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Occurrence and Distribution of Fish Species in the Great and Little Miami River Basins, Ohio and Indiana, Pre-1900 to 1998

By Stephanie Harrington

Water-Resources Investigations Report 99-4198

U.S. DEPARTMENT OF THE INTERIOR
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Foreword

The mission of the U.S. Geological Survey (USGS) is to assess the quantity and quality of the earth resources of the Nation and to provide information that will assist resource managers and policymakers at Federal, State, and local levels in making sound decisions. Assessment of water-quality conditions and trends is an important part of this overall mission.

One of the greatest challenges faced by water-resources scientists is acquiring reliable information that will guide the use and protection of the Nation's water resources. That challenge is being addressed by Federal, state, interstate, and local water-resource agencies and by many academic institutions. These organizations are collecting water-quality data for a host of purposes that include compliance with permits and water-supply standards; development of remediation plans for specific contamination problems; operational decisions on industrial, wastewater, or water-supply facilities; and research on factors that affect water quality. An additional need for water-quality information is to provide a basis on which regional- and national-level policy decisions can be based. Wise decisions must be based on sound information. As a society we need to know whether certain types of water-quality problems are isolated or ubiquitous, whether there are significant differences in conditions among regions, whether the conditions are changing over time, and why these conditions change from place to place and over time. The information can be used to help determine the efficacy of existing water-quality policies and to help analysts determine the need for and likely consequences of new policies.

To address these needs, the U.S. Congress appropriated funds in 1986 for the USGS to begin a pilot program in seven project areas to develop and refine the National Water-Quality Assessment (NAWQA) Program. In 1991, the USGS began full implementation of the program. The NAWQA Program builds upon an existing base of water-quality studies of the USGS, as well as those of other Federal, state, and local agencies. The objectives of the NAWQA Program are to

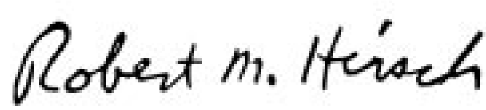
- Describe current water-quality conditions for a large part of the Nation's freshwater streams, rivers, and aquifers.
- Describe how water quality is changing over time.
- Improve understanding of the primary natural and human factors that affect water-quality conditions.

This information will help support the development and evaluation of management, regulatory, and monitoring decisions by other Federal, state, and local agencies to protect, use, and enhance water resources.

The goals of the NAWQA Program are being achieved through ongoing and proposed investigations of 59 of the Nation's most important river basins and aquifer systems, which are referred to as study units. These study units are distributed throughout the Nation and cover a diversity of hydrogeologic settings. More than two-thirds of the Nation's freshwater use occurs within the 59 study units, and more than two-thirds of the people served by public water-supply systems live within their boundaries.

National synthesis of data analysis, based on aggregation of comparable information obtained from the study units, is a major component of the program. This effort focuses on selected water-quality topics using nationally consistent information. Comparative studies will explain differences and similarities in observed water-quality conditions among study areas and will identify changes and trends and their causes. The first topics addressed by the national synthesis are pesticides, nutrients, volatile organic compounds, and aquatic biology. Discussions on these and other water-quality topics will be published in periodic summaries of the quality of the Nation's ground and surface water as the information becomes available.

This report is an element of the comprehensive body of information developed as part of the NAWQA Program. The program depends heavily on the advice, cooperation, and information from many Federal, state, interstate, tribal, and local agencies and the public. The assistance and suggestions of all are greatly appreciated.



Robert M. Hirsch
Chief Hydrologist

CONTENTS

FIGURES

TABLES

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
Length		
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
Area		
acre	4,047	square meter
acre-foot	1,233	cubic meter
square mile (mi^2)	2.590	square kilometer

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$°C = (°F - 32) / 1.8$$

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Occurrence and Distribution of Fish Species in the Great and Little Miami River Basins, Ohio and Indiana, Pre-1900 to 1998

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ABSTRACT

Historically, 133 fish species representing 25 families have been documented in the Great and Little Miami River Basins. Of these, 132 species have been reported in the basins since 1901, 123 since 1955, 117 since 1980, and 113 post-1990. Natural processes and human activities have both been shown to be major factors in the alteration of fish-community structure and the decrease in species diversity. In the late 1800's, dam construction and the removal of riparian zones restricted fish migration and altered habitat. Industrialization and urbanization increased considerably in the 1900's, further degrading stream habitat and water quality. Species requiring riffles and clean, hard stream bottoms were the most adversely affected. The use of agricultural and industrial chemicals prompted fish-consumption advisories and an increase in studies reporting the occurrence of external fish anomalies. Over the last 20 years, water quality has improved in part because of the upgrading of wastewater-treatment facilities; and, as a result, many streams of the Great and Little Miami River Basins generally meet or exceed existing water-quality standards. Although significant improvements have occurred in the basins, continued efforts to improve water quality and restore the physical habitat of streams will be necessary to increase fish abundance and biodiversity.

INTRODUCTION

In 1991, the U.S. Geological Survey began the National Water-Quality Assessment (NAWQA) Program. The long-term goals of the NAWQA Program are to describe the status and trends in the water quality of a large, representative part of the Nation's surface- and ground-water resources and to provide a sound scientific understanding of the primary natural and human factors affecting the quality of these resources (Hirsch and others, 1988). The Great and Little Miami River Basins is one of more than 50 major river and aquifer systems—termed "study units"—chosen by the NAWQA Program to represent the diverse geography, water resources, and land and water uses in the Nation. The Great and Little Miami River Basins study unit (hereafter termed the study area) includes (1) three large watersheds in the Ohio River Basin, (2) largely agricultural watersheds affected by two major urban areas and rapid urbanization, and (3) a heavily used glacial aquifer system that is one of the most productive in the Nation (Rowe and Baker, 1997). Part of the study area—the Mill Creek Basin in Cincinnati, Ohio was not included in this report because of severe ecological impairment caused by decades of stream-channel modification and discharge of pollutants from sanitary sewers, municipal treatment plants, industrial outfalls, and waste-storage facilities. In addition, historical fish data for this basin are not readily available prior to the late 1980's. Those interested in fish-survey data collected in the Mill Creek Basin are referred to Ohio Environmental Protection Agency (1994a).

One objective of the NAWQA program is to document and describe natural and human influences on the health of aquatic ecosystems in each basin. Information about biological communities in streams is collected in each study area to help define relations between the physical, chemical, and biological characteristics of streams (Gurtz, 1994). To address this objective and to aid in the design of ecological studies in the Great and Little Miami River Basins study area, a review of available information has been completed. This report summarizes historical information on the fish species that occur in the Great Miami River, Little Miami River, and Whitewater River; the factors that influence distribution and occurrence; and the changes that have been or are currently being made to improve fish-species biodiversity.

DESCRIPTION OF THE GREAT AND LITTLE MIAMI RIVER BASINS

The Great and Little Miami River Basins cover approximately 7,350 mi^2 (fig. 1). Altitudes in the study area range from 1,550 ft in the northern part to 450 ft at the southern boundary. The climate is temperate continental; mean annual temperature ranges from 49×××° to 55°F, and average annual precipitation ranges from 36 in. in the north to 42 in. in the south. Three large river systems drain the study area. The Great Miami River (drainage area, 5,330 mi^2) and the Little Miami River (drainage area, 1,757 mi^2) are in southwestern Ohio, and the Whitewater River (drainage area, 1,460 mi^2) is in southeastern Indiana. The Whitewater River exits Indiana in Dearborn County and joins the Great Miami River in Hamilton County near Cincinnati. Both the Great and Little Miami Rivers drain directly into the Ohio River.

Streamflow in the study area is affected by five flood-retention dams and eight lowhead dams in the Great Miami River Basin (Miami Conservancy District, 1998), one dam on the East Fork Whitewater River, and four dams on the East Fork Little Miami River and main stem of the Little Miami River, respectively (Ohio Environmental Protection Agency, 1985, 1984a; Robert Gable, Ohio Department of Natural Resources, oral commun., 1999). The study area contains seven reservoirs with capacities greater than 5,000 acre-feet; the two largest are Indian Lake, near Russells Point, Ohio, and Brookville Lake, near Brookville, Indiana.

The Mad River, a Great Miami River tributary, receives the greatest amount of ground-water discharge in the study area (Koltun, 1995). As a result, this river is able to support assemblages of coldwater organisms that meet the Ohio Environmental Protection Agency's (OEPA) designated aquatic life use criteria for a coldwater habitat (Rankin and others, 1996a).

The study area spans two ecoregions, the Eastern Corn Belt Plains and the Interior Plateau. Most of the study area lies within the Eastern Corn Belt Plains, which is characterized by flat to gently rolling terrain underlain by glacial till and rich soils. The southern part of the study area lies within the Interior Plateau, which is characterized by rugged terrain, woodlands, and a mixture of glaciated and unglaciated areas. Approximately 80 percent of land in the study area is used for agricultural activities, primarily row-crop production of corn, soybeans, and wheat. Principal livestock are swine, cattle, and poultry. Residential, commercial, and industrial land make up 13 percent of the area, and the remaining area consists of forests (7 percent) and water bodies or wetlands (1 percent). Major industries, which are concentrated along the Dayton-Cincinnati corridor, produce automobile parts, business and computer equipment, chemicals, household goods, paper products, and processed foods and beverages.

In 1995, the estimated population of the study area was approximately 2.8 million, mostly concentrated in the vicinity of the largest cities in the study area: Cincinnati, Dayton, and Hamilton, Ohio (Rowe and Baker, 1997).

HUMAN FACTORS INFLUENCING RECORDS OF FISH OCCURRENCE AND DISTRIBUTION

Numerous changes and advances in scientific methods and technology have occurred since the earliest records of fish occurrence and distribution were made in the study area. Four human factors affect the validity of records of fish occurrence and distribution, as well as temporal trends among sample periods and (or) individual species shown later in the report.

Changes in nomenclature have been made over time as a result of improved identification skills and the need to establish guidelines for common names of fish used by fishermen, biologists, and the market. Many early specimens recorded as a single, distinct species were later found to be two or more individual species. For example, neither white and black crappie nor black and smallmouth buffalo were considered to be separate species until the late 1800's and early 1900's, respectively (Trautman, 1981). Sauger and walleye are popular game fish that are difficult to distinguish from

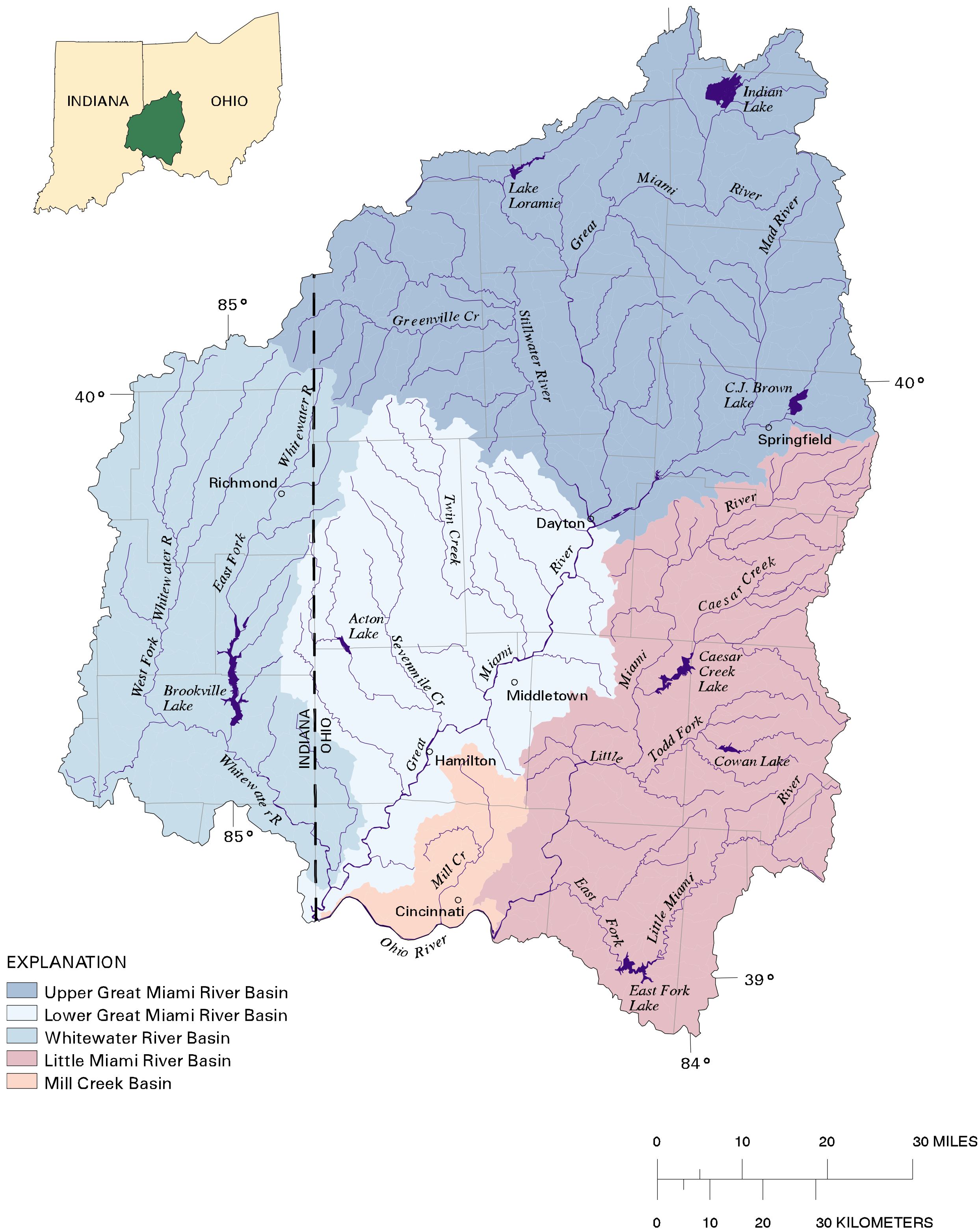

Figure 1. The Great and Little Miami River Basins.

one another, and many early reports of walleye by local fishermen may have actually been sauger.

Occurrence of fish species documented over time may reflect improvements in sampling techniques and equipment. Early 1800's methods of collection included seining, spear fishing, and hook and line. Efficiency of fish capture increased significantly with the introduction of gill and pound nets in 1855, and then again in 1952, when the electric shocker was first used. The Ohio Environmental Protection Agency (1984b) stated that more efficient sampling techniques used in their 1984 survey were responsible for the collection of additional species, particularly larger riverine species, not documented by Trautman during the 1955-80 period.

Exotic and native fish have been introduced or accidentally released into the study area since the early 1700's. Cavender (1981) reported that the number of non-native species had increased "at an alarming rate" during the 1970's as a result of bait-fish, aquarium, and sport-fishing industries. Historically, 13 exotic species have been collected in the study area. The common carp, goldfish, and redear sunfish are introduced species that seem to be well established. Others, such as the American eel, white catfish, eastern banded killifish, western mosquitofish, and brook trout, are somewhat established but in very few areas. For the species rainbow trout, brown trout, chain pickerel, striped bass, and grass carp, there is no evidence that sustainable populations exist. The grass carp was introduced as a means of controlling aquatic vegetation; it is stocked in its sterile, triploid, form to avoid invasion of this species into water bodies where they are unwanted (Ohio Department of Natural Resources, 1989). Species and hybrids stocked by the Ohio Department of Natural Resources into streams in the study area include the rainbow trout and brown trout (Mad River) and saugeye (Great Miami River). Species stocked into reservoirs and ponds include channel catfish, walleye, largemouth bass, tiger muskie, and hybrid striped bass (Ohio Department of Natural Resources, 1990). The Indiana Department of Natural Resources currently stocks only rainbow trout into the Whitewater River (Brian Shoney, Indiana Department of Natural Resources, oral commun., 1999)

Few references to hybrids can be found in the pre-1980 literature. Therefore, historical information on the occurrence and distribution of hybrids in the study area is limited. Hybrids are frequently documented as a full species or are referenced in large geographic areas, making relevance to the study area difficult to determine. Historically, hybrids were generally believed to be accidents of nature (Trautman, 1981). More recent studies have shown that environmental factors such as overcrowding and habitat degradation play an important role in an increasing trend in hybridization (Trautman, 1981). OEPA documented 18 hybrids in the Great and Little Miami River Basins during 1980-89 and 26 hybrids during 1990-98 (table 1). Because of the lack of hybrid records and the inability of many ichthyologists to accurately distinguish among hybrid species, hybridizations are not considered further in this report.

Table 1. Fish hybrids documented by the Ohio Environmental Protection Agency since1980

[Source: Ohio Environmental Protection Agency (1983a, 1983b, 1984a, 1984b, 1985, 1991, 1994, 1995, 1996, 1997)]

River carpsucker x quillback carpsucker	Brown bullhead x black bullhead	Bluegill x pumpkinseed
Hybrid x minnow	Yellow bullhead x brown bullhead	Bluegill x orangespotted sunfish
Carp x goldfish	Striped bass x white bass	Longear sunfish x bluegill
Striped shiner x river chub	Hybrid x sunfish	Longear x orangespotted sunfish
Striped shiner x rosyface shiner	Green sunfish x bluegill	Pumpkinseed x longear
Striped shiner x stoneroller	Green sunfish x pumpkinseed	Orangespotted sunfish x pumpkinseed
Striped shiner x hornyhead chub	Green sunfish x longear	Sauger x walleye
Striped shiner x rosefin shiner	Green sunfish x orangespotted sunfish	Rainbow darter x orangethroat darter
Striped shiner x creek chub	Green sunfish x hybrid	

HISTORICAL RECORDS OF FISH OCCURRENCE

The first records of fish occurrence in the Ohio territories were written by English traders in the early 1700's. Significant contributors to historical fish-data collections in the 19th century include C.S. Rafinesque, John H. Klippart, and James A. Henshall. Interest in the distribution and occurrence of fish species increased after 1920, and data were collected by many state agencies, universities, and individuals. Milton B. Trautman compiled these historical data with findings from his own surveys in "Fishes of Ohio," first published in 1957. The work was later revised to include occurrence and distribution data for 1955-80 (Trautman, 1981). Early records of fish occurrence in the Whitewater River in Indiana were made by Plummer (1851), Evermann (1886), Hay (1894), Shoemaker (1942), and Gerking (1945). Since 1982, extensive collections of fish data have been compiled by the OEPA.

Historical records of fish occurrence in the Great and Little Miami Basins are summarized in table 2 and figure 2. The table is divided into five time periods[1]: pre-1900, 1901-54, 1955-80, 1980-89, and 1990-98. Selected time periods are those used by Trautman (pre-1900 to 1980) or were chosen to represent current conditions (1980 to 1998). Most of the information was compiled from comprehensive publications by Trautman (1981), the Ohio Environmental Protection Agency (1983a, 1983b, 1984a, 1984b, 1985, 1991, 1992a, 1992b, 1994b, 1995, 1996, and 1997) and Gerking (1945). Common and scientific names in table 2 are those published in the fifth edition of "Common and Scientific Names of Fishes From the United States and Canada" (Robins and others, 1991).

Since European settlement in the 1700's, a total of 133 species representing 25 families have been documented in the study area. Of these, 132 species have been reported since 1901, 123 since 1955, 117 since 1980, and 113 post-1990. Forty-five new species were documented during 1901-55; 12 new species during 1955-80; 7 during 1980-89; and 2 during 1990-98. A significant decrease in the number of species recorded in each watershed was observed between 1955-80. The greatest loss of intolerant species was also recorded during this time period. After 1980, however, increases in the number of fish species were observed in the Great Miami, Little Miami, and Whitewater Basins.

Ten fish species have not been collected from the study area since before 1955 (Ohio lamprey, least brook lamprey, brook trout, streamline chub, bluebreast darter, lake sturgeon, pugnose minnow, blacknose shiner, channel shiner, and channel darter) and five have not been collected since before 1980 (blue catfish, burbot, paddlefish, chain pickerel, goldeye). During a 1993 survey, the blue sucker, a rare and intolerant species, was collected by the OEPA in the Great Miami River after an absence of over 35 years, and in the Little Miami River for the first time. OEPA (1996) considered the presence of this species an indication of improving water quality. The redfin shiner was reported by OEPA in the Little Miami River for the first time in 1998. The crystal darter, extirpated[2] from Ohio's waters, was collected once by McGinty (1967?) in the Whitewater River Basin. The validity of this record was highly questioned, owing to the lack of verified specimens and skepticism from other investigators, and was therefore omitted from table 2. Other questionable records omitted from the table include the occurrence of the blackchin shiner, longnose dace, northern brook lamprey, common shiner (which was most likely a striped shiner), and the popeye shiner. The redfin shiner was omitted from the Whitewater records because it was most likely a misidentified rosefin shiner (Greg Seegert, EA Engineering, written commun., 1990).

Natural processes and human activities have both been shown to be major factors in the decline of many species. The main factor controlling fish-species abundance is a suitable environment, which includes physical characteristics of a stream such as stream order, depth, drainage area, linear distance, and gradient (Ohio Environmental Protection Agency, 1983a). Changes in landscape brought about by the settlers in the early 1800's resulted in the degradation of the region's surface waters. The response of individual species to alterations in physical features and water quality resulted in changes in species occurrence and distribution. The following sections summarize the history of human influences on fish communities in the study area.

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[1]Data obtained from Trautman and OEPA were for multiyear periods rather than for the exact year that a species was collected; therefore, an overlap for 1980 was unavoidable in the temporal subdivision in this report.

[2] ODNR classification for species that occurred in Ohio at the time of European settlement and that has since disappeared from the State.

Table 2. Historical occurrence of fish species in the Great and Little Miami River Basins

[Abbreviations: I, intolerant species; M, moderately intolerant; D, declining; N, non-native; E, endangered species; T, threatened; S, special interest; EXT, extirpated; R, rare; U, uncommon; Letters in parentheses indicate Indiana listed species]

			Great Miami River					Little Miami River					Whitewater River				
Scientific name[1]	**Common name**	**Status**	**pre-1900**	**1901-54**	**1955-80**	**1980-89**	**1990-98**	**pre-1900**	**1901-54**	**1955-80**	**1980-89**	**1990-98**	**pre-1900**	**1901-54**	**1955-80**	**1980-89**	**1990-98**
PETROMYZONTIDAE																	
Ichthyomyzon bdellium (Jordan, 1885)	Ohio lamprey	E, I											x	x			
Ichthyomyzon castaneus Girard, 1858	Chestnut lamprey															x	
Lampetra aepyptera (Abbott, 1860)	Least brook lamprey	D							x								
Lampetra appendix (DeKay, 1842)	American brook lamprey	I		x	x	x	x							x			
POLYODONTIDAE																	
Polyodon spathula (Walbaum, 1792)	Paddlefish	T, I		x	x				x				x	x			
ACIPENSERIDAE																	
Acipenser fulvescens Rafinesque, 1817	Lake sturgeon	(E), E		x										x			
LEPISOSTEIDAE																	
Lepisosteus osseus Linnaeus, 1758	Longnose gar			x	x	x	x		x	x	x	x	x	x		x	x
Lepisosteus platostomus Rafinesque, 1820	Shortnose gar	E														x	x
AMIIDAE																	
Amia calva Linnaeus, 1766	Bowfin				x	x	x										
HIODONTIDAE																	
Hiodon alosoides (Rafinesque, 1819)	Goldeye	E, I, D								x							
Hiodon tergisus Lesueur, 1818	Mooneye	I				x	x				x	x				x	x
CLUPEIDAE																	
Alosa chrysochloris (Rafinesque, 1820)	Skipjack herring				x	x	x				x	x				x	x
Dorosoma cepedianum (Lesueur, 1818)	Gizzard shad				x	x	x			x	x	x		x	x	x	x
Dorosoma petenense (Gunther, 1867)	Threadfin shad						x										
SALMONIDAE																	
Oncorhynchus mykiss (Walbaum, 1792)	Rainbow trout		x		x	x	x				x						
Salmo trutta Linnaeus, 1758	Brown trout			x		x	x										
Salvelinus fontinalis (Mitchill, 1814)	Brook trout	T	x	x													
UMBRIDAE																	
Umbra limi (Kirtland, 1840)	Central mudminnow			x		x	x		x	x	x	x	x	x			
ESOCIDAE																	
Esox americanus vermiculatus Lesueur, 1846	Grass pickerel			x	x	x	x		x	x	x	x			x	x	
Esox lucius Linnaeus, 1758	Northern pike			x	x	x	x				x		x				
Esox masquinongy Mitchill,1824	Muskellunge	(S), S, D			x		x		x	x							
Esox niger Leuseur, 1818	Chain pickerel				x												
CATOSTOMIDAE																	
Carpiodes carpio (Rafinesque, 1820)	River carpsucker		x			x	x	x			x	x	x	x	x	x	x
Carpiodes cyprinus (Lesueur, 1817)	Quillback carpsucker		x		x	x	x	x		x	x	x	x	x	x	x	x
Carpiodes velifer (Rafinesque, 1820)	Highfin carpsucker			x	x	x	x		x		x	x		x	x	x	x
Catostomus commersoni (Lacepede, 1803)	White sucker			x	x	x	x		x	x	x	x	x	x	x	x	x
Cycleptus elongatus (Lesueur, 1817)	Blue sucker	(S), E, I, D		x			x					x	x	x			
Erimyzon oblongus (Mitchill, 1814)	Creek chubsucker	D	x	x	x	x	x		x	x	x	x					
Erimyzon sucetta (Lacepede, 1803)	Lake chubsucker	T, D			x	x	x										
Hypentelium nigricans (Lesueur, 1817)	Northern hog sucker	M		x	x	x	x		x	x	x	x	x	x	x	x	x
Ictiobus bubalus (Rafinesque, 1818)	Smallmouth buffalo			x		x	x		x		x	x					x
Ictiobus cyprinellus (Valenciennes, 1844)	Bigmouth buffalo					x	x				x	x				x	
Ictiobus niger (Rafinesque, 1819)	Black buffalo					x	x			x	x	x					
Minytrema melanops (Rafinesque, 1820)	Spotted sucker			x	x	x	x		x	x	x	x			x		x
Moxostoma anisurum (Rafinesque, 1920)	Silver redhorse	M		x		x	x		x	x	x	x		x	x	x	x
Moxostoma carinatum (Cope, 1870)	River redhorse	(S), S, I		x		x	x		x		x	x		x		x	x
Moxostoma duquesnei (Lesueur, 1817)	Black redhorse	I		x	x	x	x		x	x	x	x	x	x	x	x	x
Moxostoma erythrurum (Rafinesque, 1818)	Golden redhorse	M		x	x	x	x		x	x	x	x	x	x	x	x	x
Moxostoma macrolepidotum (Lesueur, 1817)	Shorthead redhorse	M		x	x	x	x		x	x	x	x	x	x	x	x	x
CYPRINIDAE																	
Campostoma anomalum (Rafinesque, 1820)	Central stoneroller			x	x	x	x		x	x	x	x	x	x	x	x	x
Carassius auratus (Linnaeus, 1758)	Goldfish				x	x	x			x	x	x			x		
Clinostomus elongatus (Kirtland, 1838)	Redside dace	(E), I, D		x	x	x	x		x				x	x		x	x
Ctenopharyngodon idella (Valenciennes, 1844)	Grass carp					x	x										
Cyprinella spiloptera (Cope, 1868)	Spotfin shiner			x	x	x	x		x	x	x	x		x	x	x	x
Cyprinella whipplei Girard, 1856	Steelcolor shiner			x		x	x		x	x	x	x	x	x	x	x	x
Cyprinus carpio Linnaeus, 1758	Common carp		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Erimystax dissimilis (Kirtland, 1840)	Streamline chub	I, D	x					x						x			
Erimystax x-punctata (Hubbs and Crowe, 1956)	Gravel chub	M	x	x	x	x	x	x	x	x	x	x		x		x	x
Exoglossum laurae (Hubbs, 1931)	Tonguetied minnow	T, I, D		x	x	x	x		x	x	x	x					
Hybognathus nuchalis Agassiz, 1855	Mississippi silvery minnow	E				x		x					x				
Luxilus chrysocephalus Rafinesque, 1820	Striped shiner			x	x	x	x		x	x	x	x	x	x	x	x	x
Lythrurus ardens (Cope, 1868)	Rosefin shiner	M, D		x	x	x	x		x	x	x	x		x	x	x	x
Lythrurus umbratilis (Girard, 1856)	Redfin shiner			x	x	x	x					x					
Macrhybopsis storeriana (Kirtland, 1847)	Silver chub			x		x	x	x	x		x	x		x		x	x

Table 2. Historical occurrence of fish species in the Great and Little Miami River Basins---Continued

[Abbreviations: I, intolerant species; M, moderately intolerant; D, declining; N, non-native; E, endangered species; T, threatened; S, special interest; EXT, extirpated; R, rare; U, uncommon; Letters in parentheses indicate Indiana listed species]

			Great Miami River					Little Miami River					Whitewater River				
Scientific name[1]	**Common name**	**Status**	**pre-1900**	**1901-54**	**1955-80**	**1980-89**	**1990-98**	**pre-1900**	**1901-54**	**1955-80**	**1980-89**	**1990-98**	**pre-1900**	**1901-54**	**1955-80**	**1980-89**	**1990-98**
Nocomis biguttatus (Kirtland, 1840)	Hornyhead chub	I, D		x	x	x	x			x			x	x	x	x	x
Nocomis micropogon (Cope, 1865)	River chub	I, D		x	x	x	x	x			x	x		x	x	x	x
Notemigonus crysoleucas (Mitchill, 1814)	Golden shiner			x	x	x	x		x	x	x	x	x	x		x	x
Notropis amblops (Rafinesque, 1820)	Bigeye chub	I, D		x	x	x	x		x	x				x		x	x
Notropis atherinoides Rafinesque, 1818	Emerald shiner			x	x	x	x		x	x	x	x	x	x	x	x	x
Notropis blennius (Girard, 1856)	River shiner			x		x		x	x		x	x		x	x	x	
Notropis boops Gilbert, 1884	Bigeye shiner	T, I, D	x		x						x	x			x		x
Notropis buccatus (Cope, 1865)	Silverjaw minnow			x	x	x	x		x	x	x	x	x	x	x	x	x
Notropis buchanani Meek, 1896	Ghost shiner								x		x	x					
Notropis heterolepis Eigenmann and Eigenmann, 1893	Blacknose shiner	E, I, D		x					x								
Notropis photogenis (Cope, 1865)	Silver shiner	I		x	x	x	x		x	x	x	x		x	x	x	x
Notropis rubellus (Agassiz, 1850)	Rosyface shiner	I, D		x	x	x	x	x	x	x	x	x	x	x	x	x	x
Notropis stramineus (Cope, 1865)	Sand shiner	M		x	x	x	x		x	x	x	x		x	x	x	x
Notropis volucellus (Cope, 1865)	Mimic shiner	I, D		x	x	x	x		x	x	x	x		x	x		x
Notropis wickliffi Trautman, 1931	Channel shiner	I		x					x					x			
Opsopoeodus emiliae Hay, 1881	Pugnose minnow	E, I, D		x													
Phenacobius mirabilis (Girard, 1856)	Suckermouth minnow			x	x	x	x		x		x	x		x	x	x	x
Phoxinus erythrogaster (Rafinesque, 1820)	Southern redbelly dace	D		x	x	x	x		x	x	x	x	x	x	x	x	x
Pimephales notatus (Rafinesque, 1820)	Bluntnose minnow			x	x	x	x		x	x	x	x	x	x	x	x	x
Pimephales promelas Rafinesque, 1820	Fathead minnow		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Pimephales vigilax (Baird and Girard, 1853)	Bullhead minnow					x	x	x			x	x					x
Rhinichthys atratulus (Hermann, 1804)	Blacknose dace			x	x	x	x		x	x	x	x	x	x	x	x	x
Semotilus atromaculatus (Mitchill, 1818)	Creek chub			x	x	x	x		x	x	x	x	x	x	x	x	x
ICTALURIDAE																	
Ameiurus melas (Rafinesque, 1820)	Black bullhead		x	x	x	x	x	x	x	x	x	x		x	x		x
Ameiurus natalis (Lesueur, 1819)	Yellow bullhead		x	x	x	x	x		x	x	x	x	x	x	x	x	x
Ameiurus nebulosus (Lesueur, 1819)	Brown bullhead			x	x	x	x		x		x	x					
Ictalurus catus (Linnaeus, 1758)	White catfish				x		x										
Ictalurus furcatus (Lesueur, 1840)	Blue catfish	E			x												
Ictalurus punctatus (Rafinesque, 1818)	Channel catfish			x	x	x	x		x	x	x	x	x	x	x	x	x
Noturus eleutherus Jordan, 1877	Mountain madtom	E, I, D							x		x	x					
Noturus flavus Rafinesque, 1818	Stonecat	I		x	x	x	x	x	x	x	x	x	x	x	x	x	x
Noturus gyrinus (Mitchill, 1817)	Tadpole madtom			x	x	x	x					x					
Noturus miurus Jordan, 1877	Brindled madtom	I, D		x	x	x	x		x			x		x	x	x	x
Noturus stigmosus Taylor, 1969	Northern madtom	E, I, D				x			x	x	x	x		x		x	x
Pylodictis olivaris (Rafinesque, 1818)	Flathead catfish					x	x		x		x	x	x	x	x	x	x
ANGUILLIDAE																	
Anguilla rostrata (Lesueur, 1817)	American eel	T		x	x					x		x	x	x			
CYPRINODONTIDAE																	
Fundulus diaphanus (Lesueur, 1817)	Eastern banded killifish									x							
Fundulus notatus (Rafinesque, 1820)	Blackstripe topminnow		x	x	x	x	x	x	x		x	x					
POECILIIDAE																	
Gambusia affinis (Baird and Girard, 1853)	Western mosquitofish					x											
GADIDAE																	
Lota lota (Linnaeus, 1758)	Burbot	S			x					x							
PERCOPSIDAE																	
Percopsis omiscomaycus (Walbaum, 1792)	Trout-perch			x				x	x		x	x		x			x
ATHERINIDAE																	
Labidesthes sicculus (Cope, 1865)	Brook silverside	M	x	x	x	x	x		x	x	x	x				x	x
PERCICHTHYIDAE																	
Morone chrysops (Rafinesque, 1820)	White bass			x		x	x				x	x		x		x	x
Morone saxatalis (Walbaum, 1792)	Striped bass						x					x					x
CENTRARCHIDAE																	
Ambloplites rupestris (Rafinesque, 1817)	Rock bass			x	x	x	x		x	x	x	x	x	x	x	x	x
Lepomis cyanellus Rafinesque, 1819	Green sunfish			x	x	x	x		x	x	x	x	x	x	x	x	x
Lepomis gibbosus (Linnaeus, 1758)	Pumpkinseed			x	x	x	x		x	x	x	x					x
Lepomis gulosus (Cuvier, 1829)	Warmouth			x	x	x	x		x		x	x					
Lepomis humilis (Girard, 1858)	Orangespotted sunfish			x	x	x	x		x	x	x	x		x		x	x
Lepomis macrochirus Rafinesque, 1819	Bluegill			x	x	x	x		x	x	x	x		x	x	x	x
Lepomis megalotis (Rafinesque, 1820)	Longear sunfish	M		x	x	x	x		x	x	x	x	x	x	x	x	x
Lepomis microlophus (Gunther, 1859)	Redear sunfish				x		x					x					x
Micropterus dolomieu Lacepede, 1802	Smallmouth bass	M		x	x	x	x		x	x	x	x	x	x	x	x	x
Micropterus punctulatus (Rafinesque, 1819)	Spotted bass			x	x	x	x		x	x	x	x		x	x	x	x
Micropterus salmoides (Lacepede, 1802)	Largemouth bass			x	x	x	x		x	x	x	x	x	x	x	x	x
Pomoxis annularis Rafinesque, 1818	White crappie			x	x	x	x		x	x	x	x	x	x	x	x	x
Poxomis nigromaculatus (Lesueur, 1829)	Black crappie			x	x	x	x		x		x	x		x	x	x	

Table 2. Historical occurrence of fish species in the Great and Little Miami River Basins---Continued

[Abbreviations: I, intolerant species; M, moderately intolerant; D, declining; N, non-native; E, endangered species; T, threatened; S, special interest; EXT, extirpated; R, rare; U, uncommon; Letters in parentheses indicate Indiana listed species]

			Great Miami River					Little Miami River					Whitewater River				
Scientific name[1]	**Common name**	**Status**	**pre-1900**	**1901-54**	**1955-80**	**1980-89**	**1990-98**	**pre-1900**	**1901-54**	**1955-80**	**1980-89**	**1990-98**	**pre-1900**	**1901-54**	**1955-80**	**1980-89**	**1990-98**
PERCIDAE																	
Ammocrypta pellucida (Putnam, 1863)	Eastern sand darter	(S), S, I, D		x			x		x					x		x	x
Etheostoma blennioides Rafinesque, 1819	Greenside darter	M		x	x	x	x		x	x	x	x	x	x	x	x	x
Etheostoma caeruleum Storer, 1845	Rainbow darter	M		x	x	x	x		x	x	x	x	x	x	x	x	x
Etheostoma camurum (Cope, 1870)	Bluebreast darter	(E), T, I	x														
Etheostoma exile (Girard, 1859)	Iowa darter	S		x	x	x	x										
Etheostoma flabellare Rafinesque, 1819	Fantail darter			x	x	x	x		x	x	x	x	x	x	x	x	x
Etheostoma microperca Jordan and Gilbert, 1888	Least darter	S		x	x	x	x			x	x	x					
Etheostoma nigrum Rafinesque, 1820	Johnny darter			x	x	x	x		x	x	x	x	x	x	x	x	x
Etheostoma spectabile (Agassiz, 1854)	Orangethroat darter			x	x	x	x		x	x	x	x		x	x	x	x
Etheostoma variatum Kirtland, 1838	Variegate darter	(E), I		x		x			x	x	x	x	x	x		x	x
Etheostoma zonale (Cope, 1868)	Banded darter	I		x	x	x	x		x	x	x	x	x	x	x	x	x
Perca flavescens (Mitchill, 1814)	Yellow perch			x	x	x	x						x	x			x
Percina caprodes (Rafinesque, 1818)	Logperch	M		x	x	x	x		x	x	x	x	x	x	x	x	x
Percina copelandi (Jordan, 1877)	Channel darter	T, I		x					x								
Percina maculata (Girard, 1859)	Blackside darter			x		x	x		x	x	x	x		x	x	x	x
Percina phoxocephala (Nelson, 1876)	Slenderhead darter	I, D		x		x	x		x	x	x	x		x			x
Percina shumardi (Girard, 1859)	River darter	T				x											
Stizostedion canadense (Smith, 1834)	Sauger				x	x	x				x	x	x	x		x	x
Stizostedion vitreum (Mitchill, 1818)	Walleye			x		x	x				x	x		x		x	x
SCIAENIDAE																	
Aplodinotus grunniens Rafinesque, 1819	Freshwater drum			x	x	x	x		x		x	x	x	x	x	x	x
COTTIDAE																	
Cottus bairdi Girard, 1850	Mottled sculpin			x	x	x	x		x	x	x	x	x	x	x	x	x
GASTEROSTEIDAE																	
Culaea inconstans (Kirtland, 1841)	Brook stickleback			x	x	x	x		x	x	x	x	x	x			
TOTAL SPECIES			**15**	**95**	**88**	**103**	**104**	**16**	**84**	**71**	**91**	**96**	**52**	**83**	**60**	**75**	**82**

[1] "The author's name follows the specific name directly and without punctuation if the species, when originally described, was assigned to the same genus in which it appears here; if the species was described in another genus, the author's name(s) appears in parentheses" (Robins and others, 1991).

Sources: Aderkas, E., and McReynolds, H.E. (1963?); Brown, E.H., Jr. (1960); Cavender, T.M., Ohio State University, written commun.1999; Dorsett, M.J. (1995); Evermann, B.W. (1886); Gerking, S.D. (1945); Hay, O.P. (1894); Huffaker, S. (1971); Fisher, B., Indiana Department of Natural Resources, written commun., 1999; Indiana Department of Natural Resources (1998); Kinglsey, D.W., and Kiley, A.L. (1989); McGinty, D.J. (1967?); Ohio Environmental Protection Agency (1983a,1983b,1984a, 1984b, 1985,1991, 1992a, 1992b, 1994, 1995,1996, 1997); Plummer, J.T. (1851); Rankin E.T., and Yoder, C.O. (1999); Shoemaker, H.H. (1942); Simon, T.P., U.S. Fish and Wildlife Service, written commun., 1999; Trautman, M.B. (1981); Walterhouse, M.B. (1983); Wecker, K., Ohio Department of Natural Resources, written commun., 1999; Rice, D., Ohio Department of Natural Resources, oral commun., 1999; Shindel, H.L., and others (1999).

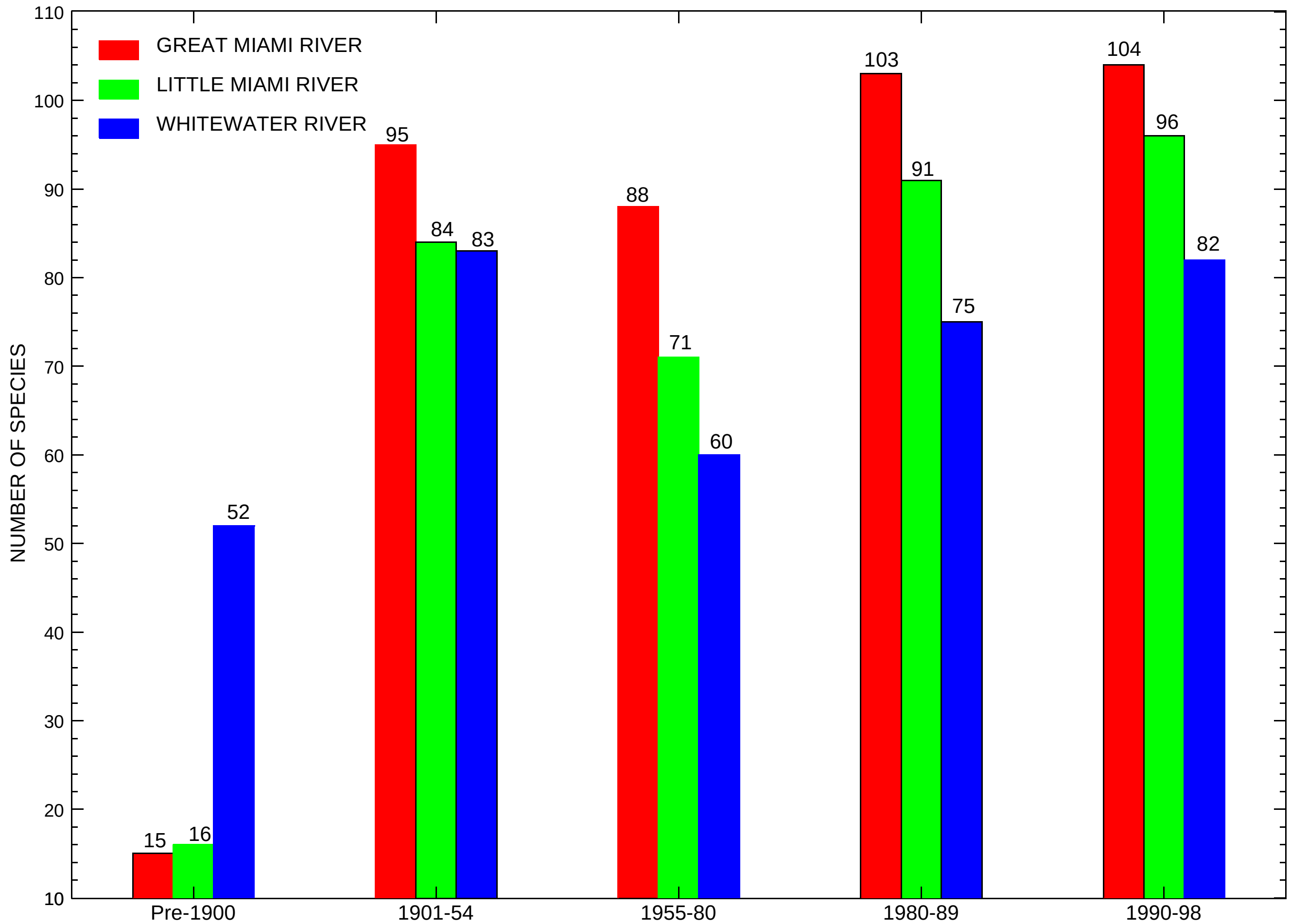

Figure 2. Occurrence of fish species in the Great and Little Miami River Basins.

Pre-1900

Immigration into Ohio increased after the signing of the Treaty of Greenville in 1795 and the addition of Ohio to the Union in 1803 (Trautman, 1981). By 1900, the population in the study area had reached an estimated 1,000,000 (James Kell, Ohio Department of Development, written commun., 1997). The increase in human population and corresponding land alteration began to have noticeable effects on the fish community. Forests were removed, swamps drained, and fields ditched and tiled to provide land for industry and agriculture. Riparian-zone decline accelerated runoff rates into nearby streams, causing increased turbidity and siltation of stream bottoms and depletion of aquatic vegetation. Organic waste from lumber mills, breweries, and food-processing plants caused declines in oxygen concentrations in the streams. Numerous dams constructed for mills and other manufacturing purposes became obstructions that prevented fish from reaching spawning areas.

Insufficient regulation of a developing commercial fishing industry resulted in a decrease in the abundance of fish in lakes and streams (Trautman, 1981). Smaller species became more abundant because of the decline of larger predators and changes in habitat. In response to concerns over declines in the abundance and diversity of fish, the Indiana Fish Commission introduced laws protecting fish from illegal commercial and sustenance fishing (Dennis, 1892). The Ohio Fish Commission (OFC) constructed fish hatcheries and introduced exotic species. Rainbow trout and brook trout were first introduced into the Mad River at this time.

Those species requiring riffles and clean, hard stream bottoms were the most adversely affected during this period. The intolerant bluebreast darter was extirpated from study area streams, whereas species tolerant to turbid or silted bottoms, such as common carp, benefited and became among the most abundant species in the area. Fish occurrence in the study area for the pre-1900 period consisted of 67 species representing 18 families. The reduced number of species reported prior to 1900 relative to later time periods may have resulted from ineffective collection methods and (or) incomplete documentation.

1901-54

Human population in the study area continued to rise, reaching an estimated 1,800,000 in 1950 (James Kell, written commun., 1997). Rapid expansion of large factories after World War II increased the amount of untreated or minimally treated wastewater discharge into streams. According to Rankin and others (1996), "This period was likely the greatest in terms of the magnitude and severity of degradation to Ohio streams and rivers." Additional dams built for industrial and domestic uses restricted fish migration; the migratory lake sturgeon was not found after this time. The Mad River in Clark and Champaign Counties was first dredged in the early 1900's to drain surrounding swampland. Work to ditch, drain, straighten, or eliminate streams in the area continued until the 1940's. Species that require slow-flowing and weedy streams (such as the golden shiner) were greatly reduced in number, and the tolerant creek chub became a dominant species.

State and Federal agencies began to recognize the effects of soil erosion on fish communities in the early 1900's. Trautman (1981) reported, "Studies made since 1925 have proved that since then, if not before, soil suspended in water has been the most universal pollutant in Ohio, and the one which has most drastically affected the fish fauna." Silt interferes with fish respiration, suffocates viable eggs before they hatch, and eliminates gravel, boulder, and bedrock-bottom habitats. Silt-covered stream bottoms also inhibit the growth of aquatic vegetation, which is useful in reducing turbidity and maintaining clear water. Elimination of vegetation results in reduction of shaded and resting areas and shelter from the current or predators.

Species intolerant of silt and turbid waters were the most affected during this period. Blacknose shiner, pugnose minnow, channel shiner, channel darter, brook trout, streamline chub, and Ohio lamprey are not recorded in the study area after this period. The least brook lamprey and lake sturgeon were recorded exclusively at this time. Silt-tolerant species such as orangespotted sunfish and suckermouth minnow not previously found began migrating into the study area. Brown trout were first introduced to the Mad River during this period. Between 1901 and 1954, a total of 107 species representing 20 families were recorded in the study area. Five species recorded during the pre-1900 period were not collected at this time. Of those five, two were intolerant[3] species (40 percent). Forty-five species not recorded during the pre-1900 period were documented during 1901-54; 15 of these were intolerant (33 percent). This period displayed a net gain of 40 species. This increase in fish species likely reflects improvements in sampling techniques and equipment.

1955-80

By 1980, the number of people in the study area had reached approximately 2,500,000. Industrialization and urbanization also increased considerably, and agricultural land was converted to accommodate residential, transportation, and industrial uses. Remaining acreage dedicated to farming was increased in size, and brush or other cover was removed. Fields were plowed more frequently, subjecting them to increased erosion rates. Removal of vegetation and drainage of land resulted in increased frequency of flash floods. Channelization of streams and digging and redredging of ditches continued. Construction of the Brookville Reservoir was completed on the East Fork of the Whitewater River in Indiana in 1974. The creation of this reservoir flooded many locations where the variegate darter, a state endangered species, was previously found. The use of commercial fertilizers and detergents greatly increased during this period. Effects of the pesticide DDT became apparent in the 1970's, and eating fish from water bodies in which sediments had high concentrations of DDT was discouraged (Trautman, 1981).

Exotic fish species were continually introduced, but with little success. Chain pickerel and blue catfish were introduced and found only during this period. Burbot, eastern banded killifish, and goldeye also were

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[3] OEPA (1988) classifies intolerant species as those whose abundance or range have decreased with degrading water and habitat quality, and are predominantly found in streams with good water quality.

collected exclusively at this time. Paddlefish were not found in the study area after this period. Continued dredging in the Mad River, a Great Miami River tributary, created straight channels without pools or riffles, and the existing fish communities consisting of black bass, suckers, and catfishes, became dominated by smaller species such as blacknose dace and creek chub. The absence of the intolerant river redhorse and silver chub in the study area during this time may be attributed to increased siltation and turbidity due to agricultural runoff in the area. Both species were found again in 1984 but were classified as endangered species until 1987. Fish recorded in the study area for this period consisted of 101 species representing 21 families. Twelve new species (redear sunfish, bowfin, goldeye, skipjack herring, black buffalo, chain pickerel, lake chubsucker, goldfish, blue catfish, white catfish, eastern banded killifish, burbot) were collected. Twenty species recorded during 1901-54 were not collected during 1955-80. Ten of these 20 were intolerant species (50 percent). Fourteen species not recorded during 1901-54 period were documented during this period, two of which were intolerant (14 percent). Across the study area a net loss of six species was recorded between the 1901-54 and 1955-80 periods.

1980-89

The Clean Water Act was passed in 1972 and was further amended by the Water Quality Act of 1987. As a direct result of these laws, several billion dollars were invested to construct new wastewater treatment plants (WWTP's) and to upgrade older facilities. Nonpoint sources such as agricultural runoff, urban stormwater runoff, streambank erosion, and feedlot runoff were recognized as significant sources of contamination. During 1983-90, contaminants from nonpoint sources, particularly manure from animal husbandry operations, killed more fish and other aquatic life in the Stillwater River (a Great Miami River tributary) than did discharge from point sources (Ohio Environmental Protection Agency, 1991).

Species diversity decreased and the abundance of intolerant species increased because of the combined effects of nonpoint nutrient contamination from cattle and swine operations, WWTP's, combined sewer overflows, and poor instream habitat (Ohio Environmental Protection Agency, 1996). Some areas downstream from WWTP's were characterized by low concentrations of oxygen and a high incidence of external anomalies (deformities, eroded fins, lesions, and tumors, collectively known as DELT's). Species that were unable to adjust to these and other stresses were reduced in numbers or eliminated by lowered reproductive success or death. During this period, mooneye, shortnose gar, bigmouth buffalo, and grass carp were reported for the first time. Species collected exclusively during this period include river darter, western mosquitofish, and chestnut lamprey. The Mississippi silvery minnow was collected for the first time in the Great Miami River. Trautman believed this species to have been extirpated from the State since before 1900 (Ohio Environmental Protection Agency, 1984b). Fish diversity in the study area for this period consisted of 110 species representing 21 families. Ten species recorded during 1955-80 were not collected at this time. Two of these 10 were intolerant species (20 percent). Nineteen species not recorded during the 1955-80 period were documented during this period, four of which were intolerant (21 percent). The net gain for this period was nine species.

1990-98

Dredging and straightening of stream channels and removal of woody riparian vegetation continued to be common practices throughout the Great and Little Miami River Basins. Studies showed that aquatic-life-use impairments caused by point sources of contamination were declining in the study area, but impairments caused by nonpoint sources had increased (Rankin and others, 1996a). Major sources of water-quality impairment in the study area included municipal and industrial wastewater discharges and urban and agricultural runoff. According to Rankin and others (1996b), "Sedimentation resulting from agricultural activities is undoubtedly the most pervasive single cause of impairment from nonpoint sources. This cause is responsible for more major/moderate impairment than any other cause except organic enrichment and habitat disturbance * * *."

The threadfin shad and striped bass were first found in the study area at this time. The blue sucker, one of Ohio's rarest and most endangered fish species, was found in the Great Miami River and Whitewater River after a 40-year absence. In 1993, this species was discovered for the first time in the Little Miami River (Ohio Environmental Protection Agency, 1996). Evidence of successful reproduction by blue suckers in Ohio had not been documented for approximately 50 years, and the presence of this highly intolerant species is considered an indication of improving water quality (Ohio Environmental Protection Agency, 1995). OEPA's 1998 survey of the Little Miami River Basin documented the collection of the brindled madtom, which had not been collected since before 1954, and the first collection of the redfin shiner in this river. In 1997, the Indiana Department of Natural Resources collected the trout-perch in the Whitewater River, where it had not been collected in more than 40 years (Brant Fisher, Indiana Department of Natural Resources, written commun., 1999). Fish abundance in the study area for this period consisted of 113 species representing 22 families. Four species recorded during 1980-89 were not collected at this time. None of these four were intolerant species. Seven species not recorded during the previous time period were documented during this period, one of which was intolerant (14 percent). The net gain was three species for this period.

FISH AS INDICATORS OF ECOSYSTEM HEALTH

Contaminant discharges, chemical spills, and overflows are a significant source of stress for fish communities. Exposure to some contaminants has been linked to reduced fertility, egg hatchability, and offspring viability; impaired reproductive hormone activity; altered sexual development and behavior; slow growth rates; and cancer (Goodbred and others, 1997; U.S. Environmental Protection Agency, 1997).

Fish anomalies are strongly correlated with toxic conditions and other chemical-related stresses in streams, and are useful as indicators of water quality and fish health (Sanders and others, 1999; Rankin and others, 1996b). Sanders and others (1999) state that studies reporting the occurrence of external fish anomalies have increased since the mid-1960's. The Great and Little Miami Rivers each had six sites with high rates of anomalies (>5 percent) during 1991-95 (Ohio Environmental Protection Agency, 1996). A study of DELT's in seven Ohio streams including the East Fork Little Miami River and Little Miami River mainstem found that "the most frequently occurring species with DELT anomalies were carp, largemouth bass*** black buffalo, silver redhorse, quillback, golden redhorse, black redhorse, and channel catfish" (Sanders and others, 1999).

During 1983-95, 49 spills and other pollutant releases killed approximately 58,600 fish and other aquatic organisms in the Little Miami River Basin. Agriculture-related releases, primarily manure runoff and fertilizer spills, were the leading causes (Ohio Environmental Protection Agency, 1995). The Indiana Department of Natural Resources recorded two fish kills in the Whitewater River Basin during 1987-98 (Elizabeth Nightingale, Indiana Department of Natural Resources, written commun., 1999). Mortalities were attributed to the release of process water and fire runoff. In 1988, a significant fish kill occurred on the Great Miami River in Montgomery County. More than 260,000 wild animals, mostly fish, were killed as a result of elevated water temperatures caused by powerplant cooling water discharge (Ohio Department of Natural Resources, 1988). OEPA reported 54 fish kills in Ohio in 1992, ranking the state 10th nationally (Rankin and others, 1992).

The Indiana Department of Natural Resources first included fish in their endangered species list in 1971 and then listed only one species. This list was later revised in 1975 to include an additional 20 species (Kathy Quinback, Indiana Department of Natural Resources, written commun., 1999). Forty species were included on the first Ohio endangered species list, published in 1976 by the Ohio Department of Natural Resources (ODNR), Division of Wildlife. Since 1990, seven listed species have been found in the Great Miami River, eight species in the Little Miami River, and four Ohio and four Indiana species in the Whitewater River (table 3). Forty percent of Ohio's fish species were endangered, threatened, extirpated, extinct or declining in 1992, up 10 percent from totals prior to 1980 (Rankin and others, 1992). Declining species, such as pugnose minnow and blacknose shiner, are generally intolerant species that rely on permanent streamflow, clean substrates, and otherwise good habitat. The presence of endangered or threatened species in a stream increases the likelihood that the stream can support warmwater assemblages of aquatic organisms, satisfying OEPA's Warmwater Habitat criteria (Rankin and others, 1996b).

CURRENT WATER QUALITY OF THE GREAT AND LITTLE MIAMI RIVER BASINS

Many streams of the Great and Little Miami River Basins are considered high quality and exceed

Table 3. Currently (1998) listed endangered species found in the Great and Little Miami River Basins since 1990

[Sources: Kendra Wecker, Ohio Department of Natural Resources, written commun., 1998; Indiana Department of Natural Resources, 1998.]

Status	Great Miami River	Little Miami River	Whitewater River
Endangered	Blue sucker	Blue sucker Mountain madtom Northern madtom	Shortnose gar Northern madtom Redside dace[1] Variegate darter[1]
Threatened	Tonguetied minnow	Tonguetied minnow Bigeye shiner American eel	
Special interest	Muskellunge Iowa darter River redhorse Eastern sand darter Least darter	River redhorse Least darter	Eastern sand darter[2] River redhorse[2]

[1] Indiana 1998 listed species.
[2] Ohio and Indiana listed species.

the minimum Clean Water Act criteria (Rankin and others, 1996a). Most of the Little Miami River and Lower Whitewater River are designated Exceptional Warmwater Habitat (EWH), supporting “unusual and exceptional” assemblages of aquatic organisms (Ohio Environmental Protection Agency, 1995). Forty-one percent of the Great Miami River main stem was in full attainment of EWH in 1993 (Sanders and others, 1999). Sections of the Great Miami River have had poor to very poor water quality in the past but have recently improved substantially in response to WWTP upgrades (Ohio Environmental Protection Agency, 1997). OEPA listed the Great Miami River as one of Ohio’s rivers with the greatest number of significantly improved sites between 1970 and 1995 (Rankin and others, 1996a). The number of sampling sites with elevated rates of external anomalies on the Great Miami River downstream from Dayton declined substantially between 1988 and 1995. Most of the Great Miami River is classified by the OEPA as a Warmwater Habitat (WWH), supporting “typical” warmwater assemblages of aquatic organisms. The upper Great Miami River demonstrated significant improvements in aquatic community performance[4] and water quality in 1994 compared to surveys in 1982 (Ohio Environmental Protection Agency, 1996). OEPA (1996) stated that “The changes observed since 1982 rank as some of the most significant improvements observed for any Ohio river or stream in our 17 years of experience conducting statewide biological surveys.” Most of the observed improvements have resulted from reduced loading of nutrients, ammonia, and chlorine as a consequence of the upgrading of municipal WWTP facilities. More than $6 billion has been spent since 1972 to control contamination from industrial and municipal wastewater in an effort to improve the stream quality in Ohio (Rankin and others, 1996b).

Water-quality problems continue in areas adversely affected by combined-sewer overflows, urban runoff, and livestock operations. Siltation, habitat alteration, organic enrichment, and an increase in residential land use are among the leading causes of aquatic-life impairment in Ohio (Rankin and others, 1996a). Although significant improvements have occurred in the study area, biological recovery to full Exceptional Warmwater Habitat status is incomplete, and because of permanent hydrologic modifications,

[4] Aquatic community performance can be defined as a measure that “portrays the results of water quality management efforts in direct terms, i.e. decreases and increases in community health (as reflected by biological community structure and function) * * * ” (Ohio Environmental Protection Agency, 1988; Marc Smith, Ohio Environmental Protection Agency, written commun., 1999).

unattainable in some parts of the study area. Indications of continued negative effects include lower than expected Index of Biotic Integrity scores[5], elevated numbers of fish with anomalies, predominance of tolerant species, and fish kills (Ohio Environmental Protection Agency, 1995). Continued efforts to improve water quality and restore the physical habitat of streams are necessary to increase fish abundance and biodiversity in the Great and Little Miami River Basins.

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