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WHITE RIVER MAINSTEM 2020: A DETAILED ANALYSIS OF THE FISH COMMUNITY AND AQUATIC HABITAT

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ABSTRACT. The White River Mainstem Project was completed in the summer and fall of 2020 to assess the health of the West Fork White River and White River (WR) from headwaters to confluence. The Indiana Department of Environmental Management, Indiana Department of Natural Resources, and Muncie Sanitary District Bureau of Water Quality sampled 405 river miles, resulting in 62 fish community surveys yielding 17,232 fish comprising 94 species. The Index of Biotic Integrity (IBI) was calculated for every sample, and the average IBI score was 41, with 79% of IBI scores above or equal to 36, indicating they can support healthy fish populations. Thirteen sites, many in the lower reaches of the White River, had IBI scores below 36, indicating fish populations are impaired. The Qualitative Habitat Evaluation Index (QHEI) was also used at each site to assess the available habitat for the fish community with 79% of sites falling within the *good* or *excellent* category and only one site falling into the *poor* category. Results from this project will serve as a benchmark of fish communities, water quality, and aquatic habitat found in 2020. More information about the project can be found at idem.IN.gov/WhiteRiverProject.

Keywords: fish community, water quality, biological monitoring

INTRODUCTION

The West Fork White River (WFWR) begins in rural Randolph County just west of the Ohio border in Winchester. Flowing west, it passes through Muncie and Anderson before meandering southwest through the Indianapolis metropolitan area. South of that location, the WFWR flows for 214 river miles (RM) before joining the East Fork White River near Petersburg to form the White River (WR). From this confluent point, the WR flows an additional 49.5 RM, meeting the Wabash River near Mount Carmel, Illinois. This entire stretch is 405 RM, with a total drainage area of 29,372.8 km^2. The drainage area consists of approximately 41% cropland, 34% forest, 11% wetland, and 10% developed land (USGS 2016). For the purposes of this publication, we will refer to the combined WFWR and WR as simply the White River (WR).

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Historically, the WR has been subjected to various forms of anthropogenic influences. These began with the placement of the state capital, 1820–21, which was to be located in the central portion of the state and have access to a "navigable" stream. It is not surprising that other cities and towns followed suit and staked their claim on the WR, using the river as a roadway to transport goods (Dunn 1910). Early European colonization led to urbanization that turned the WR into a dumping location for unregulated industrial discharges and untreated sewage. In the early 1900s, only 6% of the 33 principal cities and towns in the White River Basin had some form of wastewater treatment (Tucker 1922). The timing of these anthropogenic changes has led researchers like Gammon (1977) to believe that the fish communities documented by Rafinesque (1820), Jordan (1878), and Eigenmann & Beeson (1894) were already being affected.

Years of unregulated industrial and sewage discharges led to The Clean Water Act (CWA) in 1972, which established a goal of restoring our aquatic ecosystems through strict regulation of point-source pollution. The results of this legislation have been well documented regarding fisheries improvements in Midwestern streams (Gammon et al. 1981; Karr et al. 1986; Gammon 1998; Pyron et al. 2006; Holloway et al. 2018). Unfortunately, the CWA did not stop a 1999 fish kill in Anderson that resulted in 4.6 million fish dying in a 43-mile stretch from there to Broad Ripple Village in Indianapolis (Ball 2000; Keller 2000). Recovery efforts have included fish stocking and increased sampling done by the Indiana Department of Natural Resources (Clark-Kolaks 2011).

The WR fish communities have been sampled repeatedly by the Indiana Department of Environmental Management (IDEM), Indiana Department of Natural Resources (DNR) and Muncie Bureau of Water Quality (BWQ), but to date this project was the most comprehensive one-year study of a single stream in Indiana history (Kingsley 1983; Ball 2000; Hoffman 2007; Clark-Kolaks 2011). This "snapshot" of the WR aims to provide a better understanding of not only the biological communities, but also the physical habitat and water quality. The scope of this project was multifaceted, but this manuscript is a description of the fish communities.

METHODS

Site selection.—Collaboratively, IDEM, DNR, and BWQ biologists chose sites that would be beneficial for all three organizations. Even though each of these organizations has the same overall goal of protecting Indiana's natural resources, each agency has distinct protocols. A top priority of investigators was to ensure that sites would not exclude any of the participating agencies' objectives. For example, IDEM's focus was to continue their probabilistic monitoring program, which uses sites within a given basin to provide an overview of the physical, chemical, and biological quality of a specific geographical location. The DNR mission focused on the population dynamics of the WR black bass (Largemouth Bass (*Micropterus salmoides*), Smallmouth Bass (*Micropterus dolomieu*), and Spotted Bass (*Micropterus punctulatus*)), Rock Bass (*Ambloplites rupestris*), and catfish (*Ictalurus* spp. and *Pylodictis* spp.) populations. Similarly, to IDEM, the BWQ continued their yearly biological monitoring of the WR to assess stream health using chemical and biological results. Compiling these objectives warranted a massive and all-encompassing sampling plan that included a total of 62 sampling locations (Table 1, Fig. 1).

Fish monitoring.—Following the Index of Biotic Integrity (IBI) expectations for the Eastern Corn Belt Plain (ECBP) (Simon & Dufour 1998) and White River drainage (Simon 1992), all sites sampled consisted of a sample reach that was 15× the average wetted width of the river with a minimum of 50 m and a maximum of 500 m. Fish were collected using either pulsed-direct current boat-, barge-, backpack-, or canoe-mounted electrofishing unit, with a current output range of 12–16 amps, a voltage range up to 500 volts, and a pulse frequency setting of 60 pulses per second. Electrofishing took place during low flow (June-October), and all available habitats were sampled working upstream. After the completion of each sample reach or one hour of electrofishing, whichever occurred first, all fish were identified to species, bulk weighed, length measured (minimum/maximum), and released back to the stream (IDEM 2018). The regionally calibrated 12 metric IBI for the Eastern Corn Belt Plain and White River Drainage quantifies the effects of anthropogenic impacts on streams based on reference conditions. A categorical classification of fish communities was assigned to sampling sites based on IBI scores, with all scores over 36 indicating full support of fish life (Simon 1992; Simon & Dufour 1998; IDEM 2020).

Qualitative Habitat Evaluation Index (QHEI).—Earlier biologists identified habitat usage and fish community associations in Indiana waters, followed by creation of the QHEI scoring procedure that correlated fish and habitat variables (Gorman & Karr 1978). The QHEI allows a measurable outcome for available fish and macroinvertebrate invertebrate habitat using six scored metrics. These scoring categories represent the various types of substrates and habitats associated with biological communities of a stream. Metric scoring categories include substrate, instream cover, channel morphology, riparian zone, pool/glide and riffle/run quality, and gradient (Rankin 1989). The results of this application are scored from 0 (poor quality) to 100 (high quality) and can be used to determine if there is an underlying habitat issue when water quality parameters do not show impairment (IDEM 2019). Further emphasizing the importance of evaluating the physical stream environment,

Table 1.—Fish sampling locations with site number, date sampled, county(ies), latitude, longitude, and river mile sampled during the White River Mainstem Project in 2020. River miles calculated by Indiana DNR using aerial photography.

Site Number	Date Sampled	County(ies)	Latitude	Longitude	River Mile
1	06/30/20	Randolph	40.15006	-84.91978	368.2
2	06/17/20	Randolph	40.18216	-84.96859	348.5
3	06/17/20	Randolph	40.18002	-85.03518	343.6
4	06/30/20	Randolph	40.17945	-85.07307	341.0
5	07/08/20	Randolph	40.16875	-85.14661	336.0
6	10/05/20	Randolph	40.16189	-85.21297	331.7
7	06/18/20	Delaware	40.15323	-85.29461	324.6
8	06/29/20	Delaware	40.14878	-85.31327	323.4
9	06/16/20	Delaware	40.19655	-85.36724	317.2
10	06/10/20	Delaware	40.17855	-85.49511	308.9
11	06/15/20	Delaware	40.16445	-85.53039	306.5
12	06/08/20	Delaware	40.13133	-85.55662	302.5
13	09/21/20	Madison	40.10608	-85.62389	297.0
14	07/29/20	Madison	40.10769	-85.67442	293.0
15	07/29/20	Madison	40.11819	-85.69047	291.6
16	09/21/20	Madison	40.11050	-85.71112	290.2
17	09/22/20	Madison	40.11756	-85.73451	288.6
18	09/22/20	Madison	40.13167	-85.78593	284.8
19	09/16/20	Madison	40.14179	-85.86304	278.6
20	09/16/20	Hamilton	40.12800	-85.90872	275.8
21	09/14/20	Hamilton	40.09471	-85.96872	268.6
22	09/10/20	Hamilton	40.05208	-86.01455	263.9
24	08/06/20	Hamilton	40.03762	-86.02571	262.3
25	08/06/20	Hamilton	39.96802	-86.04920	254.3
27	09/10/20	Hamilton	39.95699	-86.06114	253.8
28	09/10/20	Marion	39.92599	-86.07599	250.9
29	08/25/20	Marion	39.91005	-86.10532	247.9
30	09/23/20	Marion	39.90136	-86.11580	246.9
32	09/10/20	Marion	39.87016	-86.13381	243.1
33	09/09/20	Marion	39.86995	-86.15774	241.4
34	09/10/20	Marion	39.84627	-86.17961	239.1
35	09/09/20	Marion	39.78772	-86.19511	233.7
36	08/24/20	Marion	39.77175	-86.18658	232.2
37	08/31/20	Marion	39.73731	-86.17093	229.2
38	08/31/20	Marion	39.72659	-86.18659	227.9
39	08/25/20	Marion	39.66661	-86.23694	222.1
40	09/15/20	Morgan	39.55895	-86.27419	211.0
41	09/24/20	Morgan	39.50908	-86.32305	204.9
42	08/24/20	Morgan	39.49390	-86.39260	199.8
43	09/15/20	Morgan	39.43400	-86.44855	191.7
44	09/30/20	Morgan	39.38099	-86.50167	185.9
45	09/08/20	Morgan	39.37325	-86.55834	181.5
46	09/14/20	Owen	39.35047	-86.65877	174.7
47	09/29/20	Owen	39.26096	-86.79830	157.8
48	09/29/20	Owen	39.20550	-86.86651	148.8
49	09/28/20	Greene	39.16583	-86.89300	142.0
50	09/08/20	Greene	39.11086	-86.96264	134.3
51	09/28/20	Greene	39.01842	-86.97211	123.9
52	10/13/20	Greene	38.95802	-86.99431	115.7
53	09/14/20	Greene	38.90975	-87.09648	105.1
54	10/05/20	Daviess/Knox	38.82683	-87.18632	91.0
55	08/27/20	Daviess/Knox	38.81501	-87.23202	84.4

Table 1.—Continued.

Site Number	Date Sampled	County(ies)	Latitude	Longitude	River Mile
56	09/08/20	Daviess/Knox	38.74841	-87.23724	75.7
57	08/27/20	Daviess/Knox	38.70903	-87.26964	70.7
58	08/25/20	Daviess/Knox	38.61669	-87.24002	57.8
59	08/26/20	Daviess/Knox	38.55887	-87.23886	51.5
60	08/26/20	Knox/Pike	38.51238	-87.28845	45.7
61	08/27/20	Knox/Pike	38.52896	-87.33520	42.6
62	10/07/20	Knox/Pike	38.53202	-87.45461	29.4
63	09/08/20	Gibson/Knox	38.50478	-87.53305	22.7
64	10/06/20	Gibson/Knox	38.45697	-87.64134	9.3
65	09/30/20	Gibson/Knox	38.41578	-87.72870	0.5

the creation of the QHEI has allowed a more calculated and refined look at the relationship between Indiana fish and habitat. Central Indiana tributaries of the WFWR have shown a positive correlation between IBI and QHEI scores (Sullivan et al. 2004; Lau et al. 2006).

RESULTS

Fish monitoring.—The results of electrofishing sampling events yielded 17,232 individual fish representing 94 species from 18 families (Table 2). The most abundant family was Cyprinidae. This family is the largest of the freshwater fish families (Nelson 1994) and encompasses the minnows and carps from which 29 species were represented in this study. Cyprinidae comprised over one-third of all fish sampled (n = 5996; 34.8%). Other most common families included Catostomidae (16.0%), Percidae (13.8%), Centrarchidae (11.7%), and Ictaluridae (8.5%).

The most abundant fish species collected was Bluegill (*Lepomis macrochirus*) with 1,804 fish collected at 87% of sites sampled (Table 2). Longear Sunfish (*Lepomis megalotis*) was the second most abundant species collected with 1,273 fish being collected at 85% of sites sampled. Spotfin Shiner (*Cyprinella spiloptera*) was the third most common species collected, but it was found at the greatest percentage of sites, with 1,161 fish being collected at 92% of sites. A total of 1,104 Bluntnose Minnow (*Pimephales notatus*) was collected at 63% of sites, followed by Sand Shiner (*Notropis stramineus*) with 1,018 fish collected at 62% of sampled sites.

Many sport fish species were collected during sampling, including Largemouth Bass, Smallmouth Bass, Spotted Bass, Rock Bass, Channel Catfish (*Ictalurus punctatus*), Flathead Catfish (*Pylodictis olivaris*), and Blue Catfish (*Ictalurus furcatus*). Rock Bass was the most numerous sport fish collected (760 fish), but Smallmouth Bass was collected at the greatest number of sites (73%), followed by Channel Catfish (66%). Smallmouth Bass was collected sporadically from Site 2 all the way through to Site 64 (Table 2), and ranged in length from 30 mm to 465 mm. Largemouth Bass was collected from Site 1 through 38 and was more common in the impounded reaches of the WR through Indianapolis (Table 2). Their total length range was 41 mm to 457 mm. Spotted Bass was collected sporadically in the upper sites, but it became more prevalent starting at Site 38 to the confluence of the Wabash River at Site 65 (Table 2). Spotted Bass total length range was 43 mm to 373 mm. Rock Bass was only collected consistently in the upper 240 miles of the WR and total length range was 30 mm to 262 mm. Channel Catfish was found consistently from Sites 20 through 65 and total length range was 56 mm to 754 mm, whereas Blue Catfish was only collected in the lower 124 miles of the river (Table 2) and total length range was 84 mm to 900 mm. Flathead Catfish was also more abundant in the lower sites but was collected in Sites 17 through 65 (Table 2), and total length range was 53 mm to 1054 mm.

The average IBI score was 41, with scores ranging from 14 to 56 (Table 3). Most sites fell within the *fair* (47%) or *good* (26%) categories, with 21% of the sites falling within the *poor* or *very poor* categories. Only 6% of sites fell within the *excellent* category. Seventy-nine percent of sites had an IBI score of 36 or greater, indicating they support fish communities. Except for Site 4, most sites that had an IBI score below 36, indicating impairments to aquatic life, occurred in the last

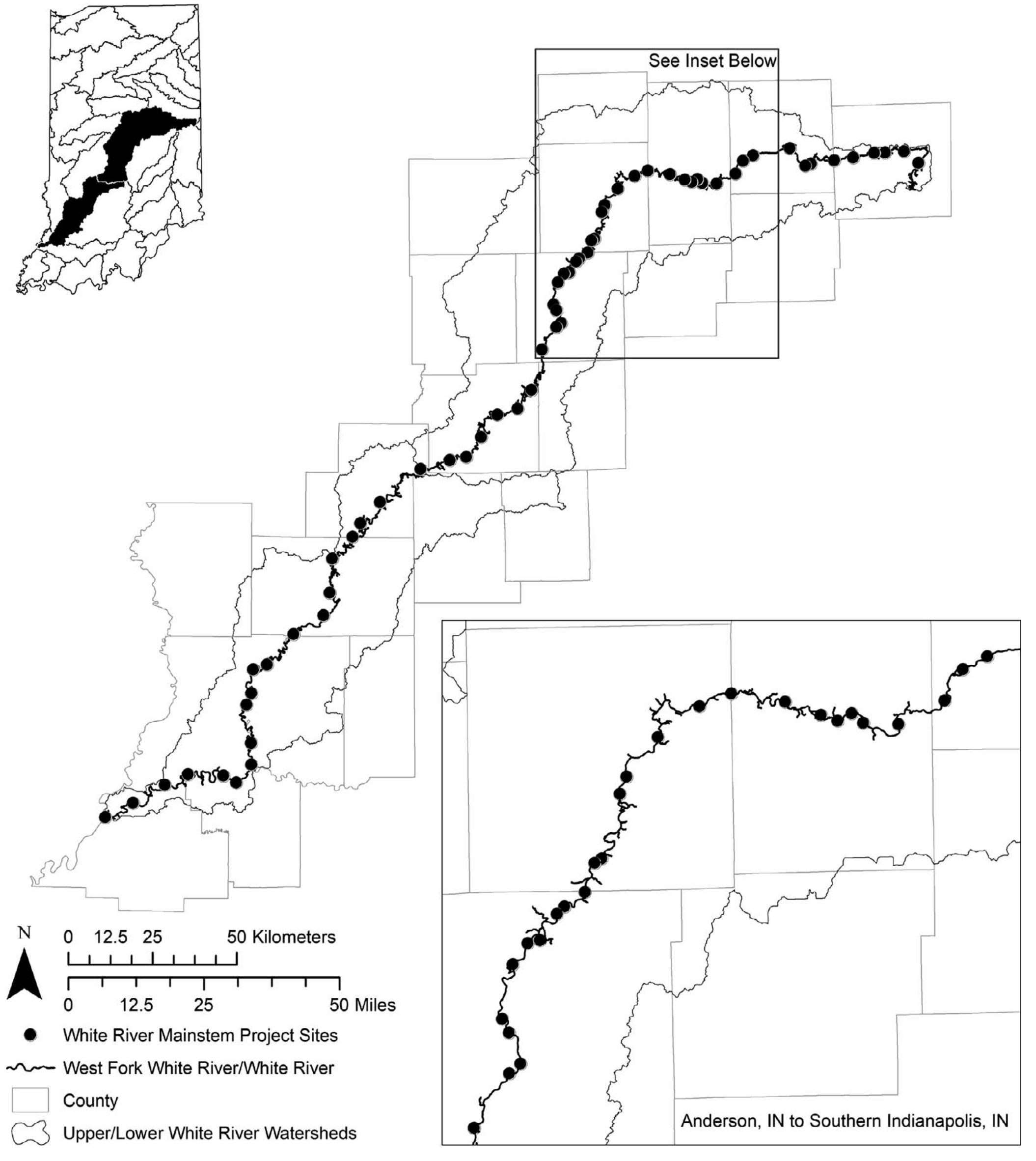

Figure 1.—Fish sampling locations sampled during the White River Mainstem Project in 2020.

160 miles of the river. The two lowest scores of 14 came from sites 51 and 53.

The average QHEI score was 68, with scores ranging from 41 to 87. Almost all sites fell within *good* (48%), *excellent* (31%), or *fair* (19%) categories, and only one site (Site 1) fell within the *poor* (< 1%) category (Table 3).

A Pearson correlation coefficient was calculated between total IBI scores and all QHEI metrics. This analysis showed significant correlations between total IBI score and substrate ($r(60) = 0.65$, $p < 0.05$), instream cover ($r(60) = 0.32$, $p = 0.01$), pool/glide quality ($r(60) = 0.29$, $p = 0.02$), and the riffle metrics ($r(60) = 0.51$, $p < 0.05$).

DISCUSSION

The WR is an important recreational, biological, and economical resource in Indiana. Its fish communities have been monitored periodically by multiple agencies, but these surveys only represented individual portions of the river. The WR Mainstem Project completed in 2020 provided a

Table 2.—Fish species collected at associated sampling sites during the White River Mainstem Project in 2020.

Family or Species Common Name	Species Scientific Name	Sampling Site Numbers
Lampreys- *Petromyzontidae*		
Chestnut Lamprey	*Ichthyomyzon castaneus*	50,51,52,54,55
Sturgeons - *Acipenseridae*		
Shovelnose Sturgeon	*Scaphirhynchus platorynchus*	47,52,53,55,56,58-64
Gars - *Lepisosteidae*		
Spotted Gar	*Lepisosteus oculatus*	56,58,59,63
Longnose Gar	*Lepisosteus osseus*	43,47-51,55-65
Shortnose Gar	*Lepisosteus platostomus*	42-51,53-65
Mooneyes – *Hiodontidae*		
Goldeye	*Hiodon alosoides*	45,55
Mooneye	*Hiodon tergisus*	56
Freshwater Eels - *Anguillidae*		
American Eel	*Anguilla rostrata*	35,55
Herrings - *Clupeidae*		
Skipjack Herring	*Alosa chrysochloris*	62
Gizzard Shad	*Dorosoma cepedianum*	15,22,24,27,30-33, 35-40,42, 45-52,55-60, 62-65
Carps and Minnows - *Cyprinidae*		
Central Stoneroller	*Campostoma anomalum*	2,5-8,11,13-17,19,20,24,28,33,41,42,45,46
Grass Carp	*Ctenopharyngodon idella*	39,42,45-47,50,51,53-56,58,59,61,63-65
Spotfin Shiner	*Cyprinella spiloptera*	2-12,14-22,24,25,28,30,32,34-65
Steelcolor Shiner	*Cyprinella whipplei*	41
Common Carp	*Cyprinus carpio*	4,7,15,21,22,24,25,27,30-36,38-55,57-65
Mississippi Silvery Minnow	*Hybognathus nuchalis*	49,50,55,56,58,59,61,62,64,65
Bigeye Chub	*Hybopsis amblops*	46
Silver Carp	*Hypophthalmichthys molitrix*	39,45-51,53,55,56,58-65
Striped Shiner	*Luxilus chrysocephalus*	1,6,13,21,41-43
Redfin Shiner	*Lythrurus umbratilis*	6,7,8,10
Shoal Chub	*Macrhybopsis hyostoma*	64
Silver Chub	*Macrhybopsis storeriana*	62,64
Hornyhead chub	*Nocomis biguttatus*	16
River Chub	*Nocomis micropogon*	6,11-13,15,17,18
Golden Shiner	*Notemigonus crysoleucas*	21,32
Emerald Shiner	*Notropis atherinoides*	45,46,49,52,59,61-65
River Shiner	*Notropis blennius*	64
Silverjaw Minnow	*Notropis buccatus*	6,11,43,46,48
Silver Shiner	*Notropis photogenis*	7-9,11,12,15-18,22,25,34,43
Rosyface Shiner	*Notropis rubellus*	2,3,5-7,9-14,16-18,20,34
Sand Shiner	*Notropis stramineus*	2,5-11,13-15,17,19-21,24,33,35,39-43,44,46,48-50,52-58,61,62,64
Mimic Shiner	*Notropis volucellus*	7,12,17,39,43
Channel Shiner	*Notropis wickliffi*	64
Suckermouth Minnow	*Phenacobius mirabilis*	35,44,52,54,56,57,62,64
Bluntnose Minnow	*Pimephales notatus*	1-21,24-25,29-46,48,56
Fathead Minnow	*Pimephales promelas*	13,36
Bullhead Minnow	*Pimephales vigilax*	39,41-50,52,54-65
Blacknose Dace	*Rhinichthys atratulus*	7
Creek Chub	*Semotilus atromaculatus*	1-3,5-8,13,15,17,19,24

Table 2.—Continued.

Family or Species Common Name	Species Scientific Name	Sampling Site Numbers
Suckers - *Catostomidae*		
River Carpsucker	*Carpiodes carpio*	37,38,40,42-65
Quillback	*Carpiodes cyprinus*	27,34-39,44-46,48,51,55,56,58,59,62-64
Highfin Carpsucker	*Carpiodes velifer*	53,62
White Sucker	*Catostomus commersonii*	1,2,5-8,10,12,14,15,18-20,30
Blue Sucker	*Cycleptus elongatus*	45-50,53-59,61-65
Northern Hog Sucker	*Hypentelium nigricans*	1-3,5-20,24-30,33,36,38,39,41,42,52
Smallmouth Buffalo	*Ictiobus bubalus*	38-40,44-65
Bigmouth Buffalo	*Ictiobus cyprinellus*	43,45-53,55-56,62-65
Black Buffalo	*Ictiobus niger*	39,45-48,50,51,54,55,57-59,62,63,65
Spotted Sucker	*Minytrema melanops*	6,8,13,15-18,21-25,30-32,35,44
Silver Redhorse	*Moxostoma anisurum*	13,24,30,34,36-39,42,45,52,55
Smallmouth Redhorse	*Moxostoma breviceps*	45,47
Black Redhorse	*Moxostoma duquesnei*	3-12,14,15,17-28,30,35-39,43
Golden Redhorse	*Moxostoma erythrurum*	4,6-10,12-15,17,21,24,27,28,30-32,35-37,39,41,42,45-47,59
Shorthead Redhorse	*Moxostoma macrolepidotum*	20,39-48,50,52,54,55,57,59,61
North American Catfishes - *Ictaluridae*		
Yellow Bullhead	*Ameiurus natalis*	3-8,10,11,13,16-22
Blue Catfish	*Ictalurus furcatus*	51,54,55,59,61,62,65
Channel Catfish	*Ictalurus punctatus*	20,22-27,29-34,36-65
Mountain Madtom	*Noturus eleutherus*	52
Stonecat	*Noturus flavus*	2,5,6,9-11,13,16,17,24,33
Brindled Madtom	*Noturus miurus*	22,24,27,64
Freckled Madtom	*Noturus nocturnus*	48
Flathead Catfish	*Pylodictis olivaris*	17,20,25,32,33,35,36,38-44,46,48-65
Pikes and Mudminnows - *Esocidae*		
Redfin Pickerel	*Esox americanus*	2,20,22,24
New World Silversides – *Atherinopsidae*		
Brook Silverside	*Labidesthes sicculus*	19,24,32,35,38,43-46,49,52,55,60,61,63,64
Topminnows - *Fundulidae*		
Blackstripe Topminnow	*Fundulus notatus*	2,3,6-8,21,27,29,30,36,38
Livebearers - *Poeciliidae*		
Western Mosquitofish	*Gambusia affinis*	19,21,44,49,64
Sculpins – *Cottidae*		
Mottled Sculpin	*Cottus bairdii*	1-3,5-7,9-18,20,24,25
Temperate Basses - *Moronidae*		
White Bass	*Morone chrysops*	24,25,51,53-55,57,59,62-65
Yellow Bass	*Morone mississippiensis*	32,41,48
Sunfishes – *Centrarchidae*		
Rock Bass	*Ambloplites rupestris*	1-3,5-37,43
Green Sunfish	*Lepomis cyanellus*	2,4,6-38,40-44,49,51,52,60,64,65
Warmouth	*Lepomis gulosus*	14,35,37
Orangespotted Sunfish	*Lepomis humilis*	41,60,62
Bluegill	*Lepomis macrochirus*	1-3,6,8-44,46,48-52,58,60-65
Longear Sunfish	*Lepomis megalotis*	1-16,18-38,40-47,49,50,52,58,62-65

Table 2.—Continued.

Family or Species Common Name	Species Scientific Name	Sampling Site Numbers
Redear Sunfish	*Lepomis microlophus*	1,8,18,25-28,30-32,34,36,38,48
Largemouth Bass	*Micropterus salmoides*	1,4,5,6,8,10,11,13,14,16,17-32,34-38
Smallmouth Bass	*Micropterus dolomieu*	2-4,6-46,50,52,55,64
Spotted Bass	*Micropterus punctulatus*	15,17,24,38,40-65
Black Crappie	*Pomoxis nigromaculatus*	4,13,22,24,29,36,38,50
Perches and Darters - *Percidae*		
Eastern Sand Darter	*Ammocrypta pellucida*	43
Greenside Darter	*Etheostoma blennioides*	1-3,5-7,9-20,22-30,33-37,40-44
Rainbow Darter	*Etheostoma caeruleum*	1-3,5-20,22-25,28-30,33,35,41-44,48,52
Slough Darter	*Etheostoma gracile*	64
Harlequin Darter	*Etheostoma histrio*	52
Johnny Darter	*Etheostoma nigrum*	1,2,5-7,9,13,14,16-24,29,33-36,42,44
Orangethroat Darter	*Etheostoma spectabile*	18-20,32,38,41,42,44,64
Logperch	*Percina caprodes*	2,6,7,8-12,16-18,20-30,33-36,38-45
Blackside Darter	*Percina maculata*	7-9,11-14,16,18-20,25
Slender Darter	*Percina phoxocephala*	41-44,46,48
Dusky Darter	*Percina sciera*	40-47,49,52,54-57,59-62,65
Sauger	*Sander canadensis*	43,44,46-49,51,54,57
Walleye	*Sander vitreus*	39
Drums and Croakers - *Sciaenidae*		
Freshwater Drum	*Aplodinotus grunniens*	36,39,45-65

holistic picture of current fish communities and supporting aquatic habitat and water chemistry.

The extensive sampling done by the BWQ since the early 1980s allowed for a historical look at the diversity of fishes found throughout the upper section of the WR. Results from the 2020 sampling were consistent with all past sampling done in this stretch. Improvements in local water quality have led to an increase in sensitive species, such as Smallmouth Bass and Golden Redhorse, and a decrease in Common Carp, a tolerant species throughout Muncie over the last 40+ years. Since 2010, 53.8% of all species sampled on the WR have been sensitive to pollution, while 20.6% have been pollution-tolerant species (Holloway 2020). These values were similar to those collected during the 2020 sampling, where sensitive species made up 46.8%, and 27.0% were tolerant.

The Indiana DNR collected fishes from a site near Mounds State Park to south of Indianapolis, IN in 2011 (Clark-Kolaks 2011), overlapping with sites 13 through 35 of the 2020 survey. Sampling in 2011 collected 56 species from 12 families, while 53 species from 13 families were collected from the same stretch in 2020. Earlier sampling conducted through this reach in Marion County by Kingsley (1983) documented 35 species collected from 8 families, and Environmental Science Engineering (1987) collected 44 species from 9 families.

Sauger (*Sander canadensis*), White Crappie (*Pomoxis annularis*), and Yellow Perch (*Perca flavescens*) were the only species collected in 2011 that were not collected in 2020. Six Sauger were collected in 2011; based on their ages, these were likely remnants from a 2005 stocking. No natural reproduction has ever been documented from this effort (Clark-Kolaks 2011). Sauger were collected at multiple locations downstream of Marion County, while White Crappie and Yellow Perch were not collected at any location during 2020 (Table 2). Species collected in 2020 but not in 2011 were the American Eel (*Anguilla rostrata*), Hornyhead Chub (*Nocomis biguttatus*), Mimic Shiner (*Notropis volucellus*), Silver Redhorse (*Moxostoma anisurum*), Shorthead Redhorse (*Moxostoma macrolepidotum*), Brindled Madtom (*Noturus miurus*), and Spotted Bass (*M. punctulatus*). The average IBI did not differ greatly between 2011(49 *good*) and 2020 (45 *good*).

The lower portion of the WR from Martinsville to Mount Carmel, IL was sampled by Indiana

Table 3.—Site number, Index of Biotic Integrity (IBI) score, IBI rating, Qualitative Habitat Evaluation Index (QHEI) score, and QHEI rating for each site sampled during the White River Mainstem Project in 2020. For IBI and QHEI Ratings, E = excellent, G = good, F = fair, P = poor, and VP = very poor (see Tables 1 & 2 for location and species details).

Site #	IBI	IBI Rating	QHEI	QHEI Rating	Site #	IBI	IBI Rating	QHEI	QHEI Rating
1	40	F	41	P	35	44	F	56	F
2	50	G	77	E	36	46	G	65	G
3	40	F	72	G	37	36	F	52	F
4	20	VP	51	F	38	44	F	60	G
5	50	G	78	E	39	40	F	84	E
6	42	F	70	E	40	34	P	71	G
7	50	G	78	E	41	42	F	74	G
8	42	F	69	G	42	44	F	60	G
9	54	E	80	E	43	46	G	64	G
10	40	F	74	E	44	44	F	54	F
11	52	G	82	E	45	46	G	64	G
12	52	G	82	E	46	38	F	63	G
13	56	E	82	E	47	34	P	74	G
14	54	E	62	G	48	42	F	66	G
15	48	G	68	G	49	20	VP	59	F
16	50	G	76	E	50	40	F	66	G
17	50	G	87	E	51	14	VP	64	G
18	52	G	75	E	52	44	F	71	G
19	48	G	79	E	53	14	VP	65	G
20	54	E	82	E	54	36	F	66	G
21	34	P	57	F	55	38	F	64	G
22	44	F	66	G	56	32	P	56	F
24	52	G	81	E	57	34	P	60	G
25	46	G	67	G	58	32	P	51	F
27	44	F	64	G	59	38	F	55	F
28	42	F	84	E	60	32	P	54	F
29	40	F	64	G	61	34	P	51	F
30	44	F	68	G	62	38	F	66	G
32	38	F	63	G	63	38	F	48	F
33	46	G	80	E	64	44	F	80	E
34	40	F	71	G	65	28	P	59	G

DNR in 2004 (Hoffman 2007). The 2004 sampling stretch overlapped with 2020 sites 43–65 of this study and consisted of 18 sampling sites and documented 70 species representing 17 families. For this same stretch of the WR, the 2020 sampling documented 76 species from 15 families. Species unique to the 2004 survey were Bowfin (*Amia calva*), Steelcolor Shiner (*Cyprinella whipplei*), Rosyface Shiner (*Notropis rubellus*), Blackstripe Topminnow (*Fundulus notatus*), Mottled Sculpin (*Cottus bairdii*), Striped Bass (*Morone saxatilis*), Largemouth Bass, and White Crappie. Steelcolor Shiner, Rosyface Shiner, Blackstripe Topminnow, Mottled Sculpin, and Largemouth Bass were collected in the 2020 survey, but not within this reach. Seining, in addition to electrofishing, conducted during 2004 sampling may have affected the ability to capture certain species. Species collected in 2020 but not in 2004 included Mooneye (*Hiodon tergisus*), American Eel, Silver Shiner (*Notropis photogenis*), Skipjack Herring (*Alosa chrysochloris*), Mimic Shiner, Spotted Sucker (*Minytrema melanops*), Smallmouth Redhorse (*Moxostoma breviceps*), Brindled Madtom, Rock Bass, Greenside Darter (*Etheostoma blennioides*), Harlequin Darter (*Etheostoma histrio*), and Slough Darter (*Etheostoma gracile*). Sampling effort between the two studies were similar, but record low rainfall in September 2020 resulted in low water levels leading to gravel bars and shallow water habitat being exposed which may have resulted in more shiners and darters being collected in 2020. The average IBI score in 2004 was 40 *fair* and was 35 *fair* in 2020.

Species collected at a single location and in low abundances (less than 10 individuals) during the 2020 sampling, included Mooneye, Skipjack Herring, Steelcolor Shiner, Bigeye Chub (Hybopsis amblops), Shoal Chub (*Macrhybopsis hyostoma*), Hornyhead Chub (*N. biguttatus*), River Shiner (*Notropis blennius*), Channel Shiner (*Notropis wickliffi*), Blacknose Dace (*Rhinichthys atratulus*), Mountain Madtom (*Noturus eleutherus*), Freckled Madtom (*Noturus nocturnus*), Eastern Sand Darter (*Ammocrypta pellucida*), Slough Darter, Harlequin Darter, and Walleye (*Sander vitreus*) (Table 2). Crawford et al. (1996) found Channel Shiner and Harlequin Darter had rare occurrences in the White River Basin, but by employing other sampling techniques these species were found to be common in the lower WR (Fisher 2008; Brant Fisher, Pers. Comm.).

No state endangered fish species were collected in 2020; however, the American Eel was recently added as an Indiana species of greatest conservation need. An American Eel was sampled from Site 55 near Edwardsport, and the second was collected at Site 35 near Indianapolis. A recent increase in documentation for American Eels from Indiana anglers suggests that this species occurs sporadically throughout the WR as far north as Muncie by the BWQ in 2015 (Brant Fisher, Pers. Comm.).

Invasive Bighead Carp (*Hypophthalmichthys nobilis*) and Grass Carp (*Ctenopharyngodon idella*) were established in the southern USA after accidental hatchery release decades ago (Freeze & Henderson 1982) and in the Wabash River around 1995 (Kolar et al. 2005). It is unknown when Silver Carp (*Hypophthalmichthys molitrix*) was first detected in the WR, but Hoffman (2007) documented an individual near Hazelton in 2004. Three invasive species were collected during this project, including Common Carp (*Cyprinus carpio*), Grass Carp, and Silver Carp. Silver Carp occurred commonly in the lower portion of the WR, as well as upstream to Site 39 just south of Indianapolis (Table 2). This location is just downstream of the low-head dam at Harding Street, which may preventing further upstream migration. During large rain events, many low-head dams are compromised, allowing fish passage (Hayer et al. 2014; Hastings et al. 2016); depending on the time of year, this may provide a reproduction trigger for Invasive Carp (DeGrandchamp et al. 2008). No Bighead Carp or Black Carp (*Mylopharyngodon piceus*) were documented during the 2020 survey. However, Bighead Carp has been documented in the watershed as early as 1996 (Brant Fisher, Pers. Comm.), and more recently during other sampling near the town of Washington and further downstream near Petersburg (Sarah Molinaro, Pers. Comm.), and Black Carp has been documented in Posey County (Brant Fisher, Pers. Comm.).

As previously mentioned, a comprehensive survey of all 405 miles of the WR has not been conducted. The closest a previous survey has come was in 1992 when 30 sites were sampled by Simon (1992). In 1992, the average IBI score was 34 (*poor*); half of the sites sampled had an IBI score of *fair*, while the other 47% were classified as *poor* or *very poor*. Only one site was categorized as *good*, and none were categorized as *excellent*. In 2020, only 29% of sites were either *poor or very poor*, and the average IBI score was 41 *fair*. Simon (1992) attributed many of the *poor or very poor* scores to the influence of nearby power plants. Lower scores were documented in 2020 in lower reaches of the river near Petersburg (sites 60 and 61), where the AES Petersburg Power Plant is located; however, the lowest IBI scores were at sites 51 and 53. These two sites had a lower number of species and total number of fish collected when compared to other sites.

The WR fish communities improved substantially since Craven (1914) found the WR downstream from Indianapolis to be in "serious condition" for 100 miles because of the amount of sewage and industrial waste discharge. Although the WR experienced several major fish kills due to pollution, the river currently maintains a robust fish community. Artz et al. (2020) found that from 1979 – 2015 macroinvertebrate assemblages in the upper WR improved likely due to the implementation of the Clean Water Act. In addition, Holloway et al. (2018) found notable changes in the upper WR with a shift from pollution-tolerant species to sensitive species over a 33-year period. Less work has been done on the lower reaches of the WR. However, the comprehensive documenting of the fish community during this project will allow for many more questions to be asked and answered as we move foreword. As environmental efforts continue throughout the WR watershed this manuscript will serve as documentation of the current conditions of fish communities, water quality, and aquatic habitat found in 2020.

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