designated use impairments due to anthropogenic substrate alterations and flow regime alterations have been documented in the Webb Creek subwatershed (HUC 040802030201). These tributaries flow primarily through rural areas where NPS such as failing septic systems, agricultural runoff, animal access sites, and stream bank erosion have been identified. An update to the Mid-Shiawassee River WMP was completed and approved under CMI and Section 319 criteria in 2011. It is a priority for the NPS program to continue to work with the local watershed group in addressing NPS pollution in the nonattainment areas of the river.

- **Flint River (HUC 04080204)**

  The Flint River watershed drains approximately 1,332 square miles and has 18 subwatersheds. The watershed has a population of over 600,000 people, 250,000 of which depend on the Flint River as an emergency backup supply for drinking water. Major tributaries include the South and North Branch Flint Rivers, and Kearsley, Thread, Swartz, and Misteguay Creeks. Moderately stable flow is found in the upper South Branch Flint River and in the headwater reaches of some tributaries. Land use in the Flint River watershed is dominated by agriculture (49 percent) followed by forested (16 percent), nonforested (15 percent), urban development (15 percent), and wetland (3 percent). The loss of wetlands from channelization and tiling has decreased flow stability, increased erosion and sedimentation, and altered stream temperature regimes.

  The North Branch of the Flint River (HUC 0408020404) and the South Branch of the Flint River (HUC 0408020401) are prioritized for NPS control activities. These watersheds include Kearsley Creek, Gilkey Creek, and the South Branch of the Flint River, which have approved WMPs and active stakeholder involvement. NPS pollution from septic systems, stream bank erosion, agricultural runoff, fertilizers, pesticides, urban storm water runoff, and increased development are of concern within these watersheds. The South Branch of the Flint River watershed is a high priority for protection practices due to its hydrologic stability, in-stream habitat, and biologic diversity.

  The North Branch of the Flint River includes the Holloway Reservoir and Mott Lake, which provide recreational opportunities in the region with numerous local parks, beaches, and access points located on these water bodies. NPS pollution has been identified as contributing to designated use impairments in the Holloway Reservoir and Mott Lake.

- **<u>Cass River (HUC 04080205)</u>**

  The Cass River watershed encompasses an area of 908 square miles (approximately 578,812 acres), contains 1,352 total river miles, and hundreds of miles of county drain. Of the total river miles, only 352 linear miles are classified as perennial. The Cass River flows to the Saginaw River and eventually to Saginaw Bay. Located in Michigan's Lower Peninsula's thumb region, the watershed includes portions of Genesee, Huron, Lapeer, Saginaw, Sanilac, and Tuscola Counties. The watershed has a number of designated use impairments and is currently covered by TMDLs for *E. coli* and dissolved oxygen. While relatively clean water flows in the Cass River system, sediment and nutrient enrichment continue to threaten water quality. The major sources of sediments and nutrients are eroding stream banks and road crossings as well as agriculture. Restoration of the impaired stream reaches and protection of the natural forested riverine corridor are key priorities for this watershed.

***Lake Erie Basin***

- **St. Clair River/Lake St. Clair (HUCs 04090001 and 04090002)**

  This high priority area includes the Pine, Black, and Belle Rivers, as well as direct drainage watersheds to the St. Clair River and Lake St. Clair in St. Clair and Macomb Counties. Lake St. Clair and the St. Clair River provide drinking water to more than five million residents in Michigan and Ontario, and are among the most heavily used recreational areas in the Great Lakes for fishing, boating, and swimming. It is estimated that nearly 50 percent of all sport fish caught in the Great Lakes are caught in Lake St. Clair, and that recreational boating in the lake contributes over $200 million a year to the economy of southeast Michigan. Abundant shoreline along the river and lake also provides many recreational opportunities for local residents and tourists.

  The St. Clair River has been identified as a Great Lakes AOC by the United States and Canadian federal governments. Lake St. Clair was identified as a Biodiversity Investment Area at the 2000 State of the Lakes Ecosystem Conference as well as a priority "eco-reach" that provides critical habitat for numerous plant and animal species, especially in the region's coastal wetlands. In the Belle River watershed, recent surveys have confirmed very high mussel species diversity that includes endangered mussel species.

  Intermittent beach closures due to elevated bacteria levels, failing or inadequate septic systems, sites of unrestricted cattle access, and illicit discharges are problems in the area. Despite the significant progress made over the past five years to correct problems, issues remain due to soil type and historical development in the area.

  At this time, a WMP has not yet been developed for the Belle River watershed; however, an active watershed group has formed and a grant was recently (July 2011) award to St. Clair County for the development of a Belle River WMP to be completed within the next two to three years. A CMI and Section 319 approved WMP was developed for the Black River in October 2010.

- **Clinton River North Branch (HUC 0408000303)**

  The Clinton River North Branch subwatershed is located primarily in Macomb County, encompassing a large portion of the central and northern areas of the county and extending into Oakland, Lapeer, and St. Clair Counties. These headwater streams are

high quality, coldwater designated trout streams that provide recreational activities for the region.

Historically, the Clinton River North Branch subwatershed experienced a significant loss of wetlands as agriculture and other land uses expanded in the region. Today, the land use in the Clinton River North Branch remains predominately agricultural. However, due to the area's close proximity to metro Detroit, development pressure continues to threaten the remaining wetlands, natural areas, and agricultural land of the subwatershed. This development pressure has created an increasing need to take preventive/proactive actions to help preserve the water quality of the Clinton River North Branch.

The Clinton River North Branch has an active watershed advisory group, which was instrumental in the development of a WMP for the Clinton River North Branch. The Clinton River North Branch WMP was CMI and Section 319 approved in 2011 and since its approval, the watershed advisory group has been seeking opportunities to implement actions from the WMP. With an active watershed group that has shown an interest in implementing actions for the WMP, there is a unique opportunity for NPS Program staff to facilitate and promote a more sustainable development path for the Clinton River North Branch.

- **Stony (HUC 0409000301) and Paint Creeks (HUC 040900030104)**

  Stony and Paint Creeks are hydrologically separate subwatersheds; however, they are considered as one by the Stony/Paint subwatershed group due to their close proximity and shared communities within their drainage areas. Both creeks are high quality, coldwater tributaries of the Clinton River. Stony Creek continues to retain many high quality characteristics, but it is threatened by increasing development, particularly in the southern end of the subwatershed. Stony Creek is home to a wealth of unique natural areas that are protected in both the public and private domains. Paint Creek is managed as a trout stream from Lake Orion to its confluence with the Clinton River. Brown trout reproduce in Paint Creek, but they are supplemented with an annual stocking by the MDNR. Much of the stream is bordered by public land and recreational trails, making it valued by the public in southeast Michigan due to its numerous recreational opportunities and high potential for sport fishing.

  As development in the watershed continues, the potential for negative environmental effects on Stony and Paint Creeks increases. Problems of concern include water quality impacts from erosion, sedimentation, and increased inputs of storm water pollutants, as well as water quantity impacts from more impervious surfaces and the loss of wetlands, woodlands, and riparian vegetation.

  Fourteen communities, two counties, and two school districts were involved in the development of the CMI and Section 319 approved Stony Creek/Paint Creek WMP and they continue to meet regularly.

- **Johnson Creek (HUC 040900040201)**

  Johnson Creek is widely recognized as one of the highest quality streams in the Rouge River watershed. Stream characteristics such as cool, clear water; significant groundwater discharge; cobble and gravel substrates; and sensitive fish, plant, reptile, amphibian, and macroinvertebrate taxa make Johnson Creek a valuable ecological and recreational resource to protect and restore. Johnson Creek is the only designated coldwater stream in the Rouge River watershed. Its unique recreational use as a

brown trout fishery and its ability to support a threatened fish population (the redside dace) make Johnson Creek deserving of aggressive protection and restoration measures.

Maintaining cool and clear water will require thoughtful planning of development and storm water management practices as well as preservation of priority natural areas and the riparian corridor. Measures should be taken to reduce the impact of impervious surfaces and to increase native stream bank vegetation and shading along Johnson Creek. In addition to pending land use change in its watershed, the creek is also at risk due to high storm water flows, high nutrient loads, and high sediment loads that threaten the integrity of the creek. Further, fecal inputs from sanitary seepage, improper septic system maintenance and operation, and other sources must be minimized.

Johnson Creek has an approved TMDL for dissolved oxygen from 6 Mile Road downstream to the confluence with the Walled Lake Branch of the Rouge River. The pollutant of concern for dissolved oxygen in Johnson Creek is suspended solids. For suspended solids, the effect on dissolved oxygen is a secondary effect. Suspended solids discharged primarily during high flow conditions settle on the stream bottom and have the greatest adverse effect under low flow conditions. Sources of suspended solids to the stream include point sources with individual NPDES permits; permitted storm water sources, including municipal, industrial, and construction sites; and runoff from agricultural, wetlands, and forest land.

Collectively, the existing suspended solids load from these sources must be reduced by 85 percent to achieve the dissolved oxygen WQS.

Johnson Creek is also subject to watershed-wide TMDLs for *E. coli* and biota. Johnson Creek is also on the impaired waters list for PCBs in fish tissue and in the water column, and mercury in the water column.

There are several active groups working on the protection and restoration measures in the Johnson Creek watershed. Johnson Creek is included in the Rouge River WMP. The Alliance of Rouge Communities submitted a revised WMP in June 2011 seeking Section 319 criteria approval that is currently under review. The Alliance of Rouge Communities is an active watershed group and continues to work to implement watershed protection goals. Friends of the Rouge is another very active nonprofit organization that works within the Johnson Creek watershed and the greater Rouge River basin to promote restoration and stewardship. Friends of the Rouge programs include volunteer watershed-wide monitoring information and outreach workshops, restoration projects, and Rouge River cleanup events.

- **Ecorse Creek (HUC 040900040501)**

Ecorse Creek is a highly urbanized watershed located in Wayne County. There are three primary water courses within the watershed that drain into the Ecorse Creek, which then drains to the Detroit River. These are the North Branch, the LeBlanc Drain, and the Sexton-Kilfoil Drain. All three major water courses within the watershed have extensive hydraulic and pollution problems.

The Ecorse Creek watershed, in its entirety, is identified on Michigan's Section 303(d) list as failing to meet Michigan WQS for pathogens and for the protection of warmwater aquatic life. A TMDL, water quality targets, and quantifiable pollutant load reductions

have been developed to protect aquatic biota within the Ecorse Creek watershed. In 2008, a TMDL for *E. coli* was developed for the Ecorse Creek watershed.

The Ecorse Creek watershed has a CMI approved WMP that is in the process of being updated to achieve Section 319 approval. Communities in the Ecorse Creek watershed are part of a larger combined watershed group called Alliance of the Downriver Watersheds. This is comprised of the Ecorse Creek watershed, the combined downriver watershed, and the Lower Huron River watershed. The Alliance of the Downriver Watersheds is active and continues to meet regularly.

- **Upper Huron River/Kent Lake (HUC 040900050106)**

  The Kent Lake subwatershed of the Huron River is located in southwestern Oakland County and extends into Brighton and Green Oak Townships in Livingston County. The drainage area is 556 square miles extending from the headwaters of the Huron River downstream to the Kent Lake impoundment in the Kensington Metropark. The subwatershed contains nearly 700 individual lakes comprising approximately 9,000 acres, Pettibone and Norton Creeks, and innumerable wetlands.

  Land use in the Kent Lake subwatershed ranges from heavily commercial and residential areas in the east and south to small rural farms and housing in the north and west. There are two Metroparks and four state recreation areas in the subwatershed, along with numerous county, city, and village parks totaling roughly 22,000 acres of publicly owned land. So exceptional is the ecological value of this area that the Nature Conservancy recently deemed portions of the subwatershed as "globally significant."

  Water quality concerns in the watershed range from nutrient and bacterial loading issues that result in many beach closings in the area, to issues of water clarity and toxicity. Additional water quality concerns include turbidity, conductivity, pesticides, and pollutants such as PCBs and mercury. Fourteen communities, one county, and one school district were involved in the development of the Kent Lake/Upper Huron WMP and they continue to meet periodically.

- **Middle Huron River Subbasins (HUCs 04090005-02 through -04)**

  The Huron River watershed is a Michigan natural treasure. More than 525,000 residents use the river for recreation, drinking water, and power generation. The river supports one of Michigan's finest smallmouth bass fisheries, and is the only designated Scenic River in southeastern Michigan. The watershed contains two-thirds of the area's public recreation lands, and is home to numerous threatened and endangered plant and animal species and habitat types. The Nature Conservancy has recognized the ecological value of portions of the watershed and counts it among the Conservancy's aquatic conservation priorities in Michigan.

  The Middle Huron watershed, located in the vicinity of Ann Arbor, has water quality issues related to phosphorus, sediment, altered hydrology, and pathogens.

  There is an active group of communities and institutions that have been implementing activities to reduce phosphorus and other pollutants since 1995. The highest ranking subwatersheds for phosphorus loading are Mill Creek, Mallets Creek, and Fleming Creek. Of these, Fleming Creek is in need of a WMP to guide restoration activity. Sediment is a concern in several Middle Huron subwatersheds including

Honey Creek, Millers Creek, Mallets Creek, and Swift Run. Many of these subwatersheds have also been highly modified by hydrologic alterations and need restoration activities aimed at detention, wetland restoration, low impact development, or other means of green infrastructure that retains water on-site longer.

- **Portage Creek Subbasin ( HUC 0409000503)**

  The Portage Creek watershed covers 89 square miles of the 908 square mile Huron River watershed. It lies upstream of the Middle Huron section. It encompasses parts of six townships, two villages, and four counties. Nearly 16,000 acres of lakes and wetlands are located in the watershed. More than 11,300 acres are publicly-owned state land. The protected natural areas contain some of the most diverse and rich native ecosystems remaining in the Portage Creek watershed and southeastern Michigan. It is also one of the most unstable streams in the Huron River watershed and is threatened by altered hydrology as well as lack of development standards and protection ordinances.

  Areas of high habitat quality and species diversity persist in the watershed due to the extent of state-owned lands, undeveloped private lands, and land protected through conservation easements. The connectedness and expansiveness of the remaining natural areas and native habitats directly impact the water quality in the watershed. As the Portage Creek watershed communities develop, there is potential for negative environmental impacts to increase, including water quality impacts from erosion, sedimentation, and increased inputs of storm water pollutants. Hydrology is impacted as wetlands, woodlands, floodplains, and other natural features that regulate water quantity are altered or replaced with impervious surfaces.

  The remaining natural areas in the Huron River watershed were mapped and prioritized in 2002, and updated in 2007, through the Bioreserve Project of the Huron River Watershed Council. One hundred and two sites (23,908 acres) in the Portage Creek watershed were identified as priority natural areas.

  The priority goals and objectives in the Portage Creek watershed include maintaining and increasing the natural buffers, increasing the amount of protected land through ordinances and conservation easements, restoring converted wetlands, increasing the use of development standards, and promoting low-impact development concepts.

- **Raisin River – Headwaters (HUC 0410000201)**

  The headwater portions of the Raisin River, specifically Iron Creek, Goose Creek, Evans Creek, and the Upper Raisin River, have been identified by the Nature Conservancy as having significant regional ecological importance due to the remaining diverse mussel beds. This region has the most historically intact assemblage of mussels and other aquatic species of any river in southern Michigan. Currently, water quality is fairly good in these upper reaches. The Raisin River WMP lists these as high priority areas for protection measures including land use controls, buffers, easements, and ordinances.

- **West Branch of the St. Joseph River (Headwaters of the Maumee River) (HUC 0410000302)**

  Drainage from the West Branch of the St. Joseph River, located in Hillsdale County, flows through three states before entering Lake Erie. The West Branch of the St. Joseph River is important because it forms the headwaters of the system, contains

unique mussel populations and high quality habitat, and receives significant amounts of sediment and pesticides. It is also one of the last remaining watersheds in the area without an MDEQ approved WMP; although, it is covered by a larger tri-state watershed planning effort, which provides background information and a framework for a planning project to build upon.

There is coordination among the Hillsdale Conservation District, the Nature Conservancy, and the St. Joseph River Watershed Initiative. The Nature Conservancy operates an Upper St. Joseph River watershed project in Angola, Indiana, focused on protection of the East Fork of the West Branch. This tributary contains a mussel community that represents the best remaining example of a biological community that was once common in the western Lake Erie watershed.

The St. Joseph River Watershed Initiative is a group working on behalf of the entire tri-state (Michigan, Ohio, and Indiana) St. Joseph watershed and acts as a coordinator by using its resources and expertise to gather data, identify critical areas, and lead management planning in the subwatersheds. The overall goal of the St. Joseph River Watershed Initiative is to reduce the loads of sediment, pesticides, pathogens, and nutrients to meet target loads by organizing stakeholders in the subwatersheds and developing WMPs. The St. Joseph River Watershed Initiative prepared a WMP for the larger tri-state St. Joseph River watershed and submitted it to the MDEQ for Section 319 approval. The MDEQ provided comments in response, but to date, the plan has not been resubmitted nor does it have CMI approval. Although the plan has been approved by Indiana for Section 319, a WMP should be developed and implemented for the Michigan portion of the watershed.

- **Tiffin River Watershed (HUC 04100006)**

The Tiffin River and its tributaries drain 553.3 square miles in northwest Ohio and 251 square miles in southeast Michigan and include parts of Defiance, Williams, and Fulton Counties in Ohio as well as parts of Hillsdale and Lenawee Counties in Michigan. The Tiffin River is formed by the confluence of two tributaries; Bean Creek and Mill Creek, which join together in Fulton County, 51 miles upstream of the Maumee River. The Tiffin River and its tributaries flow in a southerly direction to drain into the Maumee River and eventually the Western Lake Erie Basin. The Tiffin River flows through an area used extensively for agricultural crop production. Land use in the watershed is approximately 85 percent cropland, 9 percent woodland, 1 percent pasture, and 5 percent other land uses. Corn and soybeans are the principal crops; other feed grains and hay for livestock are also grown.

A largely agricultural watershed, the Bean Creek subwatershed is unique in southern Michigan with several excellent coldwater tributaries. Several endangered species have been identified in Bean Creek. It also has a history of water quality problems in several stream stretches, including erosion and sedimentation, pathogen contamination from failed septic systems, and bacterial contamination from intensive livestock operations.

The Tiffin River watershed is one of seven subbasins located within the Maumee River watershed and one of ten areas included for study in the Western Lake Erie Basin project area. It represents 7.7 percent of the Maumee watershed and 7.1 percent of the Western Lake Erie Basin project area. The Tiffin River watershed was also selected as a priority for the development of a detailed, agriculturally-based watershed model to address water quality issues related to sediment and nutrient loading. The work is funded by the United States Army Corps of Engineers, Buffalo District, under the Section 516(e) program of the Water Resources Development Act of 1996. The overall

objective of this project is to develop a tool that can be used to evaluate various land management scenarios to assist local land managers and decision makers in targeting local "on the ground" land management practices that will serve to improve water quality by minimizing sediment erosion and nutrient loading problems in the watershed.

The MDEQ will participate in this effort as a stakeholder to help define the scope and focus for the model to meet individual watershed needs. There is no approved WMP for this watershed. It is a goal for the MDEQ to work with stakeholders in the United States Army Corps of Engineers modeling project to incorporate the results into a WMP to address NPS pollutants and to protect remaining high quality waters.

### 2.20 Septage

Septage is a domestic waste pumped from septic tanks, portable toilets, etc. The Septage Program regulates the septage hauling industry and septage disposal practices. Companies, as well as the vehicles they use, must be licensed. In addition, a permit is required to apply septage to the land. Septage may be taken to a municipal wastewater treatment facility or may be applied to agricultural land. The MDEQ administers the program with assistance from participating LHDs.

### 2.21 Soil Erosion and Sedimentation Control

The Soil Erosion and Sedimentation Control Program is administered under the authority of Part 91, Soil Erosion and Sedimentation Control, of the NREPA. Part 91 provides for the control of erosion and prevention of off-site sedimentation from earth change activities. Part 91 is administered and enforced by state, county, and municipal agencies with oversight by the MDEQ.

The MDEQ's major responsibilities are to train staff members of the Part 91 agencies in the proper administration and enforcement of Part 91 and to conduct periodic audits of the administering agencies to ensure their Soil Erosion and Sedimentation Control Programs are in compliance with Part 91.

### 2.22 Source Water Assessment

The reauthorization of Act 399 requires federal guidance and defines state requirements for a Source Water Assessment Program. Act 399 requires the state to identify the areas that supply public tap water, inventory contaminants and assess source water susceptibility to contamination, and inform the public of the results. In 1998, the MDEQ convened a Source Water Assessment Program Advisory Committee composed of key stakeholders to assist with Source Water Assessment Program development. Michigan's Source Water Assessment Program was approved by the USEPA in October 1999.

Information on nearly 18,000 drinking water sources, serving approximately 10,600 noncommunity water systems and 1,250 community water systems, was collected over a 6-year period. Potential sources of contamination were inventoried, and susceptibility to contamination was determined. The completed Source Water Assessment Program Report and all data were transmitted to the USEPA in December 2004. The Source Water Assessment Program Report is available at http://www.michigan.gov/deqwater under Drinking Water, Source Water Assessment. New sources undergo a source water assessment as they are approved. The MDEQ also continues to encourage surface water suppliers to plan and implement protection activities. To date, six communities have obtained state approval for their Source Water Intake Protection Program Plans.

## 2.23 Wellhead Protection

The MDEQ's Wellhead Protection Program assists local communities that utilize groundwater for their municipal drinking water supply systems to protect their water source. A Wellhead Protection Plan minimizes the potential for contamination by identifying and protecting the area that contributes water to municipal water supply wells. Such protection help avoids costly groundwater cleanups.

Funding for activities is available through a state Wellhead Protection grant program and is designed to assist communities in the development and implementation of a Wellhead Protection Program. The state grant program funds 50 percent of eligible activities while the other 50 percent is matched with local funds. Grant money is awarded each year to public water supply systems based on a scoring system that ranks communities of similar size.

## 2.24 Wetlands Protection

The MDEQ, WRD, has administered a statewide wetland regulatory program for over 30 years. The WRD also manages Michigan's wetland resources through public education programs that encourage wetland preservation and restoration, cooperation with governmental and nongovernmental agencies to encourage the evaluation and management of wetlands on a local and watershed basis, and development of a monitoring and assessment program.

Michigan's Goemaere-Anderson Wetland Protection Act was passed in 1979 (Part 303 of the NREPA). Through passage of the Wetland Protection Act, Michigan took direct legislative action to regulate and minimize wetland losses. This act provides for the preservation, management, protection, and use of wetlands; requires permits to alter wetlands; and provides penalties for illegal wetland alteration. A wetland is defined in Part 303 as:

> ". . . land characterized by the presence of water at a frequency and duration sufficient to support, and that under normal circumstances does support, wetland vegetation or aquatic life and is commonly referred to as a bog, swamp, or marsh."

The Wetland Protection Act further defines regulated wetlands as those wetlands contiguous to the Great Lakes or Lake St. Clair, an inland lake, pond, river, or stream; and noncontiguous wetlands greater than five acres in size. The state also has the authority to regulate any noncontiguous wetlands that are determined to be essential to the preservation of the natural resources of the state once the landowner has been notified. Part 303 requires that persons planning to conduct certain activities in regulated wetlands apply for, and receive, a permit from the state before beginning the activity.

Michigan's Wetland Protection Program was approved by the USEPA in accordance with the requirements of Section 404(h) of the CWA in August 1984. With this approval, Michigan became the first state to assume administration of Section 404. The CWA limits state assumption of Section 404 authority in "traditionally navigable waters." The United States Army Corps of Engineers, Detroit District, retains Section 404 jurisdiction in these waters, which includes the Great Lakes, connecting channels (such as the Detroit River), and river mouth areas upstream to the limits of the traditional navigational channel or the Great Lakes ordinary high water mark.

The MDEQ processes approximately 4,000 to 6,000 permit applications per year under Section 404. About 1,500 of these applications propose wetland impacts; the remainder propose to alter lakes and streams only. The MDEQ staff work with permit applicants to redesign proposals, when necessary, to avoid and minimize resource impacts.

Michigan's regulatory program generally requires mitigation for all wetland impacts, although the MDEQ staff may waive this requirement for projects impacting less than one-third acre if no reasonable opportunity for mitigation exists, or for projects having a basic purpose of creating or restoring wetlands. Mitigation may be considered only after the applicant has demonstrated avoidance and minimization of impacts, and it has been determined that a project is otherwise permitable. A mitigation proposal must result in no net loss of wetlands upon completion of a project. Mitigation requirements and ratios are established by rule and are defined by staff as a condition of the permit decision. Financial assurances are required to ensure completion of any mitigation project that is not completed in advance of associated impacts. Mitigation sites must be permanently protected through a conservation easement. Administrative rules defining the establishment and use of mitigation banks were promulgated in 1997 (see R 281.951, Wetland Mitigation Banking). Fifteen mitigation banks are currently listed in Michigan's Wetland Mitigation Bank Registry. A number of other mitigation bank sites are currently under consideration or development.

Michigan also has developed other regulatory and nonregulatory programs to manage Michigan's wetland resources, including:

- Part 303 authorizes regulation of wetlands by a local unit of government provided that the local unit uses the same definition of wetlands as Part 303, and permit criteria that are consistent with Part 303. Currently, over 40 communities in Michigan have local wetland protection ordinances.
- The MDEQ has organized and leads the Wetland Work Group, an informal interagency team including various state, federal, and nongovernmental organizations concerned with wetland restoration and management.
- To encourage consideration of wetland issues, the WRD provides technical assistance to local watershed planning organizations. WRD staff have been working closely with watershed groups to assist in locating areas that have a high potential for wetland restoration. Using existing datasets and GIS technology, WRD staff created a GIS layer that highlights these wetland restoration areas and ranks them in terms of their potential (high, moderate, and low).
- The WRD has developed a landscape-scale wetland assessment method to assist watershed groups in managing, protecting, and restoring wetlands in the context of watershed management planning. Originally developed by the USFWS, the WRD makes use of GIS data, including National Wetland Inventory maps, to provide an evaluation of wetland functions to make more effective decisions regarding the need for wetland protection, restoration, or management in watershed.
- The MDEQ provides for protection of wetlands through the use of conservation easements that offer comprehensive and permanent protection to high quality wetlands. Conservation easements over exceptional wetland sites may be provided to fulfill mitigation requirements, when appropriate, or wetlands that are avoided during the planning of an authorized construction project may also be protected under an easement.

The WRD is working with partners to develop a wetland monitoring and assessment program to assess the quality and quantity of Michigan's wetland resources and guide future program development. This includes recent development of the Michigan Rapid Assessment Method and Landscape Level Wetland Assessment, as well as working with Great Lakes researchers on coastal wetland monitoring and the National Wetland Condition Assessment.

## 2.25 Water Protection Special Initiatives

### *2.25.1 Aquatic Invasive Species*

Michigan's aquatic ecosystems are experiencing significant negative effects from AIS that are already present and the state's waters are continually threatened by new invasions. An invasive species is defined as a species that is not native and whose introduction causes, or is likely to cause, economic or environmental harm, or harm to human health.

The introduction of AIS into the Great Lakes and inland state waters threatens the ecology of water resources as well as the economic, societal, and public health conditions of the region and states. These AIS compete with native species for food and habitat, and can directly or indirectly harm or displace native species, degrade habitat, and alter food webs. AIS can also have significant economic effects on waterfront property values, tourism, utilities, and other industries.

AIS enter Michigan waters through various human-assisted vectors such as maritime commerce (e.g., ship ballast water and hull fouling), fishing and aquaculture, canals and diversions, trade of live organisms, and tourism and development activities (Canadian Aquatic Invasive Species Network, 2009). Actions taken to date to prevent the introduction of new AIS include regulatory and voluntary efforts, educational programs to increase awareness, monitoring and surveillance activities, and management/control actions by a variety of partners. However, much work remains to protect water resources from new introductions of AIS from around the world, other waters across the country, and adjacent areas of the Great Lakes watershed, as well as minimize the harmful effects of AIS already in Michigan waters.

The Great Lakes region has been impacted by both the intentional and unintentional introduction of AIS since the settlement of the region by Europeans. Since the 1800s, at least 182 nonindigenous aquatic organisms have colonized habitats of the Great Lakes ecosystem. These species include: algae (27), vascular plants (55), invertebrates (66), fish (28), and bacteria and viruses (6) (National Oceanic and Atmospheric Administration, 2011). About 55 percent of these species are native to Eurasia; 13 percent are native to the Atlantic Coast. Prior to the institution of new ballast water management regulations in July 2006, a new nonindigenous species was being discovered in the Great Lakes, on average, once every 28 weeks (Riccardi, 2006; Great Lakes Environmental Research Laboratory, 2009).

A variety of federal and state legislation addresses AIS. In particular, the federal Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (amended by the National Invasive Species Act of 1996) addresses the issue of invading species. This law has five purposes:

- Prevent unintentional introductions.
- Coordinate research, control, and information dissemination activities.
- Develop and carry out environmentally sound control methods.
- Minimize economic and ecological impacts.
- Establish a research and technology program to benefit state governments.

Part 413, Transgenic and Nonnative Organisms, of the NREPA, was last amended in 2009 and provides a list of prohibited and restricted invasive species within the state. In addition to creating a list of both restricted and prohibited species, the act defines possession regulations, lays out a permitting process, and lists violations, penalties, and liabilities. The MDNR and MDARD are responsible for administering Part 413.

Michigan's first Aquatic Nuisance Species State Management Plan was approved in 1996 and updated in 2002. This plan, now called the AIS State Management Plan, is currently being

revised with anticipated completion in 2012. The AIS State Management Plan outlines new actions for implementation in addition to maintaining and enhancing existing efforts to adequately prevent the introduction of new AIS, limit the spread of established AIS, detect and respond to new invaders, and minimize the harmful effects of AIS in Michigan waters, including the Great Lakes, connecting channels, rivers and streams, inland lakes, and wetlands. The AIS State Management Plan identifies strategic actions in categories including legislative and policy, regulation (including compliance, enforcement, and inspection), information and education, research and monitoring, and early detection and rapid response. The prevention of nonnative, aquatic organisms including microorganisms (pathogens), invertebrates, algae, aquatic vascular plants, fish, other animals, and parasites that enter and establish populations in Michigan waters and cause harm to the ecosystem, environment, economy, or human health are considered using a vector and pathway approach. The AIS State Management Plan also integrates and builds upon existing AIS prevention and control efforts.

The four goals on which the AIS State Management Plan is based are as follows:

- Goal I: Prevent new introductions of AIS into Michigan waters.
- Goal II: Limit the spread of established populations of AIS throughout Michigan waters.
- Goal III: Develop a state-wide interagency early detection and rapid response program to address new AIS invasions.
- Goal IV: Manage and control AIS to minimize the harmful ecological, economic, social, and public health impacts resulting from established populations.

Additional information regarding AIS in Michigan is available at www.michigan.gov/aquaticinvasives.

Michigan recognizes the potential threats of new AIS to the Great Lakes; therefore, measures are being taken to prevent introductions via two specific high priority pathways: ballast water discharges and the Chicago Area Waterway System.

Ballast water, water taken on board large vessels to provide stability and balance during a voyage, is a significant contributor to the introduction of AIS; therefore, Michigan passed ballast water control legislation in 2005. Pursuant to this legislation, the MDEQ implements a state ballast water discharge permit program for ocean-going vessels. Michigan reissued its ballast water general permit in February 2012. The USEPA issued a federal Vessel General Permit in 2008 as a result of a 2005 United States court ruling. However, in April, 2009, the MDEQ filed a petition challenging the USEPA Vessel General Permit in the 6$^{th}$ Circuit Court. Michigan's challenge along with those filed by several environmental organizations in three other United States Circuit Courts was consolidated by Order in the United States Circuit Court of Appeals for the Washington DC Circuit Court in May 2009. The petition claims that the USEPA failed to immediately and comprehensively regulate the discharge of ballast water from oceangoing vessels in the Great Lakes in a manner that satisfies WQS through the Great Lakes ecosystem and adequately protects those waters against further introductions of harmful invasive species when it issued the Vessel General Permit. Michigan reached a settlement agreement with the USEPA in February 2011. The steps outlined in the settlement agreement for the USEPA to issue the next draft Vessel General Permit are currently underway. The next draft Vessel General Permit was released in November 2011 and a final permit is expected in November 2012. In addition, the United States Coast Guard issued final regulations pertaining to ballast water discharges in March 2012. Despite these actions at the federal level, Michigan's ballast water legislation and state permit remain effective in order to prevent further AIS introductions.

Michigan is working to promote actions to prevent Asian carps (i.e., silver and bighead carp) from invading the Great Lakes through litigation and legislation. In December 2009, Michigan

Attorney General Mike Cox filed suit in the United States Supreme Court on behalf of the state of Michigan against the state of Illinois and the Metropolitan Water Reclamation District of Greater Chicago for allowing Asian carp to potentially invade the Great Lakes through the Chicago Sanitary and Ship Canal and other managed waterways. The suit calls for the development and implementation of plans to permanently and physically separate carp-infested waters in the Illinois River basin, the canal, and connected waterways from Lake Michigan as well as the implementation of immediate actions to close some of the locks on the Chicago Sanitary and Ship Canal and connecting channels, operate electric barriers in the canal at maximum efficiency, and monitor for Asian carp and eradicate any Asian carp found. The states of Ohio, Minnesota, Wisconsin, New York, and Pennsylvania, and the Canadian Province of Ontario joined Michigan in support of these efforts. Ultimately, in September 2011, a federal court of appeals panel upheld a district court ruling denying the request for immediate action; however, the lawsuit in the federal district court for permanent action remains pending.

Michigan continues to support legislation addressing Asian Carp including the proposed "Close All Routes and Prevent Asian Carp Today" (or CARP ACT). The legislation would direct the United States Army Corps of Engineers to implement many of the same emergency measures to keep Asian carp out of the Great Lakes. Discussions and activities to prevent Asian carp from becoming established in the Great Lakes are ongoing.

### *2.25.2 Saginaw Bay Coastal Initiative*

The Saginaw Bay Coastal Initiative was formed in August 2006. Through the Saginaw Bay Coastal Initiative, the MDEQ and other state agencies started working with citizens, local government officials, and multiple regional and federal agencies to develop and implement a comprehensive approach to promoting environmentally sound economic development and resource restoration in the Saginaw Bay coastal areas. The MDEQ continues to be engaged in the process, but the leadership of this effort has shifted to the local stakeholders and the increased ownership this brings better enables the continued work toward the goals of:

- Identifying methods to enhance the economic development of the Saginaw Bay coastal area and the quality of its parks and beaches and other natural areas.
- Seeking partnerships to develop new cultural, recreational, and social resources for Saginaw Bay area citizens and visitors.
- Working with local interests to improve water quality in Saginaw Bay and its associated waterways.

The Saginaw Bay Coastal Initiative encourages regular discussions to determine how state, federal, and local interests can work together to achieve resource protection, improve environmental quality, and expand economic development. This includes opportunities to discuss the local impact of state and federal programs and to look for opportunities to meet the goals of these programs through new and innovative means. Additional information regarding the Saginaw Bay Coastal Initiative can be found at http://www.michigan.gov/deq/ under Issues to Watch.

Shoreline deposits of decaying organic matter, abundant plant and algae growth, and beach closures are a concern along Saginaw Bay and other Great Lakes near shore areas (see Chapter 5). In 2008, the National Oceanic and Atmospheric Administration initiated an extensive, five-year study of Saginaw Bay to generate a better understanding of the multiple stressors that are affecting the character of both the nearshore and open water regions of Saginaw Bay. This study is devoted to understanding the mechanisms and processes that are affecting the bay. The MDEQ is collaborating with researchers in an effort to address questions about designated use support.

### *2.25.3 Clean Water Act Section 404 Permit Program*

In 1984, Michigan became the first state to receive USEPA approval to administer the CWA Section 404 Permit Program. Although at least 34 states have their own wetlands program, only 2 states, Michigan and New Jersey, have been able to meet all the requirements to assume the CWA Section 404 Program. To maintain Michigan's authorization under Section 404, state law must remain consistent with federal regulation including exemptions, general permits, public notice procedures, and review criteria. In addition to meeting these requirements, Michigan's law provides the citizens of the state with a significant savings in time and money while providing efficient and effective protection of wetland resources by clearly defining wetlands that are regulated, providing permitting time frame requirements, and streamlining and consolidating permit review.

In 2008, the USEPA published findings from a 10-year review of Michigan's Section 404 Program and although the USEPA found that, in general, Michigan's administration of the program was good, they identified changes that are needed to maintain federal consistency. These changes include administrative actions/procedures, revision of administrative rules, statute amendments to clarify exemptions, and updating the program Memorandum of Agreement. Over the last two years, the WRD has been busy working with stakeholders on the changes required to maintain our state program.

## 2.26 Cost/Benefit Assessment

The activities described in this chapter are carried out by several MDEQ divisions and offices. Full quantification of expenditures is not possible at this time. However, the WRD alone spent approximately $52.3 million in fiscal year 2010 and $44.8 million in fiscal year 2011 for the implementation of water quality protection, restoration, and monitoring programs. Sources include federal funds, state general funds, CMI state bond funds, and fees. These expenditures support MDEQ staffing and operating expenses as well as grants and loans to local governments and organizations. A variety of water quality protection activities are implemented through these funds, including regulatory requirements, technical and financial assistance, and education/outreach efforts. These expenditures also leverage substantial local funds and services, since many of the programs and grants have cost-share or match requirements.

The benefits associated with the implementation of these programs are numerous, although it is not possible to accurately quantify the benefits in strictly monetary terms. From a financial perspective, tourism currently is Michigan's second largest source of jobs and revenue, after manufacturing. Citizens and out-of-state tourists spend billions of dollars each year in Michigan, much of that on outdoor sports and recreation that depend on clean water, air, and forests. Popular activities include hunting, fishing, boating, and swimming at Great Lakes and inland beaches. The revenues from these activities far exceed the money spent on water quality protection and monitoring activities each year. Aside from strictly financial considerations, clean water is also essential to protect human health, drinking water quality, biological diversity, and quality of life issues, which attract many businesses and citizens to live and work in Michigan.

**CHAPTER 3**
**WATER QUALITY MONITORING**

Environmental monitoring is an essential component of the MDEQ mission. Comprehensive water quality monitoring is necessary to improve natural resource management, maintain sustainable ecosystems, and protect public health. Although the MDEQ is the lead state agency responsible for monitoring, assessing, and managing the state's surface water and groundwater, effective water resource management is best achieved through the formation and implementation of meaningful coalition partnerships with outside entities including other state and federal agencies, Canadian organizations, local governments, tribes, universities, industry, environmental groups, and citizen volunteers. Wherever possible, the MDEQ strives to organize and direct the resources and energies created by these partnerships through a "watershed approach" to protect the quality and quantity of the state's water resources.

Many MDEQ water quality monitoring and water pollution control programs are integrated and implemented according to a 5-year rotating watershed cycle to facilitate effective watershed management. Michigan has 57 major watersheds based on the USGS's 8-digit HUCs. Water quality assessment efforts focus on a subset (approximately 20 percent) of these major watersheds each year (Figure 3.1).

In January 1997, the MDEQ completed a monitoring report entitled, "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (Strategy) (MDEQ, 1997). It was developed specifically to identify the activities and resources needed to establish a comprehensive, state-of-the-art water quality monitoring program, and has guided Michigan's monitoring program implementation. The Strategy consists of nine interrelated elements: fish contaminants, water chemistry, sediment chemistry, biological integrity, wildlife contaminants, bathing beaches, inland lake quality and eutrophication, stream flow, and volunteer monitoring. The Strategy specifically identifies four monitoring goals:

- Assess the current status and condition of waters of the state and determine whether WQS are being met.
- Measure spatial and temporal water quality trends.
- Evaluate the effectiveness of water quality protection programs.
- Identify new and emerging water quality issues.

The evolving nature of management and program needs, technology, and technical monitoring guidance/science requires continuous evaluation of existing activities to ensure effective, comprehensive monitoring and to identify opportunities for improvement. Program assessment led to an update of the 1997 Strategy in May 2005 (MDEQ, 2005a) (available at http://www.michigan.gov/deqwater under Water Quality Monitoring, Assessment of Michigan Waters). Another impetus for the update was a requirement by the USEPA that states produce a comprehensive monitoring program strategy that serves all water quality management needs

and addresses all state waters. The purpose of the update was to: (1) describe ongoing monitoring activities (including monitoring objectives, study design, indicators, data analysis, data management, and reporting); (2) identify potential future monitoring activities, to the extent possible; (3) identify program gaps and a timeline for addressing them; and (4) specify resource needs (staff, funding, and technical).

The Strategy does not specifically address wetland monitoring. The WRD submitted a Wetland Monitoring and Assessment Strategy to the USEPA, Region 5, in January 2009. This strategy recognizes that gaps remain in Michigan's wetland monitoring program. Wetland Program Development Grant funding from the USEPA has been provided to the WRD to address remaining gaps, including steps to encourage integration of wetland monitoring into existing statewide water quality monitoring. The WRD is also working on serveral cooperative projects to monitor wetlands, including:

- A National Wetland Condition Assessment Intensification project, between the WRD and Central Michigan University, which includes sampling of 70 Great Lakes coastal wetland sites over a 3-year period (2010, 2011, 2012). This project includes the use of the fish, invertebrate, and water chemistry protocols from the Great Lakes Coastal Wetland Monitoring Plan, in conjunction with Michigan's Rapid Assessment Method (MiRAM).
- Implementation of a Pilot Wetland Monitoring Project in the Saginaw Bay AOC, a coastal wetland monitoring project coordinated by the WRD with Central Michigan University, similar to the National Wetland Condition Assessment Intensification. It includes implementation of the fish, invertebrate, and water chemistry protocols, in conjunction with the Michigan's Rapid Assessment Method on 5 coastal wetland sites in the Saginaw Bay AOC, for two years.
- The WRD is working with Central Michigan University and the other academic partners involved in a basin-wide coastal wetland monitoring project funded through a Great Lakes Restoration Initiative grant to implement all of the protocols in the Great Lakes Coastal Wetland Monitoring Plan. Specifically, the role of the WRD in this project is to facilitate communication between the academic researchers and various state agencies throughout the Great Lakes region about the project and future applications of the data.

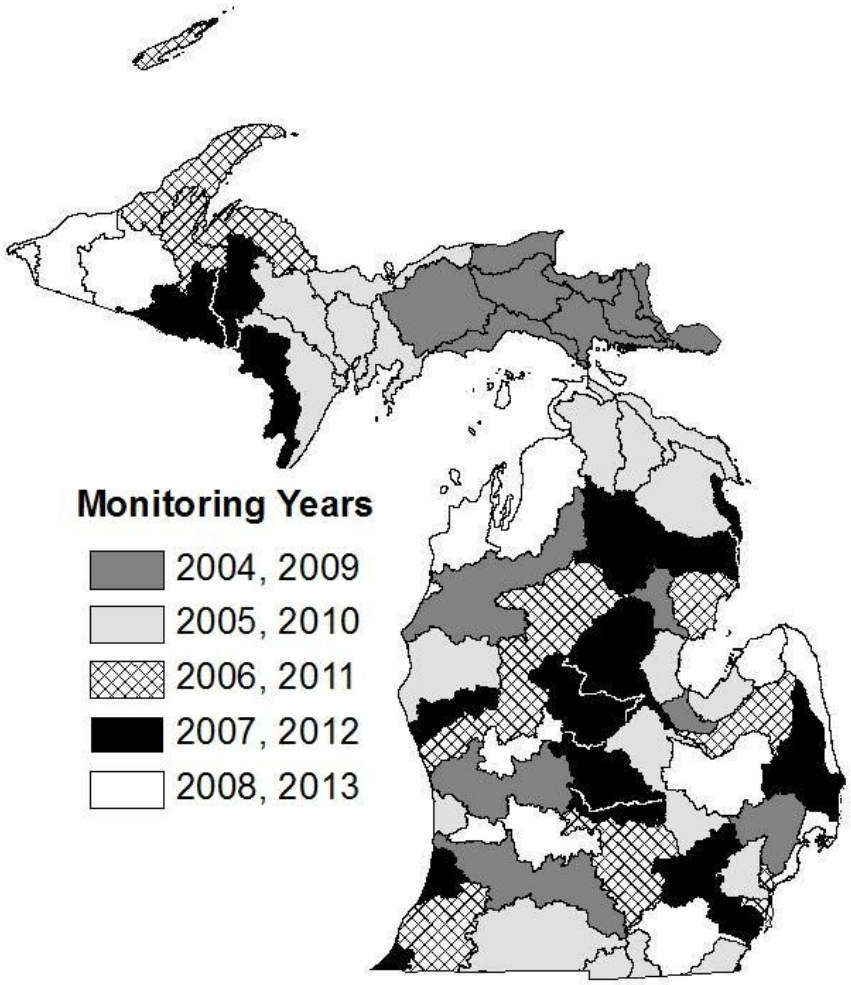



Figure 3.1 Five-Year Rotating Watershed Cycle.

## CHAPTER 4
## ASSESSMENT METHODOLOGY

### 4.1 Introduction

Michigan's assessment methodology describes the data and information used to determine designated use support, explains how these data and information are used to determine designated use support for surface waters of the state, and describes how data are reported using five categories. Ultimately, this methodology describes the process used to develop several of the appendices and summary tables included in this IR to satisfy the requirements of Sections 305(b) and 303(d) of the federal CWA.

The internal coordination and review process used to generate Sections 305(b) and 303(d) lists is carried out by a team of MDEQ technical staff and managers with considerable knowledge of local watershed conditions/issues and expertise in aquatic and fisheries biology, limnology, ecology, environmental engineering, chemistry, microbiology, and mammalian/aquatic toxicology.

### 4.2 Data and Information Used to Determine Designated Use Support

The MDEQ considers readily available and quality checked data and information collected and submitted by the MDEQ, its grantees and contractors, other agencies, and the public (including volunteer monitoring groups). Sources of data and information include:

- The MDEQ's water quality monitoring program data that includes eight interrelated elements: fish contaminants, water chemistry, sediment chemistry, biological integrity and physical habitat, wildlife contaminants, bathing beach monitoring, inland lakes monitoring, and stream flow (see Chapter 3).

  As part of the MDEQ's water quality monitoring program, sites for biological integrity and water chemistry monitoring are selected using both targeted and probabilistic study designs. The probabilistic monitoring approach is used to address statewide and regional questions about water quality. Targeted monitoring is used to fulfill specific monitoring requests, assess known or potential problem areas or areas where more information is needed, achieve assessment coverage of a watershed, and provide information to support and evaluate the effectiveness of MDEQ water protection programs (e.g., NPDES, NPS, and Site Remediation). All site-specific data are considered to determine designated use support. Generally, the other types of monitoring are conducted using targeted study designs.

- Michigan's 2010 IR (LeSage and Smith, 2011), which serves as a baseline for the 2012 IR and is modified using new data and information.

- Fish Consumption Advisories established by the Michigan Department of Community Health (MDCH) as of May 2011.

- Dilution calculations, trend analyses, or predictive models for determining the physical, chemical, or biological integrity of surface water bodies.

- Reports of fish kills and chemical spills.

- Surface water quality monitoring data submitted by the general public or outside agencies. This information was solicited by the MDEQ in a notice on the MDEQ Web-based Calendar in the following publications: April 11, April 25, May 9, and May 23, 2011. Information was also solicited from the Michigan Department of Transportation, MDARD, MDNR, United States Forest Service, USFWS, and USEPA via e-mail on April 26, 2011.

- Surface water, drinking water, and source water quality assessments conducted under Section 1453 of the federal Safe Drinking Water Act, enacted by Public Law 93-523, December 16, 1974, as amended, through August 6, 1996, being Title 42 of the United States Code (U.S.C.), Section 300j-13.

- Remedial investigation/feasibility studies to support Records of Decision under the Comprehensive Environmental Response, Compensation, and Liability Act, 1980 PL 96-510 or Part 201 of the NREPA.

To ensure adequate time for proper data analysis, the MDEQ applies a cutoff date for newly collected data considered for the IR (i.e., data that were not used for development of the 2010 IR). For the 2012 IR, the MDEQ considered all new readily available and quality-checked water quality data and information collected by the MDEQ and its grantees/contractors within the two-year period immediately following the data considered for the 2010 IR. In other words, data collected during the period from January 1, 2009, to December 31, 2010, were considered for the 2012 IR. Data collected prior to January 1, 2009, that were unable to be used for the 2010 IR were considered for the 2012 IR using the current assessment methodology. Water Chemistry Monitoring Project (WCMP) data collected through 2009 were used for this IR. WCMP data collected in 2010 were not quality-checked in sufficient time to be used for this IR. Data collected after the December 31, 2010, cutoff date were considered for inclusion in the 2012 IR on a case-by-case basis as determined appropriate by the MDEQ. TMDL documents completed in 2011 were used to prepare this IR. Water quality data collected since January 1, 2009, and submitted to the MDEQ by June 4, 2011, by other parties (e.g., in response to the data solicitation described in the above bulleted list, from the Michigan Clean Water Corps volunteer monitoring database, etc.) were evaluated according to this assessment methodology and potentially used to help prepare the 2012 IR.

The quality assurance/quality control requirements for water, sediment, and fish tissue chemistry and biological data collected by the MDEQ are described in the MDEQ's Quality Management Plan (MDEQ, 2005b). To ensure acceptable data quality, the MDEQ also requires all grantees or vendors receiving state or federal money for the purpose of conducting water quality monitoring to prepare Quality Assurance Project Plans prior to sample collection (MDEQ, 2002a). Other data, such as data submitted by outside agencies or the public, must satisfy the MDEQ's quality assurance/quality control requirements to be used to make designated use support determinations of supporting or not supporting, to change the designated use support, or to reassign water bodies to different categories. Data that do not fully satisfy the MDEQ's quality assurance/quality control requirements or data that are collected and analyzed using techniques that are less rigorous than techniques used by the MDEQ to make designated use support determinations may be used to list a water body for further evaluation (i.e., as insufficient information).

Each dataset for a water body is evaluated to determine if the data are representative of existing conditions and of adequate quality to make designated use support decisions. Data may not be representative of existing conditions if land use, point sources, or hydrologic conditions were substantially modified. Data may not be of adequate quality if field or laboratory methods changed. In addition, the quantity of data; duration, frequency, magnitude, and timing of WQS exceedances; analytical method sensitivity; and contextual information (e.g., naturally occurring, weather, and flow conditions, etc.) are considered. Target sample sizes may be given in this assessment methodology to determine designated use support; however, these sample sizes are not applied as absolute rules. Generally, data that are collected to determine compliance with permitted activities, such as NPDES discharge data, are not used to determine designated use support; however, ambient data that are collected for this purpose may be considered.

### 4.3 Determination of Designated Use Support

At a minimum, all surface waters of the state are designated and protected for all of the following designated uses: agriculture, navigation, industrial water supply, warmwater fishery, other indigenous aquatic life and wildlife, partial body contact recreation, and fish consumption (R 323.1100[1][a]-[g] of the Part 4 rules). In addition, all surface waters of the state are designated and protected for total body contact recreation from May 1 to October 1 (R 323.1100[2]). Specific rivers and inland lakes as well as all Great Lakes and specific Great Lakes connecting waters are designated and protected for coldwater fisheries (R 323.1100[4]-[7]). Several specific segments or areas of inland waters, Great Lakes, Great Lakes bays, and connecting channels are designated and protected as public water supply sources (R 323.1100[8]). The Part 4 rules form the basis for this assessment methodology.

Most designated uses have one or more types of assessment that may be used to determine support. For example, to determine support for the other indigenous aquatic life or wildlife designated use, biological or physical/chemical assessment (e.g., rapid bioassessment of the macroinvertebrate community or chemical analysis of water samples) may be used. The assessment types include biological, habitat, physical/chemical, toxicological, pathogen indicators, other public health indicators, and other aquatic life indicators (default types from the USEPA ADB). In addition, a variety of parameters may be considered for the same assessment type. For example, physical/chemical assessments to determine fish consumption designated use support may include analysis of mercury concentration in fish tissue or PCB concentration in the water column.

Michigan uses the principle of independent applicability when making a support determination for each designated use for each water body. If data for more than one parameter are available that are used to determine support for the same designated use, then each data type is evaluated independently to determine support for the designated use. If any one type of data indicates that the designated use is not supported, then generally, the water body is listed as not supporting that designated use. In some instances, data require reevaluation to resolve discrepancies. Some particular data types or situations may require consideration of multiple data types in combination. If no data are available for any assessment methods, then a water body is considered not assessed.

A single parameter may be used to make support determinations for more than one designated use. For example, appropriate data for a water body may reveal that water column mercury concentrations exceed the wildlife and human noncancer value (HNV) (nondrinking water) (R 323.1057); therefore, both the other indigenous aquatic life and wildlife, and fish consumption designated uses are not supported. Another example includes the situation where water column copper concentrations exceed the WQS and lead to both poor macroinvertebrate and

warmwater fish communities; therefore, both the other indigenous aquatic life and wildlife, and warmwater fishery designated uses are not supported. The inclusion of a parameter under a specific designated use in this assessment methodology does not preclude the use of that parameter to make support determinations for a different designated use.

This section of the IR describes how data and information are generally used by the MDEQ to make a decision to report for a water body, one of the following conditions for each designated use: supporting, not supporting, insufficient information, or not assessed. This assessment methodology attempts to list the main assessment types and parameters that are used to determine support for each designated use. Water body, assessment, or data types that are not specifically discussed in this assessment methodology (including uncommon data or unusual circumstances) are considered on a case-by-case basis using best professional judgment (BPJ) and are evaluated consistent with WQS. Though infrequent, when BPJ is used to make a designated use support determination, justification is documented in the designated use comment field in the ADB record. Water bodies listed as having insufficient information will generally be revisited in the correct basin year as resources allow (Figure 3.1). Comments specific to the development of each assessment, including details regarding the use of BPJ, are also accessible via the MiSWIMS (http://www.michigan.gov/miswims) by selecting the 'Assessment' view under the Map Search, choosing the designated use of interest as well as the category(ies) of interest, then using the 'Assessment' Identify Layer and the "I"dentify Tool to bring up information linked directly from the ADB.

## 4.4 Designated Uses: Agriculture, Navigation, and Industrial Water Supply

### *4.4.1 Assessment Type: No Specific Indicator or Assessment Method*

The MDEQ does not conduct specific assessments to evaluate support of the agriculture, navigation, and industrial water supply designated uses. These uses are assumed to be supported unless there is site-specific information indicating otherwise. In a scenario where site-specific information is used, the information is evaluated on a case-by-case basis using BPJ.

## 4.5 Designated Use: Warmwater Fishery and Coldwater Fishery

All surface waters of the state are designated and protected for warmwater fishery. In addition, specific rivers and inland lakes as well as all Great Lakes and specific Great Lakes connecting waters are designated and protected for coldwater fishery per R 323.1100(4)-(7).

### *4.5.1 Assessment Type: Physical/Chemical*

#### *4.5.1.1 Dissolved Oxygen Concentration*

The number of instantaneous dissolved oxygen measurements needed to make a support determination for the warmwater and coldwater fishery designated uses is made on a case-by-case basis using BPJ. Continuous data collected over a longer time period (e.g., two weeks) that are representative of conditions and capture environmental variability (e.g., due to changes in weather and temperature) are preferred over periodic single samples. Consideration of contextual information is especially important when making designated use determinations using dissolved oxygen concentrations (sample collection time of day, weather conditions, etc.). Ambient dissolved oxygen data are compared to WQS per R 323.1064 and R 323.1065, depending on water body type.

*4.5.1.2 Temperature*

The amount of temperature data needed to make a support determination for the warmwater and coldwater fishery designated uses is made on a case-by-case basis using BPJ. Continuous data collected over a longer time period (e.g., two weeks) that are representative of conditions and capture environmental variability (e.g., due to changes in weather and temperature) are preferred over periodic single samples. Ambient temperature data are compared to WQS per R 323.1069, R 323.1070, R 323.1072, R 323.1073, and R 323.1075, depending on water body type.

*4.5.1.3 Ammonia (un-ionized) Concentration*

The number of total ammonia measurements needed to make a support determination for the warmwater fishery designated use is made on a case-by-case basis using BPJ. Supporting site-specific pH and temperature data are generally required. Continuous pH and temperature data over a longer time period (e.g., two weeks) are preferred. Calculated un-ionized ammonia data are compared to WQS per R 323.1057.

*4.5.1.4 Dissolved Solids*

Designated use support determination using dissolved solids data is made on a case-by-case basis using BPJ and R 323.1051.

*4.5.1.5 pH*

The number of pH measurements needed to make a designated use support determination is made on a case-by-case basis using BPJ. Ambient pH data are compared to WQS per R 323.1053.

### *4.5.2 Assessment Type: Biological*

*4.5.2.1 Fish Community*

In addition to chemical and physical assessment types, Michigan uses rapid bioassessment of fish communities in wadeable streams and rivers [generally Procedure 51 (P51) (MDEQ, 1990)] to determine support for the warmwater fishery and coldwater fishery designated uses. Fish community biosurvey sites are selected using targeted study designs.

Rivers and streams with no site-specific fish community biosurvey results are considered not assessed unless other data are available to assess this use as described elsewhere in this Section (4.5).

Using P51, warmwater fish communities are scored with metrics that rate water bodies from excellent (+5 to +10) to poor (-10 to -5). Fish ratings from -4 to +4 are considered acceptable.

Water bodies with warmwater fish communities rating acceptable or excellent using P51 are determined to support the warmwater fishery designated use. Fish communities collected from designated coldwater streams using P51 are determined to support the coldwater fishery designated use if the relative abundance of salmonids is equal to or greater than 1%. One bioassessment result is generally considered sufficient to make this determination.

Using P51, a determination of not supporting or insufficient information is made for water bodies that have metrics that rate the warmwater fish community poor, have coldwater fish communities with salmonid relative abundance of less than 1%, or if fewer than 50 fish are

collected or if the relative abundance of fish with anomalies exceeds 2% (applies to both warmwater and coldwater fisheries) depending on the quality and amount of supporting contextual information available. For example, a poor fish community result may require the collection of additional information to determine data representativeness. In this case, a determination of insufficient information is made. Generally, targeted biosurvey results should have sufficient supporting information available to determine survey representativeness and to list the water body as not supporting using one survey result.

For biological communities that rate poor, current and past weather conditions, assessments of biological communities in adjacent stream or river segments, and the source and frequency of pollutant exposure are considered to determine if conditions are ongoing or temporary. If conditions are determined to be temporary, a water body may be listed as having insufficient information. For example, a water body with a temporarily poor biological community due to a short-term chemical spill may be listed as having insufficient information if remediation occurred and the community was expected to recover.

Fish community data for wadeable streams and rivers collected using methods other than P51 are evaluated on a case-by-case basis using BPJ. For example, fish community data collected as part of the MDNR Fisheries Division's Status and Trend monitoring can be evaluated based on community structure and compared to the definitions for Coldwater and Warmwater Fishery Use as stated in R 323.1043 and R 323.1044. Biological integrity data regarding instances where P51 is not appropriate (e.g., wetlands, lakes, ephemeral water bodies, nonwadeable rivers, etc.) will be evaluated on a case-by-case basis using BPJ. For example, one of the factors considered to determine support of the coldwater fishery designated use in coldwater lakes is the presence of indicator species such as cisco.

## 4.6 Designated Use: Other Indigenous Aquatic Life and Wildlife

### *4.6.1 Assessment Type: Physical/Chemical*

#### *4.6.1.1 Water Column Toxic Substance Concentrations*

To determine other indigenous aquatic life and wildlife designated use support for toxic substances, ambient water column chemical concentrations are compared to Wildlife, Aquatic Maximum, and Final Chronic Values per R 323.1057 using Figure 4.1. Water chemistry monitoring sites are selected using both targeted and probabilistic study designs. All site-specific water column chemistry data are used to determine other indigenous aquatic life and wildlife designated use support.

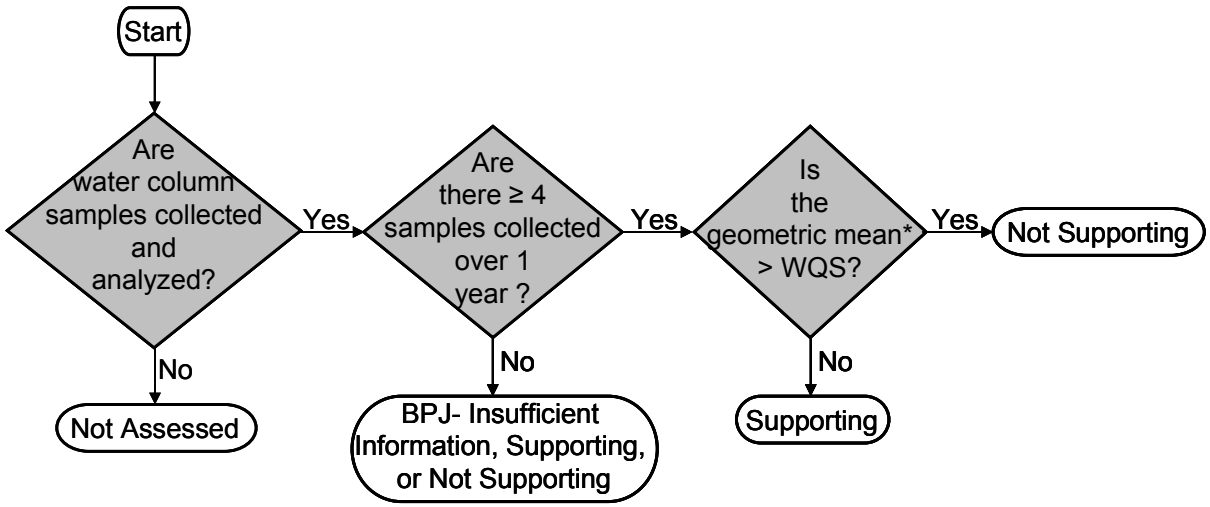



Figure 4.1. Determination of other indigenous aquatic life and wildlife designated use support using water column toxic substance concentration. *Geometric mean is used per R 323.1207(1)(g)(iii).

Because statewide exceedance of WQS is recognized as an issue for both total mercury and total PCBs and because the source of these exceedances is atmospheric in nature and therefore principally relevant on a broad scale, statewide TMDLs are being developed and scheduled for completion in 2013 to address the impairment of the Other Indigenous Aquatic Life and Wildlife designated use.

*4.6.1.2 Water Column Nutrient Concentrations*

Ambient water column nutrient concentrations are used in conjunction with biological indicators to determine support of the other indigenous aquatic life and wildlife designated use per R 323.1060 using BPJ since Michigan does not have numeric standards for ambient concentrations of plant nutrients. Samples collected during the period of July through September, when the impacts due to nutrient expression are most likely to occur, are particularly important for making designated use support determinations.

For inland lakes, Carlson's trophic status index (TSI) in conjunction with aquatic macrophyte surveys, are considered to determine designated use support. Individual TSI values are calculated using late summer data for each trophic state indicator: summer secchi depth (transparency), total phosphorus concentration (epilimnetic), and chlorophyll *a* concentration (photic zone) (Table 4.1). An overall TSI is determined from the mean of the individual TSI values and the trophic status classification is determined based on the criteria listed in Table 4.2. The TSI and qualitative macrophyte surveys are combined to potentially shift a trophic status to the next category based on denser than expected macrophyte conditions under the TSI calculation. Inland lakes classified as oligotrophic, mesotrophic, or eutrophic are generally determined to support the other indigenous aquatic life and wildlife designated use. Inland lakes that are classified as hypereutrophic are generally listed as insufficient information with the goal of conducting additional, site specific, monitoring to confirm the trophic designation and whether impairments of the designated uses are realized.

| Table 4.1. Carlson's TSI Equations. | |
|---|---|
| $TSI_{SD} = 60 - 33.2 \log_{10}SD$ | SD = Secchi depth transparency (m) |
| $TSI_{TP} = 4.2 + 33.2 \log_{10}TP$ | TP = total phosphorus concentration (ug/l) |
| $TSI_{CHL} = 30.6 + 22.6 \log_{10}CHL$ | CHL = chlorophyll *a* concentration (ug/l) |

| Table 4.2 Michigan Inland Lakes Trophic Status Classification Criteria. | | | | |
|---|---|---|---|---|
| Trophic State | Carlson's TSI | TP (ug/l) | SD (m) | CHL (ug/l) |
| Oligotrophic | <38 | <10 | >4.6 | <2.2 |
| Mesotrophic | 38-48 | 10-20 | 2.3-4.6 | 2.2-6 |
| Eutrophic | 48-61 | 20-50 | 0.9-2.3 | 6-22 |
| Hypereutrophic | >61 | >50 | <0.9 | >22 |

*4.6.1.3 Physical Characteristics*

R 323.1050 addresses the following physical characteristics of a water body: turbidity, color, oil films, floating solids, foams, settleable solids, suspended solids, and deposits. Michigan does not have specific assessment methods or numeric standards for these physical characteristics; therefore, BPJ (including visual observation) in conjunction with other assessment types (e.g., biological) is used to determine the other indigenous aquatic life and wildlife designated use support based on this narrative standard.

### *4.6.2 Assessment Type: Biological*

*4.6.2.1 Macroinvertebrate Community*

In addition to chemical and physical assessment types, Michigan uses rapid bioassessment of macroinvertebrate communities in wadeable streams and rivers (generally P51; MDEQ, 1990) to determine support for the other indigenous aquatic life and wildlife designated use. Using P51, macroinvertebrate communities are scored with metrics that rate water bodies from excellent (+5 to +9) to poor (-5 to -9). Macroinvertebrate ratings from -4 to +4 are considered acceptable. Biosurvey sites are selected using both targeted and probabilistic study designs. All site-specific biosurvey data are considered to determine other indigenous aquatic life and wildlife designated use support.

Rivers and streams with no site-specific macroinvertebrate community biosurvey results are considered not assessed.

Water bodies with macroinvertebrate communities rating acceptable or excellent (i.e., total P51 macroinvertebrate community score -4 to +9) are determined to support the other indigenous aquatic life and wildlife designated use. One bioassessment result is generally considered sufficient to make this determination.

A determination of not supporting or insufficient information is made for water bodies with macroinvertebrate communities rated poor (total P51 macroinvertebrate community score -5 to -9) depending on the quality and amount of supporting contextual information available. For example, a poor macroinvertebrate community result from a biosurvey conducted as part of probabilistic monitoring may require the collection of additional information to determine data representativeness. In this case, a determination of insufficient information is made. Generally, targeted biosurvey results should have sufficient supporting information available to determine survey representativeness and to list the water body as not supporting using one survey result. For biological communities that rate poor, current and past weather conditions, assessments of biological communities in adjacent stream or river segments, and the source and frequency of pollutant exposure are considered to determine if conditions are ongoing or temporary (see Section 4.5.2.1).

Macroinvertebrate data for wadeable streams and rivers collected using methods other than P51 are evaluated on a case-by-case basis using BPJ. Biological integrity data regarding

instances where P51 is not appropriate (e.g., wetlands, lakes, ephemeral streams, etc.) will be evaluated on a case-by-case basis using BPJ.

Nonwadeable rivers are assessed using Michigan's Qualitative Biological and Habitat Survey Protocols for Nonwadeable Rivers (MDEQ, Nonwadeable Procedure, in preparation). Using this nonwadeable procedure, macroinvertebrate communities are scored with metrics that rate water bodies from excellent to poor. Macroinvertebrate ratings from 76-100 are considered excellent, 50-75 good, 25-49 fair, and 0-24 are considered poor.

Nonwadeable rivers with macroinvertebrate communities rating excellent, acceptable, or fair (i.e., total macroinvertebrate community score ≥25) are determined to support the other indigenous aquatic life and wildlife designated use. One bioassessment result is generally considered sufficient to make this determination.

Similar to determinations made for wadeable streams and rivers, a determination of not supporting or insufficient information is made for nonwadeable rivers with macroinvertebrate communities rated poor (total macroinvertebrate community score 0-24) depending on the quality and amount of supporting contextual information available.

*4.6.2.2 Bacteria, Algae, Macrophytes, and Fungi*

Site-specific visual observation of bacteria, algae, macrophytes, and fungi may be used to make a support determination for the other indigenous aquatic life and wildlife designated use. In addition, water column nutrient concentrations may also be used to support this determination (see Section 4.6.1.2).

A determination of not supporting may be made if excessive/nuisance growths of algae (particularly, *Cladophora*, *Rhizoclonium*, and cyanobacteria) or aquatic macrophytes are present. Although the determination of excessive, nuisance conditions is made using BPJ, P51 offers the following guidance to make these determinations for streams:

- *Cladophora* and/or *Rhizoclonium* greater than 10-inches long covering greater than 25% of a riffle.
- Rooted macrophytes present at densities that impair the designated uses of the water body.
- Presence of bacterial slimes.

For inland lakes, chlorophyll *a* (used as a surrogate for algal biomass) is a component of the TSI calculation and is used quantitatively to determine the trophic state (see Section 4.6.1.2).

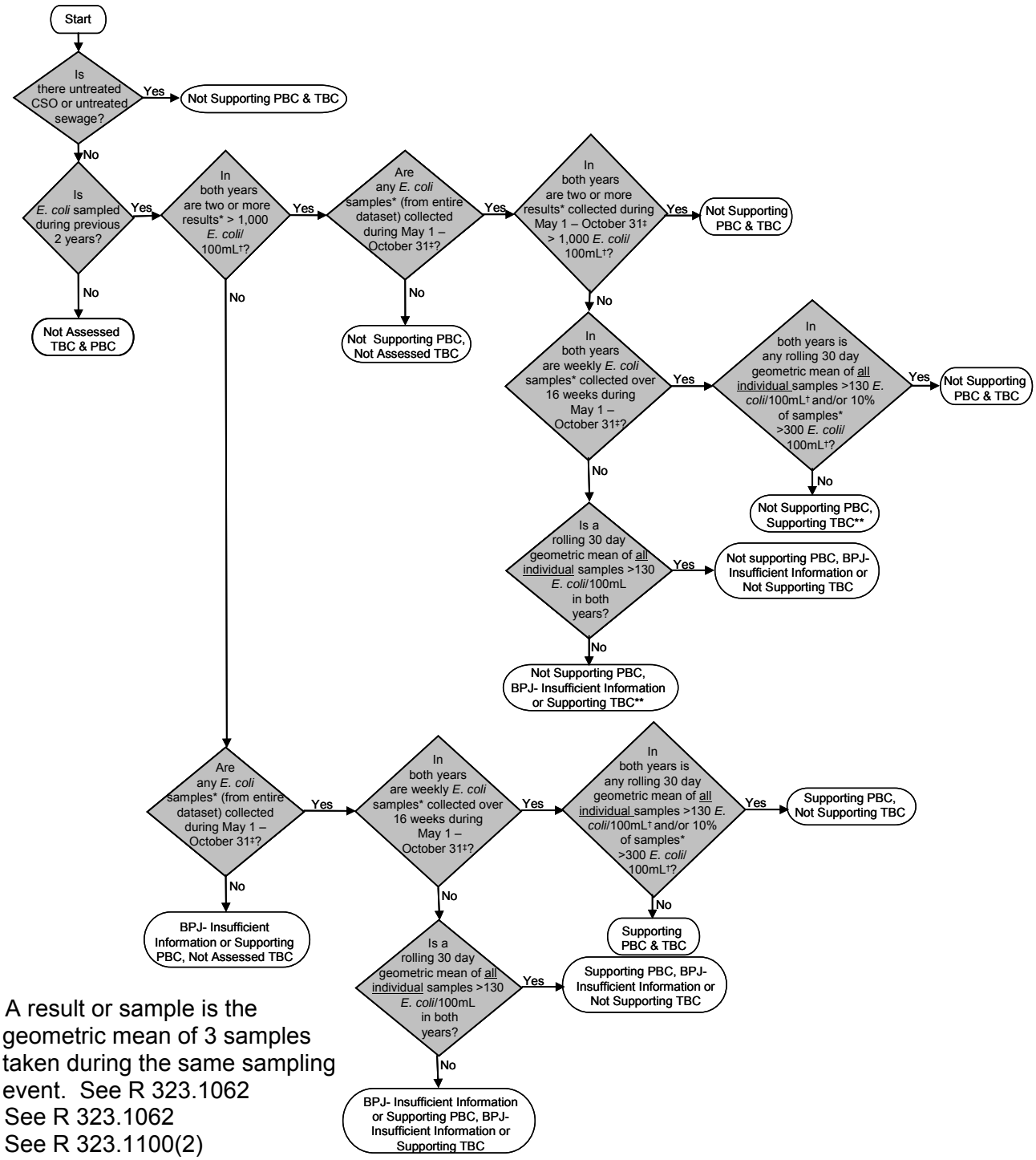
## 4.7 Designated Use: Partial Body Contact Recreation and Total Body Contact Recreation

The partial body contact recreation designated use applies to all water bodies year-round while the total body contact recreation designated use applies to all water bodies during May 1 to October 31.

### *4.7.1 Assessment Type: Pathogen Indicators*

*4.7.1.1 E. coli*

Michigan uses ambient *E. coli* concentration to determine partial body contact and total body contact recreation designated use support using Figure 4.2a for beaches and Figure 4.2b for streams and rivers (non-beach).



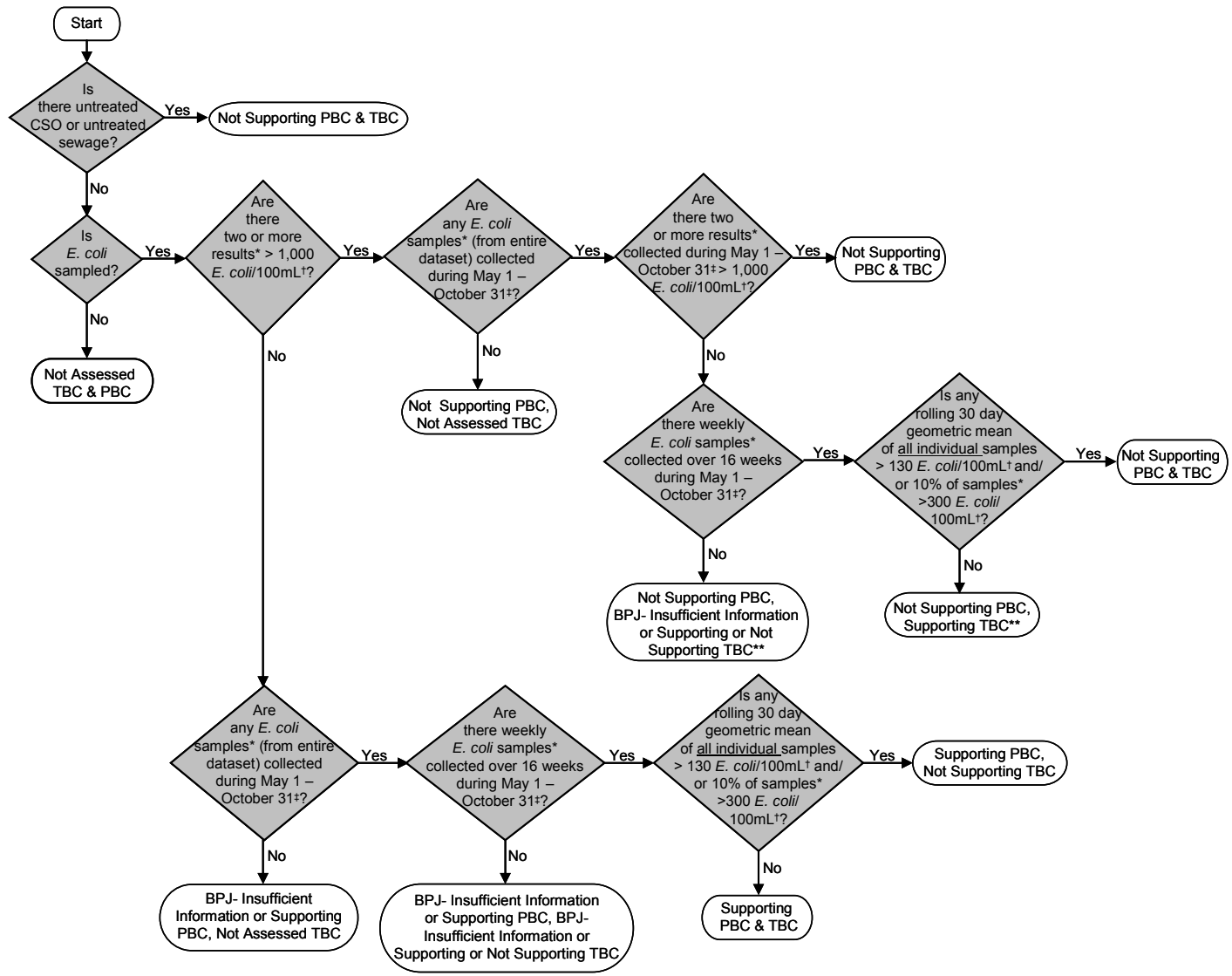

* A result or sample is the geometric mean of 3 samples taken during the same sampling event. See R 323.1062

† See R 323.1062

‡ See R 323.1100(2)

** It is possible to arrive at a decision of supporting for total body contact recreation and not supporting for partial body contact recreation if *E. coli* concentrations are low during the total body contact recreation season (May 1 through October 31) and high during the nonrecreation season.

Figure 4.2a. Determination of partial body contact and total body contact designated use support using ambient *E. coli* water column concentration for Michigan beaches.




* A result or sample is the geometric mean of 3 samples taken during the same sampling event. See R 323.1062

† See R 323.1062

‡ See R 323.1100(2)

** It is possible to arrive at a decision of supporting for total body contact recreation and not supporting for partial body contact recreation if *E. coli* concentrations are low during the total body contact recreation season (May 1 through October 31) and high during the nonrecreation season.

Figure 4.2b. Determination of partial body contact and total body contact designated use support using ambient *E. coli* water column concentration for Michigan streams and rivers (non-beaches).

## 4.8 Designated Use: Fish Consumption

Michigan uses a variety of assessment types and parameters to determine fish consumption designated use support. Data considered include the concentration of bioaccumulative chemicals of concern (BCCs) (as listed in Table 5 of the Part 4 Rules) in the water column, fish tissue mercury concentration, fish consumption advisories issued by the MDCH, and final chronic values.

### *4.8.1 Assessment Type: Physical/Chemical*

#### *4.8.1.1 Water Column and Fish Tissue Mercury Concentrations*

To be conservative, site-specific water column and fish tissue data are used together to determine fish consumption designated use support. Ambient water column mercury concentrations are compared to the HNV (nondrinking water) WQS (1.8 nanograms per liter [ng/L]); fish tissue mercury concentrations in edible portions are compared to Michigan's fish tissue value for mercury (0.35 milligrams per kilogram [mg/kg]).

Because statewide exceedance of the total mercury WQS is recognized as an issue and because the source of this exceedance is atmospheric in nature and therefore principally relevant on a broad scale, a statewide TMDL is being developed and scheduled for completion in 2013 to address the impairment of the Fish Consumption designated use.

Michigan's fish tissue mercury value development method is similar to the USEPA's development method for the national fish tissue criterion (USEPA, 2001). Michigan's fish tissue mercury value (0.35 mg/kg) was derived using the same exposure scenario used to derive Michigan's HNV (nondrinking water) WQS of 1.8 ng/L. Michigan's fish tissue value for mercury is the concentration that is not expected to pose a health concern to people consuming 15 grams or less of fish per day.

The fish tissue mercury value is not an ambient WQS; however, the MDEQ considers the direct use of fish tissue mercury data appropriate to help determine fish consumption designated use support.

Fish consumption designated use support for mercury is determined by using Figure 4.3 to make a decision for water column mercury concentration, using Figure 4.4 to make a decision for fish tissue mercury concentration, and finally using Table 4.3 to determine overall fish consumption designated use support for mercury using the results from the Figures 4.3 and 4.4 decision processes. The overall designated use support for mercury determination from Table 4.3 is used for the Sections 305(b) and 303(d) reporting process.

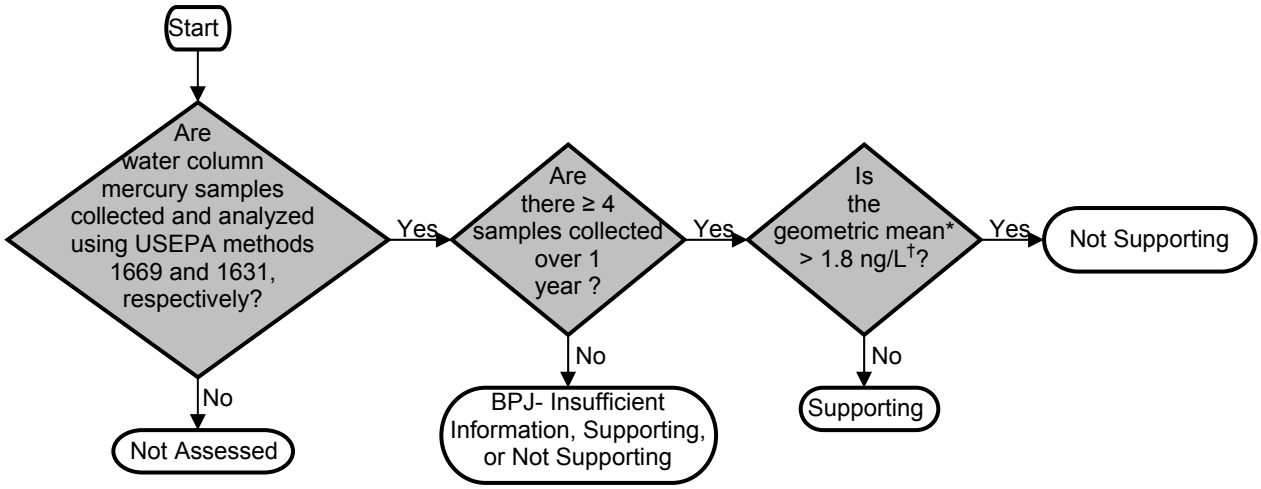



Figure 4.3. Determination of fish consumption designated use support using water column mercury concentration. This figure must be used in conjunction with Figure 4.4. The final overall fish consumption designated use support determination using mercury data is made using Table 4.3. * Geometric mean is used per R 323.1207(1)(g)(iii). † Michigan WQS HNV (nondrinking water) for mercury.

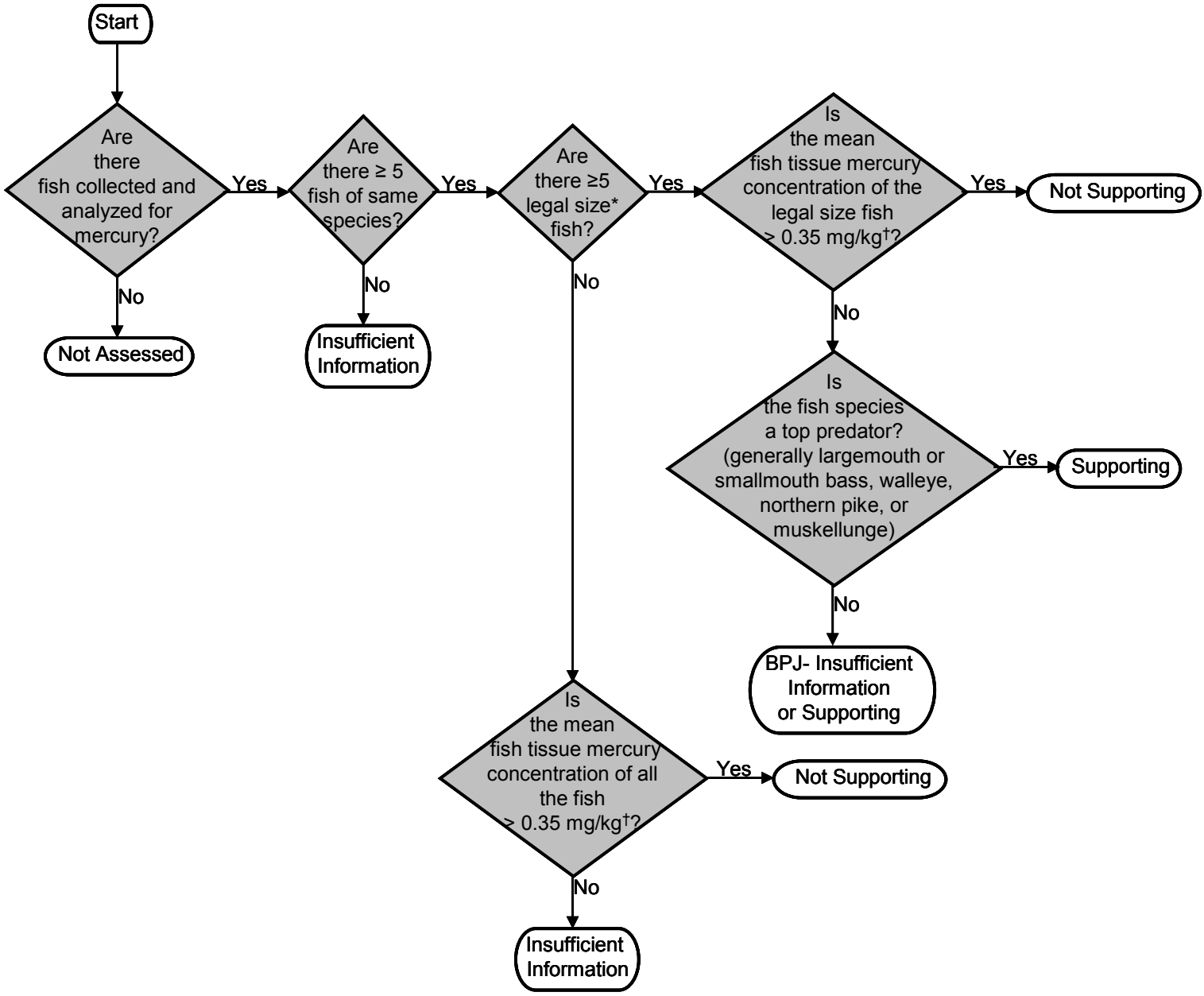



Figure 4.4. Determination of fish consumption designated use support using fish tissue mercury concentration. This figure must be used in conjunction with Figure 4.3. The final overall fish consumption designated use support determination using mercury data is made using Table 4.3. * Legal size fish refers to the current minimum size limit regulations described in Michigan's Fishing Guide and Inland Trout and Salmon Guide published by the MDEQ.
† Michigan's fish tissue value for mercury.

| Table 4.3. Overall fish consumption designated use support determination for mercury using water column and fish tissue mercury concentration. | | |
|---|---|---|
| Decision based on mercury water column data (from Figure 4.3) | Decision based on mercury fish tissue data (from Figure 4.4) | Overall fish consumption designated use support for mercury |
| Supporting | Supporting | Supporting |
| Supporting | Not Supporting | BPJ*- Supporting, Not Supporting, or Insufficient Information |
| Supporting | Not Assessed/ Insufficient Information | Supporting |
| Not Supporting | Supporting | Not Supporting |
| Not Supporting | Not Supporting | Not Supporting |
| Not Supporting | Not Assessed/ Insufficient Information | Not Supporting |
| Not Assessed/ Insufficient Information | Supporting | Supporting |
| Not Assessed/ Insufficient Information | Not Supporting | Not Supporting |
| Not Assessed/ Insufficient Information | Not Assessed/ Insufficient Information | Not Assessed/ Insufficient Information |

* In addition to the elements discussed in Section 4.2, the size and species of fish collected and analyzed, and the existence or potential for site-specific mercury fish consumption advisories, are considered when making designated use support decisions using BPJ.

*4.8.1.2 Water Column PCB Concentration*

To determine fish consumption designated use support for PCBs, the ambient water column PCB concentration is compared to the Human Cancer Value (HCV) (0.026 ng/L) (R 323.1057). PCB samples should be collected and analyzed according to protocols published by the USEPA (1997a and 1997b), with the exception that dissolved and particulate fractions are combined. For PCBs, a sample size of 1 is considered sufficient information to determine WQS nonattainment. This approach is justified by the existence of a large PCB dataset for the state as a whole, which shows virtually 100% exceedance of the HCV for total PCBs. If there are no appropriate PCB data, then a water body is considered not assessed. Water bodies with one or more ambient water column PCB sample results greater than the HCV are determined to not support the fish consumption designated use.

The fish tissue PCB value is not an ambient WQS; however, the MDEQ considers the use of the MDCH advisory listing based on fish tissue PCB data as appropriate in helping determine fish consumption designated use support. The MDCH issues a fish consumption advisory due to PCBs on a water body specific basis when the median total PCB concentration in fillet samples of any species exceeds 0.05 mg/Kg (wet weight).

Because statewide exceedance of WQS is recognized as an issue for PCBs and because the source of this exceedance is atmospheric in nature and therefore principally relevant on a broad scale, a statewide TMDL is being developed and scheduled for completion in 2013 to address the impairment of the Fish Consumption designated use.

#### *4.8.1.3 Water Column BCCs Concentration other than Mercury and PCBs*

To determine fish consumption designated use support for BCCs other than mercury and PCBs in the water column, ambient water column chemical concentrations are compared to the HNV and HCV (nondrinking water) per R 323.1057 using Figure 4.1 (see Section 4.6.1.1).

### *4.8.2 Assessment Type: Other Public Health Indicators*

#### *4.8.2.1 Fish Consumption Advisories for BCCs other than Mercury (Primarily PCBs, DDT, Chlordane, and Dioxin)*

For contaminants other than mercury, a water body is considered to not support the fish consumption designated use if the MDCH has issued a site-specific fish consumption advisory for that water body. The MDCH bases their advisories on fish tissue contaminant data collected as part of the Michigan Fish Contaminant Monitoring Program and recommendations made by the MDEQ.

## 4.9 Designated Use: Public Water Supply

Several specific segments or areas of inland waters, Great Lakes, Great Lakes bays, and connecting channels are designated and protected as public water supply sources [R 323.1100(8)].

### *4.9.1 Assessment Type: Physical/Chemical*

#### *4.9.1.1 Toxic Substances in Water Column*

To determine public water supply designated use support for toxic substances other than BCCs, ambient water column chemical concentrations are compared to the HNV and HCV for drinking water per R 323.1057 using Figure 4.1 (see Section 4.6.1.1).

Public water supply designated use support determination for BCCs is problematic and there is generally insufficient information available to make a determination. The HNV and HCV for drinking water (surface WQS) calculations use an exposure scenario that includes human consumption of 15 grams of fish and two liters of water daily. The majority of human exposure to a BCC using this scenario would be from the consumption of fish. In other words, the relative human exposure to a BCC in surface waters via water consumption is minimal. Currently, Michigan's rules do not contain a methodology to derive human health values that protect solely for the consumption of two liters of untreated surface water per day. Maximum contaminant levels, the maximum permissible level of a contaminant in water that is delivered to any user of a public water system, used by the MDEQ, Drinking Water and Environmental Health Section, do not include a specific fish consumption component in the calculation.

WQS (HNV and HCV for drinking water) and maximum contaminant levels are calculated differently and have different purposes. Due to the inconsistency between these values, comparisons of ambient water column BCC concentration to HNVs and HCVs for drinking water are not made. For example, the ambient PCB concentration at the point of a community water supply intake may exceed the PCB HCV drinking water value (0.026 ng/L) while the finished (i.e., treated) water may be determined to be below the PCB maximum contaminant level (0.5 micrograms per liter [ug/L]). The MDEQ, Surface Water Assessment Section and Drinking Water and Environmental Health Section, will work together and with the USEPA to determine a long-term solution for this issue.

*4.9.1.2 Taste and Odor*

To determine public water supply designated use support, site-specific complaints of taste and odor causing substances in community source waters are considered on a case-by-case basis.

## 4.10 Assessment Units and Determination of Geographic Extent

Michigan uses the NHD coding scheme (1:24,000 resolution) to georeference water bodies when generating the Sections 305(b) and 303(d) lists. As a base assessment unit, Michigan uses 12-digit HUCs (Appendix A). The geographic extent of a designated use support determination for each water body is made on a case-by-case basis. The 12-digit HUC base assessment unit is used as a default when listing streams and rivers to facilitate record keeping and mapping. Each 12-digit HUC base assessment unit may be split into multiple assessment units if site-specific information supports a smaller assessment unit (e.g., contextual information such as land use, known areas of contamination, point source pollution location, specific fish consumption advisory geographic information, barriers such as dams that restrict fish migration, etc.). An assessment unit may consist of all water bodies in a 12-digit HUC (as a maximum) or specific stream segments or lakes in a 12-digit HUC.

Beyond using the 12-digit HUC as a base assessment unit, contextual information is considered when making a determination of the geographic extent that data collection points represent. For example, if a macroinvertebrate community survey conducted in the lower reach of a branch of a river indicates support of the other indigenous aquatic life and wildlife designated use and a second survey conducted farther upstream (several 12-digit HUCs upstream) in the same river branch also indicates designated use support, then contextual information may be considered to make a determination that the spanned river miles also support the designated use. In this example, contextual information may include similar physical habitat, similar land use, absence of point sources, absence of contaminated sites, etc. In other words, if contextual information indicates that it is appropriate, data collected from an assessment unit may be used to make designated use determinations for surrounding water body segments in different assessment units that lack data.

Generally, 12-digit HUCs are used as a base assessment unit for the public water supply designated use. For the public water supply designated use in inland intakes, the geographic extent of the assessment unit is the 12-digit HUC in which the intake is located.

For public water supply intakes that are located in the Great Lakes or connecting channels, a concept of a Critical Assessment Zone (CAZ) around each intake was developed based on a Sensitivity Factor calculated for each intake. The two attributes used to develop the Sensitivity Factor are the water depth above the intake structure and the perpendicular distance from shore or length of the intake pipeline. Other factors such as localized flow patterns, thermal effects, wind effects, lake bottom characteristics, benthic nepheloid layers, etc., may be used to complete the sensitivity analysis. A radius for the CAZ, ranging from 3,000 feet for the most sensitive intakes to 1,000 feet for the least sensitive intakes, is assigned based on the Sensitivity Factor. A shape with this radius is then drawn around the intake to illustrate the CAZ. If the CAZ intersects the shoreline, then the geographic extent of the assessment unit is determined on a case-by-case basis as the most influential 12-digit HUCs that are along the shoreline within the CAZ. For intakes that are located in open waters of the Great Lakes where the CAZ does not intersect the shoreline, the geographic extent of the assessment unit is 1.5 square miles.

Ultra low-level PCB monitoring conducted by the MDEQ indicates that PCB concentrations exceed the HCV WQS (0.026 ng/L) in all waters sampled. Based on these results, all river miles in the individual watersheds sampled for PCBs are listed as not supporting the fish consumption designated use for PCBs in the water column.

The geographic extent of some beaches is not currently available. In these instances, a geographic extent of 0.2 shoreline miles was used as a default value.

Streams and rivers are listed in terms of miles. Wetlands are listed in terms of acres. Generally, inland lakes are listed in their entirety as acres, and Great Lakes and bays are listed in terms of square miles, except for Great Lake and inland lake beaches, which are listed in terms of shoreline miles for pathogen concerns.

### 4.11 Assessment Unit Assignment to Categories

After support determinations for all designated uses and geographic extent decisions are made for an assessment unit, categories are assigned using a multiple category system. The following categories and subcategories are used:

Category 1: All designated uses are supported, no use is threatened.

Category 2: Available data and/or information indicate that some, but not all of the designated uses are supported.

Category 3: There is insufficient available data and/or information to make a designated use support determination.

Category 4: Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed.

- Category 4a: A TMDL to address the impairment-causing pollutant has been approved or established by the USEPA.
- Category 4b: Other approved pollution control mechanisms are in place and are reasonably expected to result in attainment of the designated use within a practical time frame.
- Category 4c: Impairment is not caused by a pollutant (e.g., impairment is due to lack of flow or stream channelization).

Category 5: Available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed.

An assessment unit is considered threatened and is placed in Categories 4 or 5 when water quality data analysis demonstrates a declining trend that is expected to cause that water body to not attain WQS by the next listing cycle (2014). An assessment unit is not attaining WQS when any designated use is not supported (i.e., Category 4 or 5). Assessment units placed in Category 5 form the basis for the Section 303(d) list and the TMDL development schedule (see Chapter 9 for additional information regarding TMDLs).

A few instances exist where the MDEQ has determined that assessment units do not support one or more designated uses, but other appropriate pollution control mechanisms are in place. These assessment units are placed in Category 4b. As described above, the pollution control mechanism for a Category 4b water body is expected to result in the attainment of the

designated use within a practical timeframe. Considerations to determine if a pollution control mechanism is appropriate to place a water body in Category 4b include, but are not limited to: the scale of the project (e.g., geographic extent affected, duration, etc.) and the anticipated level of impact on water quality. The MDEQ works closely with the USEPA to develop any new listings in Category 4b.

Assessment methodologies used for streams and rivers are also used for channelized streams, when appropriate, including rapid bioassessment of macroinvertebrate and fish communities according to the five-year rotating watershed cycle.

An assessment unit is listed in Category 4c when sufficient water quality data and information are available to determine all of the following:

- A specific designated use is not supported (e.g., the other indigenous aquatic life and wildlife designated use is not supported based on a P51 poor macroinvertebrate community rating).

- The cause of the designated use nonattainment is due to something other than a pollutant (e.g., channel maintenance activity or beaver dam).

- No pollutant would cause the designated use nonattainment if the above cause did not occur.

Assessment units are only placed in Category 4c when MDEQ monitoring staff determines (using P51 or other appropriate techniques) that sufficient water quality data and information are available to clearly indicate that the Category 4c listing requirements explained in the preceding paragraph fully apply.

Key factors considered by MDEQ monitoring staff to help differentiate whether pollutants or other causes are responsible for the observed nonattainment include: water/sediment chemistry and microbiological data when such data are available for the assessment unit, riparian land use characteristics, and P51 habitat metric scores, particularly those for the epifaunal substrate/available cover, embeddedness, sediment deposition, channel alteration, channel sinuosity, bank stability, bank vegetative protection, and riparian vegetative zone width metrics.

It should be noted that the MDEQ recognizes sediment to be a pollutant. If MDEQ aquatic biologists determine that a pollutant (including riparian sediment) is responsible for an assessment unit not supporting a designated use, then that assessment unit is listed in Category 5. Additionally, if channel modification activities in an upstream assessment unit result in sedimentation problems in a downstream assessment unit to a point which causes a designated use to not be supported, then that downstream assessment unit is listed in Category 5.

Michigan uses a multiple category system; therefore, placement of an assessment unit in Category 4c based on a determination that a designated use is not supported and the cause is not a pollutant does not preclude placement of that assessment unit in Category 5 (or any other category) based on a designated use support determination for a different designated use.

Assessment units that do not support a designated use due to multiple causes may be listed in multiple categories for that designated use. For example, an assessment unit may have a TMDL completed for sedimentation; therefore, the assessment unit is listed in Category 4a for

the other indigenous aquatic life and wildlife designated use. The same assessment unit may have a mercury TMDL scheduled but not yet completed; therefore, the assessment unit is also listed in Category 5 for the other indigenous aquatic life and wildlife designated use (see Table 4.4, Assessment Unit 10). In this case, the assessment unit is reported in both Categories 4a and 5 for the other indigenous aquatic life and wildlife designated use.

The following example (Table 4.4) adapted from USEPA guidance, illustrates Michigan's use of a multiple category system.

Table 4.4. Examples of assessment unit assignment to categories using a multiple category system with three designated uses. S = Supporting, NS = Not Supporting, - = Not Assessed, ? = Insufficient Information, / = Designated use does not apply to assessment unit. In designated use support summary tables (e.g., Tables 5.2, 5.3, 6.2, 7.2, and 8.1) Category 3 is reported as two subcategories: Insufficient Information and Not Assessed.

| | Designated use A | Designated use B | Designated use C | Assigned Categories |
|---|---|---|---|---|
| Assessment Unit 1 | S | S | S | 1 |
| Assessment Unit 2 | NS | NS | NS | 5 |
| Assessment Unit 3 | S | S | - | 2, 3 |
| Assessment Unit 4 | S | S | ? | 2, 3 |
| Assessment Unit 5 | S | - | ? | 2, 3 |
| Assessment Unit 6 | S | NS (nonpollutant) | S | 2, 4c |
| Assessment Unit 7 | S | ? | NS | 2, 3, 5 |
| Assessment Unit 8 | S | NS (nonpollutant) | | 2, 4c, 3* |
| Assessment Unit 9 | - | NS (TMDL approved) | NS | 3, 4a, 5 |
| Assessment Unit 10 | - | NS (TMDL approved) NS | - | 3, 4a, 5 |

* Currently designated uses that do not apply to an assessment unit are assigned not assessed in the ADB (e.g., coldwater fishery). This issue will be corrected over the next five-year rotating watershed cycle through specific record review process.

Justification for designated use support determination for each assessment unit is contained in the ADB. A comprehensive list of designated use support determinations is provided in Appendix B.

### 4.12 Impairment Cause and Source

When a determination is made that a designated use is not supported (i.e., an assessment unit is placed in Category 4 or 5), the cause and source of impairment are identified. Generally, the cause of impairment is the parameter(s) used to determine that the designated use is not supported unless a biological indicator is used. The source of impairment is determined using BPJ and supporting contextual information.

In addition, sediment toxic substance concentration data may be used to support other assessment types to make support determinations for the other indigenous aquatic life and wildlife, fish consumption, or other designated uses. Sediment data are collected from water bodies when there is direct knowledge or reasonable expectation of heavy metal or organic chemical contamination at levels that may impair biological communities by direct toxicity or cause fish consumption problems. Contaminated sediments may be listed as the source of impairment when sediment pollutant concentrations exceed screening concentrations

(McDonald et al., 2000; Jones and Gerard, 1999; and Ontario Ministry of the Environment, 1993) or when sediment toxicity test results demonstrate excessive toxicity.

### 4.13 Delisting Category 5 Assessment Units

Assessment units are removed from the Section 303(d) list (i.e., moved from Category 5 to another category) by the MDEQ using representative data and the current assessment methodology. Data analysis used to remove an assessment unit from the Section 303(d) list must be at least as rigorous a data analysis as was originally used to list the water body. Specific instances that justify the removal of assessment units from Category 5 include:

- A TMDL has been developed for all pollutants and approved by the USEPA (assessment unit is placed in Category 4a).

- A corrective, remediation action plan has been approved to be implemented or the problem source(s) has been removed, thereby, eliminating the need for a TMDL (assessment unit is placed in Category 4b or when water quality is reevaluated and it is determined that the designated use is supported, the assessment unit is placed in Category 2 or Category 1).

- The source of impairment for the initial designated use support determination was an untreated CSO and updated information reveals that the untreated CSO has been eliminated or control plan elements have been implemented in a legally binding document that includes a schedule for elimination of the untreated discharge (assessment unit is placed in Category 3 unless the corrective action program has not yet been completed, then it is placed in Category 4b).

- Reassessment of the assessment unit using updated monitoring data or information, techniques, or WQS, indicates that the water body now supports the designated use (assessment unit is placed in Category 1 or Category 2), or that additional monitoring or information is needed to determine whether the designated use is supported (assessment unit is placed in Category 3). For example, a water body may be moved from Category 5 to Category 3 if one year of new data indicated designated use support, but additional monitoring is needed to ensure continued designated use support.

- Reexamination of the monitoring data or information used to make the initial designated use support determination reveals that the decision was either incorrect or inconsistent with the current assessment methodology.

- Reassessment of a water body indicates that the cause of impairment is not a pollutant (assessment unit is placed in Category 4c).

- The assessment unit is determined to be within Indian Country, as defined in 18 U.S.C., Section 1151. These water bodies are not considered waters of the state of Michigan, and therefore, are not appropriate to include on the Section 303(d) list.

## 4.14 Assessment Methodology Changes

Minor edits and clarification changes were made to update the 2010 assessment methodology for the 2012 IR. There were no substantial changes to data interpretation methods; however, some of the other updates include:

- Added example to Section 4.5.2.1 explaining possible use of data from the MDNR Fisheries Division, if received.
- Reworded Figure 4.2 to enable two consecutive years of data review for partial body contact and total body contact designated use support assessment. This change was made to increase the level of confidence in assessment decisions by better accounting for ongoing versus temporary conditions.

# CHAPTER 5
# ASSESSMENT RESULTS: THE GREAT LAKES, BAYS, CONNECTING CHANNELS (ST. MARYS, ST. CLAIR, AND DETROIT RIVERS), AND LAKE ST. CLAIR

## 5.1 Trophic Status

Reductions in phosphorus loading to Lakes Michigan, Huron (Saginaw Bay), and Erie have substantially contributed to improved water quality. Improvements in the Great Lakes are attributable, in part, to effluent nutrient limits in NPDES permits issued to municipal and industrial facilities. For Great Lakes protection, Michigan's WQS restrict point source discharges of phosphorus to 1 mg/L as a maximum monthly average. Lower limits may be, and often are, imposed to protect designated uses in receiving or downstream waters.

Legislation passed in 1977 that reduced the allowable phosphorus content in household laundry detergents sold in Michigan to less than 0.5% phosphorus by weight has contributed to the reduction of phosphorus discharged from point sources. Legislation passed in 2009 reduced the allowable phosphorus content in any cleaning agent intended for use in household clothes washing machines and, beginning July 1, 2010, dishwashers sold in Michigan to 0.5% by weight expressed as elemental phosphorus. This legislation is expected to further reduce phosphorus loads from wastewater treatment plants and on-site treatment systems. NPS phosphorus reduction efforts have also contributed to improved Great Lakes water quality and will be aided by legislation that goes into effect in 2012 banning the use of phosphorus-containing lawn fertilizers. The current trophic status of each of Michigan's Great Lakes is presented in Table 5.1.

Table 5.1 Trophic status of the Great Lakes bordering Michigan.

| Lake | Trophic Status (nutrient level) |
|---|---|
| Superior | Oligotrophic* (low) |
| Huron | Oligotrophic* (low) |
| Saginaw Bay | Eutrophic† (high) |
| Michigan | Oligotrophic* (low) |
| Erie (Central Basin) | Oligotrophic/mesotrophic* (moderate) |
| Western Basin | Mesotrophic* (moderate) |

*USEPA, 2011a; †USEPA, 2011b

## 5.2 Water Chemistry of the Great Lakes Connecting Channels

Great Lakes connecting channel (St. Marys, St. Clair, and Detroit Rivers) monitoring efforts and results through 2005 are summarized in annual reports prepared by the Great Lakes Environmental Center (GLEC) under contract with the MDEQ (most recent reports - GLEC, 2006a and 2007a). Key findings from water chemistry monitoring of the three Great Lakes connecting channels bordering Michigan (Detroit, St. Clair, and St. Marys Rivers) follow:

- Detroit River nutrient concentrations have decreased significantly since the late 1960s, with an order-of-magnitude decline in total phosphorus concentrations from a high of 0.13 mg/L in 1969. Data collected between 1992 and 2004 indicate seasonal fluctuations in phosphorus and nitrogen parameters, with an increasing trend in total phosphorus concentration. Mercury and trace metals data (cadmium, chromium, copper, lead, nickel, and zinc) obtained from 1998 to 2004 indicate a decreasing concentration trend for lead and an increasing concentration trend for mercury, with some apparent seasonal fluctuations. No trends for cadmium, chromium, copper, nickel, and zinc were indicated. In general, statistically significant differences ($p<0.05$) between upstream and downstream concentrations were not apparent, with the exception of mercury, which was significantly higher at the upstream station.

- St. Clair River total phosphorus concentrations have declined from the 1980s to 2004. Mercury and trace metals data (cadmium, chromium, copper, lead, nickel, and zinc) obtained from 1998 to 2004 indicate that chromium and nickel concentrations decreased, while zinc and lead increased; no trends for cadmium, copper, or mercury were indicated. Spatial analyses indicate that total phosphorus, orthophosphate, ammonia, nitrate, nitrite, cadmium, chromium, copper, lead, nickel, and zinc concentrations increased from upstream to downstream.

- Little historic water chemistry data are available for the St. Marys River, but data obtained from 1998 to 2004 indicate that zinc, ammonia, nitrate, and nitrite concentrations have increased, whereas cadmium, chromium, and nickel concentrations have decreased; no trends for mercury, copper, lead, or total phosphorus were indicated. Nutrient concentrations fluctuated seasonally. Spatial analyses indicate that total phosphorus, orthophosphate, and nitrite concentrations increased from upstream to downstream, as did chromium, copper, lead, and nickel concentrations.

- Comparisons of Great Lakes connecting channel water chemistry data for toxic chemicals with applicable Michigan WQS showed that total PCB concentrations exceeded the applicable Rule 57 water quality value (0.026 ng/L) in 59 of the 60 samples collected at all connecting channel locations, and total DDT concentrations exceeded the applicable Rule 57 water quality value (0.011 ng/L) in 13 of the 24 samples collected at all connecting channel locations. Mercury exceeded the applicable Rule 57 water quality value (1.3 ng/L) in 101 of 245 samples collected at all connecting channel locations. Concentrations of the other trace metals (cadmium, chromium, copper, lead, nickel, and zinc) met the applicable Rule 57 water quality values at all connecting channel locations. Base/neutral and volatile organic compounds were largely not detected above the quantification level.

Great Lakes connecting channel monitoring efforts continue and data through 2008 will be summarized in a comprehensive report with bays (see Section 5.3) and rivers and streams (see Section 7.2), expected to be completed in 2012.

### 5.3 Water Chemistry of Saginaw Bay and Grand Traverse Bay

Saginaw Bay and Grand Traverse Bay monitoring efforts and results through 2005 are summarized in annual reports prepared by the GLEC under contract with the MDEQ (most recent reports - GLEC, 2006b and 2007b). Key findings from water chemistry monitoring of Saginaw and Grand Traverse Bays are summarized below.

- Saginaw Bay nutrient and chlorophyll *a* data from 1993 to 2004 reflect mesotrophic to eutrophic conditions, depending on the location sampled. Total phosphorus concentrations remain relatively constant and continue to be above the target total phosphorus concentration of 0.015 mg/L established by the "Michigan Phosphorus Reduction Strategy for the Michigan Portion of Lake Erie and Saginaw Bay" (MDNR et al., 1985). Average annual chlorophyll *a* concentrations also remain relatively constant and often exceed 10 ug/L, an accepted threshold for eutrophic conditions.

- Grand Traverse Bay nutrient, chlorophyll *a*, and water clarity data reflect oligotrophic conditions and excellent water quality. During 1998-2005, the bay-wide median total phosphorus and chlorophyll *a* concentrations in Grand Traverse Bay were 0.005 mg/L and 2 ug/L, respectively.

- Comparison of recent Saginaw Bay and Grand Traverse Bay trace metals and mercury water chemistry data with applicable Michigan WQS showed that average mercury concentrations in both bays met the mercury Rule 57 water quality value of 1.3 ng/L. All mean concentrations of cadmium, chromium, copper, lead, nickel, and zinc at all sampling locations in Grand Traverse Bay and Saginaw Bay met applicable Rule 57 water quality values.

Saginaw Bay and Grand Traverse Bay monitoring efforts continue and data through 2008 will be summarized in a comprehensive report with connecting channels (see Section 5.2) and rivers and streams (see Section 7.2), expected to be completed in 2012.

### 5.4 Fish Contaminants

Several projects have been implemented in the Great Lakes basin to monitor temporal and spatial trends in fish contaminant levels:

- The USEPA, Great Lakes National Program Office, collects and analyzes whole lake trout from the open waters of Lakes Superior, Michigan, Huron, and Ontario, and walleye from Lake Erie.

- The federal-state coordinated fillet trend monitoring program collects and analyzes chinook and coho salmon from Lakes Superior, Michigan, and Huron, and rainbow trout from Lake Erie. This program was discontinued as of 2009.

- Michigan's whole fish contaminant trend monitoring effort, initiated in 1990, focuses on fish collected from ten fixed stations located in the Great Lakes bays and connecting channels.

The USEPA lake trout data for Lakes Superior, Michigan, Huron, and Ontario indicate that total PCB and DDT concentrations in all four lakes declined between the 1970s and 2000. Also, Lake Michigan lake trout had higher levels of total PCBs and total DDT than lake trout from the other Great Lakes. Concentrations of most contaminants in Lake Superior lake trout were lower than concentrations from the other Great Lakes. The USEPA walleye data for Lake Erie indicate that total PCB and DDT concentrations declined since 1977. Additional results and general conclusions from the USEPA lake trout and walleye data and the federal-state chinook and coho salmon fillet trend monitoring, including information regarding PCBs, DDT, chlordane, and toxaphene concentrations, are presented in the Michigan Fish Contaminant Monitoring Program: 2008 Annual Report (Bohr and VanDusen, 2009).

In 1990, Michigan initiated a fixed station fish contaminant trend monitoring project to measure spatial and temporal trends of certain bioaccumulative contaminants. Trend stations in Great Lakes waters are located in Keweenaw Bay (Lake Superior), Little Bay de Noc and Grand Traverse Bay (Lake Michigan), Thunder Bay and Saginaw Bay (Lake Huron), Lake St. Clair, Brest Bay (Lake Erie), and in the St. Marys, St. Clair, and Detroit Rivers. Adult fish are collected from each site at a target interval of two to five years, and analyzed as whole fish samples. Whole fish fixed station trend monitoring data collected between 1990 and 2007 were reviewed and general trend conclusions for the Great Lakes and connecting channels are summarized below (Bohr and VanDusen, 2009):

- Lindane, terphenyl, polybrominated biphenyl (PBB), heptachlor, and aldrin were not quantified in any of the fish sampled. However, heptachlor epoxide and dieldrin (breakdown products of heptachlor and aldrin) were quantified in most of the samples analyzed.

- In addition to heptachlor epoxide and dieldrin, several chemicals were quantified in fish consistently, indicating that they are ubiquitous in the aquatic environment. These include mercury, hexachlorobenzene, total PCB, total chlordane, and total DDT.

- Apparent toxaphene was found primarily in walleye and lake trout from the Great Lakes and connecting channels. The highest concentrations of apparent toxaphene were quantified in lake trout from Lake Superior.

- All species from the Great Lakes and connecting channels tended to have higher concentrations of chlorinated organic contaminants than the same species from inland lakes.

- Carp and walleye from the St. Marys River had lower concentrations of organic contaminants than carp from Lake St. Clair and the Detroit River. Carp and walleye from the St. Marys River had higher concentrations of mercury than carp and walleye from Lake St. Clair and the Detroit River.

- Total PCB, DDT, and chlordane concentrations have declined at all 10 Great Lakes and connecting channel trend sites, with declines averaging 6%, 9%, and 10% per year, respectively.

- Trends in dioxin toxicity equivalence concentrations have been monitored in lake trout from Lake Superior (Keweenaw Bay), Lake Michigan (Grand Traverse Bay), and Lake Huron (Thunder Bay), and in carp from Lake Huron (Saginaw Bay). Dioxin concentrations have declined at all 4 sites, with an average decline of 8% per year since the early 1990s.

- Mercury concentrations have increased in at least 1 species of fish monitored from each of the Great lakes sampling sites, with 2 exceptions: no trend has been measured in samples from the St. Marys River, and mercury concentrations in carp from the Detroit River have declined 7% per year since 1990.

In addition, edible portion fish tissue contaminant monitoring was conducted in 2008 in western Lake Erie, Saginaw Bay and Thunder Bay in Lake Huron, Little bay de Noc (northern Lake Michigan), and in Lake Superior off Isle Royale and Munising (Bohr and VanDusen, 2011a). In 2009 edible portion samples of chinook salmon were taken from two sites in Lake Huron,

lake trout from Grand Traverse Bay were analyzed, coho and chinook salmon were taken from Lake Michigan, and walleye were sampled from Lake Superior at the Tahquamenon River (Bohr and VanDusen 2011b). Edible portion sampling is often targeted toward known sites of contamination, sites popular with sport anglers, and sites with public access.

### 5.5 Beaches

In 2009, 225 public beaches (owned by a city, county, etc.) on the Great Lakes and connecting channels were monitored and 181 reported no exceedances of the *E. coli* WQS for total body contact. There were 44 beaches that reported a total of 118 exceedances.

In 2010, 224 public beaches were monitored and 158 reported no exceedances of the *E. coli* WQS for total body contact. There were 66 beaches that reported a total of 147 exceedances.

The Michigan Beach Web site (http://www.deq.state.mi.us/beach) provides access to a database containing beach closings and *E. coli* data collected by LHDs. Currently, 606 public beaches located along the Great Lakes are listed in the database; although, water quality data are not available for all beaches. Data for Great Lakes beaches in Michigan are also available at http://oaspub.epa.gov/beacon/beacon_national_page.main.

### 5.6 Decaying Organic Matter Deposits

Deposits of dead and decaying organic matter are reportedly fouling beaches along Michigan's Great Lakes shoreline including, but not limited to, Grand Traverse Bay, Saginaw Bay, and western Lake Erie. While increased aquatic vegetation growth is typically associated with elevated nutrient concentrations, many of the shoreline deposits are occurring where ambient phosphorus and nitrogen concentrations are very low or declining. Similar problems are being reported along the Wisconsin Lake Michigan shoreline, the Ohio and Pennsylvania Lake Erie shoreline, and the New York Lake Ontario shoreline, where, like Michigan, shorelines are being fouled by decaying organic matter that may interfere with the enjoyment of beaches and nearshore waters.

Once thought to be caused primarily by the presence of excessive nutrients (phosphorus), there is growing evidence that the increased organic matter deposits may be the result of a complex interaction between nutrients and exotic mussel species (Hecky et al., 2004), changes in wind patterns over the Great Lakes (Waples and Klump, 2002), and fluctuating water levels (Harris, 2004). Research is ongoing to identify the causes and sources for these shoreline deposits with the hope that effective solutions can be found. Although phosphorus concentrations do not appear to be solely responsible for the shoreline deposits, programs and policies intended to reduce phosphorus in all waters of the state remain important components of efforts to improve and protect water quality.

The MDEQ has been and will continue to work with the research community, other governmental agencies, and the public toward an understanding of the causes/sources responsible and a solution to the shoreline deposit problem. In October 2008 and April 2009, staff members from the National Oceanic and Atmospheric Administration, MDEQ, and various Michigan universities met to review information and evaluate work plans for Saginaw Bay during the 2009 field season. During the 2009 and 2010 field seasons physical, chemical, and biological data believed to be directly or indirectly related to environmental processes responsible for the shoreline deposition problem were collected from the greater Saginaw Bay area. This data is being analyzed in conjunction with information from follow-up studies conducted in 2011 and final reports are expected in 2012.

## 5.7 Designated Use Support Summary

Designated use support summaries for Michigan waters of the Great Lakes, bays, connecting channels, and Lake St. Clair are presented in Tables 5.2 and 5.3. Michigan uses a multiple category system (i.e., assessment units may be placed in one or more category, see Section 4.11); therefore, Great Lake square miles and Great Lake shoreline miles and connecting channel miles are not totaled. Key designated use support results for Michigan waters of the Great Lakes, connecting channels, and Lake St. Clair follow. Impairment cause and source information for assessment units not supporting designated uses is presented in Chapter 9.

- Generally shoreline areas of the Great Lakes are not assessed to determine support for the other indigenous aquatic life and wildlife designated use. Water chemistry was monitored specifically around two small areas (one each on Lake Michigan and Little Traverse Bay) in the vicinity of groundwater seeps associated with cement kiln dust remediation sites.

- Considerable progress has been made to eliminate untreated CSO discharges to the Great Lakes connecting channels. The majority of the St. Clair River, 33.3 miles, supports the total body contact and partial body contact recreation designated uses. A small portion of the St. Clair River, 7.5 miles located from Marysville upstream to Lake Huron, is listed in Category 4b. Ambient *E. coli* data collected in 2008 and 2009 met WQS; however, untreated CSOs remain in the city of Port Huron. CSO elimination is scheduled for completion by 2016. An *E. coli* TMDL was completed for the Detroit River in 2008; therefore, these 25.7 miles are listed in Category 4a. Some untreated CSO discharges still exist; consequently, all of the St. Marys River miles are listed as not supporting the total body contact and partial body contact recreation designated uses.

- The Michigan waters of the Great Lakes, their connecting channels, Saginaw and Grand Traverse Bays, and Lake St. Clair are listed as not supporting the fish consumption designated use due to elevated concentrations of PCBs, DDT, mercury, chlordane, and/or dioxin. Atmospheric deposition is considered to be the major source of these persistent bioaccumulative chemicals.

- Water chemistry results indicate that all 125 Great Lakes connecting channel miles are not supporting the fish consumption and other indigenous aquatic life and wildlife designated uses due to elevated concentrations of PCBs in the water column. The primary source of PCBs is atmospheric deposition. Mercury concentrations in the St. Marys and St. Clair Rivers are usually below the 1.3 ng/L WQS, but mercury concentrations in the Detroit River often exceed 1.3 ng/L.

- Periodic taste and odor problems associated with nuisance growths of blue-green algae, initially reported as *Microcystis,* occur near the Bay City municipal drinking water intakes in Saginaw Bay. As a result of this occasional problem, the two Bay City drinking water intake zones in Saginaw Bay are listed as not supporting the public water supply designated use. A nutrient reduction strategy for Saginaw Bay (MDNR et al., 1985) is in place; therefore, a TMDL is not scheduled for this area. Research activities directed at this intake issue are included in the ongoing Saginaw Bay study conducted by the National Oceanic and Atmospheric Administration.

- Deposits of decaying organic matter along some Great Lakes shorelines is a significant problem and may interfere with beach recreational use and access to the water in some places along Saginaw Bay and western Lake Erie. Microorganisms have been identified in the decaying matter; however, the standards apply only to ambient water. Water quality is routinely monitored at Saginaw Bay beaches and areas where WQS are exceeded are listed as not supporting the total and/or partial body contact recreation designated use and a TMDL is scheduled according to the assessment methodology.

  The WQS require that nutrients be limited to the extent necessary to prevent stimulation of plant/algae growths that are or may become injurious to the designated uses. However, it is widely believed that nutrients are only one of the many factors contributing to this problem and the relative importance of nutrients compared with other causes is unclear. The presence of the shoreline deposits where phosphorus concentrations are significantly less than those in Saginaw Bay (e.g., Grand Traverse Bay and Lake Michigan's eastern shore) indicate that this is a legitimate question.

  The WQS also require that the state's surface waters not have any "deposits" in "unnatural quantities which are or may become injurious to any designated use." Deposits of decaying organic material occur naturally in aquatic systems, and are frequently observed along the Great Lakes and inland lakes.

  A careful evaluation of available data and scientific information, and a comparison against WQS reveals that there is insufficient information to determine whether designated uses are not supported as a result of the decaying organic matter. Consequently, 142 miles of Saginaw Bay and 37.5 miles of western Lake Erie shoreline are listed as having insufficient information to determine support of the total and partial body contact recreation designated uses. In addition, 1,262 square miles of Saginaw Bay and western Lake Erie are listed as having insufficient information to determine support of the other indigenous aquatic life and wildlife designated use.

Table 5.2 Designated use support summary for the Great Lakes, bays, and Lake St. Clair (approximately 42,167 square miles / 3,314 shoreline miles). No Great Lakes and bays are listed in Category 1 since comprehensive water quality data and/or information are not available for any locations.

| Designated Use | Supporting | Insufficient Information | Not Assessed | Not Supporting | | | |
|---|---|---|---|---|---|---|---|
| | Category 2 | Category 3 | Category 3 | Category 4a | Category 4b | Category 4c | Category 5 |
| Agriculture ($mi^2$ / shoreline mi)* | 42,167 / 3,131 | 0 | 0 / 183 | 0 | 0 | 0 | 0 |
| Navigation ($mi^2$/ shoreline mi)* | 42,167 / 3,131 | 0 | 0 / 183 | 0 | 0 | 0 | 0 |
| Industrial Water Supply ($mi^2$/ shoreline mi)* | 42,167 / 3,131 | 0 | 0 / 183 | 0 | 0 | 0 | 0 |
| Warmwater Fishery ($mi^2$) | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Coldwater Fishery ($mi^2$/ shoreline mi)* | 0 | 0 | 42,167 / 3,134 | 0 | 0 | 0 | 0 |
| Other Indigenous Aquatic Life and Wildlife ($mi^2$ /shoreline mi)*† | 280 / 4.2 | 1,262 / 55 | 40,625/ 3,255 | 0 | 0 | 0 | 0 |
| Partial Body Contact Recreation (shoreline mi) † | 73.4 | 179.8 | 3,057 | 0.5 | 0 | 0 | 3.1 |
| Total Body Contact Recreation (shoreline mi) † | 31.1 | 221.4 | 3,057 | 0.6 | 0 | 0 | 3.6 |
| Fish Consumption ($mi^2$/ shoreline mi)* | 0 | 0 | 0 / 262 | 0 | 0 | 0 | 42,167 / 3,052 |
| Public Water Supply ($mi^2$) ‡ | 0 | 10.5 | 63 | 0 | 3 | 0 | 0 |

* Geographic extent may be reported in two different measurement units for this designated use (square miles ($mi^2$)/shoreline mi). These values represent different assessment units (i.e., shoreline miles do not correspond to the $mi^2$ listed).

† These designated uses apply to all surface waters of the state; however, these particular values represent shoreline miles/beaches. Not all designated uses have been assessed for all shoreline miles.

‡ Approximately 76.5 $mi^2$ of the Great Lakes and bays are protected for the public water supply designated use.

N/A indicates that the designated use is not applicable.

Table 5.3 Designated use support summary for the Great Lakes connecting channels (St. Marys, St. Clair, and Detroit Rivers) in Michigan (approximately 125 total miles). No connecting channels are listed in Category 1 since comprehensive water quality data and/or information are not available for any locations.

| Designated Use | Supporting | Insufficient Information | Not Assessed | Not Supporting | | | |
|---|---|---|---|---|---|---|---|
| | Category 2 | Category 3 | Category 3 | Category 4a | Category 4b | Category 4c | Category 5 |
| Agriculture (mi) | 125 | 0 | 0 | 0 | 0 | 0 | 0 |
| Navigation (mi) | 125 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial Water Supply (mi) | 125 | 0 | 0 | 0 | 0 | 0 | 0 |
| Warmwater Fishery (mi) | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Coldwater Fishery (mi) | 0 | 0 | 125 | 0 | 0 | 0 | 0 |
| Other Indigenous Aquatic Life and Wildlife (mi) | 0 | 0 | 0 | 0 | 0 | 0 | 125 |
| Partial Body Contact Recreation (mi) | 33.3 | 0 | 0 | 25.7 | 7.5 | 0 | 16 |
| Total Body Contact Recreation (mi) | 33.3 | 0 | 0 | 25.7 | 7.5 | 0 | 16 |
| Fish Consumption (mi) | 0 | 0 | 0 | 0 | 0 | 0 | 125 |
| Public Water Supply (mi) * | 0 | 2 | 3 | 0 | 0 | 0 | 0 |

* Approximately 5 of the 125 connecting channel miles are protected for the public water supply designated use.

N/A indicates that the designated use is not applicable.

# CHAPTER 6
# ASSESSMENT RESULTS: INLAND LAKES AND RESERVOIRS

## 6.1 Trophic Status

Carlson's TSI is used by the MDEQ to assess and classify Michigan's 730 public access lakes (see Section 1.2.2). This classification system is based on an index derived from a combination of three field measurements: (1) summer Secchi depth (transparency); (2) total phosphorus concentration (epilimnetic); and (3) chlorophyll *a* concentration (photic zone). The numerical value of the index increases as the degree of eutrophication increases. Historically, inland lake monitoring efforts have been directed toward obtaining baseline data for all 730 public access lakes.

During 2009 and 2010, 124 public access lakes were sampled and reassessed as part of the Lake Water Quality Monitoring Assessment Project. The majority (72%) of Michigan's public access lakes that were sampled in 2009 and 2010 have moderate (mesotrophic) or low (oligotrophic) nutrient levels (Table 6.1).

Table 6.1 Trophic status summary of Michigan's public access lakes sampled in 2009 and 2010 (N=124).

| Trophic Status | Number of Lakes |
|---|---|
| Oligotrophic (low nutrients) | 18 (15%) |
| Mesotrophic (moderate nutrients) | 71 (57%) |
| Eutrophic (high nutrients) | 31 (25%) |
| Hypereutrophic (excessive nutrients) | 4 (3%) |

Results of an MDEQ and USGS cooperative project that sampled 364 inland lakes as part of the Lake Water Quality Monitoring Assessment Project during 2001 through 2005 indicate that approximately 17% are oligotrophic, 53% are mesotrophic, 22% are eutrophic, and 4% are hypereutrophic (Fuller and Minnerick, 2008).

During 2009 and 2010, over 200 lakes were sampled each year as part of the Cooperative Lakes Monitoring Program, under the Michigan Clean Water Corps (for additional information see http://www.micorps.net). One hundred and thirteen of these lakes were sampled for the three primary trophic status indicators (Secchi depth, total phosphorus, and chlorophyll *a*). Of these lakes, 36 were classified as oligotrophic, 64 mesotrophic, 11 eutrophic, and 1 hypereutrophic.

## 6.2 Fish Contaminants

In 1990, Michigan initiated a fixed station fish contaminant trend monitoring project to measure spatial and temporal trends of certain bioaccumulative contaminants. Adult fish are collected from each site at a target interval of two to five years, and analyzed as whole fish samples. Fish

have been collected from eight inland lakes (Gogebic, Grand Sable, South Manistique, Higgins, Houghton, Gun, Gull, and Pontiac) as part of the fish contaminant trend monitoring project. Whole fish fixed station trend monitoring data collected since 1990 were reviewed and general trend conclusions for inland lakes are summarized below (Bohr and VanDusen, 2009):

- Lindane, terphenyl, PBB, heptachlor, and aldrin were not quantified in any of the fish sampled. However, heptachlor epoxide and dieldrin (breakdown products of heptachlor and aldrin) were quantified in most of the samples analyzed.

- In addition to heptachlor epoxide and dieldrin, several chemicals were quantified in fish consistently, indicating that they are ubiquitous in the aquatic environment. These include mercury, hexachlorobenzene, total PCB, total chlordane, and total DDT.

- Fish from inland lakes tended to have higher concentrations of mercury than the same species from the Great Lakes or connecting channels.

- Total PCB concentrations declined at all the inland lake trend sites monitored since 1990 except 1, with an average decline of 9% per year. The exception was Grand Sable Lake, where total PCB concentrations in lake trout increased 9% between 1991 and 1995. No samples have been collected from that lake since 1995.

- Total DDT concentrations declined at 9 of the 10 inland lake trend sites since 1990, with an average decline of 7% per year. The exception was again Grand Sable Lake, where no trend was observed.

- Total chlordane concentrations declined at all of the inland lake trend sites where a trend could be detected, and the average decline was 10% per year. No trend was detected at 2 inland lakes because chlordane concentrations were consistently below the analytical quantification level.

- Significant trends in mercury concentrations have been detected at 2 of the 8 inland lake trend sites. Mercury concentrations in walleye from Lake Gogebic declined 7% per year between 1991 and 2005, and increased in lake trout from Grand Sable Lake between 1991 and 1995.

In addition, edible portion fish tissue contaminant monitoring was conducted in 2008 and 2009 at 78 inland lakes and reservoirs. Edible portion sampling is often targeted toward known sites of contamination, sites popular with sport anglers, and sites with public access. Results of the edible portion monitoring are used by the MDEQ in determining the status of the Fish Consumption designated use for a given water body.

The edible portion monitoring data are also used by the MDCH to update fish consumption advisories. Based on the inland lake and reservoir monitoring conducted in 2008 and 2009 the MDCH relaxed the consumption advisory for 1 lake and 2 reservoirs while expanding the advisories for 5 lakes/reservoirs. The expanded advisories were primarily for species not previously sampled; an exception was Goose Lake (Marquette County) where elevated levels of selenium were measured in two species of fish after high concentrations had been measured in water samples.

Complete fish tissue results are presented in the Michigan Fish Contaminant Monitoring Program Annual Reports for 2009 and 2010 (Bohr and VanDusen, 2011a; 2011b).

## 6.3 Beaches

In 2009, a total of 189 public beaches (owned by a city, county, etc.) on inland lakes were monitored and 150 had no exceedances of the *E. coli* WQS for total body contact. There were 39 beaches that reported a total of 94 exceedances.

In 2010, a total of 206 public beaches on inland lakes were monitored and 164 had no exceedances of the *E. coli* WQS for total body contact. There were 42 beaches that reported a total of 62 exceedances.

The Michigan Beach Web site (http://www.deq.state.mi.us/beach) provides access to a database containing beach closings and *E. coli* data collected by LHDs. Currently, 606 public beaches located on inland lakes are listed in the database; although, not all beaches are monitored.

## 6.4 Designated Use Support Summary

A designated use support summary for Michigan inland lakes and reservoirs is presented in Table 6.2. Michigan uses a multiple category system (i.e., assessment units may be placed in one or more category, see Section 4.11); therefore, inland lake and reservoir acres and shoreline miles are not totaled. Key designated use support results follow. Impairment cause and source information for assessment units not supporting designated uses is presented in Chapter 9.

- Physical and chemical monitoring indicates that approximately 98% of the assessed inland lake and reservoir acres support the other indigenous aquatic life and wildlife designated use. Several water bodies are not supporting this designated use due to nuisance plant/algae growth problems caused by elevated phosphorus concentrations in the water column and/or sediments. Torch Lake (Houghton County) and Crooked Lake (Missaukee County) are not supporting this designated use and are listed in Category 4b due to historical copper stamp sand contamination and sediment problems from a historic wood chemical factory, respectively.

- Water chemistry and fish tissue monitoring indicates that about 10% of the assessed inland lake and reservoir acres support the fish consumption designated use. Atmospheric deposition continues to be a major source of PCBs and mercury to Michigan's inland lakes and reservoirs; however, localized sources are still contributing to mercury and PCB fish contamination problems in some inland lakes and impoundments.

- Cisco population monitoring indicates that approximately 59% of the inland lakes designated and assessed for the coldwater fishery designated use, support the use, while the remaining 41% have insufficient information to make a designated use support determination.

- Generally, the total body contact and partial body contact recreation designated use is reported as shoreline miles for beaches. Three lakes are listed in their entirety as acres due to nonbeach issues. *E. coli* data from the Calhoun County Health Department for Lee Lake, St. Joseph River watershed, are available; however, these data are insufficient to make a designated use support determination. An *E. coli* TMDL for

Potters Lake, Flint River watershed, was completed in 2004; therefore, this water body is listed in Category 4a. Manistee Lake, at the mouth of the Manistee River, is listed in Category 5 with *E. coli* as the cause and untreated CSOs as the source and a long-term control program is in place involving sewer separation to address overflows by 2016 from all outfalls.

- Little Shag, Bass, and Little Lakes, in the Escanaba watershed near Gwinn, are listed as having insufficient information to determine designated use support for the navigation, other indigenous aquatic life and wildlife, and coldwater or warmwater fishery designated uses. Historic deposits of partially decayed sawdust from the white pine harvest of the 1800s are present in the lakes. Monitoring was conducted at these lakes in late 2011. These results, once analyzed, will be used for designated use support assessment during the next Integrated Report cycle

- In 2011, a phosphorus TMDL was completed and approved by the USEPA for Goose Lake (Marquette County). In 2011, an *E. coli* TMDL was completed and approved by the USEPA for C.S. Mott Lake – Bluebell Beach (Genesee and Lapeer Counties).

Table 6.2 Designated use support summary for inland lakes and reservoirs (approximately 872,109 acres). No inland lakes or reservoirs are listed in Category 1 since comprehensive water quality data and/or information are not available for any locations.

| Designated Use | Supporting | Insufficient Information | Not Assessed | Not Supporting | | | |
|---|---|---|---|---|---|---|---|
| | Category 2 | Category 3 | Category 3 | Category 4a | Category 4b | Category 4c | Category 5 |
| Agriculture (acres) | 870,999 | 0 | 0 | 0 | 1,110 | 0 | 0 |
| Navigation (acres) | 870,167 | 832 | 0 | 0 | 1,110 | 0 | 0 |
| Industrial Water Supply (acres) | 870,999 | 0 | 0 | 0 | 1,110 | 0 | 0 |
| Warmwater Fishery (acres) | 1,082 | 752 | 869,981 | 295 | 0 | 0 | 0 |
| Coldwater Fishery (acres) | 131,815 | 92,827 | 647,467 | 0 | 0 | 0 | 0 |
| Other Indigenous Aquatic Life and Wildlife (acres) | 470,595 | 13,405 | 376,888 | 6,658 | 3,139 | 0 | 1,423 |
| Partial Body Contact Recreation (acres/shoreline mi) *† | 0 / 67.8 | 126 / 17.2 | 870,164 / 0.8 | 850 / 1 | 0 / 0 | 0 / 0 | 969/ 2.6 |
| Total Body Contact Recreation (acres/shoreline mi) *† | 346 / 17.8 | 126 / 66.6 | 869,818 / 0.2 | 850 / 1 | 0 / 0 | 0 / 0 | 969 / 3.8 |
| Fish Consumption (acres) | 34,549 | 17,311 | 508,288 | 554 | 173 | 0 | 311,320 |
| Public Water Supply (acres) ‡ | 0 | 129 | 284 | 0 | 0 | 0 | 0 |

***** Geographic extent may be reported in two different measurement units for this designated use (acres/shoreline mi). These values represent different assessment units (i.e., shoreline miles do not correspond to the acres listed).

† These designated uses apply to all surface waters of the state; however, some of these values represent shoreline miles. In most cases shoreline miles are bathing beaches. Shoreline records are created and entered into the ADB on a case-by-case basis where information is available. Records have not been established for all shoreline miles. The total number of inland lake and reservoir shoreline miles in the ADB is 89.4 miles. A small number of records exist for shoreline miles that have no data available and therefore are not assessed; however, this is not a comprehensive value for all not assessed inland lake and reservoir shoreline miles. The total number of inland lake and reservoir shoreline miles is not known.

‡ Approximately 414 acres of inland lakes and reservoirs are protected for the public water supply designated use.

## CHAPTER 7
## ASSESSMENT RESULTS: RIVERS

### 7.1 Biological Integrity

All available biological assessments (e.g., fish and macroinvertebrate communities, targeted and probabilistic study designs) are evaluated using the assessment methodology (Chapter 4) and potentially used to determine designated use support. As part of the MDEQ's water quality monitoring program, sites are selected using both targeted and probabilistic study designs to assess the biological integrity of rivers and streams using macroinvertebrate communities. The MDEQ's Macroinvertebrate Community Status and Trend Monitoring Procedure (MDEQ, in preparation) is used to estimate the number of river miles supporting the other indigenous aquatic life and wildlife designated use. Results are available for watersheds monitored in 2006 through 2010 (draft data) (Figure 3.1 and Table 7.1). Results from this project will also be used to assess statewide designated use support status and temporal trends in biological integrity.

Table 7.1 Proportion of river miles (draft data) supporting the other indigenous aquatic life and wildlife designated use based on macroinvertebrate community assessment results for watersheds monitored in 2006 through 2010 using the MDEQ's Macroinvertebrate Community Status and Trend Monitoring Procedure. Proportion of river miles is shown with 95% confidence interval range.

| Watershed/watershed group | Year monitored | Number of survey stations | River miles (%) supporting the other indigenous aquatic life and wildlife designated use | 95% Confidence Interval Range (%) |
|---|---|---|---|---|
| Northern Upper Peninsula (Keweenaw area) | 2006 | 38 | 100 | 92 – 100 |
| Muskegon | 2006 | 50 | 98 | 94 - 100 |
| Upper Grand | 2006 | 40 | 92 | 84 - 100 |
| St. Joseph/ Paw Paw | 2006 | 32 | 87 | 75 - 99 |
| Tawas/ AuGres | 2006 | 24 | 96 | 87 - 100 |
| Cass | 2006 | 37 | 91 | 81 - 100 |
| Detroit River Tributaries | 2006 | 30 | 30 | 14 - 46 |
| Menominee River | 2007 | 29 | 100 | 90 - 100 |
| White River | 2007 | 32 | 100 | 91 - 100 |
| Maple/Looking Glass | 2007 | 40 | 97 | 92 - 100 |
| Black River (SW MI) | 2007 | 5 | 100 | 55 - 100 |
| Galien River | 2007 | 5 | 100 | 55 - 100 |
| Black River (NE MI) | 2007 | 16 | 100 | 83 - 100 |
| Au Sable River | 2007 | 28 | 100 | 90 - 100 |
| Tittabawassee River | 2007 | 38 | 100 | 92 - 100 |
| Black River (E MI) | 2007 | 31 | 96 | 88 - 100 |

| Watershed/watershed group | Year monitored | Number of survey stations | River miles (%) supporting the other indigenous aquatic life and wildlife designated use | 95% Confidence Interval Range (%) |
|---|---|---|---|---|
| Huron River | 2007 | 30 | 83 | 68 - 98 |
| Western Upper Peninsula | 2008 | 24 | 100 | 88 - 100 |
| Northwest Michigan | 2008 | 34 | 94 | 85 - 100 |
| Rogue/Flat | 2008 | 33 | 100 | 90 - 100 |
| Thornapple River/Rabbit | 2008 | 44 | 93 | 85 - 100 |
| Pigeon – Cherry | 2008 | 27 | 73 | 41 - 100 |
| Flint River | 2008 | 46 | 92 | 84 - 100 |
| Lake St. Clair Tribs | 2008 | 4 | 75 | 0 - 100 |
| River Raisin | 2008 | 36 | 100 | 92 - 100 |
| Clinton | 2009 | 33 | 94 | 86 - 100 |
| Saginaw | 2009 | 3 | 100 | 37 - 100 |
| Rifle | 2009 | 28 | 100 | 90 - 100 |
| Kalamazoo | 2009 | 40 | 100 | 93 - 100 |
| Lower Grand | 2009 | 44 | 84 | 74 - 94 |
| Manistee/Big Sable | 2009 | 34 | 100 | 92 - 100 |
| Eastern Upper Peninsula - East | 2009 | 26 | 96 | 88 - 100 |
| Eastern Upper Peninsula - West | 2009 | 26 | 100 | 89 - 100 |
| Maumee Tribs | 2010 | 35 | 94 | 86 - 100 |
| Rouge | 2010 | 48 | 79 | 68 - 90 |
| Shiawassee | 2010 | 49 | 84 | 73 - 95 |
| Kawkawlin/Wiscoggin | 2010 | 2 | 100 | 22 - 100 |
| Thunder Bay/Cheboygan/ Black | 2010 | 31 | 100 | 91 - 100 |
| Pere Marquette/Pentwater | 2010 | 28 | 100 | 90 - 100 |
| Macatawa | 2010 | 12 | 100 | 78 - 100 |
| Upper St. Joseph | 2010 | 31 | 96 | 84 - 100 |
| Central Upper Peninsula | 2010 | 29 | 100 | 90 - 100 |

## 7.2 Water Chemistry

The MDEQ and its partners collect water samples from many rivers and streams throughout the state as part of the WCMP and other special studies and analyze them for a variety of parameters. Results from monitoring conducted in 2005 as well as older study results and trend analysis are summarized below. Tributary monitoring efforts continue and results through 2008 will be summarized in a comprehensive report with connecting channels (see Section 5.2) and bays (see Section 5.3) expected to be completed in 2012.

Key results from 2005 monitoring include the following:

- Based on recent WCMP data, the most ubiquitous problem continues to be PCBs. Similar to previous years' results, results from a total of 43 samples (from 10 locations) collected from streams and rivers during 2005 showed that 100% exceeded the most restrictive PCB WQS of 0.026 ng/L (HCV per R 323.1057) (Aiello, 2008). Total PCB concentrations were highest in a sample collected at the Lower Kalamazoo River (18 ng/L) and lowest in a sample collected at the Thunder Bay River (0.082 ng/L).

Because the industrial use of PCBs has been banned, the primary sources of PCBs to water are likely historical sediment contamination and ongoing atmospheric deposition.

- Similar to previous years' results, elevated levels of mercury were relatively common in water samples analyzed from 2005. Of the 98 sites monitored, 48 (49%) had geometric mean mercury concentrations exceeding the most restrictive mercury WQS of 1.3 ng/L (Wildlife Value per R 323.1057) (Aiello, 2008). Geometric mean mercury concentrations were highest at Montgomery Creek, Gogebic County (5.9 ng/L), and lowest at the Shiawassee River, Oakland County (0.31 ng/L). Atmospheric deposition is the primary source of elevated mercury levels.

- All trace metal samples other than mercury from the 98 locations that had sufficient information to make a determination met applicable WQS during 2005 (Aiello, 2008).

- Analysis of tributary monitoring results from 1998 through 2005 indicates that median normalized total phosphorus, chloride, and total suspended solids concentrations from 1998 through 2005 exceeded historic background concentrations at approximately 45%, 68%, and 58% of the 31 sites evaluated, respectively (Aiello, 2008).

Key results from monitoring prior to 2005 and trend analysis include the following:

- During 1998 through 2005, median normalized total mercury ranged from 0.028 ng/L at the Au Sable River to 5.5 ng/L at the Lower Kalamazoo River; median normalized total chromium ranged from 0.02 ug/L at the Au Sable River to 1.8 ug/L at the River Rouge; median normalized total copper ranged from 0.23 ug/L at the Au Sable River to 3.6 ug/L at the Clinton River; and median normalized total lead ranged from 0.04 ug/L at the Au Sable River to 2.3 ug/L at the Flint River (Aiello, 2008).

- Temporal trends in tributaries monitored from 1998 through 2005 were analyzed for turbidity, dissolved oxygen, pH, specific conductance, temperature, total chloride, total suspended solids, nitrogen (Kjeldahl, ammonia, nitrate, and nitrite), total phosphorus, chromium, copper, lead, and mercury (Aiello, 2008). Thirteen of 31 sites evaluated for temporal trends showed a statistically significant trend ($p \leq 0.05$), whether increasing or decreasing, in one or more of these constituents over the period of interest (1998 through 2005). Decreasing trends were found more than twice as frequently as increasing trends. For most constituents, a decreasing trend indicates improving stream water quality conditions (Aiello, 2008).

- A total of 30 dioxin and furan samples were collected at 7 locations during 2001 through 2003 (Aiello, 2003, 2004, and 2005). This sampling took place at the Tittabawassee River and additional sites within the Saginaw Bay watershed. Of these 30 samples, 20 were collected near the mouth of the Tittabawassee River; all 20 exceeded the Rule 57 HCV (0.0086 picograms per liter [pg/L]) applicable to total 2,3,7,8-TCDD toxicity equivalence concentration, and 4 also exceeded the Rule 57 Wildlife Value (0.0031 pg/L) for 2,3,7,8-TCDD. The remaining ten samples were collected at the Cass, Flint, Shiawassee, Saginaw, and West Branch Tittabawassee Rivers; and a station on the Tittabawassee River immediately upstream of Dow Chemical - Midland's outfall 031. Of these locations, all but the West Branch Tittabawassee River had at least 1 sample that exceeded the HCV.

- Numerous emerging issue contaminants, including base/neutral organic compounds, Methyl tert-butyl ether (MTBE), benzene, toluene, ethylbenzene, and xylene (BTEX), total cyanide, perfluorooctane sulfonates, and perfluorooctanoic acid, have been monitored at the WCMP locations. From 1999 to 2004, a total of 440 samples were analyzed for base/neutral organic compounds, MTBE and BTEX, and 225 samples for total cyanide as part of the WCMP (Aiello, 2003, 2004, and 2005). All samples were below applicable Rule 57 water quality values, and almost all were below analytical quantification. Thus, sampling for these contaminants was discontinued after 2004.

- In addition to water sampling in recent years, the USGS and MDEQ evaluated potential trends for 28 water quality constituents (physical properties, major ions, nutrients, bacteria, pH and alkalinity, and suspended sediments) for selected National Stream Quality Accounting Network stations in Michigan (Syed and Fogarty, 2005). Data were collected from 1973 to 1995 from the Au Sable, Clinton, Grand, Kalamazoo, Manistee, Manistique, Muskegon, and Pigeon Rivers. The study results show an overall improvement in water quality at the Clinton, Manistee, and Pigeon Rivers for some parameters. The Clinton and Pigeon Rivers showed significant negative trends (decreasing concentration) in the concentration of nitrogen compounds. The Kalamazoo and Muskegon Rivers showed significant positive trends (increasing concentrations) in nitrogen compounds. Due to data and analysis method limitations, the Clinton River was the only river that could be analyzed for phosphorus trends; it showed a significant negative trend in total phosphorus concentration.

### 7.3 Fish Contaminants

In 1990, Michigan initiated a fixed station fish contaminant trend monitoring project to measure spatial and temporal trends of certain bioaccumulative contaminants. Adult fish are collected from each site at a target interval of two to five years, and analyzed as whole fish samples. Carp were collected periodically from five river impoundment trend monitoring sites since 1990. These sites were located on the Muskegon, Grand, Kalamazoo, St. Joseph, and Raisin Rivers. Whole fish fixed station trend monitoring data collected since 1990 were reviewed and general trend conclusions for rivers are summarized below (Bohr and VanDusen, 2009):

- Lindane, terphenyl, PBB, heptachlor, and aldrin were not quantified in any of the fish sampled. However, heptachlor epoxide and dieldrin (breakdown products of heptachlor and aldrin) were quantified in most of the samples analyzed.

- In addition to heptachlor epoxide and dieldrin, several chemicals were quantified in fish consistently, indicating that they are ubiquitous in the aquatic environment. These include mercury, hexachlorobenzene, total PCBs, total chlordane, and total DDT.

- Average total PCB concentrations were highest in carp from the Kalamazoo River site. The Kalamazoo River has extensive areas of PCB contaminated sediments, a problem that is being addressed under state and federal programs.

- Total PCB concentrations declined at all 5 river trend sites, with an average decline of 8% per year since 1990.

- Total DDT concentrations declined at 4 of 5 river trend sites, with an average decline of 10% per year since 1990. The exception was the Grand River (at Grand Rapids) where no trend could be detected.

- Total chlordane concentrations declined at all 5 river trend sites, with an average decline of 8% per year since 1990.

- Mercury concentrations decreased 2% per year in fish from the River Raisin. No significant trends were measured in the Grand, Kalamazoo, Muskegon, or St. Joseph Rivers.

The MDEQ uses caged fish in rivers to identify sources of bioaccumulative contaminants and identify spatial trends in contaminant concentrations. Caged fish studies were conducted in the Betsie, Manistique, Platte, Rogue, and Thornapple Rivers watersheds in 2008. Caged fish studies were conducted in the Kalamazoo, Rifle, and Clinton Rivers watersheds in 2009. Reports for these caged fish studies are not yet complete.

In addition, edible portion fish tissue contaminant monitoring was conducted recently in 8 river reaches: the River Raisin at Monroe, Kawkawlin River, upper reaches of the Escanaba River, Flat River downstream of Belding, Manistique River downstream of Manistique Papers Dam, Muskegon River downstream of Croton Dam, Bad River, and the Rifle River. Edible portion sampling is often targeted toward known sites of contamination, sites popular with sport anglers, and sites with public access. Results of the edible portion monitoring are used by the MDEQ in determining the status of the Fish Consumption designated use for a given water body.

The edible portion monitoring data are also used by the MDCH to update fish consumption advisories. Based on the most recent river monitoring the MDCH relaxed the consumption advisory for the Rifle River and expanded the advisory for the River Raisin. In addition, the MDCH released new consumption advice for brook trout from the upper Escanaba River due to localized elevated levels of selenium.

Complete fish tissue results are presented in the Michigan Fish Contaminant Monitoring Program Annual Reports for 2009 and 2010 (Bohr and VanDusen, 2011a; 2011b).

### 7.4 Beaches

In 2009, a total of 6 public beaches on a river were monitored and 3 reported no exceedances of the *E. coli* WQS for total body contact. There were 3 beaches that reported a total of 6 exceedances.

In 2010, a total of 7 public beaches on rivers were monitored and 6 reported no exceedances of the *E. coli* WQS for total body contact. There was 1 beach that reported one exceedance.

The Michigan Beach Web site (http://www.deq.state.mi.us/beach) provides access to a database containing beach closings and *E. coli* data collected by LHDs. Currently, 34 public beaches located on rivers are listed in the database.

### 7.5 Designated Use Support Summary

A designated use support summary for Michigan rivers and streams is presented in Table 7.2. Michigan uses a multiple category system (i.e., assessment units may be placed in one or more category, see Section 4.11); therefore, river miles are not totaled. Key designated use support results follow. Impairment cause and source information for assessment units not supporting designated uses is presented in Chapter 9.

- The majority of the river miles that are not supporting one or more designated uses indicated by poor biological communities have been highly modified by channel maintenance activities carried out primarily by Michigan's county drain commissions. These channel maintenance activities (including channel straightening, dredging, riparian vegetation removal, and snag removal) may result in poor biological communities caused by nonpollutants (habitat and/or flow alterations); therefore, these river miles are placed in Category 4c. The number of Category 4c river miles for the other indigenous aquatic life and wildlife designated use decreased from 6,738 miles in the 2008 IR. This change in Category 4c mileage is mainly due to availability of new biological data for many water bodies with channel maintenance activities including that collected in 2008 for Saginaw Bay and Lake Huron coastal tributaries (i.e., Pigeon and Cherry Rivers in Huron County) and reevaluation of designated use support using 2004 assessment methodology changes.

- Of the approximately 5,465 river miles assessed for the total body contact recreation designated use, about 3.6% were determined to support this designated use. Approximately 54% of the assessed river miles have TMDLs completed. Most of the remaining assessed river miles have insufficient information to determine total body contact recreation designated use support.

- A small portion of the mouth of the Manistique River is listed in Category 4b. Ambient *E. coli* data collected in 2007 met WQS; however, an untreated CSO remains that could result in the exceedance of WQS. The CSO is scheduled for elimination by December 31, 2019.

- Water column PCB monitoring using highly sophisticated and sensitive sampling/analytical techniques indicates that 100% of the assessed river miles are not attaining PCB WQS; therefore, a significant number of river miles are listed as not supporting the fish consumption designated use and/or the other indigenous aquatic life and wildlife designated use. Atmospheric deposition is considered to be the major source of this persistent bioaccumulative chemical.

- Approximately 95% of the 55,189 river miles assessed for the fish consumption designated use are determined to not support this designated use. The primary causes are PCBs and mercury (in fish tissue and water column). Atmospheric deposition is considered to be the primary source of these persistent bioaccumulative chemicals.

- A 17.1-mile reach of the River Raisin (Lenawee County) is not supporting the public water supply designated use because nitrate-nitrogen concentrations in the source water are above the USEPA's maximum contaminant level (10 mg/L) for nitrates. A USEPA-approved TMDL is in place to remediate this problem. This listing for River Raisin does not strictly follow the assessment methodology (i.e., the listing encompasses an area much larger than the 12-digit HUC; see Section 4.10) since the listing was created prior to the 2008 assessment methodology update and was meant to encompass a stretch of the river between two distinct drinking water intakes.

- The extent of river miles not supporting the fish consumption designated use is widespread (Figure 7.1). Mercury in fish tissue, mercury in water column, PCB in fish tissue, and PCB in water column are the primary causes for river miles to not support the fish consumption designated use (Figures 7.2 through 7.5). These four parameters have been sampled at many locations statewide. Sampling locations that do not overlay river miles that are not supporting the fish consumption designated use may have insufficient

information to determine use support or may indicate designated use support. Please note that a color copy of Figure 7.1 is required to view all information. This IR is available in color at http://www.michigan.gov/deqwater under Water Quality Monitoring, Assessment of Michigan Waters.

- A majority of the river miles support the other indigenous aquatic life and wildlife designated use (Figure 7.6). The primary causes for river miles to not support the other indigenous aquatic life and wildlife designated use are PCB in water column, mercury in water column, and habitat alterations (Figures 7.7 through 7.9). PCB and mercury in the water column have been sampled at many locations statewide (Figures 7.8 and 7.9). Sampling locations that do not overlay river miles that are not supporting the other indigenous aquatic life and wildlife designated use may have insufficient information to determine use support or may indicate designated use support. Please note that a color copy of Figure 7.6 is required to view all information. This IR is available in color at http://www.michigan.gov/deqwater under Water Quality Monitoring, Assessment of Michigan Waters.

- A variety of TMDLs were completed and approved by the USEPA in 2010 and 2011 resulting in newly listed river miles in Category 4a. In 2010 an *E. coli* TMDL was completed for the Clinton River (Macomb, Oakland, and St. Clair Counties). In 2011 *E. coli* TMDLs were completed for Planter Creek (Gogebic County), Black River (St. Clair County), Three Mile Creek and Holly Drain (Shiawassee County), and East Branch Coon Creek (Macomb County). In 2011 a phosphorus TMDL was completed for Goose Creek (Marquette County). In 2011 a dissolved oxygen TMDL was completed for East Branch Coon Creek (Macomb County).

Table 7.2 Designated use support summary for rivers in Michigan (approximately 76,433 total miles). No rivers are listed in Category 1 since comprehensive water quality data and/or information are not available for any locations.

| Designated Use | Supporting | Insufficient Information | Not Assessed | Not Supporting | | | |
|---|---|---|---|---|---|---|---|
| | Category 2 | Category 3 | Category 3 | Category 4a | Category 4b | Category 4c | Category 5 |
| Agriculture (mi) | 76,397 | 0 | 0 | 0 | 36 | 0 | 0 |
| Navigation (mi) | 76,397 | 0 | 0 | 0 | 36 | 0 | 0.06 |
| Industrial Water Supply (mi) | 76,397 | 0 | 0 | 0 | 36 | 0 | 0 |
| Warmwater Fishery (mi) | 8,835 | 1,095 | 64,301 | 1,537 | 5.4 | 332 | 1,067 |
| Coldwater Fishery (mi) | 5,729 | 872 | 69,545 | 138 | 3.5 | 68 | 75 |
| Other Indigenous Aquatic Life and Wildlife (mi) | 47,546 | 3,219 | 14,119 | 1,871 | 202 | 2,274 | 8,559 |
| Partial Body Contact Recreation (mi) | 627 | 3,485 | 67,492 | 2,895 | 2.5 | 0 | 1,931 |
| Total Body Contact Recreation (mi) | 195 | 3,639 | 67,330 | 2,948 | 2.5 | 0 | 2,319 |
| Fish Consumption (mi) | 2,492 | 70 | 22,039 | 786 | 1,867 | 0 | 50,044 |
| Public Water Supply (mi) * | 0 | 0.1 | 575 | 17 | 0 | 0 | 0 |

* Approximately 592 of the 76,433 river miles are protected for the public water supply designated use.

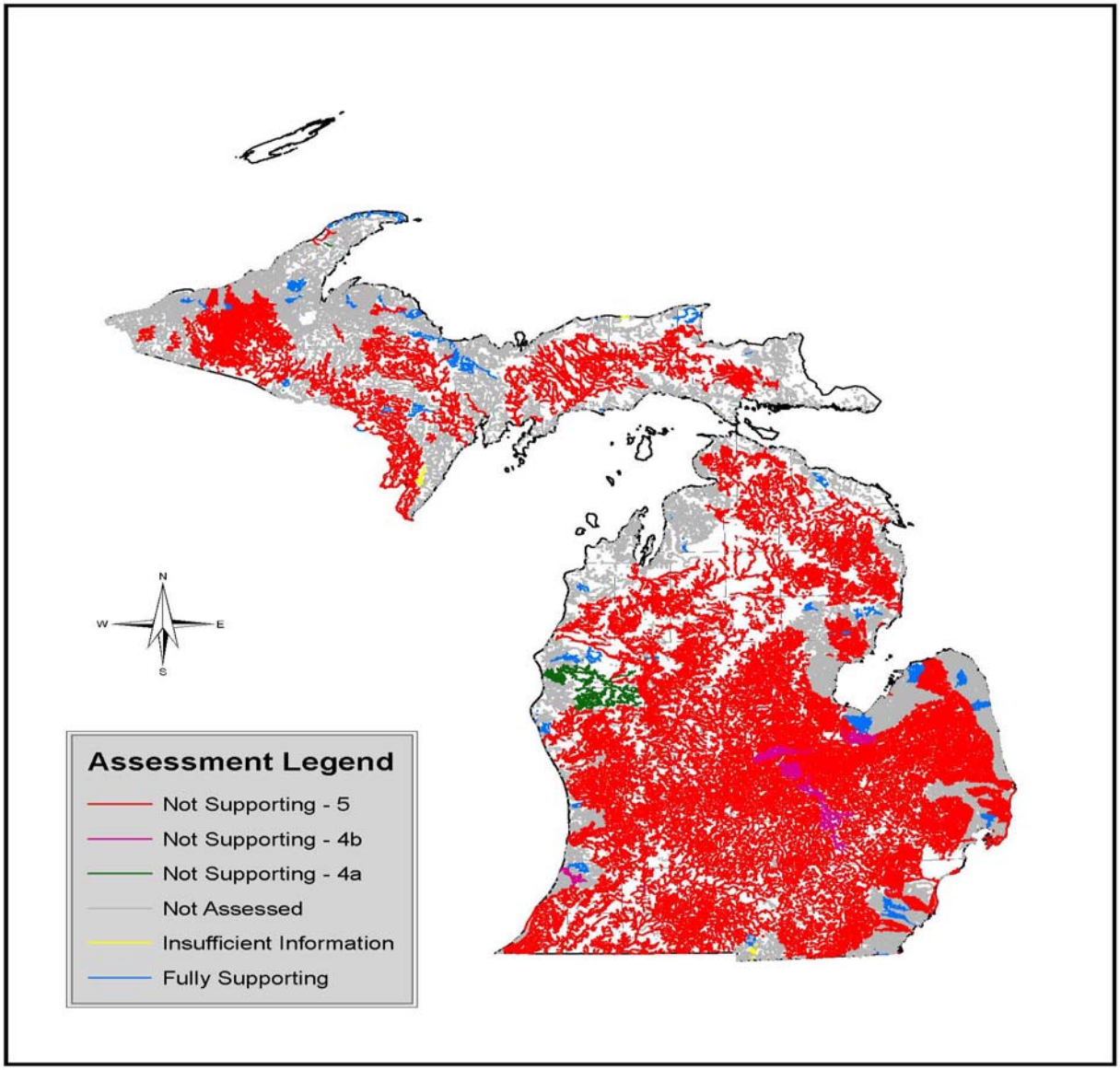



**Figure 7.1 Fish consumption designated use support for Michigan rivers.**

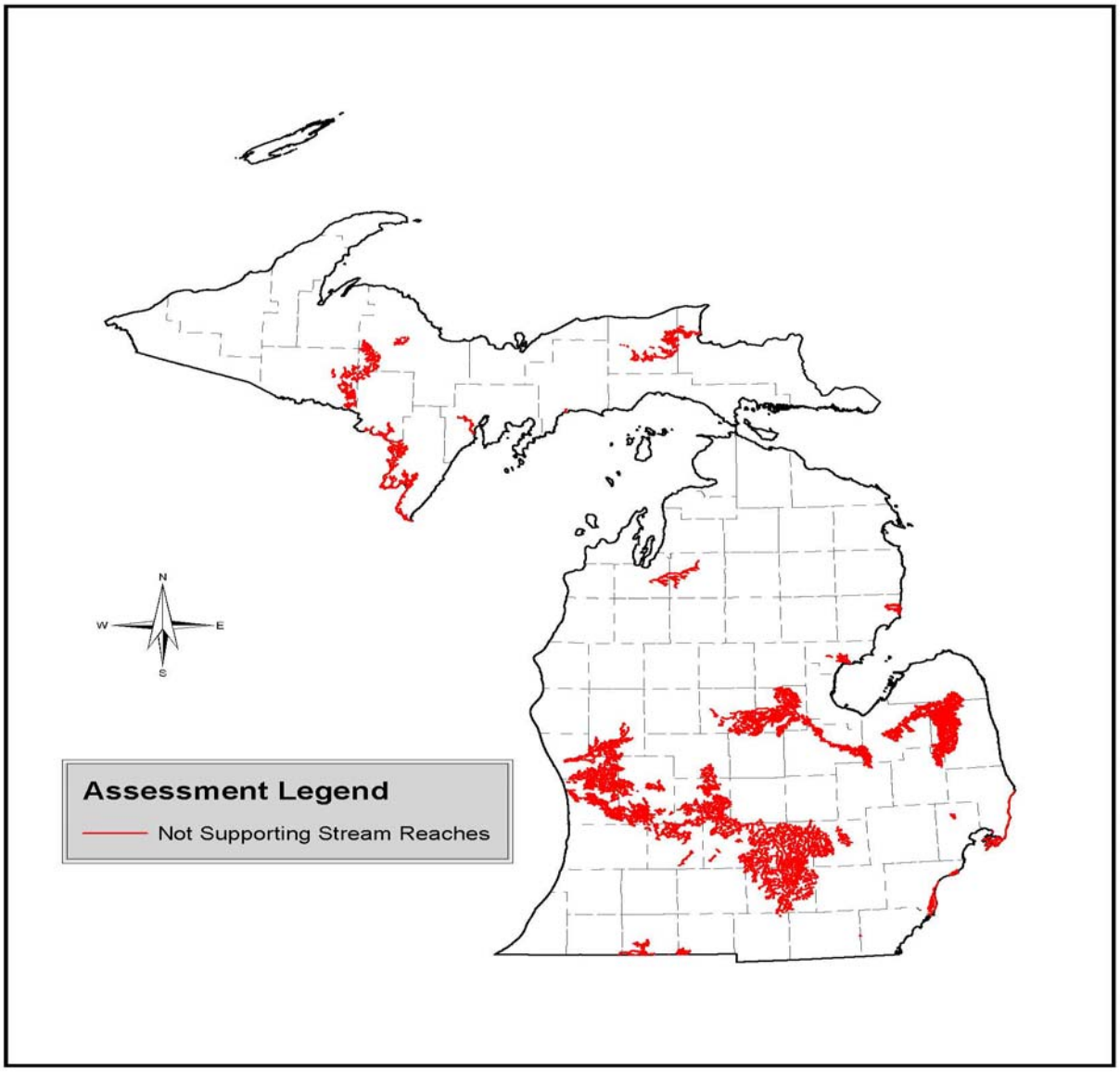



**Figure 7.2 Rivers not supporting the fish consumption designated use based on mercury in fish tissue (Category 5.)**

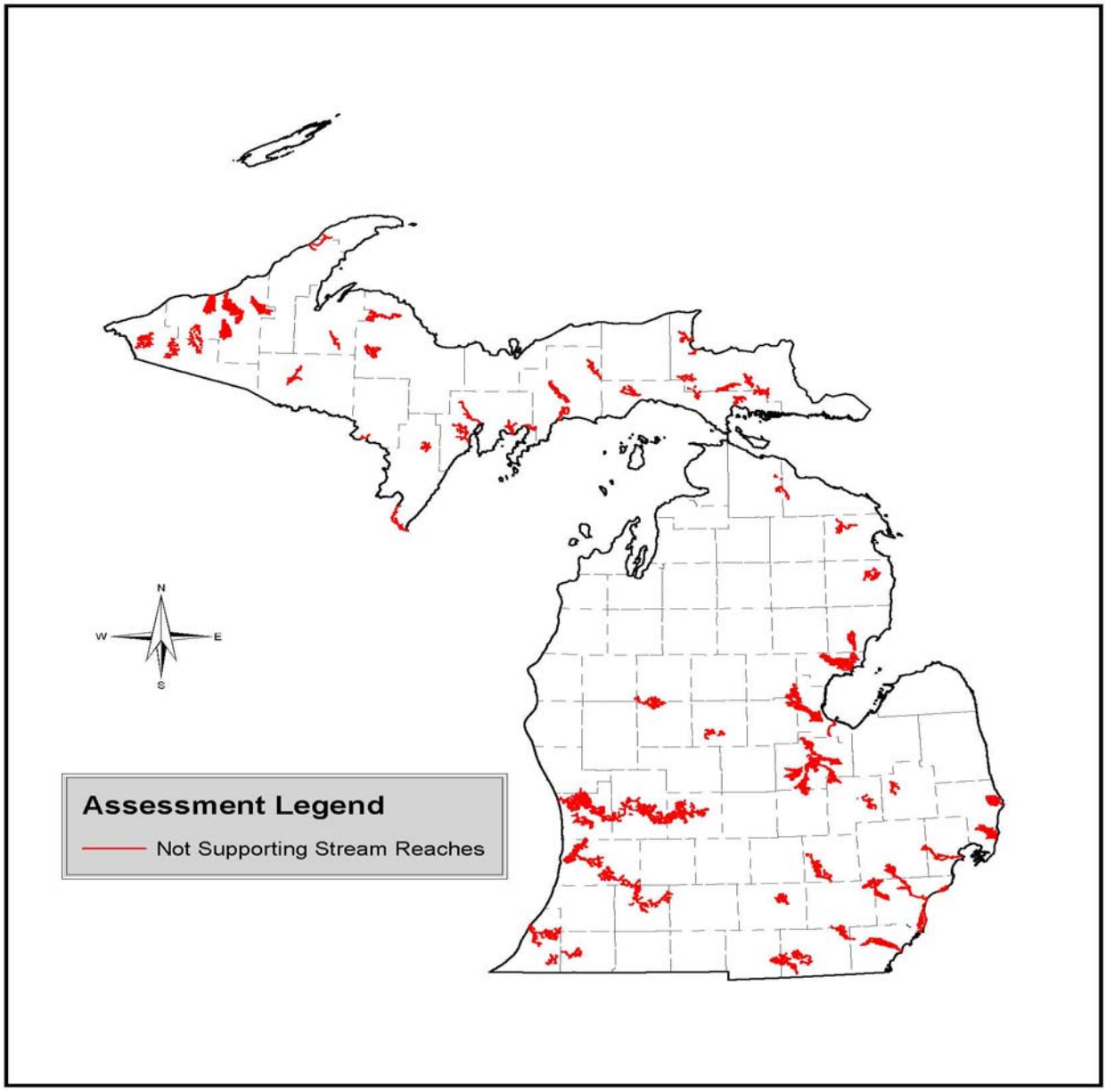



**Figure 7.3 Rivers not supporting the fish consumption designated use based on mercury in water column (Category 5.)**

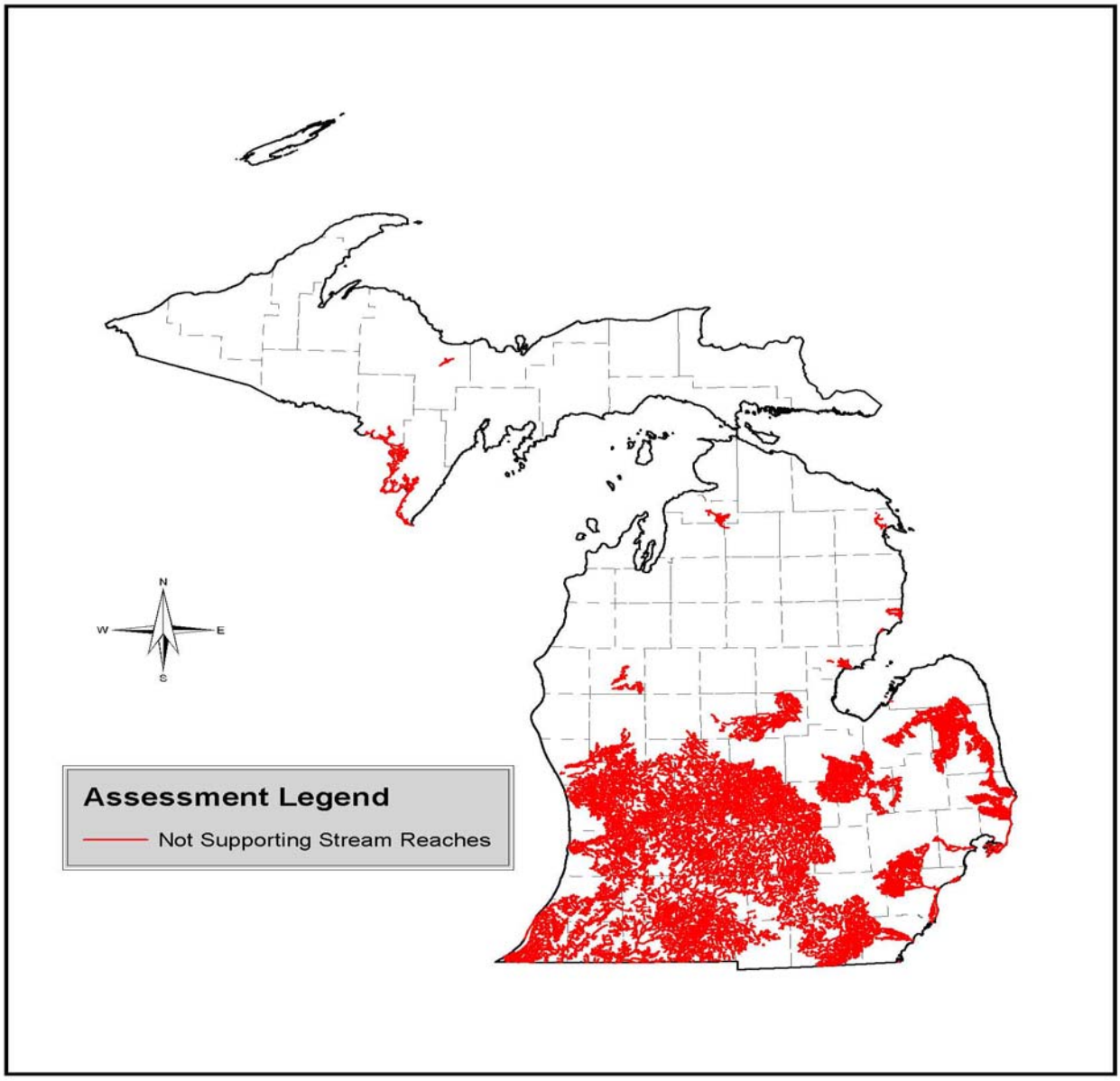



**Figure 7.4 Rivers not supporting the fish consumption designated use based on PCB in fish tissue (Category 5.)**

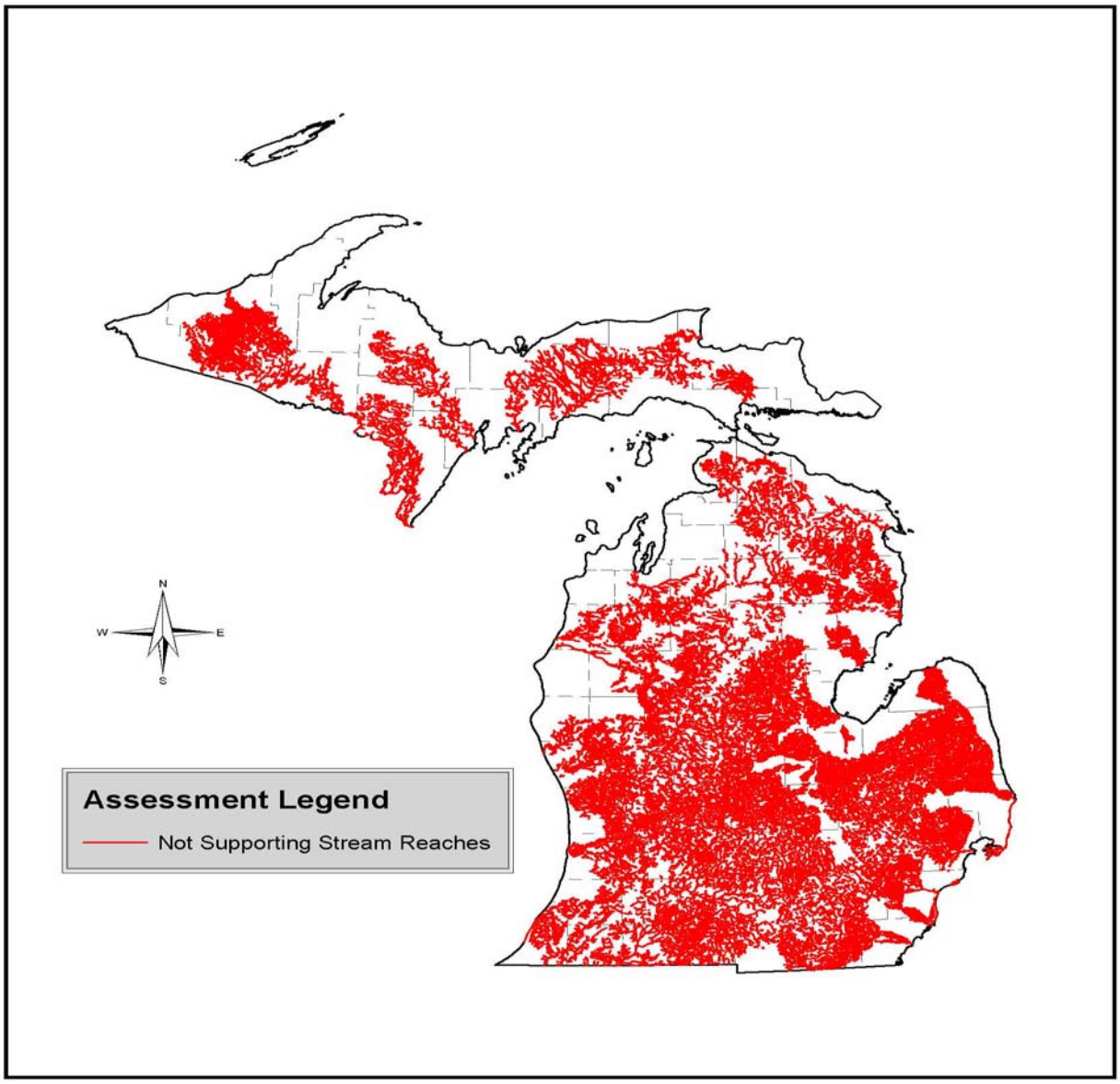



**Figure 7.5 Rivers not supporting the fish consumption designated use based on PCB in water column (Category 5.)**

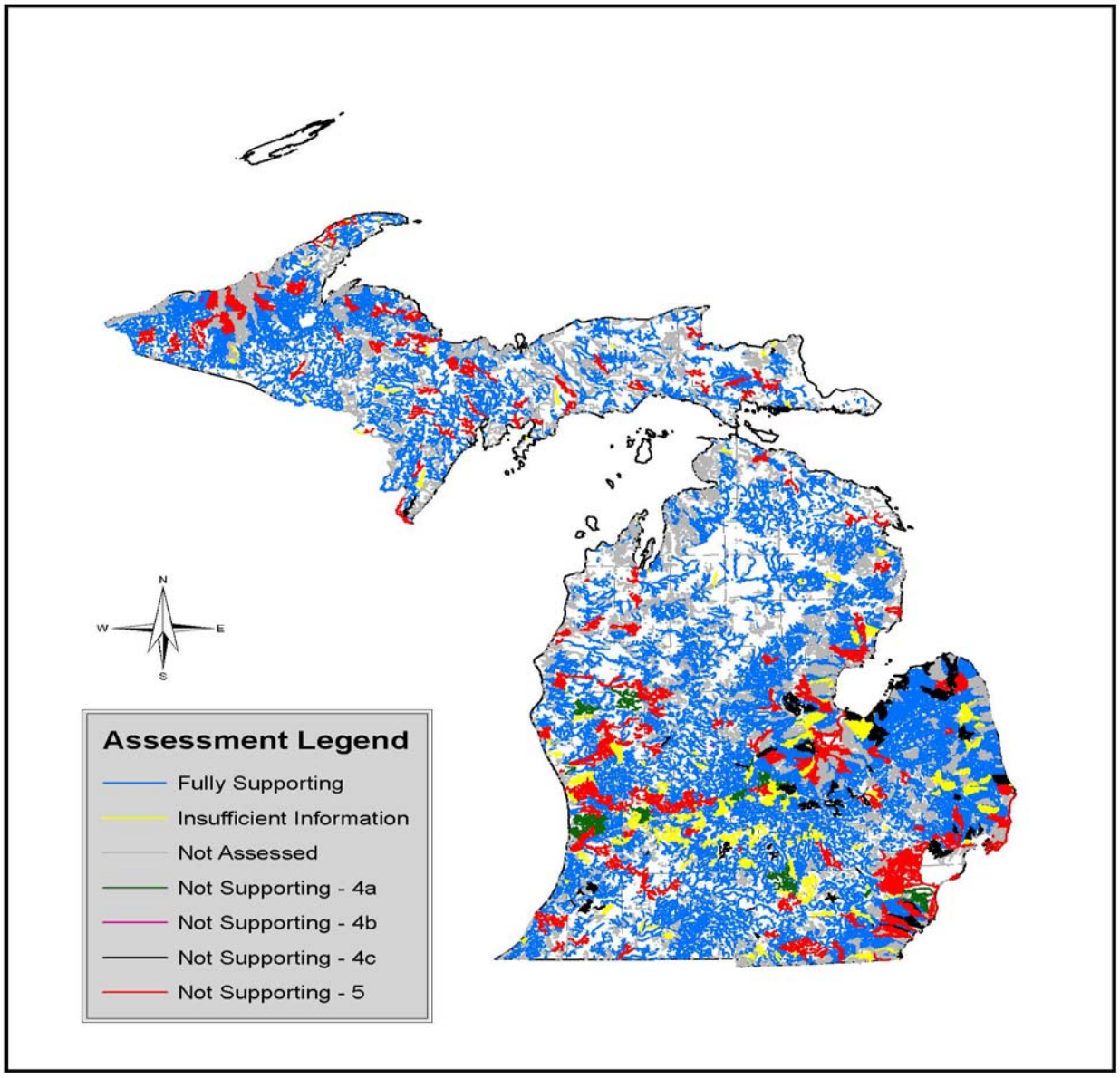



**Figure 7.6 Other indigenous aquatic life and wildlife designated use support summary for Michigan rivers.**

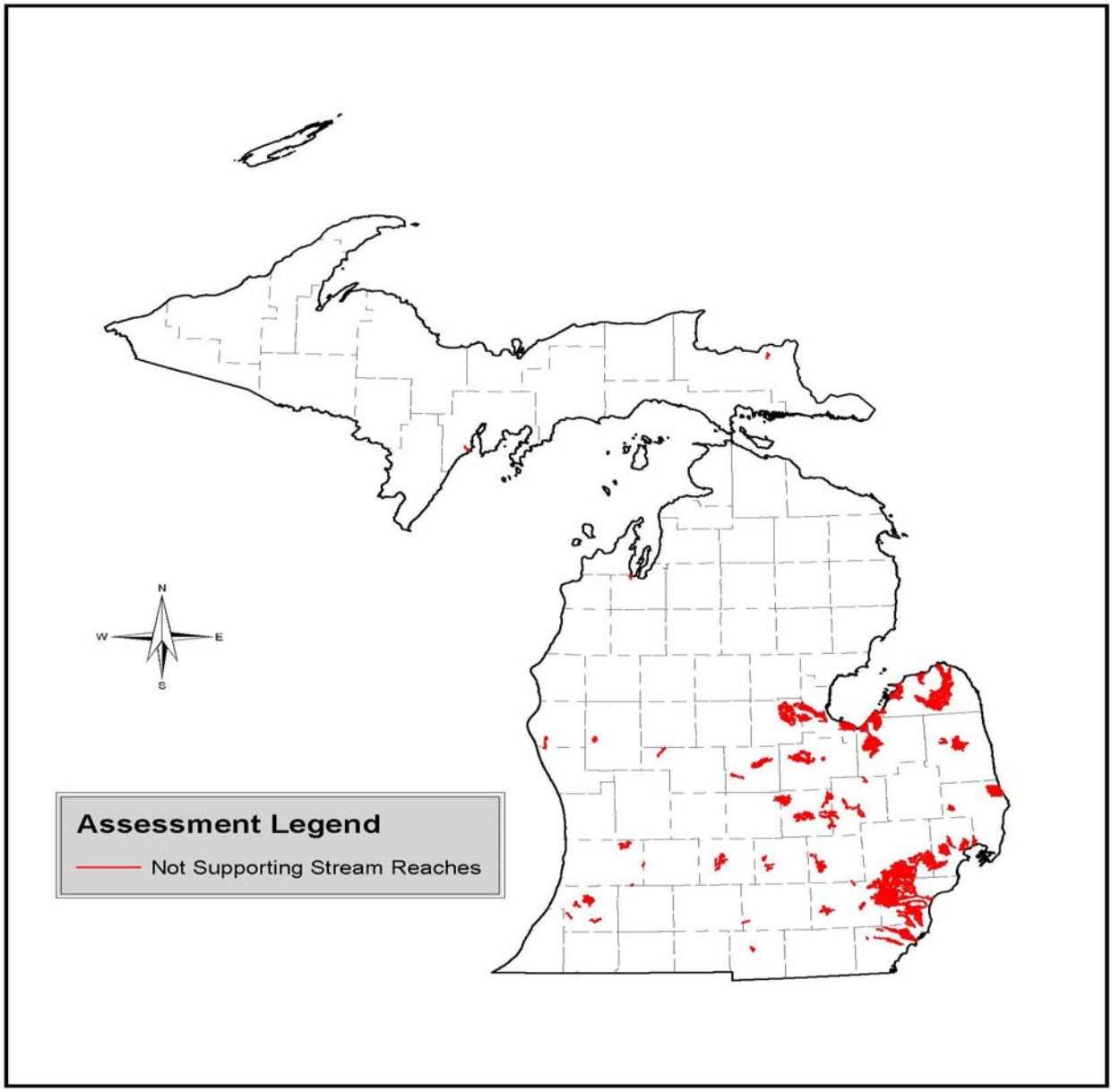



**Figure 7.7 Rivers not supporting the other indigenous aquatic life and wildlife designated use based on habitat alterations.**

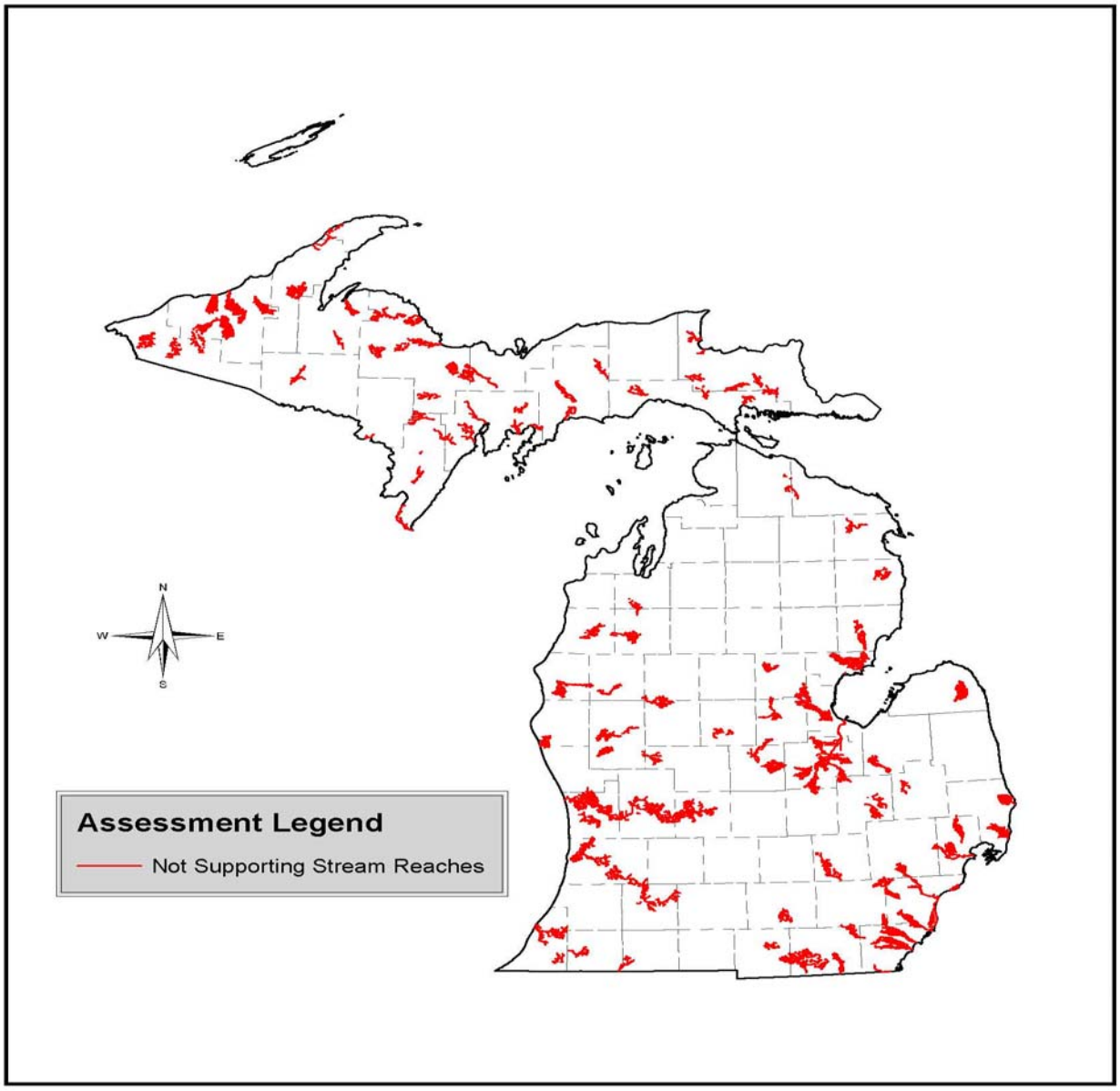



**Figure 7.8 Rivers not supporting the other indigenous aquatic life designated use based on mercury in water column.**

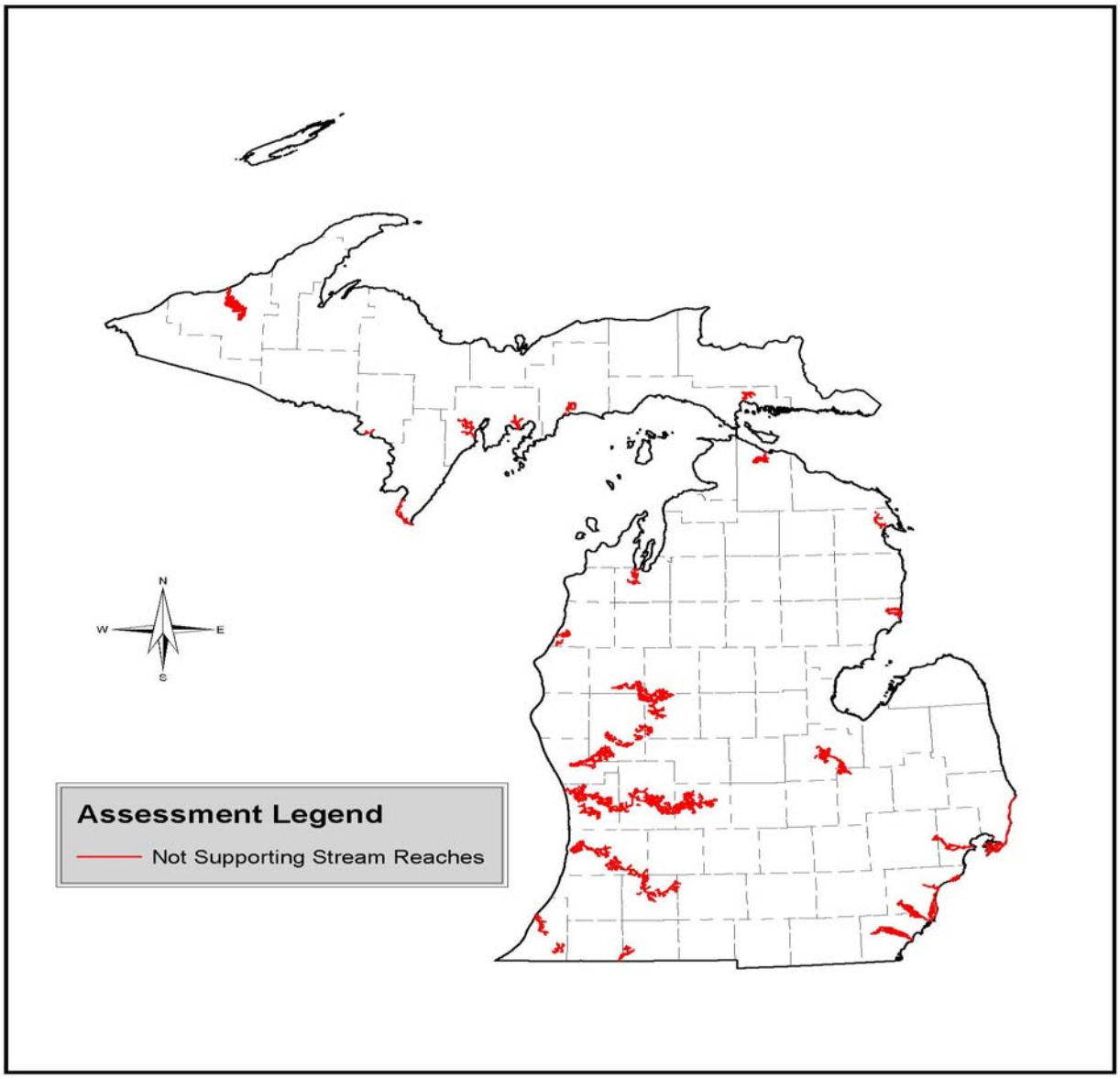



**Figure 7.9 Rivers not supporting the other indigenous aquatic life designated use based on PCB in water column.**

## CHAPTER 8
## ASSESSMENT RESULTS: WETLANDS

### 8.1 Designated Use Support Summary

Michigan's WQS apply to all surface waters of the state, including wetlands. However, some criteria may not be applicable to wetlands. For example, a highly productive wetland with abundant vegetation in shallow water and high organic content in the sediment may naturally exhibit low dissolved oxygen levels in the water column. Based on Rule 100(10) of the WQS, use attainability studies are allowed for certain wetlands to address this situation.

Michigan's wetlands are currently assessed for designated use support on an as needed basis. The known designated use support information is listed in Table 8.1. Michigan uses a multiple category system (i.e., assessment units may be placed in one or more category, see Section 4.11); therefore, wetland acres are not totaled. Details regarding the four listed wetlands follow. Impairment cause and source information for assessment units not supporting designated uses is presented in Chapter 9.

- A 10-acre wetland in the Escanaba River watershed (Marquette County) previously listed as not supporting designated uses was remediated in 1997. The other indigenous aquatic life and wildlife designated use of this wetland was restored by the reduction of nickel contamination from an upstream point source discharge.

- A small wetland area in the Grand River watershed (0.25 acres in Jackson County) is listed as having insufficient information to determine if the other indigenous aquatic life and wildlife designated use is supported due to point sources discharges and contaminated groundwater.

- Tobico Marsh (Bay County), a 680-acre marsh adjacent to Saginaw Bay, is not supporting the fish consumption designated use due to elevated PCB concentrations in carp and northern pike populations. Carp, largemouth bass, and northern pike were collected and analyzed in 2007. These new data did not result in a change to the fish consumption advisory.

- Ruddiman Creek Lagoon (21 acres in Muskegon County) is not supporting the fish consumption, and total and partial body contact recreation designated uses. This wetland is the subject of a major sediment remediation project that involves the removal of approximately 80,000 cubic yards of sediments contaminated with PCBs, metals, and polynuclear aromatic hydrocarbons.

Table 8.1 Designated use support summary for Michigan wetlands (approximately 5,583,400 total acres). All wetland acres are not entered in the ADB. Wetlands that have specific information are entered into the ADB on a case-by-case basis. No wetlands are listed in Category 1 since comprehensive water quality data and/or information are not available for any locations. N/A indicates that the designated use is not applicable.

| Designated Use | Supporting | Insufficient Information | Not Assessed | Not Supporting | | | |
|---|---|---|---|---|---|---|---|
| | Category 2 | Category 3 | Category 3 | Category 4a | Category 4b | Category 4c | Category 5 |
| Agriculture | 5,583,400 | 0 | 0 | 0 | 0 | 0 | 0 |
| Navigation | 5,583,400 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial Water Supply | 5,583,400 | 0 | 0 | 0 | 0 | 0 | 0 |
| Warmwater Fishery | 0 | 0 | 5,583,400 | 0 | 0 | 0 | 0 |
| Coldwater Fishery | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Other Indigenous Aquatic Life and Wildlife | 10 | 0.25 | 5,583,389.75 | 0 | 0 | 0 | 0 |
| Partial Body Contact Recreation | 0 | 0 | 5,583,379 | 21 | 0 | 0 | 0 |
| Total Body Contact Recreation | 0 | 0 | 5,583,379 | 21 | 0 | 0 | 0 |
| Fish Consumption | 0 | 0 | 5,582,699 | 0 | 0 | 0 | 701 |
| Public Water Supply | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

# CHAPTER 9
# WATER BODIES NOT SUPPORTING DESIGNATED USES AND CWA SECTION 303(D) REQUIREMENTS

## 9.1 Introduction

The purpose of this chapter is to provide additional information regarding water bodies that are determined to not support one or more designated uses (i.e., water bodies that are listed in Categories 4 or 5; see Section 4.11 for a description of the categories). Section 303(d) of the CWA and the USEPA's Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations, Part 130) require states to develop TMDLs for water bodies that are not meeting WQS (i.e., water bodies that are listed in Category 5). The TMDL process establishes the allowable loadings of pollutants for a water body based on the relationship between pollution sources and in-stream water quality conditions. TMDLs provide states a basis for determining the pollutant reductions necessary from both point sources and NPS to restore and maintain the quality of their water resources.

## 9.2 Impairment Cause and Source

When a determination is made that a designated use is not supported (includes both Categories 4 and 5), the cause and source (when known) of impairment is identified (see Section 4.12). Each assessment unit may be listed for one or more causes and sources of impairment. The following tables are sorted by cause or source with the greatest geographic extent listed first.

### *9.2.1 Great Lakes and Connecting Channels*

All of Michigan's Great Lakes, bays, and Lake St. Clair are listed as not supporting one or more designated use with various causes and sources of impairment (Tables 9.1 and 9.2).

Table 9.1 Michigan Great Lakes and bays not supporting designated uses listed by cause of impairment.

| Cause | Total $mi^2$ / shoreline mi |
|---|---|
| Toxic organics | |
| PCBs in fish tissue | 42,167 / 3,052 |
| Dioxin | 41,937 / 2,963 |
| Pesticides | |
| Chlordane | 29,944 / 1,975 |
| DDT | 13,250 / 1,058 |
| Metals | |
| Mercury in fish tissue | 32,857 / 2,064 |
| Nutrients | 3 |
| Taste and odor | 3 |
| Pathogens | 4.2 shoreline mi |

Table 9.2 Michigan Great Lakes and bays not supporting designated uses listed by source of impairment.

| Source | Total $mi^2$ / shoreline mi |
|---|---|
| Atmospheric deposition | 42,167 / 3,052 |
| Agriculture | 4,373 / 529 |
| Contaminated sediment | 1,137 / 0 |
| Industrial point source discharge | 3 / 0.2 |
| Municipal point source discharge | 3 / 0.1 |
| NPS | 3 / 0 |
| Collection system failures | 3 shoreline mi |
| On-site treatment systems | 0.2 shoreline mi |
| Illicit connections | 0.6 shoreline mi |
| Waterfowl | 0.4 shoreline mi |
| Source unknown | 0.5 shoreline mi |

All Great Lakes connecting channel miles are listed as not supporting one or more designated use with various causes and sources of impairment (Tables 9.3 and 9.4).

Table 9.3 Michigan connecting channel river miles not supporting designated uses listed by cause of impairment.

| Cause | Total miles |
|---|---|
| Toxic organics | |
| PCBs in water column | 125 |
| PCBs in fish tissue | 125 |
| Dioxin | 26 |
| Metals | |
| Mercury in fish tissue | 125 |
| Mercury in water column | 26 |
| Pathogens | 49 |
| Pesticides | |
| DDT | 26 |

Table 9.4 Michigan connecting channel river miles not supporting designated uses listed by source of impairment.

| Source | Total miles |
|---|---|
| Atmospheric deposition | 125 |
| CSOs | 49 |
| Illicit connections | 33 |
| Source unknown | 24 |

### *9.2.2 Inland Lakes and Reservoirs*

Many inland lakes and reservoirs that do not support one or more designated uses are impacted by atmospheric deposition of mercury and/or PCBs. Several other causes and sources of impairment are also identified (Tables 9.5 and 9.6).

Table 9.5 Michigan inland lake and reservoir acres not supporting designated uses listed by cause of impairment.

| Cause | Total acres |
|---|---|
| Metals | |
| Mercury in fish tissue | 246,271 |
| Copper | 3,174 |
| Zinc | 480 |
| Mercury in water column | 211 |
| Toxic organics | |
| PCBs in fish tissue | 144,692 |
| Dioxin | 19,945 |
| Polycyclic Aromatic Hydrocarbons | 480 |
| PCBs in water column | 614 |
| PBBs | 86 |
| Petroleum Hydrocarbons | 1,110 |
| Pesticides | |
| Chlordane | 14,376 |
| DDT | 86 |
| Nutrients | 7,836 |
| Pathogens | 1,819<br>4.8 shoreline mi |
| Selenium | 408 |
| Excess algal growth | 4284 |

Table 9.6 Michigan inland lake and reservoir acres not supporting designated uses listed by source of impairment.

| Source | Total acres |
|---|---|
| Atmospheric deposition | 311,868 |
| Source unknown | 16,991<br>4.2 shoreline mi |
| Contaminated sediment | 8,700 |
| Municipal point source discharges | 4,919 |
| Agriculture | 6,698<br>0.6 shoreline mi |
| Mine tailings | 3,102 |
| Industrial point source discharges | 1,375 |
| CSOs | 969 |
| Internal nutrient recycling | 408 |
| Unspecified storm sewer | 2,057 |
| Sewerage discharge in unsewered areas | 734 |
| Construction- site clearance | 2 |
| Waterfowl | 0.2 shoreline mi |
| Accidental release/spill | 1,110 |
| Illicit Connection/Urban Runoff/Storm Sewers | 817 |

### *9.2.3 Rivers*

Many rivers that do not support one or more designated uses are impacted by atmospheric deposition of mercury and/or PCBs. Several other causes and sources of impairment are also identified (Tables 9.7 and 9.8).

Table 9.7 Michigan river and stream miles not supporting designated uses listed by cause of impairment.

| Cause | Total mi |
|---|---|
| Toxic organics | |
| PCBs in water column | 49,691 |
| PCBs in fish tissue | 22,115 |
| Dioxin | 727 |
| PBBs | 189 |
| Petroleum hydrocarbons | 36 |
| PAHs | 2 |
| PCBs in sediment | 5 |
| Metals | |
| Mercury in fish tissue | 6,712 |
| Mercury in water column | 7,068 |
| Copper | 96 |
| Flow alterations | 3,529 |
| Pathogens | 5,294 |
| Habitat alterations | 2,640 |
| Sedimentation/siltation | 1,973 |
| Oxygen depletion | 1,410 |
| Nutrients | 675 |
| Organic enrichment (sewage) | 76 |
| Pesticides | |
| DDT | 189 |
| Chlordane | 285 |
| Cause unknown | 213 |
| Excess algal growth | 80 |
| Oil and grease | 8 |
| Thermal impacts | 40 |
| Aquatic plants | 28 |
| Selenium | 20 |
| Solids (suspended/bedload) | 17 |
| Total suspended solids | 14 |
| Total dissolved solids | 8 |
| pH (caustic) | 1 |

Table 9.8 Michigan river and stream miles not supporting designated uses listed by source of impairment.

| Source | Total mi |
|---|---|
| Atmospheric deposition | 52,316 |
| Source unknown | 6,139 |
| Habitat alterations | 3,986 |
| Hydromodifications | 3,200 |
| Municipal permitted discharges | 2,516 |
| Storm water permitted discharges | 2,434 |
| Agriculture - grazing | 2,180 |
| Agriculture - crop production | 2,165 |
| Agriculture - animal feeding/handling | 2,110 |
| Spills and unpermitted discharges | 1,750 |
| Urban related runoff/storm water | 1,899 |
| Legacy/historical pollutants | 839 |
| Industrial permitted discharges | 637 |
| NPS | 545 |
| Land application/waste sites | 570 |
| Natural | 215 |
| Resource extraction | 168 |
| Groundwater loadings | 26 |
| Construction | 22 |
| Turf management | 4 |

### *9.2.4 Wetlands*

Two wetlands, Tobico Marsh (680 acres in Bay County) and Ruddiman Creek Lagoon (21 acres in Muskegon County), are not supporting the fish consumption designated use. PCBs are the cause of impairment with multiple sources listed (Tables 9.9 and 9.10).

Table 9.9 Michigan wetland acres not supporting designated uses listed by cause of impairment.

| Cause | Total acres |
|---|---|
| Toxic organics | |
| PCBs in fish tissue | 701 |
| PCBs in water column | 21 |
| Pathogens | 21 |

Table 9.10 Michigan wetland acres not supporting designated uses listed by source of impairment.

| Source | Total acres |
|---|---|
| Atmospheric deposition | 701 |
| Groundwater loadings | 680 |
| Land application/waste sites | 680 |
| Sewage discharge in unsewered area | 21 |

## 9.3 TMDL Development

### *9.3.1 The TMDL Process*

Michigan's Section 303(d) list consists of assessment units that are listed in Category 5. A TMDL is developed for each cause (see Section 9.2) or a TMDL may address more than one related cause. In addition to the information used to determine designated use support (see Section 4.2), several references are used to develop the Section 303(d) list: 40 CFR, Parts 122, 123, and 130; USEPA Guidance for Water Quality-Based Decisions: The TMDL Process, April 1991; and New Policies for Establishing and Implementing TMDLs (August 8, 1997, Robert Perciasepe memo to USEPA Regional Administrators).

Development of a TMDL is typically preceded by collection of water quality data by the MDEQ or its contractors to document current pollutant loads within the water body of concern and further define potential sources of the pollutant. These data, in addition to any other relevant information, form the basis for determining the necessary pollutant load reductions. A TMDL document is comprised of several sections including identification of the impaired assessment unit and cause of impairment, description of water quality studies conducted to identify the extent and source(s) of the impairment, and calculation of necessary load reductions for the point source and NPS to achieve WQS. The TMDL also identifies any past, current, or future known actions to remedy the impairment and a monitoring schedule to track improvements following implementation of the TMDL.

The TMDL document is typically developed by staff members of the MDEQ. The draft document is made available for public review on the MDEQ's Web site for 30 days. The

announcement for the public comment period is published in the MDEQ calendar. During the public comment period, the MDEQ staff hold a public meeting in a community near the impaired water body to describe the TMDL and receive comments. Local stakeholders, including the general public, LHDs, local government, and county extension officials are sought to attend the meetings to contribute their expertise in identifying pollutant sources and discuss source reduction/elimination. Following the comment period, the TMDL is modified as appropriate to address comments received.

The TMDL is finalized following the public comment period and submitted to the USEPA, Region 5, for their review and approval. The USEPA has 30 days to review and approve or disapprove a TMDL. After a TMDL is approved by the USEPA, the water body is removed from the Section 303(d) list (Category 5) and reclassified as Category 4a. For additional information regarding delisting Category 5 assessment units see Section 4.13.

### *9.3.2 TMDLs Completed*

In 2010 and 2011, 30 assessment units had TMDLs developed and approved for a variety of parameters (Table 9.11). A TMDL may address multiple causes. Additional information regarding approved TMDLs is available at http://www.michigan.gov/deqwater under Water Quality Monitoring, Assessment of Michigan Waters, TMDLs.

Table. 9.11 Number of assessment units with TMDLs completed and approved in 2010 and 2011.

| Year | Parameter | Number |
|---|---|---|
| 2010 | Pathogen | 19 |
| 2011 | Pathogen | 10 |
| | Phosphorus | 1 |

### *9.3.3 TMDL Schedule*

To facilitate organization and communication, TMDL groups were created for the 2012 IR. These TMDL groups do not relate to how the USEPA counts the number of TMDLs that are scheduled or completed. A TMDL group consists of assessment units in close geographic proximity listed in Category 5 with the same cause(s) and source(s).

TMDL groups are prioritized for TMDL development considering the existing TMDL schedule (i.e., the number of TMDLs currently scheduled for each year), Michigan's five-year rotating watershed cycle (Figure 3.1), available resources to complete TMDLs, data and supporting information quality and quantity, complexity of the problem and severity of the pollution, and the USEPA's recommendation to develop TMDLs within 13 years of listing.

TMDLs for organic chemicals with atmospheric sources (e.g., PCBs, chlordane, DDT, and dioxin) will be completed over the next several years. Most will likely be addressed by a common approach; for example TMDL development for waters impaired primarily by atmospheric sources of mercury and PCBs are currently underway and scheduled to be completed in late 2012. Michigan's 303(d) list, including assessment unit information and TMDL year, is presented in Appendix C.

### *9.3.4 Changes to the Section 303(d) List*

Modifications to the 2010 Section 303(d) list to create the 2012 Section 303(d) list are provided in Appendix D. This list reflects the deletion and addition of assessment units or causes of impairment since the 2010 IR. Section 303(d) delisted assessment units may or may not support designated uses. For example, it may have been determined that the assessment unit is not supporting one or more designated uses but a TMDL is not required, or a cause of impairment may have been removed but a TMDL is still required to address a different cause of impairment. A brief delisting reason is provided in this list; detailed information may be found in the comment field in the ADB via the MiSWIMS (http://www.michigan.gov/miswims). Deletions and additions to the Section 303(d) list presented in Appendix D are also displayed on the following maps (Figures 9.1 and 9.2).

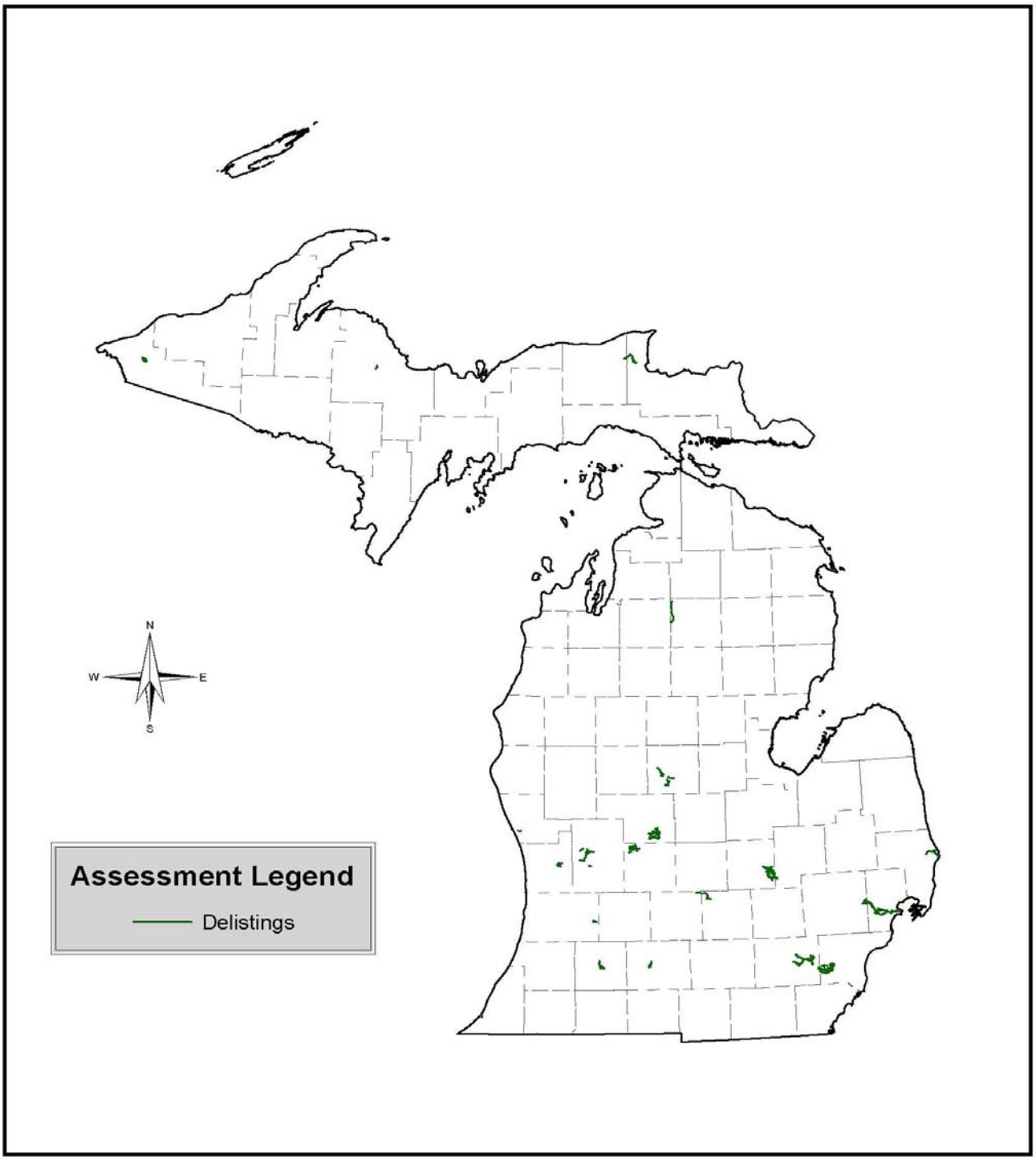



**Figure 9.1 Section 303(d) Delistings. This information is displayed in table format in Appendix D1.**

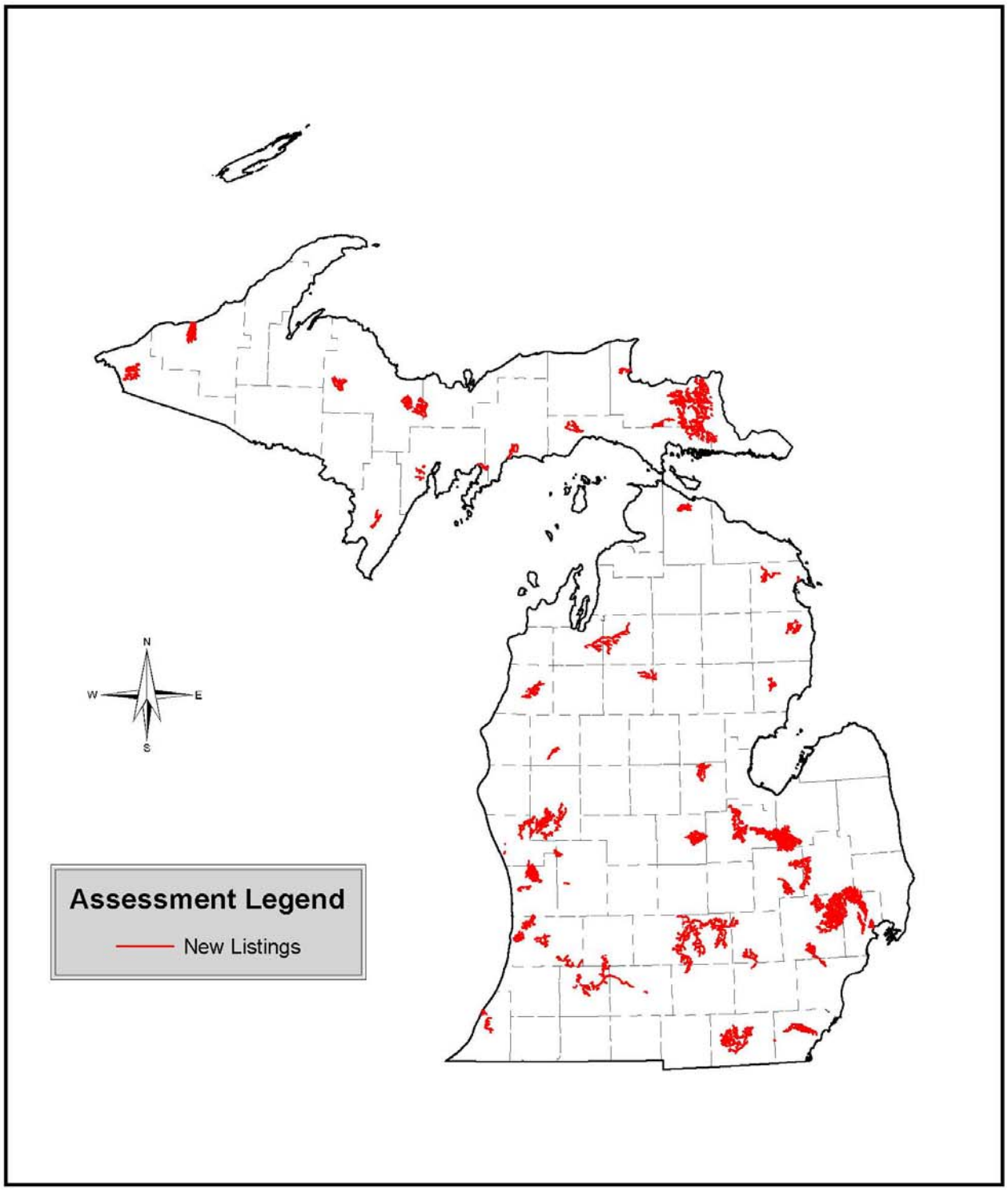



**Figure 9.2 Section 303(d) New Listings. This information is displayed in table format in Appendix D2.**

## CHAPTER 10
## PUBLIC PARTICIPATION IN THE IR

### 10.1 Introduction

The MDEQ provides opportunities for public participation in the development of the IR. The following information is a summary of those opportunities, the comments or information received from the public, and the MDEQ's response.

### 10.2 Request for Data

The MDEQ, WRD, requested ambient water quality data (chemical, biological, or physical) that was obtained by other governmental agencies, nongovernmental organizations, or the public for Michigan surface waters since January 1, 2009. All water quality data submitted to the MDEQ, WRD, before June 27, 2011, was evaluated according to the MDEQ's assessment methodology (see Chapter 4) and potentially used to help prepare this IR. This request was published on the MDEQ's calendar on April 11, April 25, May 9, and May 23, 2011, and e-mailed to key individuals in the MDNR's Fisheries Division, MDARD-Right to Farm, United States Forest Service, USFWS, University of Michigan and the USEPA. Data were received from the following organizations: Tip of the Mitt Watershed Council, City of Grand Rapids, The Watershed Center of Grand Traverse Bay, The Indian Lake Association, Water Quality Investigators Incorporated, Allendale Public Schools, Shiawassee County Health Department, Barry County Conservation District, Trout Unlimited, and The Union Lake Association.

### 10.3 Public Notice of Draft Assessment Methodology

A draft version of Chapter 4, the assessment methodology, was made available on the MDEQ's Web site for public review and comment. This announcement was published on the MDEQ's calendar on June 6, June 20 and July 4, 2011. Public comments to be considered in the development of Chapter 4 were due July 15, 2011. Comments on the draft assessment methodology were received from the Alliance for the Great Lakes and the Michigan Manufacturers Association. Public comments regarding the Assessment Methodology in their entirety and MDEQ responses are presented in Appendix E.

### 10.4 Public Notice of the Draft IR

A draft version of this IR was made available on the MDEQ's Web site for public review and comment from December 5, 2011, through January 13, 2012. This announcement was published on the MDEQ's calendar on December 5, 2011; December 19, 2011; and January 2, 2012.

The MDEQ recognizes the importance of public comments and thanks individuals and organizations that provided input, expressed water quality concerns, or posed questions. The following section summarizes the MDEQ's response to public comments pertaining to the Draft

2012 IR. Public comments to the Draft Integrated Report are presented in their entirety starting on page 33 of Appendix E.

Comment #1:
The additional criteria, which the Department has included in Figure 4.4 concerns whether top predator fish ("generally largemouth or small mouth bass, walleye, northern pile (*sic*) or muskellunge) are above 0.35 pm in (*sic*) inconsistent with promulgated rules. The promulgated rule requires the Department to label a water body as "not impaired" if the geometric mean of ALL fish is at, or below, 0.35 ppm not the geometric mean of top predator fish.

The Department cannot, as it proposes to do in Figure 4.4; list lakes as having "insufficient data" if the geometric mean of all fish specie is at or below 0.35 but top predatory fish is above 0.35. The Michigan rule is based on all fish specie. Lakes that the Department lists as "Having insufficient data" inappropriately become impaired water bodies, when the Department later imposes a state wide impairment ranking on such lakes. (Michigan Manufacturers Association)

MDEQ Response:
*To clarify the decision diagram in Figure 4.4, you have correctly stated that comparison to the value of 0.35 mg/kg of mercury is conducted for any species, provided we have a sufficient sample size (at least 5 fish). As Figure 4.4 illustrates, the assessment process does not preclude using a range of species for support determinations. Because top predators are more likely to have increased tissue concentrations of mercury, their inclusion in the diagram is meant as a step that provides additional assurance that a water body is supporting the consumption designated use if 1) the tissue mercury concentration is less than 0.35 mg/kg and 2) if the species analyzed is a top predator. Fish species that are analyzed and found to have tissue concentrations less than 0.35 mg/kg but are not top predators may be assessed as either supporting the consumption designated use, or as Insufficient Information so that future collections may target top predators to provide a more comprehensive picture of tissue concentrations which may be consumed by humans thereby maintaining a fairly conservative stance on protecting human health.*

*As a point of clarification, while Part 4, Water Quality Standards (WQS) of Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, identifies the methods by which WQS are developed and defined, it does not define the breadth of data and information to be used when evaluating water quality and comparing it to the WQS or the designated uses therein.*

*Contrary to your statement, lakes listed as having Insufficient Information do not become classified as Not Supporting (impaired); the Insufficient Information Category is used to keep record of water bodies for which additional data is needed to enable a more definitive Designated Use assessment and the process by which we assess and categorize water bodies as Insufficient Information (or any other Category) is driven by our Assessment Methodology (Chapter 4) which spells out how we compare available data to the WQS.*

Comment #2:
The DEQ also departs from the GLI and lists lakes as impaired even though fish tissue values meet the 0.35 ug/l criteria but water column values exceed a different 0.018 ug/l value. (Michigan Manufacturers Association)

MDEQ Response:

*The water column mercury concentration of 0.018 ug/L is a Water Quality Standard that is used in conjunction with fish tissue criterion. Because the water column value is a promulgated WQS and the fish tissue data is not a WQS, you are correct that the WQS is used to drive the listing in situations where we either don't have fish tissue data or where tissue data would suggest a Supporting designation (see Table 4.3).*

Comment #3:
The Draft Assessment does not adequately describe how or why Michigan water bodies are listed as impaired for PCB. There is no discussion of the geometric mean PCB fish tissue-concentration for any of the state's 46,000 inland or Great lakes. There is only a confusing discussion of PCB water column concentrations which state that EPA procedures require that only dissolved PCB water column concentrations be reported, followed by an inexplicable statement that Michigan non-the-less (*sic*) reports the combination of dissolved and particulate PCB. (Michigan Manufacturers Association)

MDEQ Response:
*Based on your comments we have added text to clarify how fish tissue PCB data is used, we agree that the text provided little explanation of this process.*

*Michigan uses water column total PCBs data to compare to the WQS of 0.026 nanograms per liter because the Standard is a total PCBs concentration. The recommended EPA methods provide the correct collection and analytical procedures, while the addition of dissolved and particulate fractions is done to obtain a concentration that is relevant and comparable to the Michigan WQS.*

Comment #4:
Other states are using Designated Use Category 4b for mercury and PCB impairments to water bodies. There is no reason for Michigan to not do the same. Water bodies having impairments in Category 4b need not create a TMDL but if the Department continues to leave these water bodies in Category 5, a TMDL will have to be developed, even though the creation of such a TMDL has no practical benefit. Again as the Department has correctly stated, the cause of these impairments are atmospheric. A TMDL can only seek to regulate water discharges. Since water discharges are an inconsequential source of the impairments; placing these water bodies in Category 5, requiring the developments (*sic*) of TMDLs and placing further controls on inconsequential water discharges are all very inappropriate. (Michigan Manufacturers Association)

MDEQ Response:
*The MDEQ did not pursue Category 4b for mercury and PCB impairments because that categorical listing is not appropriate for these statewide impairments and potentially far-ranging sources. The USEPA developed Category 4b to address water bodies for which a TMDL is not needed because other pollution control requirements are expected to result in the attainment of the WQS within a reasonable period of time. Based on USEPA guidance, states considering water bodies for the 4b Category should address various elements including: an estimate or projection of the time when the WQS will be met, schedule for implementing pollution controls, monitoring plan to track effectiveness of pollution controls, and commitment to revise pollution controls, as necessary. Because of the potential multi-jurisdictional sources (and controls) involved in the air depositional sourcing involved in these statewide impairments for mercury and PCBs the applicability of 4b is questionable. In fact, the State of Massachusetts attempted this alternative and was disapproved by the USEPA as described in the Northeast Regional Mercury TMDL, October 2007 (http://www.epa.gov/waters/tmdldocs/Northeast-Regional-*

*Mercury-TMDL.pdf, pages 4-5). We are not aware of other states using the 4b category to address statewide impairments from PCBs and mercury based on largely atmospheric deposition that may source from not only outside the state, but outside the country.*

*In contrast to your speculation that they will place further controls on water discharges, the statewide mercury and PCB TMDLs are focused on the air deposition sourcing that is understood to be the majority of pollutant loading causing the statewide impairments to water quality.*

Comment #5:

The Alliance urges MDEQ to do more to address the problem of nuisance algae. Michigan's water quality standards require that surface waters not have any "deposits" in "unnatural quantities which are or may become injurious to any designated use." Despite this standard, Michigan has failed to develop an appropriate methodology to determine what "unnatural quantities" of algae are. Michigan's failure to develop an appropriate measurement for algae impairments violates the Clean Water Act. At a minimum, the Alliance asks MDEQ to improve public awareness by listing specific beaches impaired by nuisance algae. (Alliance for the Great Lakes)

MDEQ Response:
*As the result of a Great Lakes Restoration Initiative grant in late 2010, funding was provided to increase beach monitoring through local health departments and create a database accessible through BeachGuard to store the information collected. As a result data on algal deposits were being collected more consistently in 2011 (and planned for 2012) through sanitary surveys, in addition to the Adopt-a-Beach program, and is more accessible through electronic reporting, we will be investigating ways to query and incorporate that information in future processes. Although it is not clear how transferrable that qualitative information may be to the assessment and listing process, the AGL is correct in highlighting that this source of information should be used as we discuss how to address the issue of shoreline build-up of algae and other organic material and how it is best reflected in the assessment and listing process.*

Comment #6
MDEQ's response to the (Assessment Methodology) comments said that MDEQ does not have enough information to establish a transferrable and meaningful process applicable to all areas of the Great Lakes and inland lakes. At least one other Great Lakes state, namely Minnesota, already uses lake eutrophication as a metric to evaluate use support (Guidance Manual for Assessing the Quality of Minnesota Surface Waters, Minnesota Pollution Control Agency, December 2011, page 29). In addition to measuring Secchi depth, total phosphorus, and chlorophyll-a concentrations (which MDEQ is already monitoring) the lakes are classified according to their ecoregion and depth. The Alliance urges MDEQ to adopt Minnesota's approach as a model. (Alliance for the Great Lakes)

MDEQ Response:
*The process used by Minnesota appears similar, but with more explicit standards based on ecoregion and lake type, to that used by Michigan in identifying lake eutrophication using the same measures, as described in Section 4.6.1.2 Water Column Nutrient Concentrations of the MDEQ's 2012 Integrate Report. Minnesota's approach, however, does not address Great Lakes water bodies, nor does it appear to address near shore algal buildup, the issues specific to many of the submitted comments.*

Comment #7
The proposed 2012 impaired waters list only includes two beaches in Saginaw Bay (Singing Bridge and Twinning Road beaches) due to high *E.coli* levels there. According to information provided by MDEQ, most health departments in Michigan are using EPA's beach sanitary survey form in one form or another at their beaches. This sanitary survey form allows beach managers to record the amount of algae present both on the beach and in near shore areas in the water. These beach sanitary survey forms recorded by beach managers are a readily available data source that must be used by MDEQ in developing its impaired waters list.

Like beach managers, Alliance's Adopt-a-Beach™ volunteers perform a beach assessment during their beach visits and have routinely documented high levels of algae on the beaches and in the water throughout Michigan. (Alliance for the Great Lakes)

MDEQ Response:
*Please see the response to Comment #5, above. Sanitary survey and beach assessment information currently is not a data type that is able to be used to make impairment decisions for a variety of reasons. Only since 2011 has the sanitary survey information begun to be collected and stored in a way that makes accessing and using it more feasible, and that data was not available for consideration during this 2012 reporting cycle (see Section 4.2 for discussion on data used for designated use support determination). The increased accessibility of the sanitary survey data in BeachGuard and historic beach assessment data from the Adopt-a-Beach program may be useful in future assessment processes for providing supportive information screening beaches for the need for additional monitoring or aiding in understanding what "unnatural quantities" of deposits are with regard to beach deposits of algae and other organic material – including the variability that will be inherent to that throughout the state, how beach deposits of algae are measured in a meaningful and consistent way, and how to incorporate that into an assessment method that is transferable and meaningful to all areas of the Great Lakes and inland lakes.*

Comment #8:
Michigan must address beaches that are either listed as fully supporting total or partial body contact recreation or not evaluated at all that experience more than 14 Beach Action Days in one season.

MDEQ Response:
*The number of and duration of beach closures and advisories is not always related to E. coli data, which is why it was decided not to use closures and advisories. For example, health departments may issue closures and advisories as a precaution regardless of the E. coli results because the lab tests take at least 24 hours to obtain results or the length of closures and advisories may be a reflection of the monitoring schedule and not the water quality (e.g. a 7-day closure reflecting a weekly monitoring schedule). It is important that we have a consistent approach to assessing beaches so we base decisions on monitoring data and not individual local health department public health policies because of the potential for variability between them. It should be recognized that the MDEQ has no authority over local Health Officers with regard to how they protect public health and make decisions about closures and advisories.*

Comment #9:
There are a number of beaches that are not listed as impaired for either or both total and partial body recreation that had 14 or more action days. The Alliance asks MDEQ to reconsider the health of each of these beaches due to the high number of action days. Many, if not all, of these action days were the result of high *E. coli* levels at the beach. (Alliance for the Great Lakes)

MDEQ Response:
*The assessment decisions for the following beaches were made according to our methodology (found in Figure 4.2a) for total and partial body contact.*

- *Singing Bridge Beach (Arenac County)*
- *Brimley State Park (Chippewa County*
- *Sherman Park (Chippewa County)*
- *Au Sable Township Park (Iosco County)*
- *New Baltimore Park Beach (Macomb County)*
- *Pier Park (Wayne County)*

*The Alliance cites data reported in 2011 for Brimley State Park and Sherman Park. We included data from 2009 and 2010 in the assessments made for this 2012 IR following Section 4.2 of our Assessment Methodology. It is important to note that the MDEQ is partnering with the Chippewa County Health Department to identify contamination sources and address them at the Brimley State Park and Sherman Park beaches.*

*Our methodology is designed to list beaches with data that consistently exceed our standards and does not evaluate action days for the reasons mentioned in response to Comment #8, above. Please refer to Figure 4.2a for a full description of how acceptable data is assessed relative to both partial and total body contact Designated Uses.*

*It is worth noting that the 58 beach action days in 2010 for the Au Sable Township Park Beach resulted from health department monitoring identifying an E. coli result that exceeded standards collected when dredging operations at a nearby river mouth deposited dredge spoils in the beach area. The decision was to leave the advisory in place until the dredging was concluded and sampling confirmed that E. coli levels had returned to their normal (low) background level. This beach has been tested since 2004 and reported no exceedances until August 3, 2010; monitoring results have commonly been less that 10 E. coli per 100 ml. Although not used during this assessment cycle, monitoring data in 2011 met WQS. This illustrates the difficulties in using beach action days to make listing decisions and why they are not used in this assessment process to determine Designated Use attainment.*

Comment #10:
Additionally, due to elevated *E. coli* levels detected by Alliance's Adopt-a-Beach™ volunteers, the Alliance also requests that MDEQ consider listing several additional beaches. Elevated *E. coli* levels were found at a number of beaches across Michigan. Based on the *E. coli* results detected by these volunteers, the Alliance asks MDEQ to re-evaluate these beaches and consider them for listing. Private beaches, such as Greenpoint Dunes preserve in Benzie County, need to be considered as well for statewide listings such as this. (Alliance for the Great Lakes)

MDEQ Response:
*We appreciate the volunteers' willingness to collect and analyze samples on their own. However, we are limited in our ability to consider these results due to the limitations of the data. Our WQS are based on triplicate samples, so we are unable to use one or two individual samples to make assessment and listing decisions. Most of the data used to make assessment and listing decisions comes from local health department monitoring programs, all of which are funded with state and federal funds and follow an approved Quality Assurance Project Plan (QAPP) thereby providing consistency in results across the state.*

*It may be helpful for volunteer monitors to develop partnerships with local health departments to help support the local beach monitoring program. This type of partnership can provide consistency while respecting the authority of the Health Officer to use monitoring data to protect public health.*

## Literature Cited


Aiello, C. 2003. Michigan Water Chemistry Trend Monitoring 2001 Report. Michigan Department of Environmental Quality, Water Division. Report #MI/DEQ/WD-03/085.

Aiello, C. 2004. Michigan Water Chemistry Monitoring Great Lakes Tributaries 2002 Report. Department of Environmental Quality, Water Bureau. Report #MI/DEQ/WD-04/049.

Aiello, C. 2005. Michigan Water Chemistry Monitoring Great Lakes Tributaries 2003 Report. Department of Environmental Quality, Water Bureau. Report #MI/DEQ/WB-05/058.

Aiello, C. 2008. Michigan Water Chemistry Monitoring Great Lakes Tributaries 1998-2005 Report. Department of Environmental Quality, Water Bureau. Report #MI/DEQ/WB-08/014.

Bohr, J. and J. Zbytowski. 2008. Michigan Fish Contaminant Monitoring Program: 2007 Annual Report. Michigan Department of Environmental Quality, Water Bureau. Report #MI/DEQ/WB-08/029.

Bohr, J. and J. VanDusen. 2009. Michigan Fish Contaminant Monitoring Program: 2008 Annual Report. Michigan Department of Environmental Quality, Water Bureau. Report #MI/DEQ/WB-09/044.

Bohr, J., and J. VanDusen. 2011a. Michigan Fish Contaminant Monitoring Program: 2009 Annual Report. MDEQ-WRD Report #MI/DEQ/WRD-11/019.

Bohr, J., and J. VanDusen. 2011b. Michigan Fish Contaminant Monitoring Program: 2010 Annual Report. MDEQ-WRD Report #MI/DEQ/WRD-11/028.

Canadian Aquatic Invasive Species Network. 2009. Website accessed February 9, 2009. http://www.uwindsor.ca/CAISN.

Comer, P. 1996. Wetland Trends in Michigan Since 1800: a Preliminary Assessment. Report to USEPA and DEQ-LWMD. Submitted 1996. 76 pp.

Fuller, L.M. and R.J. Minnerick. 2008. State and Regional Water-Quality Characteristics and Trophic Conditions of Michigan's Inland Lakes, 2001-2005. USGS SIR 2008-5188.

GLEC. 2006a. Great Lakes Connecting Channels Data Evaluation and Trend Analysis Report. Report #MI/DEQ/WB-06/092.

GLEC. 2006b. Water Quality Monitoring of Saginaw and Grand Traverse Bays 2005 Annual Data Report. Report #MI/DEQ/WB-07/054.

GLEC. 2007a. Great Lakes Connecting Channels 2005 Annual Data Report. Report #MI/DEQ/WB-07/066.

GLEC. 2007b. Water Quality Monitoring of Saginaw and Grand Traverse Bays. 2005 Annual Data Report. Report #MI/DEQ/WB-07/054.

Great Lakes Environmental Research Laboratory. 2009. Aquatic Invasive Species website accessed March 18, 2009. http://www.glerl.noaa.gov/res/Programs/ais/.

Harris, V. 2004. *Cladophora* Confounds Coastal Communities – Public Perceptions and Management Dilemmas. Proceedings from the *Cladophora* Research and Management in the Great Lakes workshop, University of Wisconsin-Milwaukee. December 8, 2004.

Hecky, R.E., R.EH. Smith, D.R. Barton, S.J. Guildford, W.D. Taylor, M.N. Charlton, and T. Howell. 2004. The Nearshore Phosphorus Shunt: A Consequence of Ecosystem Engineering by Dreissenids in the Laurentian Great Lakes. Can. J. Fish, Aquat. Sci. 61(7):1285-1293.

International Association for Great Lakes Research. 2002. Research and Management Priorities for Aquatic Invasive Species in the Great Lakes. 22 pp.

Jones, R. and K. Gerard. 1999. Reference Site Sediment Chemistry Report for Wadable Streams, 1994, 1997 and 1998. March 1999. MDEQ Report No. MI/DEQ/SWQ-99/060.

LeSage, S. and J. Smith. 2011. Water Quality and Pollution Control in Michigan: 2010 Sections 303(d), 305(b), and 314 Integrated Report. MI/DEQ/WB-10/001.

MacDonald, D. C. Ingersoll and T. Berger. 2000. Development and Evaluation of Consensus Based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contam. Toxicol. 39, 20-31.

MDEQ. 1990. GLEAS Procedure 51 - Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers, April 24, 1990. Revised June 1991, August 1996, January 1997, May 2002, and December 2008. http://www.michigan.gov/documents/deq/wb-swas-procedure51_280711_7.pdf

MDEQ. 1997. A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters. January 1997. Report #MI/DEQ/SWQ-96/152.

MDEQ. 2002a. Quality Assurance Project Plan Review Process - Great Lakes Environmental Assessment Section Procedure 88. May 2002.

MDEQ. 2005a. Michigan Water Quality Monitoring Strategy Update. April 2005. Report #MI/DEQ/SWQ-05/082.

MDEQ. 2005b. MDEQ Quality Management Plan (QMP). December 2, 2005. Revised July, 2008.

MDEQ. 2011. Consolidated Report on the: Environmental Protection Bond Fund, Cleanup and Redevelopment Fund, Clean Michigan Initiative Bond Fund. Annual update including Fiscal Year 2010.

MDEQ. In preparation. Macroinvertebrate Community Status and Trend Monitoring Procedure.

MDEQ. In preparation. Qualitative Biological and Habitat Survey Protocols for Nonwadeable Rivers. Draft copy available upon request.

MDNR, MDA, USDA, and MSU. 1985. State of Michigan Phosphorus Reduction Strategy for the Michigan Portion of Lake Erie and Saginaw Bay.

National Oceanic and Atmospheric Administration. 2011. National Center for Research on Aquatic invasive Species, Great Lakes Environmental Research Laboratory: *GreatLakes Aquatic Nonindigenous Species Information System* accessed May, 2011. www.glerl.noaa.gov/res/Programs/glansis/glansis.html.

Omernik, J. and A. Gallant. 1988. Ecoregions of the Upper Midwest States. USEPA, Envir. Res. Lab. Publication #EPA/600/3-88/037.

Ontario Ministry of the Environment. 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Prepared by: D. Persaud, R. Jaagumagi, and A. Hayton. Water Res. Br. OME. ISBN 0-7729-92-48-7.

Ricciardi, A. 2006. Patterns of invasion in the Laurentian Great Lakes in relation to changes in vector activity. *Divers. Distrib*. 12, 425–433.

Sommers, L.M. (ed). 1977. Atlas of Michigan. Michigan State University Press.

Strum, M. 2000. Total Great Lakes Area and Michigan's Jurisdictional Area. Army Corps. of Engineers, Detroit Office, Great Lakes Hydraulics & Hydrology Unit.

Syed, A.U. and L.R. Fogarty. 2005. Trends in Surface –Water Quality at Selected National Stream Quality Accounting Network (NASQAN) Stations, in Michigan. Scientific Investigations Report 2005-5158.

USEPA. 1997a. USGS Field Operation Plan: Tributary Monitoring. Lake Michigan Mass Balance Study Methods Compendium, Vol. 1: Sample Collection Techniques. EPA 905/R-97-012a.

USEPA. 1997b. PCBs and Pesticides in Surface Water by XAD-2 Resin Extraction. Like Michigan Mass Balance Study Methods Compendium, Vol. 2: Organic and Mercury Sample Analysis Techniques. EPA 905/R-97-012b.

USEPA. 2001. Water Quality Criterion for the Protection of Human Health: Methylmercury. Office of Science and Technology, Office of Water. EPA-823-R-01-001.

USEPA, 2010. Areas of Concern in the Great Lakes-St. Lawrence River Basin. http://www.epa.gov/glnpo/aoc/index.html

USEPA. 2011a. Great Lakes National Program Office Environmental Indicators, Trophic State of the Great Lakes. October 5, 2011. http://www.epa.gov/glnpo/glindicators/water/trophica.html

USEPA. 2011b. Saginaw River and Bay Area of Concern. October 5, 2011. http://www.epa.gov/glnpo/aoc/sagrivr.html

Waples, J. T., and J. V. Klump. 2002. Biophysical Effects of a Decadal Shift in Summer Wind Direction over the Laurentian Great Lakes, Geophys. Res. Lett., 29(8), 1201, doi:10.1029/2001GL014.