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BIODIVERSITY OF FISHES IN THE WABASH RIVER: STATUS, INDICATORS, AND THREATS

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ABSTRACT. Anthropogenic impacts on native Wabash River fish species have caused extinctions, fragmentation and loss of habitat, and range reductions that have imperiled species. Seven species that have been extirpated include the alligator gar (*Atractosteus spatula*), harelip sucker (*Moxostoma lacerum*), crystal darter (*Crystallaria asprella*), saddleback darter (*Percina vigil*), channel darter (*Percina copelandi*), stargazing darter (*Percina uranidea*), and popeye shiner (*Notropis ariommus*). The harelip sucker occurred in the Tippecanoe River but became extinct during the early 1900s. Banded pygmy sunfish (*Elassoma zonatum*) may be extirpated from Indiana, but the species status is unknown. Habitat loss has also caused the local extirpation of spotted darter (*Etheostoma maculatum*), greater redhorse (*Moxostoma valenciennesi*), and northern madtom (*Noturus stigmosus*). Range reductions have influenced the distribution of northern brook lamprey (*Ichthyomyzon fossor*), lake sturgeon (*Acipenser fulvescens*), cisco (*Coregonus artedii*), and gilt darter (*Percina evides*). Currently, five species on the endangered list for Indiana (50%) occur in the Wabash River. As sensitive species have declined in abundance, some species have increased in distribution and relative abundance: tippecanoe darter (*Etheostoma tippecanoe*), harlequin darter (*Etheostoma histrio*), and eastern sand darter (*Ammocrypta pellucida*). Intensive evaluations of the Tippecanoe and Wabash Rivers have shown increasing threats. Perhaps the greatest threat to the aquatic biodiversity of the Wabash River fish assemblage is the influence of exotic fish species, with the impact of the Asiatic carps (grass (*Ctenopharyngodon idella*), bighead (*Hypothalmichthys nobilis*), and silver (*H. molitrix*) carps) of looming concern.

Keywords: Biodiversity, status, threatened and endangered species, alien species

The Wabash River flows through the heartland of the Corn Belt Plain and is perhaps the lifeblood of the midwestern United States. Perhaps no other river has been so prominently mentioned regarding the history of North American ichthyology than the Wabash River. As a result of the influence and allure of this river, more long-term studies of large-river fishes (Forbes & Richardson 1920; Gammon 2000) may have been conducted in the Wabash River than any other North American river. In the lower Wabash River, continuous studies at the same sites have been conducted since 1905 by the State of Illinois (Forbes & Richardson 1905), while in Indiana the middle Wabash River has been studied since 1966 (Gammon 2000).

The Wabash River possesses a rich legacy of ichthyological investigations (Rafinesque 1820; Lesueur 1846; Cope 1868, 1870; Jordan 1877; Jordan & Copeland 1877; Swain 1883; Forbes & Richardson 1905). Perhaps more renowned ichthyologists may have waded in the Wabash River and its major tributaries than in any other North American river.

The purpose of this paper is to describe significant contributions that have been accomplished in the Wabash River drainage in the fields of ichthyology and fisheries biology. This paper describes contributions in the study of fish diversity, patterns in large river structure and function, and current threats to fish assemblage stability.

SIGNIFICANT CONTRIBUTIONS TO ICHTHYOLOGY OF THE WABASH RIVER

Among the most famous ichthyologists and fisheries biologists who have traversed the Wabash River are Samuel Constantine Rafinesque, Charles A. LeSueur, Edwin Drinker Cope, David Starr Jordan, Stephen A. Forbes, Charles H. Gilbert, and James R. Gammon.

Samuel Constantine Rafinesque (1783–1840) was an eccentric naturalist who was born in Galata, a suburb of Constantinople.

Rafinesque came to the United States in 1818, where he settled in Kentucky and collected various kinds of biological specimens including fish, plants, a wide variety of invertebrates, and other vertebrate animals. Rafinesque spent a significant amount of his career studying the fauna and flora of the Ohio River basin, but also evaluated fishes from the Wabash River (Call 1985). Generally, Rafinesque described organisms from memory and published his work in a series of articles. His work culminated in the *Ichthyologia Ohiensis*, which set North American ichthyology back considerably (Rafinesque 1820). Rafinesque, while traveling through the Ohio River valley, befriended James Audubon and lodged at his cabin in Henderson, Kentucky. Legend records that during one of these stays, Rafinesque was awakened by bats flying around the cabin. Rafinesque grabbed Audubon's violin and swatted at the bats, ultimately destroying the violin. Audubon got even with Rafinesque by illustrating hypothetical fishes that represented mixtures of several species. Audubon brought these drawings to Rafinesque, who described them as new species. In part, this was the basis for years of frustration and confusion (Agassiz 1855; Jordan 1876).

Charles Alexandre Lesueur (1778–1846) was considered among the most prominent ichthyologists of the early 19th century. Lesueur was born in France and studied with Professors Culver and Valenciennes from the Museum of Natural History in Paris, France. He came to North America and settled in New York, where he began studies of North American freshwater fishes. He was among the prominent scientists who left the Philadelphia Academy of Science on the "Boatload of Knowledge," which was a group of well-known scientists that relocated to New Harmony by traveling down the Ohio River and settled on the banks of the Wabash River. Lesueur joined the experimental New Harmony socialistic colony around 1820 and was there for a short time. Lesueur studied freshwater fishes of the Wabash River, but due to frustrations with other scientists at New Harmony left the settlement and returned to France before completing his treatise of North American fishes.

Edwin Drinker Cope (1840–1897) was among the first ichthyologists to have described fish from Indiana during explorations of the Virginia territory. Cope was a biologist with the Academy of Natural History in Philadelphia and became famous for the large number of dinosaurs he found. His feuds with Othniel C. Marsh, American Museum of Natural History, were known as the dinosaur wars. Cope, as was true of many scientists of his time, studied all aspects of natural history, including herpetology, ichthyology, and paleontology. It is not clear if Cope may have sampled in Indiana or if he described species that had been sent to him by other collectors, but he described species from the White River near Indianapolis and from the Wabash River near Lafayette (Cope 1867, 1868, 1870). Cope was posthumously recognized by the American Society of Ichthyologists and Herpetologists when they named their journal "Copeia" in his honor.

David Starr Jordan (1851–1931) was perhaps the most influential of all American ichthyologists. He began his career in Indiana and is considered the "Father of modern ichthyology." All current ichthyologists can trace their educational "roots" back to Jordan in some manner. Jordan had an illustrious career that began at Butler University, continued at Indiana University, and terminated at Stanford University. While Jordan was in Indiana, he retraced the footsteps of Rafinesque and unraveled the mystery of many Ohio River fishes (Jordan 1876), and then studied fishes in the White River drainage contributing substantially to the description of new species; and, all the while, training students in the understanding of fishes. Jordan, along with Barton Warren Evermann, co-authored the treatise entitled, "Fishes of North and Middle America," which was considered the definitive study on fishes. Jordan, while at Butler University, was known for his collecting trips and travels across North America instructing students in geology, natural history, and the customs of local people. Jordan's exploits are legendary, and he published extensively with his students. After leaving Indiana, Jordan purchased and had shipped to Stanford University the Indiana University fish collection. This material is currently curated at the California Academy of Science. Jordan conducted extensive studies for the Bureau of Fisheries, the United States Fisheries Commission, and surveyed the marine fishes of Japan, Hawaii, and the southeastern United States. Jordan was

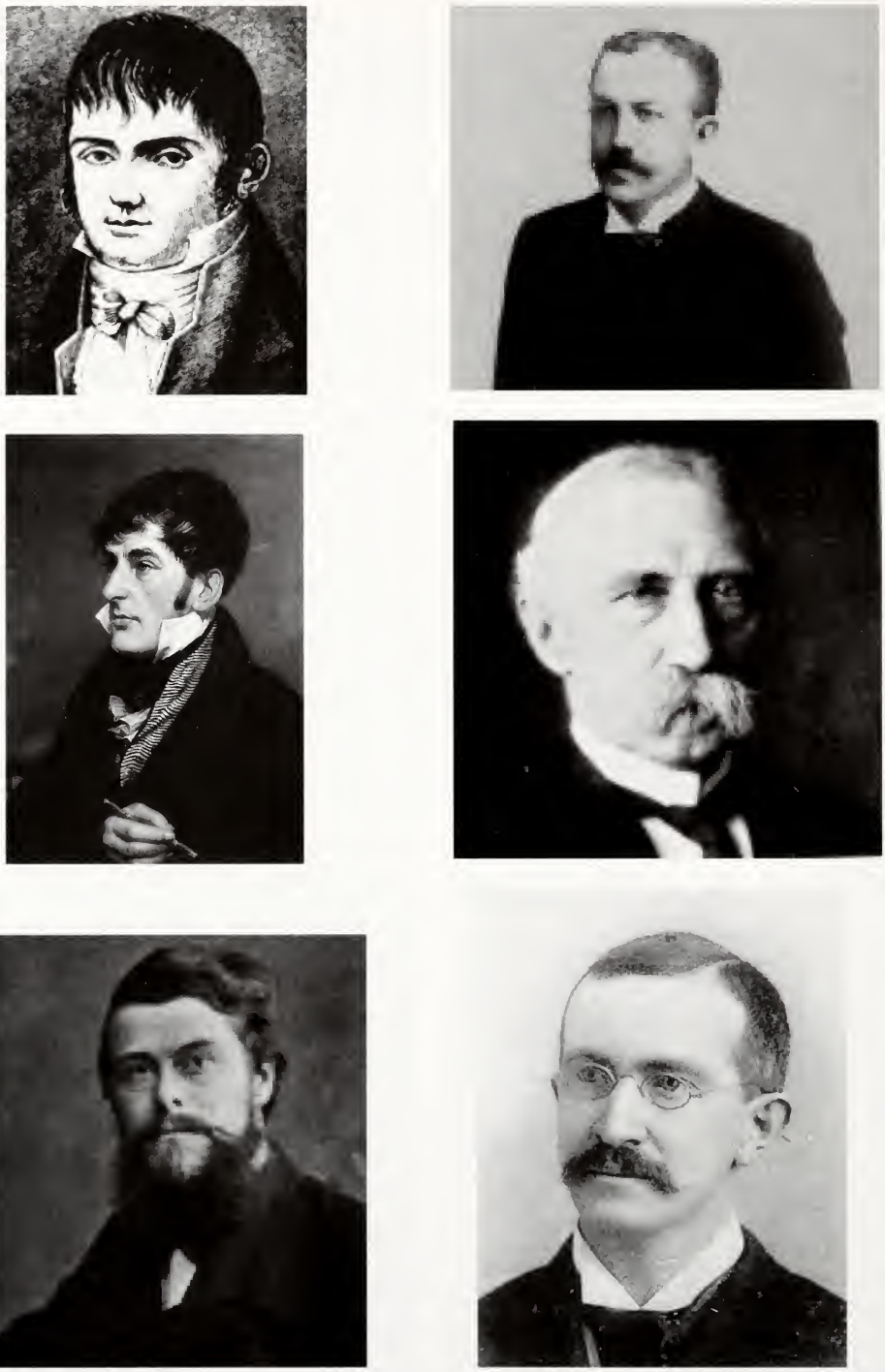

Figure 1.—Ichthyologists and fisheries biologists who made significant contributions to our knowledge of the Wabash River drainage. Top left: Samuel Constantine Rafinesque (1783–1840); Top right: David Starr Jordan (1851–1931); Center left: Charles A. Lesueur (1778–1846); Center right: Stephen A. Forbes (1844–1930); Bottom left: Edwin Drinker Cope (1840–1897); Bottom right: Charles Gilbert (1859–1928).

highly honored and respected by his students and is credited with the development of college majors.

Charles Henry Gilbert (1859–1928) became an early associate of David Starr Jordan. He first met Jordan while a high school student. Gilbert followed Jordan and studied under him first at Butler University. Later, when Jordan went to Indiana University, Gilbert followed him and received his masters and doctorate degrees. Gilbert was the first individual to receive a doctoral degree from Indiana University. He studied fishes in the White River and followed Jordan to Stanford University, where he became a professor in the Department of Zoology. According to some, Gilbert was perhaps best known for his studies of western North American fishes. He was the senior scientist on the voyages of the Albatross, which studied marine fishes and surveyed the Hawaiian Islands. His devotion to Jordan lasted until the end of his life.

Stephen Alfred Forbes (1844–1930) was the founder of the Illinois Natural History Survey. Forbes studied pollution events in the Illinois River, and ultimately conducted surveys of streams and rivers in Illinois that were published in the "Fishes of Illinois" (Forbes & Richardson 1905, 1920). Sites established by Forbes & Richardson that were sampled along the border of the lower Wabash River have contributed significantly to our knowledge of the Wabash River prior to drainage of its extensive wetlands.

James R. Gammon (1936–present) studied fish ecology and the impacts of thermal pollution on the structure and function of fish assemblages in large rivers. Gammon was a Professor at DePauw University. Gammon had significant influence on the development of large river standard operating methods, development of assessment indices, and provided a long-term database that evaluated the middle Wabash River for over 30 years (Gammon 2000).

RESULTS AND DISCUSSION

Fishes of the Wabash River drainage.—The Wabash River has 151 native fish species (Table 1). This could well be the most native fish species of any drainage in the Ohio River basin. The two principal tributaries, the West Fork White River (including the lower White River and the East Fork White River), have 126 species.

The State of Indiana has listed seven "Endangered" and five "Special Concern" species that occur in the Wabash River drainage (Table 1). The State defines endangered species as any animal species whose prospects for survival or recruitment within the state are in immediate jeopardy and are in danger of disappearing from the state. This includes all species classified as endangered by the federal government which are known to occur in Indiana. Special concern is defined as any animal species about which some problems of limited abundance or distribution in Indiana are known or suspected and should be closely monitored. Seven species are classified as State Endangered species, and they include the bantam sunfish (*Lepomis symmetricus*), greater redhorse (*Moxostoma valenciennesi*), lake sturgeon (*Acipenser fulvescens*), northern brook lamprey (*Ichthyomyzon fossor*), channel darter (*Percina copelandi*), and redside dace (*Clinostomus elongatus*), which are found within the Wabash River basin, but may be limited to either single sites or less than 10 locations. The banded pygmy sunfish (*Elassoma zonatum*) may be extirpated from Indiana, but the species status is unknown. The banded sunfish is classified as special concern. Other species occurring in the Wabash River drainage that are classified as special concern include, northern madtom (*Noturus stigmosus*), spotted darter (*Etheostoma maculatum*), tippecanoe darter (*E. tippecanoe*), and western sand darter (*Ammocrypta clara*).

Type locations.—Nine species of fishes have been described from the Wabash River system (Table 2), including two species that were described from the Wabash River proper and another two species from direct tributaries. The shovelnose sturgeon, river redhorse, grass pickerel, and Tippecanoe darter were described from the Wabash River system. The other five species were described from the White River system in the vicinity of Indianapolis.

History of extirpations.—Seven fish species, including a single species that is now extinct, have been extirpated from the Wabash River drainage. The harelip sucker (*Moxostoma lacerum*), known from the Tippecanoe River, was always considered rare; but it is not known what caused the species' demise. Some

Table 1.—Distribution and habitats of fishes of the Wabash River drainage. EP = extirpated; N = native species; NI = possibly introduced, but considered native; EX = extinct; and I = introduced.

Species	Habitats							Drainage	
	Low-Land	Upland	Big River	Stream	Creek	Lacus-trine	Subter-ranean	Wabash River	White River
Petromyzontidae									
Icthyomyzon bdellium	X	X	X	X				N	
Icthyomyzon castaneus	X	X	X	X				N	
Icthyomyzon fossor		X		X	X			N	N
Icthyomyzon unicuspis	X	X	X	X				N	
Lampetra aepyptera		X		X	X			N	N
Lampetra appendix		X		X	X			N	N
Acipenseridae									
Acipenser fulvescens	X		X					N	N
Scaphirynchus platorynchus	X		X			X		N	N
Polyodontidae									
Polyodon spathula	X		X			X		N	N
Lepisosteidae									
Atractosteus spatula	X		X			X		EP	
Lepisosteus oculatus	X		X			X		N	N
Lepisosteus osseus	X	X	X	X				N	N
Lepisosteus platostomus	X		X					N	N
Amiidae									
Amia calva	X		X	X		X		N	N
Anguillidae									
Anguilla rostrata	X		X	X				N	N
Cluepidae									
Alosa chrysochloris	X		X					N	N
Dorosoma cepedianum	X	X	X	X		X		N	N
Dorosoma petenense	X		X			X		I	I
Hiodontidae									
Hiodon alosoides	X		X					N	N
Hiodon tergisus	X		X					N	
Gadidae									
Lota lota	X		X					N	
Salmonidae									
Coregonus artedii	X					X		N	
Umbridae									
Umbra limi	X			X	X	X		N	N
Esocidae									
Esox americanus	X	X		X	X	X		N	N
Esox lucius	X	X		X	X	X		N	
Esox masquinongy	X	X	X			X		I	
Cyprinidae									
Campostoma anomalum		X		X	X			N	N
Carassius auratus								I	I
Clinostomus elongatus		X		X				N	
Ctenopharyngodon idella	X		X			X		I	I
Cyprinella lutrensis	X			X	X			NI	

Table 1.—Continued.

Species	Habitats							Drainage	
	Low-Land	Upland	Big River	Stream	Creek	Lacus-trine	Subter-ranean	Wabash River	White River
Cyprinella spiloptera		X	X	X	X		X	N	N
Cyprinella whipplei		X		X	X			N	N
Cyprinus carpio	X	X	X	X	X	X		I	I
Ericymba buccata		X		X	X			N	N
Erimystax dissimilis		X		X				N	
Erimystax x-punctata		X		X				N	
Hybognathus hayi	X		X	X				N	
Hybognathus nuchalis	X		X	X				N	N
Hybopsis amblops		X		X	X			N	N
Hypophthalmichthys molitrix	X		X					I	I
Hypophthalmichthys nobilis	X		X					I	I
Luxilus chysocephalus		X		X				N	N
Lythrurus fumeus	X			X	X			N	
Lythrurus umbratilis	X	X		X	X			N	N
Macrhybopsis hyostoma	X	X	X	X	X			N	N
Macrhybopsis storeriana	X		X	X				N	N
Nocomis biguttatus		X		X	X			N	N
Nocomis micropogon		X		X	X			N	N
Notemigonus crysoleucas	X			X	X	X		N	N
Notropis amnis	X		X	X				N	
Notropis anogenus	X					X		N	
Notropis ariommus		X	X	X				EP	EP
Notropis atherinoides	X	X	X	X		X		N	N
Notropis blennius	X		X					N	N
Notropis boops		X		X	X			N	N
Notropis buchanani	X		X					N	N
Notropis dorsalis		X		X	X			N	
Notropis hudsonius	X		X	X		X		N	
Notropis photogenis		X		X				N	N
Notropis rubellus		X		X	X			N	N
Notropis shumardi	X		X					N	
Notropis stramineus		X		X	X			N	N
Notropis texanus	X					X		N	N
Notropis volucellus	X	X	X	X		X		N	N
Opsopoeodus emilae	X		X	X	X	X		N	N
Phenacobius mirabilis	X	X		X	X			N	N
Phoxinus erythrogaster		X			X			N	N
Pimephales notatus	X	X	X	X	X			N	N
Pimephales promelas	X	X		X	X			N	N
Pimephales vigilax	X	X	X	X				N	N
Rhinichthys obtusus		X			X			N	N
Semotilus atromaculatus	X	X		X	X			N	N
Castostomidae									
Carpiodes carpio	X	X	X	X				N	N
Carpiodes cyprinus	X	X	X	X				N	N
Carpiodes velifer	X	X	X	X				N	N
Catostomus commersonii	X	X		X	X			N	N
Cycleptus elongatus	X		X					N	N

Table 1.—Continued.

Species	Habitats							Drainage	
	Low-Land	Upland	Big River	Stream	Creek	Lacus-trine	Subter-ranean	Wabash River	White River
Erimyzon oblongus	X	X		X	X			N	N
Erimyzon sucetta	X			X	X	X		N	
Hypentelium nigricans		X		X	X			N	N
Ictiobus bubalus	X		X	X				N	N
Ictiobus cyprinellus	X		X	X		X		N	N
Ictiobus niger	X		X	X				N	
Minytrema melanops	X	X		X	X			N	N
Moxostoma anisurum	X	X	X	X				N	N
Moxostoma carinatum	X	X	X	X				N	N
Moxostoma duquesnei		X		X				N	N
Moxostoma erythrurum		X		X	X			N	N
Moxostoma lacerum		X		X				EX	
Moxostoma macrolepidotum	X	X	X	X				N	N
Moxostoma valenciennesi	X	X	X					N	
Ictaluridae									
Ameiurus catus						X		I	I
Ameiurus melas	X	X		X	X	X		N	N
Ameiurus natalis	X	X		X	X	X		N	N
Ameiurus nebulosus	X	X		X		X		N	N
Ictalurus furcatus	X		X					N	N
Ictalurus punctatus	X	X	X	X		X		N	N
Noturus eleutherus		X		X				N	N
Noturus flavus		X		X	X			N	N
Noturus gyrinus	X	X		X	X	X		N	N
Noturus miurus	X	X		X	X			N	N
Noturus nocturnus	X	X		X	X			N	N
Noturus stigmosus		X		X				N	
Pylodictis olivaris	X	X	X	X		X		N	N
Amblyopsidae									
Amblyopsis spelaea		X					X		N
Aphredoderidae									
Aphredoderus sayanus	X		X	X	X			N	N
Fundulidae									
Fundulus catenatus		X		X	X				N
Fundulus dispar	X			X		X		N	N
Fundulus notatus	X	X		X	X	X		N	N
Poeciliidae									
Gambusia affinis	X			X	X	X		N	N
Atherinidae									
Labidesthes sicculus	X	X		X		X		N	
Menidia berylina	X		X					NI	
Gasterosteidae									
Culaea inconstans	X	X			X	X		N	N
Cottidae									
Cottus bairdii		X		X	X	X		N	N
Cottus carolinae		X		X	X				N
Moronidae									
Morone chrysops	X	X	X	X		X		N	N
Morone mississippiensis	X		X	X		X		N	
Morone saxatilis			X					I	

Table 1.—Continued.

Species	Habitats							Drainage	
	Low-Land	Upland	Big River	Stream	Creek	Lacus-trine	Subter-ranean	Wabash River	White River
Centrarchidae									
Ambloplites rupestris	X	X		X		X		N	N
Centrarchus macropterus	X			X	X	X		N	
Lepomis cyanellus	X	X		X	X	X		N	N
Lepomis gulosus	X	X		X	X	X		N	N
Lepomis humilis	X	X		X	X	X		N	N
Lepomis macrochirus	X	X	X	X	X	X		N	N
Lepomis microlophus	X		X			X		NI?	I
Lepomis miniatus	X			X	X	X		N	N
Lepomis symmetricus	X		X		X	X		EP	N
Micropterus dolomieu	X	X	X	X		X		N	N
Micropterus punctulatus		X		X	X			N	N
Micropterus salmoides	X	X	X	X		X		N	N
Pomoxis annularis	X	X	X	X		X		N	N
Pomoxis nigromaculatus	X	X	X			X		N	N
Elassomatidae									
Elassoma zonatum	X				X	X		EP	
Percidae									
Ammocrypta clara	X	X	X	X				EP	N
Ammocrypta pellucida		X		X				N	N
Crystallaria asprella		X		X				EP	
Etheostoma asprigene	X		X	X		X		N	N
Etheostoma blennioides		X		X	X			N	N
Etheostoma caeruleum		X		X	X			N	N
Etheostoma camurum		X		X				N	N
Etheostoma chlorosoma	X			X	X	X		N	N
Etheostoma exile	X	X		X	X	X		N	
Etheostoma flabellare		X		X	X			N	N
Etheostoma gracile	X			X	X	X		N	N
Etheostoma histrio	X	X	X	X				N	N
Etheostoma maculatum		X		X				N	N
Etheostoma microperca		X			X	X		N	N
Etheostoma nigrum	X	X		X	X	X		N	N
Etheostoma spectabile		X		X	X			N	N
Etheostoma squamiceps		X			X			N	
Etheostoma tippecanoe		X		X				N	N
Perca flavescens	X	X	X	X		X		N	I
Percina caprodes	X	X	X	X	X	X		N	N
Percina copelandi		X		X				N	EP
Percina evides		X		X				N	EP
Percina maculata		X	X		X	X		N	N
Percina phoxocephala		X		X				N	N
Percina sciera	X	X		X	X			N	N
Percina shumardi	X		X	X				N	N
Percina uranidea			X		X			EP	
Percina vigil	X			X				EP	
Sander canadensis	X		X	X		X		N	N
Sander vitreus	X		X	X		X		N	N
Sciaenidae									
Aplodinotus grunniens	X		X	X		X		N	N

Table 2.—List of fish species described from the Wabash River drainage including authority and type location.

Species	Authority	Type locality
Scaphirhynchus platorynchus	Rafinesque 1820	No specific locality, Ohio, Wabash, and Cumberland rivers, seldom reaching as high as Pittsburgh, also in Mississippi and Missouri rivers
Esox americanus	Lesueur 1846	Tributaries of Wabash River near New Harmony
Notropis ariommus	Cope 1868	White River near Indianapolis, Marion County
Moxostoma carinatum	Cope 1870	Wabash River at Lafayette
Noturus miurus	Jordan 1877	White River near Indianapolis
Etheostoma tippecanoe	Jordan & Evermann 1890	Tippecanoe River at Marshland (Delong)
Percina coeplandi	Jordan 1877	White River, 8 km N of Indianapolis
Percina evides	Jordan & Copeland 1877	White River near Indianapolis
Percina sciera	Swain 1883	Bean Blossom Creek, 9 km N Bloomington, Monroe County

speculate that the extinction may have been due to either habitat changes or environmental degradation.

The alligator gar (*Atractosteus spatula*) has not been collected from the Wabash River drainage since the turn of the 19th century. The species had been associated with the extensive riverine wetlands surrounding the Wabash River, but with the draining of these wetlands during the late 19th century, the species has been locally extirpated.

Several darters were last collected from the lower Wabash River near New Harmony near the late 1890s (Gerking 1945). The crystal darter (*Crystallaria asprella*), stargazing darter (*Percina uranidea*), and saddleback darter (*Percina vigil*) are large-river fish that are found on riffle habitats (Page 1983; Kuehne & Barbour 1983). Few riffle habitats remain in the lower Wabash River, perhaps as a result of river meandering.

The popeye shiner (*Notropis ariommus*) and channel darter (*Percina copelandi*) were originally described from the White River near Indianapolis (Cope 1867; Jordan 1877). This shiner has not been collected from the White River since the end of the 19th century (Cope 1868). The channel darter is an inhabitant of large, deep rivers and has not been collected in the White River since being described by Jordan (1877). A single record of the channel darter was published by Carney et al. (1993); however, upon inspection of the specimen at the Illinois Natural History Survey it was observed that the specimen was actually a slenderhead darter (*Percina phoxocephala*) (T.P. Simon & B.E. Fisher unpubl. data).

The banded pygmy sunfish was originally known from the lower Wabash River in the extensive backwater swamps. The species was reported by Forbes & Richardson (1905, 1920), but has not been seen since. Although the species may be still present in cypress swamps along the lower Ohio River, it is doubtful that the species is still present in Indiana. Recent on-going surveys since the early 1990s have not found any specimens. The draining of the extensive backwater wetlands along the lower Wabash River is the probable cause of this species extirpation.

Range changes.—Seven fish species have been either extirpated from the Wabash River drainage or have experienced range reductions. They include the northern brook lamprey (*Ichthyomyzon fossor*), lake sturgeon (*Acipenser fulvescens*), lake herring (*Coregonus artedii*), greater redhorse (*Moxostoma valenciennesi*), northern madtom (*Noturus stigmosus*), spotted darter (*Etheostoma maculatum*), and gilt darter (*Percina evides*). Three species have increased their range, including the eastern sand darter (*Ammocrypta pellucida*), harlequin darter (*Etheostoma histrio*), and Tippecanoe darter (*E. tippecanoe*).

The northern brook lamprey is known in Indiana from the Galena River, Lake Michigan basin, and from a few locations in the Tippecanoe River, Fulton County (unpubl. data). Aggressive lampricide treatment of streams to control sea lamprey (*Petromyzon marinus*) populations in the Lake Michigan

Table 3.—Status of known and reported occurrences of cisco in Indiana lakes including the last reported date from published or actual specimens (based on Pearson 2001).

Lake	County	Last report	Status	Reference
Manitou	Fulton	1901	Extirpated	Blatchley & Ashley 1901
Barbee (=Barber)	Kosciusko	1875	Extirpated	Jordan 1875
Little Tippecanoe (James)	Kosciusko	1955	Extirpated	Frey 1955; Pearson 2001
Oswego	Kosciusko	1955	Extirpated	Frey 1955; Pearson 2001
Secrist	Kosciusko	1975	Extirpated	Frey 1955; Pearson 2001
Tippecanoe	Kosciusko	1955	Extirpated	Jordan 1875; Pearson 2001
Winona (=Eagle)	Kosciusko	1886	Extirpated	Jordan & Evermann 1886
Maxinkuckee	Marshall	1886	Extirpated	Jordan & Evermann 1886

basin may have caused the local extirpation of native non-parasitic lampreys.

Lake sturgeon were once known from the Wabash River near Cayuga and throughout the main channel of the Wabash River (Blatchley 1935). Due to the species' large size and difficulty of collecting individuals from main channel habitats, little is known of the species status in the Wabash River. It is assumed that the species has been locally extirpated from the Wabash River, but a small population exists in the East Fork White River beneath Williams Dam (T.P. Simon, unpubl. data; B.E. Fisher, pers. comm.). This may be the only population remaining in the Ohio River drainage.

The lake herring has seen extensive range reduction as a result of cultural eutrophication and the loss of the thermocline in many glacial lakes (Pearson 2001). The species has been locally extirpated from most of the known lakes within the Tippecanoe River system (Table 3).

The greater redhorse is rare in the Wabash River drainage and was previously known from only a few locations in Vigo County (Whitaker & Wallace 1973) and from the Eel River watershed upstream of Logansport (Braun 1984). Sampling at previously known collection localities in the Wabash River and tributaries (Vigo County) has shown that the species has been locally extirpated. Currently, the species is found only in the Eel River watershed in Indiana and has not been collected anywhere else in the Ohio River drainage.

The northern madtom has not been collected from the Tippecanoe River since the late 1800s (Gerking 1945). The species has been recently reported from the Tippecanoe River, but specimen identity is unconfirmed. As a result, the current status of the species is unknown. The northern madtom has been collected from the mainstem Ohio River near Evansville at water depths of 18.6 m (B.E. Fisher unpubl. data).

The spotted darter was last collected from the Tippecanoe River in 1985 from a large riffle downstream of Winamec, Fulton County (Carney et al. 1993; T.P. Simon unpubl. data). The species has not been collected from the Wabash River drainage, but the species has been found in the East Fork White River downstream of Shoals (B.E. Fisher pers. comm.).

The gilt darter was originally found throughout the West Fork White River from Marion to Morgan County (Marguilles et al. 1980). The type locality for the gilt darter is the West Fork White River near Indianapolis. The gilt darter has been extirpated from its type locality but is considered currently stable, being found only in the middle Tippecanoe River from Rochester to Lake Shafer (B.E. Fisher pers. comm.).

The eastern sand darter has remained stable or increased in distribution throughout the Wabash River, but has not expanded in the White River watershed (B.E. Fisher pers. comm.). The species is found in the Tippecanoe River and from the Wabash River mainstem upstream to the Eel River, including many tributaries. The species is found over clean sand with moderate current.

The harlequin darter was considered to be extirpated from Indiana for more than a century (Whitaker & Gammon 1988). However, in the early 1990s, Simon & Kiley (1993) found the species in the lower White River

and upper East Fork White River watershed, as did Greg Seegert (pers. comm.). Harlequin darters are found on woody debris in moderate- to fast-flowing waters. The harlequin darter has been collected continuously from the mouth of the Patoka River up the Wabash River to the mouth of the White River, and continuing upstream of Columbus in the Sugar Creek watershed. The species is currently expanding into the West Fork White River and occurs as far north as Richland Creek (B.E. Fisher pers. comm.).

Finally, the tippecanoe darter has probably not expanded its range greatly, but more efficient sampling techniques have enabled more extensive collection (Simon 2005). Trautman (1980) has shown that abundance in Ohio can change dramatically based on annual recruitment. The Tippecanoe darter is found from the Tippecanoe River from Delong (Marshland) to the mouth with the Wabash River (Jordan & Evermann 1890), and has been collected in the lower East Fork downstream of Williams dam to Shoals (B.E. Fisher pers. comm.).

Threat of alien invasion.—The first wave of alien invasion occurred with the transplant of the common carp (*Cyprinus carpio*) and goldfish (*Carassius auratus*) into North America. These species became established and naturalized after being introduced into the mainstem rivers and streams with the intention that they might become food or game fish. Both species reach very large sizes and contribute to commercial fishery in their native habitats.

The common carp has been introduced throughout North America, and there is not a drainage or state that does not include this species. Carp are ubiquitously found throughout the Wabash River drainage. Goldfish have been much less successful in colonizing the streams and rivers of North America and are nearly absent from the Wabash River drainage. They are typically found only in the most degraded habitats in the White River watershed in the Central Canal in downtown Indianapolis.

The second wave of Asiatic aliens may prove to be much more devastating to native fish species than the first. Four large Asian species have been imported by the aquaculture industry and have escaped into the wild. The grass carp (*Ctenopharyngodon idella*), also known as the white amur, was imported into Alabama and Arkansas from eastern Asia in 1963 to control aquatic vegetation (U.S. Fish & Wildlife Service unpubl. data). An adult grass carp has been reported to eat 45 kg (99.2 lbs) of vegetation per day. The grass carp is widespread in the Wabash and lower White rivers. Individuals have been caught by anglers as far north as Lafayette (Tippecanoe County), and to the junction of the East and West Forks of the White rivers.

The bighead carp (*Hypophthalmichthys nobilis*) was brought to Arkansas in 1972 from eastern China by a private fish farmer to control plankton in culture ponds. The species escaped in the early 1980s. The bighead carp feed near the surface of rivers on organisms such as zooplankton and aquatic insect larvae and adults. Bighead carp have been observed schooling with paddlefish (*Polyodon spathula*). This species is also in direct competition with bigmouth buffalo (*Ictiobus cyprinellus*), gizzard shad (*Dorosoma cepedianum*), all larval and juvenile fishes, and native mussels. Individuals are known to grow to be about 39.5 kg (88 lbs) and 1.2 m (4 ft). Bighead carp have been collected in the middle Wabash River, middle West Fork of the White River, and the lower White River near Petersburg, Gibson County.

The silver carp (*Hypophthalmichthys molitrix*) was brought by an Arkansas fish farmer to the U.S. from Asia in 1973 to control phytoplankton and possibly for use as a food fish. Silver carp have also been used in sewage lagoons to control algae. The silver carp escaped in the early 1980s into the Mississippi River basin. This fish is a very proficient feeder that has gill rakers that are fused into sponge-like porous plates. Silver carp can consume 2–3× their weight in plankton each day. Because of its preferred food items, the silver carp is in direct competition with all native fish larvae and juveniles, adult paddlefish, bigmouth buffalo, gizzard shad, and native mussels. These fish can grow to be over 1 m (3 ft) in length and about 27.24 kg (60 lbs).

The most recent escaped Asian carp is the black carp (*Mylopharyngodon piceus*), which was brought to the U.S. in the early 1970s from eastern Asia. The black carp and grass carp resemble each other except that the black carp has fused pharyngeal teeth that are used

in crushing shells of mollusks and crustaceans, the primary food of black carp. In the 1980s, black carp was imported for use as a food fish and to control the spread of trematodes (parasites) in snails at catfish farms. The only known record of escape occurred in 1994 in Missouri, when 30 or more black carp escaped with several thousand bighead carp into the Osage River in Missouri. Black carp have reached the size of 1.29 m (4.3 ft) and over 35.87 kg (79 lbs).

The effect of Asian carp on the North American fish assemblages has still not been fully realized. It is unclear when population numbers from the second invasion will stabilize. Asian carps have the potential of affecting phytoplankton, zooplankton, and molluscan assemblages. In addition, these carps may also change the biomass and structure of native fish assemblages. The four Asian species' prolific spawning capacity and large size can reduce native species biomass.

The Wabash River system has experienced significant physical and biological changes as a result of anthropogenic effects. Drainage of wetlands has caused the loss of alligator gar and possibly the banded pygmy sunfish. Changes in the lower Wabash River have resulted in the extirpation of the crystal darter, stargazing darter, and saddleback darter. Range reduction has affected another seven species. Change in water quality, landscape and land use have reduced native fish species biodiversity and have increased Asiatic alien invaders that have restructured the fish assemblage of the Wabash River drainage. The release and escape of grass, silver, and bighead carp into the Mississippi River has seen these species spread into the lower and middle Wabash River and the lower portions of the East and West Forks of the White River. An unknown impact will be the invasion of the black carp. This species has the potential to cause the destruction of native mollusk species, thus further affecting native drainage ecosystems.

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