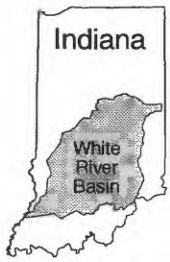
FISHES OF THE WHITE RIVER BASIN, INDIANA

U.S. Department of the Interior—U.S. Geological Survey



Since 1875, researchers have reported 158 species of fish belonging to 25 families in the White River Basin. Of these species, 6 have not been reported since 1900 and 10 have not been reported since 1943. Since the 1820's, fish communities in the White River Basin have been affected by the alteration of stream habitat, overfishing, the introduction of non-native species, agriculture, and urbanization. Erosion resulting from conversion of forest land to cropland in the 1800's led to siltation of streambeds and resulted in the loss of some silt-sensitive species. In the early 1900's, the water quality of the White River was seriously degraded for 100 miles by untreated sewage from the City of Indianapolis. During the last 25 years, water quality in the basin has improved because of efforts to control water pollution. Fish communities in the basin have responded favorably to the improved water quality.

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 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 White River Basin in Indiana was among the first 20 river basins to be studied as part of this program. One aspect of the White River Basin study is the collection of information about biological communities in streams that helps define the relations among the physical, chemical, and biological characteristics of streams (Gurtz, 1994). A review of existing information is a part of this effort. This paper summarizes historical information on the species of fish found in the White River Basin, how fish communities have been affected by man's activities, and the effect that pollution-control programs have had on reversing man's impacts.

DESCRIPTION OF THE WHITE RIVER BASIN

The White River Basin is part of the Mississippi River system and drains 11,350 square miles of central and southern Indiana (fig. 1). The basin has a humid continental climate. Average annual temperature is about 53°F; average monthly temperature ranges from 28°F in mid-January to 76°F in mid-July. Average annual precipitation is about 44 inches. Long-term average runoff ranges from about 12 inches in the northern part of the basin to more than 14 inches in the southern part of the basin. There are two nearly equal sized subbasins in the White River Basin; the eastern part of the basin is drained by the East Fork White River, and the western part is drained by the main stem of the White River. The two forks of the river converge near Petersburg, 50 miles from the White River's confluence with the Wabash River in southwestern Indiana. There are 17 low-head dams on the main stem between the headwaters and Martinsville and 3 low-head dams on the East Fork between Columbus and Williams. The basin contains 21 reservoirs with a normal capacity of 5,000 acre-feet or more; all but 2 are on tributary streams.

The population of the White River Basin in 1990 was approximately 2.1 million people, about three-fourths of which are concentrated in the northern part of the basin. The Indianapolis Metropolitan Area accounts for about 60 percent of the total population. The

Figure 1. The White River Basin.

primary land use in the basin is agriculture, which accounts for about 70 percent of the basin. Extensive soybean and corn production occurs in the northern, southwestern, and southeastern parts of the basin. In 1992, about 22 percent of the basin was planted in corn, and about 18 percent was planted in soybeans. These two crops accounted for 78 percent of all cropland. The south-central part of the basin is not farmed as extensively as other parts because of the hill and valley landscape. Most of the forested land in the basin is located in this region. There is significant industrialization in the cities of Indianapolis, Muncie, and Anderson.

The White River Basin spans three ecoregions (Omernik and Gallant, 1988). The northern and southeastern parts of the basin are in the Eastern Corn Belt Plain ecoregion, characterized by low relief. Land use is mostly row-crop agriculture. Drainage density is about one-half mile per square mile. The south-central part of the basin is in the Interior Plateau ecoregion, characterized by moderate relief and a hill and valley landscape. Land use is mixed with forest, pasture, and some row-crop agriculture, confined mainly to valley floors. Drainage density is about 2 miles per square mile. The southwestern part of the basin is in

the Interior River Lowland ecoregion, characterized by rolling hills. Land use is mixed with row-crop agriculture, pasture, forest, and oil and gas production. Drainage density is about 2 miles per square mile.

OCCURRENCE OF FISHES

The earliest recorded fish collections in Indiana are from the early 1800's, when Samuel Rafinesque and Charles Lesueur published results of their investigations from 1814 to 1827. Nearly one-third of the fish species found in the White River Basin were first described by one of these two men, who were for a time at the historic scientific research community at New Harmony, Ind. (Eigenmann, 1894). The first comprehensive work to describe the fishes of Indiana was begun in the 1870's by David Jordan (Jordan, 1877; 1878); considerable work was done in the late 1800's by Jordan and his colleagues. Few studies were done between 1900 and 1955 (McReynolds, 1966). The notable exception was by Shelby Gerking who did a significant study of the distribution of fishes in Indiana (Gerking, 1945). Gerking made collections at 412 sites in Indiana during 1940 to 1943, including 122 sites in the White River Basin. Many studies have been done since Gerking's statewide study, although none as comprehensive. Most of the subsequent studies have limited areal coverage; some have not been published and the data are not readily available.

A list of fish species found in the basin was compiled from fish sampling done as part of the White River Basin study (Nancy Baker and Jeffrey Frey, U.S. Geological Survey, written commun., 1996), 70 published studies, and unpublished information provided by the Indiana Department of Natural Resources (table 1). The table is divided into four time periods: pre–1900, 1940–43, 1955–87, and post–1987. The post–1987 period was selected to represent current conditions in the basin.

Pre–1900 data were compiled from the work of Eigenmann and Beeson (1894), Eigenmann and Fordice (1886), Gilbert (1885), Hay (1894), Jordan (1877, 1878), and Shannon (1887). The data for the period 1940–43 is from Gerking (1945).

The period 1955–87 includes the work of Aquatic Control, Inc. (1974), Bass (1964), Braun (1984), Camp Dresser & McKee (1979), Christensen (1968), EA Science and Technology, Inc. (1987), Environmental Science and Engineering, Inc. (1987), Fisher and Gammon (1981, 1983), Gammon (1965), Huffaker (1971, 1972a, 1972b), Keller (1971), Kingsley (1983, 1988), Kingsley and Flatt (1985), Lockard and Winters (1965), McReynolds (1960), Pearson (1977), Pearson and Boston (1995), Proffitt (1969), Proffitt and Benda (1971), Stillings (1977), Thomerson and Smith (1986), Tolentino and Ball (1988), WAPORA, Inc. (1976, 1978, 1984), Whitaker and Schlueter (1973), Whitaker and Gammon (1988), and Whitaker and others (1977, 1987).

Post–1987 data were compiled from the work of Andrews (1993, 1994), EA Engineering, Science, and Technology, Inc. (1995), Brant Fisher (Indiana Department of Natural Resources, written commun., 1996), Gammon (1995a), Hunter/ESE Inc. (1990), Keller (1993a, 1993b, 1994a, 1994b), Kiley (1992), Kiley and Keller (1993), Lehman (1994, 1995a, 1995b, 1995c, 1995d, 1995e, 1995f), Lewis and others (1990, 1993, 1994), Malwitz (1994), Mavrakis (1995), Pearson and Boston (1995), Simon (1992, 1994), Simon and Kiley (1993), Stefanavage (1993, 1995), and White (1996).

Nomenclature has changed over time and several of the species listed in the studies done prior to 1900 could not be equated to modern usage. Some species listed in the early studies have since been shown to be conspecific and not separate species. Scientific and common names of fishes used in this paper conform to the fifth edition of "Common and Scientific Names of Fishes from the United States and Canada" (Robins and others, 1991). The relative abundance of fish in the basin (table 1) follows Simon and others (1992) with modifications made to account for the regional distribution of some fish species.

Historically, the White River Basin has supported a variety of warm-water fish species. Since 1875, researchers have reported 158 species of fish from 25 families. Of these, 152 species have been reported since 1900 and 148 have been reported since 1943. Collections made prior to 1900 found 98 species from 23 families. Gerking found 97 species from 18 families in the 1940's. Thirty-eight species were not reported prior to 1955. The smaller number of species reported by investigators prior to 1955 may reflect differences between seining methods used for fish collection in the early studies and more efficient electroshocking methods used in most of the more recent studies.

Some of the 38 species first reported after 1955 are rare (such as the spotted sunfish, bantam sunfish, and the harlequin darter); these species may not have been present at early collecting sites but probably were present in the basin. Four of the species—the grass carp, white catfish, western mosquitofish, and the striped bass—are non-native species that have recently been introduced by man into Indiana. The white catfish commonly is stocked in pay-fishing lakes (Trautman, 1981, p. 478). Other species are native to Indiana or the Midwest and recently have been introduced or have extended their range into the basin [such as the rosefin shiner, common in southeastern Indiana and Ohio; pumpkinseed sunfish, common in northern Indiana; the threadfin shad and ribbon shiner, first reported in Indiana in 1957 and 1964, respectively (McReynolds, 1966)]. Other species are native to northern Indiana (such as the red shiner, ironcolor shiner, blacknose shiner, spottail shiner, and the weed shiner) or southern or western Indiana (ribbon shiner, pugnose shiner, bluntnose darter, and variegate darter) and recently may have been introduced or extended their range into the basin.

Two investigators have each reported finding one specimen of the spottail shiner. Only one specimen has been reported for several species, including the alligator gar, weed shiner, white catfish, and the burbot. The alligator gar was found in the White River at Hazleton in 1993 (Nancy Baker and Jeffrey Frey, written commun., 1996). This rare, large-river species previously was reported in the Wabash River at New Harmony by Jordan in 1888 (Hay, 1894), 63 miles downstream from Hazleton.

Some of the infrequently found species are difficult to distinguish from other species common in the White River Basin and may have been mis-identified. Such species reported by only one or two investigators are noted as "questionable identification" in table 1. The presence of these species in the basin needs to be confirmed by collection and verification of voucher specimens. One species, the bluntnose shiner (*Notropis simus*) reported by only one investigator, was deleted from the list of species given in table 1 because it is native to the southwestern United States and probably was mis-identified.

Six species have not been reported since before 1900 (the popeye shiner, harelip sucker, slender madtom, brook stickleback, swamp darter, and the spotted darter); 10 have not been reported since 1943 (the previous 6 plus the pallid shiner, bluebreast darter, least darter, and the Tippecanoe darter). Five of the 10 species not found since 1943 are darters. Darters in general are sensitive to changes in water quality, and Gerking (1945) considered the absence of darters to be a good indication of pollution.

Several species of fish apparently have been lost from the fauna of the White River Basin. The harelip sucker is considered to be extinct (Robins and others, 1991). The popeye shiner is considered extirpated from Indiana (Brant Fisher, Indiana Department of Natural Resources, written commun., 1996). Gerking (1945) considered the slender madtom to be exceedingly rare and possibly extirpated from Indiana. Other species such as the pallid shiner, bluebreast darter, swamp darter, spotted darter, least darter, and the Tippecanoe darter are extremely rare. Of these, the bluebreast darter, spotted darter, and Tippecanoe darter are considered endangered in Indiana (Brant Fisher, written commun., 1996). The popeye shiner and brook stickleback are intolerant of turbid water and siltation (Trautman, 1981, p. 326 and 528); these fish were

Table 1. Historical records of fish species in the White River Basin

[X indicates the fish was present in the basin; A, abundant; C, common; O, occasional; R, rare; E, extirpated or extinct; N, non-native species deliberately or accidentally introduced into the basin; SC, species is on the Indiana list of special concern; SE, species is on the Indiana list of endangered species; Q, questionable identification]

Scientific name	Common name and status	Pre 1900	1940 to 1943	1955 to 1987	Post 1987	Abundance
Petromyzontidae (lampreys)						
Ichthyomyzon castaneus Girard, 1858	chestnut lamprey		X	X	X	O
Ichthyomyzon fossor Reighard and Cummins, 1916	northern brook lamprey			X	X	R
Ichthyomyzon unicuspis Hubbs and Trautman, 1937	silver lamprey	X	X	X	X	O
Lampetra aepyptera (Abbott, 1860)	least brook lamprey	X		X		R
Lampetra appendix (DeKay, 1842)	American brook lamprey			X	X	R
Acipenseridae (sturgeons)						
Acipenser fulvescens Rafinesque, 1817	lake sturgeon SE			X	X	R
Scaphirhynchus platorynchus (Rafinesque, 1820)	shovelnose sturgeon	X	X	X	X	O
Polyodontidae (paddlefishes)						
Polyodon spathula (Walbaum, 1792)	paddlefish	X		X	X	O
Lepisosteidae (gars)						
Lepisosteus oculatus (Winchell, 1864)	spotted gar			X	X	O
Lepisosteus osseus (Linnaeus, 1758)	longnose gar	X	X	X	X	C
Lepisosteus platostomus Rafinesque, 1820	shortnose gar		X	X	X	O
Lepisosteus spatula Lacepède, 1803	alligator gar Q				X	R
Amiidae (bowfins)						
Amia calva Linnaeus, 1766	bowfin	X		X	X	O
Hiodontidae (mooneyes)						
Hiodon alosoides (Rafinesque, 1819)	goldeye	X		X	X	O
Hiodon tergisus Lesueur, 1818	mooneye	X	X	X	X	O
Anguillidae (freshwater eels)						
Anguilla rostrata (Lesueur, 1817)	American eel	X	X	X	X	O
Clupeidae (herrings)						
Alosa chrysochloris (Rafinesque, 1820)	skipjack herring		X	X	X	O
Dorosoma cepedianum (Lesueur, 1818)	gizzard shad	X	X	X	X	A
Dorosoma petenense (Günther, 1867)	threadfin shad				X	R
Cyprinidae (carps and minnows)						
Campostoma anomalum (Rafinesque, 1820)	central stoneroller	X	X	X	X	A
Carassius auratus (Linnaeus, 1758)	goldfish N		X	X	X	C
Ctenopharyngodon idella (Valenciennes, 1844)	grass carp N				X	O
Cyprinella lutrensis (Baird and Girard, 1853)	red shiner				X	R
Cyprinella spiloptera (Cope, 1868)	spotfin shiner	X	X	X	X	A
Cyprinella whipplei Girard, 1856	steelcolor shiner	X	X	X	X	C
Cyprinus carpio Linnaeus, 1758	common carp N		X	X	X	C
Erimystax dissimilis (Kirtland, 1840)	streamline chub	X	X	X	X	R
Erimystax x-punctatus (Hubbs and Crowe, 1956)	gravel chub		X		X	R
Hybognathus nuchalis Agassiz, 1855	Mississippi silvery minnow	X	X	X	X	C
Luxilus chrysocephalus Rafinesque, 1820	striped shiner		X	X	X	A
Luxilus cornutus (Mitchill, 1817)	common shiner	X	X	X	X	O
Lythrurus ardens (Cope, 1868)	rosefin shiner			X	X	R
Lythrurus fumeus (Evermann, 1892)	ribbon shiner Q			X		R
Lythrurus umbratilis (Girard, 1856)	redfin shiner	X	X	X	X	C
Macrhybopsis aestivalis (Girard, 1856)	speckled chub	X		X	X	O
Macrhybopsis storeriana (Kirtland, 1847)	silver chub	X	X	X	X	O
Nocomis biguttatus (Kirtland, 1840)	hornyhead chub	X	X	X	X	C
Nocomis micropogon (Cope, 1865)	river chub		X	X	X	C
Notemigonus crysoleucas (Mitchill, 1814)	golden shiner	X	X	X	X	O
Notropis amblops (Rafinesque, 1820)	bigeye chub	X	X	X	X	O
Notropis amnis Hubbs and Greene, 1951	pallid shiner		X			R
Notropis anogenus Forbes, 1885	pugnose shiner Q			X		R
Notropis ariommus (Cope, 1868)	popeye shiner	X				E
Notropis atherinoides Rafinesque, 1818	emerald shiner	X	X	X	X	A
Notropis blennius (Girard, 1856)	river shiner		X	X	X	C
Notropis boops Gilbert, 1884	bigeye shiner	X	X	X	X	O
Notropis buccatus (Cope, 1865)	silverjaw minnow	X	X	X	X	C
Notropis buchanani Meek, 1896	ghost shiner		X	X	X	O
Notropis chalybaeus (Cope, 1869)	ironcolor shiner Q			X		R
Notropis heterodon (Cope, 1865)	blackchin shiner	X		X		R
Notropis heterolepis Eigenmann and Eigenmann 1893	blacknose shiner Q				X	R
Notropis hudsonius (Clinton, 1824)	spottail shiner Q			X	X	R
Notropis photogenis (Cope, 1865)	silver shiner		X	X	X	O
Notropis rubellus (Agassiz, 1850)	rosyface shiner	X	X	X	X	C
Notropis shumardi (Girard, 1856)	silverband shiner			X	X	O
Notropis stramineus (Cope, 1865)	sand shiner	X	X	X	X	C
Notropis texanus (Girard, 1856)	weed shiner Q				X	R
Notropis volucellus (Cope, 1865)	mimic shiner		X	X	X	O
Notropis wickliffi Trautman, 1931	channel shiner				X	R
Opsopoeodus emiliae Hay, 1881	pugnose minnow		X	X	X	R
Phenacobius mirabilis (Girard, 1856)	suckermouth minnow		X	X	X	C
Phoxinus erythrogaster (Rafinesque, 1820)	southern redbelly dace	X	X	X	X	O
Pimephales notatus (Rafinesque, 1820)	bluntnose minnow	X	X	X	X	A
Pimephales promelas Rafinesque, 1820	fathead minnow		X	X	X	O
Pimephales vigilax (Baird and Girard, 1853)	bullhead minnow	X	X	X	X	O
Rhinichthys atratulus (Hermann, 1804)	blacknose dace	X	X	X	X	C
Semotilus atromaculatus (Mitchill, 1818)	creek chub	X	X	X	X	A
Catostomidae (suckers)						
Carpiodes carpio (Rafinesque, 1820)	river carpsucker	X	X	X	X	C
Carpiodes cyprinus (Lesueur, 1817)	quillback	X	X	X	X	C
Carpiodes velifer (Rafinesque, 1820)	highfin carpsucker	X	X	X	X	O
Catostomus commersoni (Lacepède, 1803)	white sucker	X	X	X	X	A
Cycleptus elongatus (Lesueur, 1817)	blue sucker SC	X		X	X	O
Erimyzon oblongus (Mitchill, 1814)	creek chubsucker	X	X	X	X	O
Hypentelium nigricans (Lesueur, 1817)	northern hog sucker	X	X	X	X	C
Ictiobus bubalus (Rafinesque, 1818)	smallmouth buffalo	X		X	X	C
Ictiobus cyprinellus (Valenciennes, 1844)	bigmouth buffalo	X		X	X	O
Ictiobus niger (Rafinesque, 1819)	black buffalo	X		X	X	O
Lagochila lacera Jordan and Brayton, 1877	harelip sucker	X				E
Minytrema melanops (Rafinesque, 1820)	spotted sucker	X	X	X	X	C
Moxostoma anisurum (Rafinesque, 1820)	silver redhorse	X	X	X	X	C
Moxostoma carinatum (Cope, 1870)	river redhorse SC			X	X	O
Moxostoma duquesnei (Lesueur, 1817)	black redhorse		X	X	X	C
Moxostoma erythrurum (Rafinesque, 1818)	golden redhorse		X	X	X	A
Moxostoma macrolepidotum (Lesueur, 1817)	shorthead redhorse	X	X	X	X	C
Ictaluridae (bullhead catfishes)						
Ameiurus catus (Linnaeus, 1758)	white catfish N				X	R
Ameiurus melas (Rafinesque, 1820)	black bullhead	X	X	X	X	C
Ameiurus natalis (Lesueur, 1819)	yellow bullhead	X	X	X	X	C
Ameiurus nebulosus (Lesueur, 1819)	brown bullhead	X		X	X	O
Ictalurus furcatus (Lesueur, 1840)	blue catfish			X	X	O
Ictalurus punctatus (Rafinesque, 1818)	channel catfish	X	X	X	X	C
Noturus eleutherus Jordan, 1877	mountain madtom	X	X	X	X	O
Noturus exilis Nelson, 1876	slender madtom	X				R

Table 1. Historical records of fish species in the White River Basin—Continued

[X indicates the fish was present in the basin; A, abundant; C, common; O, occasional; R, rare; E, extirpated or extinct; N, non-native species deliberately or accidentally introduced into the basin; SC, species is on the Indiana list of special concern; SE, species is on the Indiana list of endangered species; Q, questionable identification]

Scientific name	Common name and status	Pre 1900	1940 to 1943	1955 to 1987	Post 1987	Abundance
Noturus flavus Rafinesque, 1818	stonecat	X	X	X	X	C
Noturus gyrinus (Mitchill, 1817)	tadpole madtom	X	X	X	X	R
Noturus miurus Jordan, 1877	brindled madtom	X	X	X	X	O
Noturus nocturnus Jordan and Gilbert, 1886	freckled madtom			X	X	R
Pylodictis olivaris (Rafinesque, 1818)	flathead catfish	X	X	X	X	C
Esocidae (pikes)						
Esox americanus vermiculatus Lesueur, 1846	grass pickerel	X	X	X	X	C
Umbridae (mudminnows)						
Umbra limi (Kirtland, 1840)	central mudminnow	X		X		R
Aphredoderidae (pirate perches)						
Aphredoderus sayanus (Gilliams, 1824)	pirate perch	X	X	X	X	O
Gadidae (cods)						
Lota lota (Linnaeus, 1758)	burbot			X		R
Amblyopsidae (cavefishes)						
Amblyopsis spelaea DeKay, 1842	northern cavefish **SE**	X	X	X	X	R
Cyprinodontidae (killifishes)						
Fundulus catenatus (Storer, 1846)	northern studfish **SC**		X	X	X	R
Fundulus dispar (Agassiz, 1854)	starhead topminnow	X		X		R
Fundulus notatus (Rafinesque, 1820)	blackstripe topminnow	X	X	X	X	C
Fundulus olivaceus (Storer, 1845)	blackspotted topminnow				X	R
Poeciliidae (livebearers)						
Gambusia affinis (Baird and Girard, 1853)	western mosquitofish **N**			X	X	O
Atherinidae (silversides)						
Labidesthes sicculus (Cope, 1865)	brook silverside	X	X	X	X	C
Gasterosteidae (sticklebacks)						
Culaea inconstans (Kirtland, 1841)	brook stickleback	X				R
Cottidae (sculpins)						
Cottus bairdi Girard, 1850	mottled sculpin	X	X	X	X	C
Cottus carolinae (Gill, 1861)	banded sculpin	X		X	X	R
Percichthyidae (temperate basses)						
Morone chrysops (Rafinesque, 1820)	white bass	X		X	X	C
Morone mississippiensis Jordan and Eigenmann, 1887	yellow bass			X	X	O
Morone saxatilis (Walbaum, 1792)	striped bass **N**			X	X	R
Centrarchidae (sunfishes)						
Ambloplites rupestris (Rafinesque, 1817)	rock bass	X	X	X	X	C
Centrarchus macropterus (Lacepède, 1801)	flier		X	X	X	R
Lepomis cyanellus Rafinesque, 1819	green sunfish	X	X	X	X	A
Lepomis gibbosus (Linnaeus, 1758)	pumpkinseed			X	X	O
Lepomis gulosus (Cuvier, 1829)	warmouth	X	X	X	X	O
Lepomis humilis (Girard, 1858)	orangespotted sunfish	X	X	X	X	O
Lepomis macrochirus Rafinesque, 1819	bluegill	X	X	X	X	A
Lepomis megalotis (Rafinesque, 1820)	longear sunfish	X	X	X	X	A
Lepomis microlophus (Günther, 1859)	redear sunfish	X		X	X	C
Lepomis punctatus (Valenciennes, 1831)	spotted sunfish			X	X	R
Lepomis symmetricus Forbes, 1883	bantam sunfish **SC**				X	R
Micropterus dolomieu Lacepède, 1802	smallmouth bass	X	X	X	X	A
Micropterus punctulatus (Rafinesque, 1819)	spotted bass		X	X	X	A
Micropterus salmoides (Lacepède, 1802)	largemouth bass	X	X	X	X	A
Pomoxis annularis Rafinesque, 1818	white crappie	X	X	X	X	C
Pomoxis nigromaculatus (Lesueur, 1829)	black crappie	X	X	X	X	C
Percidae (perches)						
Ammocrypta clara Jordan and Meek, 1885	western sand darter			X	X	O
Ammocrypta pellucida (Putnam, 1863)	eastern sand darter **SC**	X	X	X	X	O
Etheostoma asprigene (Forbes, 1878)	mud darter			X	X	O
Etheostoma blennioides Rafinesque, 1819	greenside darter	X	X	X	X	A
Etheostoma caeruleum Storer, 1845	rainbow darter	X	X	X	X	C
Etheostoma camurum (Cope, 1870)	bluebreast darter **SE**	X	X			R
Etheostoma chlorosomum (Hay, 1881)	bluntnose darter			X		R
Etheostoma flabellare Rafinesque, 1819	fantail darter	X	X	X	X	O
Etheostoma fusiforme (Girard, 1854)	swamp darter	X				R
Etheostoma gracile (Girard, 1859)	slough darter			X	X	O
Etheostoma histrio Jordan and Gilbert, 1887	harlequin darter **SE**				X	R
Etheostoma maculatum Kirtland, 1841	spotted darter **SE**	X				R
Etheostoma microperca Jordan and Gilbert, 1888	least darter	X	X			R
Etheostoma nigrum Rafinesque, 1820	johnny darter	X	X	X	X	A
Etheostoma spectabile (Agassiz, 1854)	orangethroat darter	X	X	X	X	C
Etheostoma tippecanoe Jordan and Evermann, 1890	Tippecanoe darter **SE**		X			R
Etheostoma variatum Kirtland, 1838	variegate darter **SE**			X		R
Perca flavescens (Mitchill, 1814)	yellow perch			X		R
Percina caprodes (Rafinesque, 1818)	logperch	X	X	X	X	C
Percina copelandi (Jordan, 1877)	channel darter	X		X		R
Percina evides (Jordan and Copeland, 1877)	gilt darter **SE**	X	X	X		R
Percina maculata (Girard, 1859)	blackside darter	X	X	X	X	C
Percina phoxocephala (Nelson, 1876)	slenderhead darter	X	X	X	X	C
Percina sciera (Swain, 1883)	dusky darter	X	X	X	X	O
Percina shumardi (Girard, 1859)	river darter	X	X	X		O
Stizostedion canadense (Smith, 1834)	sauger			X	X	C
Stizostedion vitreum (Mitchill, 1818)	walleye			X	X	O
Sciaenidae (drums)						
Aplodinotus grunniens Rafinesque, 1819	freshwater drum	X	X	X	X	C

probably lost from the White River Basin as soil erosion increased and water clarity declined because of the conversion of forest land to cropland.

Eight species (the lake sturgeon, northern cavefish, bluebreast darter, harlequin darter, spotted darter, Tippecanoe darter, variegate darter, and the gilt darter) are considered to be endangered in Indiana (Brant Fisher, written commun., 1996). Additionally, five species (the blue sucker, river redhorse, northern studfish, bantam sunfish, and the eastern sand darter) are on the Indiana list of special concern (Brant Fisher, written commun., 1996).

FACTORS AFFECTING FISH COMMUNITIES

Many factors influence the abundance and distribution of fish in rivers and streams. Over the last 170 years, fish communities in the White River Basin have been affected by the alteration of natural stream habitat, overfishing, the introduction of non-native species, agriculture, and urbanization. There is evidence that fish communities already were impaired by the time Jordan began his studies in the 1870's (Gammon, 1977). A canal-building program in the basin from the 1830's to the 1850's negatively affected stream habitat. Clearing land for agriculture and the resulting erosion and changes in runoff

noticeably affected flow, turbidity, and habitat in the White River during the 1800's (Dunn, 1910, p. 19). Dunn also described steam-powered dredging operations in the White River near Indianapolis, begun in 1897, which annually removed 180,000 cubic yards of sand and gravel from the river, lowering the streambed by an average of 15 feet (Dunn, 1910, p. 20-22).

Legal and illegal commercial and sustenance fishing also seriously affected fish populations in Indiana by the late 1800's. Dennis (1891, p. 7) described the impact of overfishing:

"The laws for the protection of fish which were in force since 1880 ... proved ... to be inadequate ... Every variety of seine, net, gill-net, trap, weirs, and hedge were used indiscriminately, while dynamite destroyed its thousands ... This unfortunate state of affairs ... came near depopulating the running streams of the State ..."

In 1889, laws to control illegal harvesting of fish were strengthened. The Indiana State Fish Commissioner reported in 1892 that this legislation had been successful in the "*restoration of fish in lakes, rivers, and streams*" (Dennis, 1892, p. 5). Fish poachers were held in contempt, as illustrated by this comment from the State Fish Commissioner (Dennis, 1892, p. 7):

"He labors at night ... as a lawbreaker he is reckless, as a citizen he is worthless, and in general terms he is a 'slick citizen'. He violates the law and takes his fish in the dark and leaves no trace."

One proposed solution to the problem of depletion of native stocks of fish was the introduction of non-native species. Cotton (1885) described one possible alternative:

"The bass has few equals ... but when you undertake to raise them ... you find the cost too great. ... But we have found a foreign fish that seems to fill the want, in the German [common] *carp ... And, not withstanding the prevailing opinion in this country that they will not flourish in the waters occupied by other fish, ... in a few years we shall find plenty of them in our rivers and lakes."*

At least six non-native species have been intentionally introduced by man into the White River Basin—the goldfish, grass carp, common carp, white catfish, western mosquitofish, and the striped bass. Two of these (the goldfish and common carp) first were reported by Gerking (1945). The western mosquitofish was first reported in 1969, the striped bass was first reported in 1986 and the grass carp and white catfish have been reported only since 1991. The Indiana Department of Natural Resources currently has an active fish hatchery operation. The Department raises about 20 species of fish. Channel catfish, striped bass, bluegill, smallmouth bass, and walleye are routinely stocked in lakes and ponds. Other species of fish are stocked in lakes and ponds as necessary to maintain a viable sport fishery. The Department typically does not stock flowing waters except to replenish fish populations after a fish kill, in which case channel and flathead catfish and smallmouth and largemouth bass are the most frequently stocked species (Gary Armstrong, Indiana Department of Natural Resources, oral commun., 1996). An exception is a trial program to reintroduce sauger to the East Fork White River near Columbus.

Erosion of cropland, bank erosion from pasturing of farm animals near streams, and the resultant siltation of streambeds have resulted in decreases in the population of some fish species (Gammon and Gammon, 1991). Gammon (1995a) found that fish communities downstream from animal feed lots were severely degraded. Storm runoff from farm fields on which pesticides were recently applied also is known to endanger aquatic organisms (Nriagu and Simmons, 1984; Willis and McDowell, 1982). Organophosphate pesticides in particular have caused death (Lydy and others, 1990) and genetic and physiological changes in fish (Mayer and others, 1986). In addition to toxic effects, some pesticides and other organic chemicals have also been linked to decreased fertility in fish (Colborn and others, 1993). Appreciable concentrations of atrazine and other pesticides have been found in the White River Basin (Carter and others, 1995; Crawford, 1995), but the impact of pesticides on fish in the White River Basin is not known.

Urbanization has severely affected fish communities in the White River Basin. The population of the White River Basin has grown from 39,400 in 1820 (fewer than 200 in Indianapolis), to 860,000 in 1900 (169,000 in Indianapolis), to 2.1 million in 1990 (731,000 in Indianapolis). The effects of urban areas on fish may be acute, such as fish kills, or they may be chronic, with effects occurring gradually and lasting for years.

In the early 1900's, 70 percent of the 33 principal cities and towns in the White River Basin had no sewage treatment of any kind, and only 6 percent had some form of sewage-treatment plant (Tucker, 1922, p. 307-308). Industries also commonly discharged untreated wastewater into streams. Indianapolis had no sewage treatment, and the effect of raw sewage discharged directly to the White River was severe. Tucker (1922, p. 302) described the effect of this discharge:

"In 1909, Mr. J.A. Smith and the writer descended White River from Indianapolis and found the condition such that it produced extreme nausea. Night camp was pitched twenty miles by river below Indianapolis, and one-fourth of a mile from the river on a tributary stream, but the effects of sewage were still very disagreeable. The decaying carcasses of several hogs which had been thrown into the river by the packing houses of Indianapolis greatly aggravated the situation. The sewage of Indianapolis at this time formed practically half the volume of the stream. The bed of the stream was covered with a coating of dark, greasy, sludge, largely organic matter, to a depth of one inch or more."

Craven (1914) found the White River downstream from Indianapolis to be in a "*serious condition*" for 100 miles because of the amount of sewage and industrial wastes discharged to it.

Dennis (1892, p. 48) reported degradation of fish populations in the White River near Noblesville resulting from straw-mill waste. A similar mill in north central Indiana at that time was reported to discharge 13 tons of untreated waste per day. Gerking (1945) reported finding fewer species of fish than expected in the White River near Anderson and Muncie, given the excellent habitat present in that reach of the river. Gerking also found fish communities to be considerably impacted in the Big Blue River near New Castle and the White River near Indianapolis, compared to collections made in the late 1800's. Collections made by Christensen (1968); Aquatic Control, Inc. (1974); and WAPORA, Inc. (1978) near Indianapolis also indicated impairment of fish communities in the White River. Christensen (1968) found the impact to extend at least 30 miles downstream from the City. Thermal discharges resulting from the production of electricity used by urban areas also has been shown to affect fish communities in the White River (Simon, 1992).

From 1960 to 1992, about 160 fish kills were reported to the Indiana Department of Environmental Management for streams in the White River Basin (John Winters, Indiana Department of Environmental Management, oral commun., 1993). The largest reported fish kill in Indiana history (about 5 million fish) occurred in the White River at Indianapolis in 1976 (Kingsley, 1983) and was attributed to a protracted period of low flow in the river and the discharge of ammonia from sources in the city.

EFFECT OF POLLUTION-CONTROL PROGRAMS

Substantial amounts of money have been spent during the past several decades on programs to improve stream quality in Indiana. Public expenditures in Indiana on municipal wastewater-treatment plants and sewer systems between 1972 and 1993 total more than $1.8 billion (Indiana Department of Environmental Management, 1994, p. 3). The percentage of Indiana's population served by advanced wastewater-treatment plants increased from 0 percent to 53 percent during the same time period (Indiana Department Environmental Management, 1994, p. 327). Considerably more money has been invested in industrial wastewater treatment in Indiana. An effort to reduce non-point-source pollution in Indiana has been made as well, including programs to

reduce soil erosion and agricultural runoff, protect and restore wetlands, and reclaim abandoned mine lands. Use of conservation tillage in Indiana has increased from 24 percent of tilled acres in 1989 to 46 percent of tilled acres in 1994 (Conservation Technology Information Center, 1995).

Crawford and Wangsness (1991) and Crawford and others (1992) have reported that the quality of water in the White River has improved since the early 1980's as a result of improvements to wastewater-treatment plants for the City of Indianapolis. The addition of advanced wastewater treatment has decreased ammonia concentrations and increased oxygen concentrations in downstream reaches, thereby improving conditions for fish. EA Engineering, Science, and Technology Inc. (1995) found 63 species of fish in the White River at Indianapolis compared to as few as 9 species found by researchers prior to these improvements. Similar improvements have been found in the White River at Muncie (John Craddock, Bureau of Water Quality, City of Muncie, oral commun., 1996).

Gammon (1995b) has documented recent improvements in fish communities of the Wabash River and attributes the improvements in part to reduced nutrient and sediment runoff from agricultural land and to point-source reductions of biochemical-oxygen demand. Although there are no fish data for the White River Basin comparable to the extensive amount of data available for the Wabash River, there are encouraging indications that fish communities in the White River Basin are recovering. For example, the blue sucker is being found more frequently at more sites. Stefanavage (1995) found the blue sucker to be the dominant species in a fisheries survey done in 1994 near the mouth of the White River. This species, which is on the Indiana list of special concern, is very sensitive to water quality. Parke and King (1995) noted increasing numbers of blue suckers in the Wabash River and attributed the trend to improving water quality.

Significant progress has been made toward the restoration of fish communities in the White River Basin in the last 25 years. Such continued progress is required, however, in order to fully restore healthy fish communities to the basin. One remaining area of concern is combined-sewer overflows and stormwater runoff (Indiana Department of Environmental Management, 1994, p. 481). Combined-sewer overflows and storm runoff have contributed to numerous fish kills, including one in the White River at Indianapolis in 1994 that killed 510,000 fish (Camp Dresser & McKee, 1995).

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