Biological Assessment of Streams in the Indianapolis Metropolitan Area, Indiana, 1999–2001

By David C. Voelker

Prepared in cooperation with the
Indianapolis Department of Public Works, Office of Environmental Services

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Conversion Factors and Acronyms

Multiply	By	To obtain
inch (in.)	25.4	millimeter (mm)
square foot (ft^2)	0.09290	square meter (m^2)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
yard (yd)	0.9144	meter (m)
pound (lb)	0.4536	kilogram (kg)
ton, short (2,000 lb)	0.9072	megagram (Mg)
micrometer (µm)	0.00003937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
centimeter (cm)	0.3937	inch (in.)
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.205	pound (lb)

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

$$°F = (1.8 \times °C) + 32$$

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD83).

Acronyms used in this report:

CSO	Combined-Sewer Overflow
DNR	Indiana Department of Natural Resources
DPW	Department of Public Works (Indianapolis)
EPT	Ephemeroptera, Plecoptera, and Trichoptera
HBI	Hilsenhoff Biotic Index
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
NAWQA	National Water-Quality Assessment Program
Ohio EPA	Ohio Environmental Protection Agency
QHEI	Qualitative Habitat Evaluation Index
USGS	U.S. Geological Survey

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Abstract

During 1999–2001, benthic invertebrates and fish were sampled to describe biological communities in the White River and selected tributaries in the Indianapolis Metropolitan Area in Indiana. Twelve sites (six on the White River and six on tributaries) were sampled biannually for benthic invertebrates and annually for fish. The information complements water-chemistry data collected by the Indianapolis Department of Public Works in the study area.

Evaluation of the habitat for sites in the study area was done, using a Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio Environmental Protection Agency. The QHEI scores basin and habitat characteristics for each site, with a maximum possible score of 100. Higher scores indicate better habitat conditions for biotic communities. The QHEI scores for sites on the White River ranged from 55 at the Harding site to 71 at the Waverly site; scores on the tributaries ranged from 45 on Pogues Run to 82 on Williams Creek.

A total of 151 taxa were identified from the benthic-invertebrate samples. The Ephemeroptera, Plecoptera, and Trichoptera (EPT) Index scores for sites on the White River ranged from 0 at the Harding site to 15 at the Nora site. The Nora site, which is upstream from Indianapolis, generally scored the highest of all White River sites. Sites in the immediate vicinity of Indianapolis scored the lowest and indicate a negative effect on benthic-invertebrate communities in that reach. EPT Index scores increased in the farthest downstream reaches, which indicate that water-quality conditions had improved in comparison to sites in Indianapolis. For the tributary sites, EPT Index values ranged from 0 at Pogues Run to 16 at Buck Creek. Tributary sites on Fall Creek, Pleasant Run, and Pogues Run consistently scored 7 or lower; sites on Buck Creek, Eagle Creek, and Williams Creek scored 7 or higher.

Hilsenhoff Biotic Index (HBI) scores ranged from 4.9 (good) to 9.6 (very poor) for the White River sites and from 5.2 (good) to 8.0 (poor) for the tributary sites. The lowest scores among the White River sites were at the Nora site, indicating the best water-quality conditions were where the White River enters Marion County. The highest HBI scores were at the Morris and Harding sites, indicating the least-favorable water-quality conditions of all the White River sites. Of the tributary sites, HBI scores for Buck, Eagle, and Williams Creeks indicate fair water-quality conditions; HBI scores for Pleasant Run and Pogues Run were the highest, indicating relatively poor water-quality conditions.

On the White River, the highest Invertebrate Community Index (ICI) scores, which indicate the best benthic-invertebrate conditions, were at the Nora site. Conditions were fair to poor in the downtown Indianapolis area; ICI scores indicate slight improvement in the downstream reaches of the study area. Of the tributary sites, Buck Creek was the only site with ICI scores indicating exceptional water quality. Williams Creek ICI scores indicate good water quality; the remaining tributary-site scores reflect fair conditions.

A total of 74 species and 3 hybrids of fish were identified during the study period. The Cyprinidae (carps and minnows) was the largest group of fish identified and consisted of more than half of all fish collected. The most numerous species was the central stoneroller (*Campostoma anomalum*), which accounted for almost 25 percent of the fish identified. Two nonnative species, the koi carp (*Cyprinus carpio*) and the western mosquitofish (*Gambusia affinis*), and one species classified as an Indiana species of special concern, the northern studfish (*Fundulus catenatus*), also were collected during the study.

Indiana Index of Biotic Integrity (IBI) and Ohio Index of Biotic Integrity scores were calculated to show the condition of the fish communities at each site. Results of the Indiana IBI calculations showed no apparent differences in scores among the White River sites. Among the tributary sites, however, scores from the Pleasant Run and Pogues Run sites indicate conditions at those sites were less favorable than at the other tributary sites.

Results of the study were affected by an accidental discharge at Anderson, Indiana, where toxic chemicals were released into the White River in December 1999. The discharge resulted in the death of an estimated 117 tons of fish along more than 50 miles of the White River from Anderson to south of Indianapolis. Biologists began restocking various reaches of the river with channel catfish (*Ictalurus punctatus*) fingerlings and adult channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), rock bass (*Ambloplites rupestris*), bluegill (*Lepomis macrochirus*), redear sunfish (*Lepomis microlophus*), and white crappie (*Pomoxis annularis*) from April 2000 through November 2001. In addi-

tion to the changes in the fish population, the direct and indirect effect on the benthic-invertebrate community was not clear.

Since 1981, the U.S. Geological Survey has collected benthic invertebrates intermittently at or near three sites (Nora, Stout, and Waverly) on the White River. Historically, benthic-invertebrate data at the Nora site indicate generally good conditions as the White River enters the Indianapolis Metropolitan Area. At the Stout site, however, benthic-invertebrate data indicate that conditions were consistently more degraded than at the other two sites. At the Waverly site, data indicate some recovery in water quality, although conditions were not as good as at the Nora site.

Fish data collected during this study also were compared to a compilation of fish species historically found in the White River Basin. Two species collected in this study—the Ohio lamprey (*Ichthyomyzon bdellium*) and the banded darter (*Etheostoma zonale*)—were not reported in that compilation.

Introduction

The U.S. Environmental Protection Agency (1999) guidance document for monitoring and modeling of combined-sewer overflows (CSOs) states that baseline conditions of the receiving water need to be defined. The Indianapolis Department of Public Works (DPW), Office of Environmental Services, is responsible for managing the city's infrastructure, including the combined-sewer system in Indianapolis. The DPW is determining control strategies to mediate the effects of CSOs and other point and non-point sources of pollution on the water quality of receiving streams in the Indianapolis Metropolitan Area. The DPW has an ongoing water-monitoring program to collect surface-water-quality samples within Marion County. If surface-water sampling is used as the sole method to determine water quality, however, substantial effects on the biological communities such as habitat degradation, siltation, and flow alterations can be missed. Biological monitoring provides an assessment of water quality that integrates the effects of multiple stressors, including episodic events such as storms, which may result in chemical alterations from effluent discharged directly to the stream.

In 1999, the U.S. Geological Survey (USGS) in cooperation with the DPW began a study to assess benthic-invertebrate and fish communities in the White River and selected tributaries in the Indianapolis Metropolitan Area (fig. 1). Information gained from the assessment complements DPW's chemical monitoring of surface waters. Evaluation of stream biota is one way to determine cumulative effects of urbanization because the aquatic organisms are affected by long-term exposure to a variety of environmental changes. The biological condition of these streams cannot be attributed only to effects from CSOs because the streams are affected to some extent by all pollutant sources entering them.

Many stream biota complete most or all of their life cycles in the water, thereby serving as continuous monitors of environmental quality. Biological integrity may be the most critical assessment of stream health because stream biota are subject to a full range of environmental influences (chemical, physical, and biological). To achieve the objectives of the Clean Water Act (U.S. Environmental Protection Agency, 2002), comprehensive information about the ecological integrity of aquatic environments is needed. Biological criteria can help to identify water-quality impairments, support regulatory controls that address water-quality problems, and assess improvements in water quality from regulatory efforts.

Benthic invertebrates have limited mobility and can be used as indicators of the long-term effects of water quality in streams. Benthic invertebrates can be found in all but the most severely polluted habitats. Fish, however, may be absent because of natural or manmade causes such as dams or shallow riffles that obstruct their passage along a stream reach. Fish communities, although much more mobile than benthic invertebrates, also can represent water-quality conditions in a stream because of their sensitivity to a wide variety of environmental factors (such as habitat degradation, siltation, pesticides, nutrients, and changes in streamflow). Biological diversity can be affected by such factors as colonization rates, suitable habitat, extinction rates, competition, predation, physical disturbances, and pollution (Crowder, 1990).

One notable event on the White River during December 1999 affected the fish and benthic-invertebrate communities in the study area. The accidental discharge of thousands of gallons of toxic chemicals into the White River at Anderson, Indiana, resulted in the death of an estimated 117 tons of fish along more than 50 miles of the White River from Anderson to south of Indianapolis (Indiana Department of Environmental Management, 2000). In addition to the changes in the fish communities, the direct and indirect effect on the benthic-invertebrate community was not clear.

The White River fish kill was the result of excess amounts of chemicals used to treat wastewater from a metal-plating plant in Anderson being passed through a publicly owned wastewater-treatment plant and entering the river. The discharge occurred approximately 41 river miles upstream from the Nora site, the most upstream site sampled for this study. The suspected contaminant, sodium dimethyldithiocarbamate, is altered to form a number of compounds such as carbon disulfide, dimethylamine, carbamates, and thiram when mixed with water. The Indiana Department of Environmental Management detected carbon disulfide in samples collected from the White River in and upstream from the study area, including at the intakes for the Indianapolis Water Company (Indiana Department of Environmental Management, 2000).

In March and July 2000, Indiana Department of Natural Resources (DNR) biologists completed surveys of the affected part of the river and began restocking efforts in April. Nearly

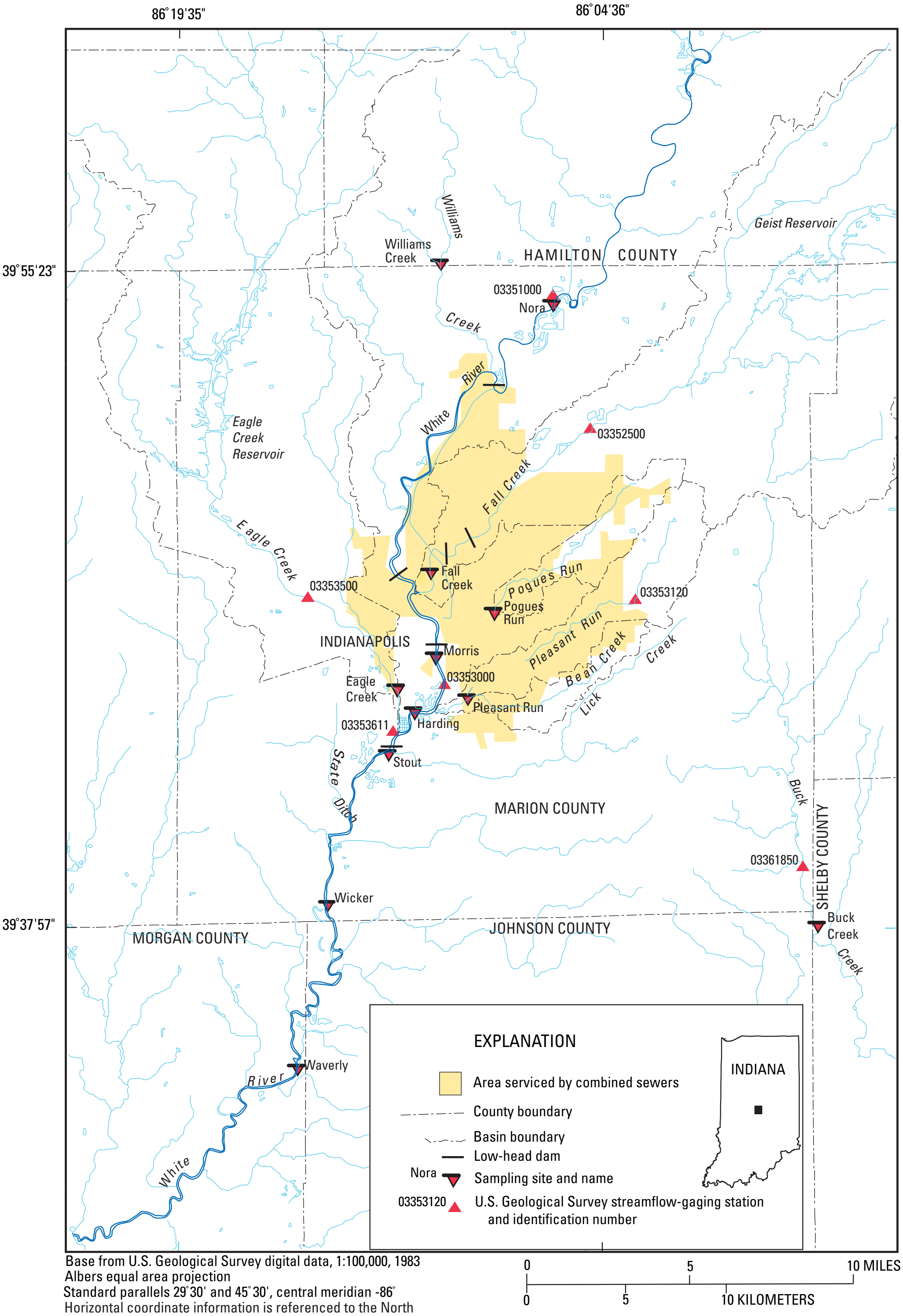


Figure 1. Location of the study area and sampling sites on the White River and tributaries in the Indianapolis Metropolitan Area, Indiana, where benthic-invertebrate and fish communities were sampled, 1999–2001.

2,000 adult game fish and 63,000 channel catfish (*Ictalurus punctatus*) fingerlings were released in the river in spring 2000. In October and November 2000, more than 475,000 fish were released at several sites between Anderson and Indianapolis. More than 100,000 additional adult and juvenile fish were released between April and November 2001. Restocked species included channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), rock bass (*Ambloplites rupestris*), bluegill (*Lepomis machrochirus*), redear sunfish (*Lepomis microlophus*), and white crappie (*Pomoxis annularis*) (Indiana Department of Natural Resources, 2003).

Purpose and Scope

This report describes the abundance and diversity of benthic-invertebrate and fish communities from 12 sites in the Indianapolis Metropolitan Area in Indiana, based on data collected during 1999–2001. Six sites were sampled on the White River and an additional six sites were sampled on selected tributaries in the Indianapolis Metropolitan Area. Results of the study provide an assessment of stream health in this urban area. The data complement water-chemistry data collected by DPW in the study area.

The methods of study are described and the collected data are presented in tables and graphs to compare changes at and among sites over the 3-year study period. The report evaluates data, using indices to assess the general health of the aquatic environment. Habitat conditions at sample sites are evaluated, using a Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio Environmental Protection Agency (Ohio EPA). Benthic-invertebrate communities are assessed with the Ephemeroptera, Plecoptera, and Trichoptera (EPT) Index, Hilsenhoff Biotic Index (HBI), and Invertebrate Community Index (ICI). Fish communities are assessed with Indices of Biotic Integrity (IBIs). Biological indices are described, and the results of the analyses are presented. Historical benthic-invertebrate data from three USGS studies conducted between 1981 and 1996 are compared with data collected for this study, along with fish data previously collected in the White River Basin.

Previous Work

Benthic-invertebrate studies by the USGS were conducted intermittently since 1981 at sites in the study area. From 1981 through 1987, three sites were sampled once a year (Crawford and others, 1992). From 1994 through 1996, 21 sites were sampled from two to six times and generally twice a year (Renn, 1998; Voelker and Renn, 2000). The data from these studies were used to compare changes in the benthic-invertebrate community over a 20-year period (1981–2001).

No USGS fish studies have been done in the study area; however, Crawford and others (1996) presented a compilation of fish species historically found in the White River Basin. That compilation of fish data was used for comparison with the fish data collected from 1999–2001.

Description of Study Area

Incorporated with Marion County, Indianapolis is the capital of Indiana and the largest city in the State. The 2000 Census (U.S. Census Bureau, 2001) reported a population of 860,454 for Marion County. Approximately 41 mi^2 of Indianapolis are serviced by a combined-sewer overflow (CSO) system. In this system, 134 CSOs discharge into the White River or its tributaries—23 CSOs discharge directly into the White River, 27 discharge to Fall Creek, 5 to Eagle Creek, 49 to Pleasant Run, 3 to Bean Creek, 24 to Pogues Run, 2 to State Ditch, and 1 to Lick Creek (fig. 1) (City of Indianapolis, 2000).

Indianapolis is in the central climate division (National Oceanic and Atmospheric Administration, 2001) and has a humid continental climate (Newman, 1966). The average annual temperature is about 53°F, and average monthly temperatures range from about 27°F in January to about 75°F in July. Precipitation averages about 41 in. a year. Annual runoff at the study sites ranged from about 12 in. to almost 16 in. during the study (Stewart and others, 2000, 2001, 2002). The study area is encompassed by the Eastern Corn Belt Plains ecoregion (Woods and others, 1998) which extends from Indiana into Ohio and Michigan. Crop production (corn and soybeans) is the predominant land use in rural areas outside of Indianapolis (Simon and Dufour, 1997).

The drainage area of the White River above the confluence of the East Fork White River is 5,372 mi^2. At the most downstream White River study site (Waverly, near river mile 211), the drainage area is 2,026 mi^2 (Hoggatt, 1975). The study extends upstream on the White River to a site near river mile 248 (Nora), which has a drainage area of 1,219 mi^2 (Hoggatt, 1975).

The USGS operates seven streamflow-gaging stations in the study area (fig. 1). Streamflow at those sites generally was low during the study period. Annual mean discharge during the study and annual mean discharge for the period of record at those sites are shown in table 1 (page 6). Annual mean discharge during the study was 52 to 75 percent of the annual mean discharge for the period of record at USGS streamflow-gaging stations in the study area. Low discharges recorded for the 2000 water year were 13 to 64 percent of the annual mean discharge for the period of record. Detailed information on streamflow-gaging stations is provided in the annual USGS Water-Data Report for Indiana (Stewart and others, 2000, 2001, 2002).

Methods of Investigation

This study involved sampling at 12 sites in the White River Basin. Six sites were on the White River, and six were on tributaries within the Indianapolis Metropolitan Area. The selection of sampling sites is described. Physical habitats were evaluated at sampling sites, using a QHEI which also is described. The collection and identification of benthic invertebrates and fish are discussed, as are the biological indices used to describe the condition of the benthic-invertebrate communities.

Selection of Sampling Sites

Eleven sites originally were sampled for benthic invertebrates and fish (fig. 1, table 2). These sites were selected to be coincident with DPW water-quality monitoring sites. In addition, sites where the USGS previously collected benthic-invertebrate data were selected to provide continuity of data and historical comparison among sites.

During the first year of data collection, the Buck Creek site was added during the second round of sampling for benthic invertebrates after the Pogues Run site was found to be dry. The site was selected to represent biological conditions on a stream draining the southeastern part of Marion County. Buck Creek is in the drainage area of the East Fork White River. During the second year of sampling (2000), the Buck Creek site was incorporated into the study plan. All of the sampling sites (fig. 1) except the Buck Creek tributary site were near DPW water-quality-monitoring sites and at sites where the USGS previously collected benthic-invertebrate data.

Physical Habitats

Basin and habitat characteristics were reported at each study site, using parameters developed by the Ohio EPA (1989) to compute a QHEI score for each site (table 3 at back of report). The QHEI is a physical-habitat index designed to provide an empirical, quantified evaluation of the general stream-habitat characteristics important to the biological communities of streams (Ohio Environmental Protection Agency, 1989). The QHEI is an index tool similar to the IBI and ICI in which selected characteristics, or metrics, are rated and then combined into a total score. Higher scores indicate better habitat conditions for biotic communities. The maximum score possible is 100. Stream characteristics include drainage area, land use, mean discharge, stream gradient, and basin description. Habitat characteristics include substrate; silt cover; extent of substrate embeddedness; instream cover; channel morphology; riparian zone; bank erosion; and pool, riffle, and run information. Scoring of these characteristics was used to arrive at a QHEI score for each site.

Benthic Invertebrates

Benthic invertebrates are used to assess stream quality because they form less-mobile communities than fish and they are collected easily with relatively inexpensive methods. Benthic invertebrates can occupy all stream habitats, have a wide range of feeding preferences, and react quickly to environmental changes. The invertebrates are a major food source for fish and other aquatic species and occupy the middle of the aquatic food chain. Because of advances in taxonomic identification and increased knowledge of their tolerance to environmental and pollution stresses, benthic invertebrates have become excellent indicators of the biological integrity of streams and rivers (Ohio Environmental Protection Agency, 1989).

Benthic invertebrates were collected twice a year from 1999 through 2001 during relatively steady-state, low-streamflow conditions. Information collected included sampling-site name, USGS sampling-site identification number, date and time of sampling, water temperature, specific conductance, dissolved-oxygen concentration, and pH at the time of sampling. Benthic-invertebrate samples were collected in May and September, during periods when most species are expected to be in early-age aquatic stages prior to their adult terrestrial stage. At each study site, samples were collected in habitat areas where the greatest diversity and abundance of benthic invertebrates were expected to occur (generally riffle areas). At the Morris and Harding sites on the White River, riffles were not present or not accessible, and the best available habitat (cobble or riprap in silty and somewhat pooled conditions) was sampled. Three samples were collected at each study site because this is the recommended minimum needed to determine the diversity and abundance of benthic invertebrates at a site (Britton and Greeson, 1988).

Benthic-invertebrate samples were collected by use of Surber samplers that had a 0.0929-m^2 sample grid and a collection-net bag-mesh opening of 210 μm. This mesh size has been recommended for collecting benthic invertebrates (Britton and Greeson, 1988). Surber samplers were placed on the streambed, and all the large surface materials within the sample grid were removed and placed in buckets for subsequent scrubbing. The area within the sample grid was scrubbed to remove benthic invertebrates attached to the substrate or embedded in the upper inch of the streambed sediments. Benthic invertebrates were preserved in 10-percent formalin and shipped to a contract laboratory for identification.

Benthic invertebrates were identified to the lowest taxonomic group possible—often genus and species. The total number of organisms, number of distinct taxa, and EPT Index scores were summarized for each of the three samples collected at each site. The results of the three samples were combined to determine the EPT, HBI, and ICI scores for the site.

The total number of distinct taxa for each sampling site was calculated by resolving ambiguous taxa, then summing the unique taxa for each sample. For the purpose of this report, ambiguous taxa are those not identified to species; they were counted as a distinct taxon only if there were no reported individuals from the next-highest common taxonomic level. Possible reasons for inability to classify to species may be that the organism was damaged or only partially present in the sample, or that the organism was at a life stage that could not be classified to a lower taxon.

The EPT Index for each sampling site was calculated from the number of taxa in the orders of Ephemeroptera, Plecoptera, and Trichoptera. The EPT Index summarizes taxa richness

Table 1. Discharge at U.S. Geological Survey streamflow-gaging stations in the Indianapolis Metropolitan Area, Indiana (from Stewart and others, 2000, 2001, 2002).

[ft^3/s, cubic foot per second]

U.S. Geological Survey streamflow-gaging station	U.S. Geological Survey station-identification number	River-mile location upstream from mouth	Annual mean discharge, in ft^3/s			Annual mean discharge, in ft^3/s, for the period of record	
			Water year				
			1999	2000	2001	Period of record	Annual mean discharge
White River near Nora, IN	03351000	247.9	1,084	507	960	1930–2001	1,134
White River at Indianapolis, IN	03353000	229.2	1,261	621	1,140	1931–2001	1,433
White River at Stout Generating Station at Indianapolis, IN	03353611	226.3	1,544	770	1,442	1992–2001	1,821
Buck Creek at Acton, IN	03361850	4.1	60.1	42.8	70.6	1968–2001	91.5
Eagle Creek at Indianapolis, IN	03353500	7.1	116	20.2	104	1939–2001	155
Fall Creek at Millersville, IN	03352500	9.2	243	143	253	1930–2001	289
Pleasant Run at Arlington Avenue at Indianapolis, IN	03353120	7.9	5.96	5.19	6.63	1960–2001	8.13

Table 2. Benthic-invertebrate and fish-community sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.

[ddmmss, degrees minutes seconds; mi, mile]

Sampling-site name	Sampling-site identification number	Latitude (ddmmss)	Longitude (ddmmss)	River-mile location upstream from mouth	Drainage area (square miles)
White River					
White River near **Nora**[1], Ind.	03351000	395435	860620	247.9	1,219
White River at **Morris** Street at Indianapolis, Ind.	394505086103001[2]	394515	861026	230.3	1,635
White River at **Harding** Street at Indianapolis, Ind.	03353193	394505	861030	227.9	1,660
White River below **Stout** Generating Station at Indianapolis, Ind.	394234086120900	394234	861209	226.2	1,898
White River at **Wicker** Road near Southport, Ind.	393827086141701	393827	861417	220.2	1,947
White River at **Waverly**, Ind.	03353660	393402	861518	211.0	2,026
Tributaries					
Buck Creek 1.2 mi downstream from Maze Road near Brookfield, Ind.	393749086030501	393749	855656	1.9	81.9
Eagle Creek at Raymond Street at Indianapolis, Ind.	394613086114700	394411	861148	1.2	209
Fall Creek at 16th Street at Indianapolis, Ind.	03352875	394720	861040	1.3	317
Pleasant Run near South Meridian Street at Indianapolis, Ind.	394358086092100	394358	860921	1.2	20.8
Pogues Run at Vermont Street at Indianapolis, Ind.	03352990	394617	860825	2.5	8.87
Williams Creek at 96th Street at Indianapolis, Ind.	03351072	395537	861020	4.8	17

[1]Short name used throughout text to identify sites is in **BOLD** type.
[2]Site formerly identified as U.S. Geological Survey streamflow-gaging station number 03353000.

within these pollution-sensitive insect groups; the index score increases with improved water-quality conditions. If identification to species was not possible and similar organisms from the next-highest classification were present, the assumption was made that those unidentified specimens were the same as those identified to lower taxa.

A modified HBI (Hilsenhoff, 1987) was calculated, using the number of individuals in each family and a tolerance value for that family, summing the products, and dividing that sum by the total number of arthropods in the sample (which include the classes Insecta, Crustacea, and Arachnoidea). This index was developed to assess organic pollution through its effects on benthic-invertebrate communities. Possible index scores range from 0 to 10 and increase with decreasing water-quality conditions.

The ICI was developed by the Ohio EPA to provide a descriptive statistic that can be used to compare sites within a study area. The ICI consists of 10 structural and functional community metrics that describe the benthic-invertebrate community sampled. Those metrics include total number of taxa present; number of mayfly (Ephemeroptera), caddisfly (Trichoptera), and dipteran taxa present; percent mayfly (Ephemeroptera), caddisfly (Trichoptera), Tribe Tanytarsini midge composition, other dipteran and non-insect composition, and tolerant organisms; and total number of EPT taxa. The ICI was calculated for each site by combining the data from the three samples collected.

Fish

Fish communities were sampled annually, following guidelines established by the USGS National Water-Quality Assessment (NAWQA) Program (Meador and others, 1993). Fish sampling was done at most sites during July of each year. Two sites on the White River—Nora and Waverly—were sampled in November 1999 and September 2000, respectively. Two tributary study sites—Fall Creek and Buck Creek—were sampled in August 2001. Fish-community data were used to calculate IBI scores developed by Indiana (Simon and Dufour, 1997) and Ohio (Ohio Environmental Protection Agency, 1987) for the Eastern Corn Belt Plains ecoregion.

Nearly identical stream reaches were sampled each year, with minor variations based on measurements and Global Positioning System (GPS) data collected each time fish sampling was done. Each IBI was calculated for the actual reach length sampled; however, for the purpose of discussion in the text and for locational information on the site maps, a mean reach length was calculated for each site.

Fish were collected with pulsed direct-current electroshocking techniques. Backpack or barge-mounted shocking equipment was used at wadeable streams, and shocking boats were used at nonwadeable sites. In the field, fish were identified by common name, weighed, and measured for length. The fish were inspected and any external anomalies (such as deformities, eroded fins, lesions and ulcers, tumors, anchor worms, black spot, leeches, fungus, ich, blindness, parasites, and popeye) were recorded. Black spot is not discussed in this report because its occurrence is a function of the presence of snails and not solely related to environmental degradation (Simon and Dufour, 1997). Typically, only the first 30 individual fish of each species collected at a site were measured and weighed. After that, the number of individuals of a species and their total weight were recorded before they were returned to the stream.

Fish not identified to species level in the field were identified in the USGS laboratory in Indianapolis. Voucher specimens (representatives of species collected from each sampling reach) either were photographed or preserved in 10-percent formalin and stored at the USGS laboratory in Indianapolis. Verification of the voucher specimens was done by Dr. Terry Keiser of Ohio Northern University. Taxonomic nomenclature followed that established by Robins and others (1991). Detailed fish data were collected at each site, including date sampled, method of collection, and electrofishing time in seconds. Data collected for individual specimens included name, voucher type, total and standard lengths, weight, and any observations of external anomalies on the fish.

Two IBIs—the Ohio IBI and Indiana IBI—were used to evaluate the fish data for this study. Both IBIs were developed for the Eastern Corn Belt Plains ecoregion, which encompasses the study area and extends into a large part of Ohio. The Ohio IBI incorporates the 12 community metrics proposed by Karr (1981). The metrics used in the Indiana IBI (Simon and Dufour, 1997) for analysis of surface-water designated-use attainment generally were developed from the metrics used by the State of Ohio (Ohio Environmental Protection Agency, 1989). These metrics include species richness, composition, presence/absence of indicator species, trophic and reproductive functions, and overall abundance and/or individual conditions (Simon and Dufour, 1997). IBIs can be considered a family of related indices rather than a single index. Differences between the Indiana and Ohio IBIs are related to how specific metrics might respond to a referenced condition. In Indiana, metrics were developed on a regional basis (Simon and Dufour, 1997). In some cases, the Ohio metrics were more stringent, or methods for collecting fish (such as minimum distance sampled) resulted in differences in metric curves between the two IBIs (Simon and Dufour, 1997).

Because the IBIs are sensitive to differences in collection method and equipment, different expectations were developed for headwater streams (drainage area less than 20 mi^2), wadeable rivers (drainage areas 20 to 1,000 mi^2), and boat sites (drainage areas greater than 1,000 mi^2). Two study sites, Pogues Run and Williams Creek, were considered as headwater sites; Buck Creek, Eagle Creek, Fall Creek, and Pleasant Run were calculated with metrics for wadeable sites. IBI scores for the six study sites on the White River were calculated as boat sites.

The IBIs rate different aspects of the fish community, based on quantitative expectations of what constitutes a fish community of high biotic integrity within a particular region or habitat type. IBI scores are based on fish-population information to determine water-quality conditions relative to index sites. The IBI is based on the assumption that different fish exist in degraded waters, compared to waters that have not been degraded. The IBI combines measures of fish-community structure, function, and health; scores are assigned to the sampled community, relative to a reference community. With both IBIs, metric scores are combined; the higher the result, the healthier the aquatic ecosystem. Interpretation of the IBI metrics incorporates setting quantitative criteria along with some professional judgment (Simon and Dufour, 1997). Because of this, the interpretation of the index scoring should be limited to observing change with time at each study site or noting relative differences among sites in the study area.

Biological Assessment of Conditions at Study Sites

In this section of the report, each study site is described by location, habitat, and biology. Maps show the location of the study sites, and discharge is described if a USGS streamflow-gaging station is at or near the site (table 1). Habitat conditions, based on the QHEI, and results of the benthic-invertebrate sampling and fish electroshocking also are described for each site.

The QHEI scores are shown in figure 2, and habitat characteristics are listed in table 3 (at back of report). Benthic-invertebrate data are summarized in tables 4 and 5 (at back of report); EPT, HBI, and ICI scores are presented in figures 3, 4, and 5, respectively. Information summarizing fish data are shown in tables 6, 7, and 8 (at back of report); scores for the Ohio and Indiana IBIs are presented in figures 6 and 7, respectively. Site-specific data for the benthic invertebrates are in tables 9 through 90; site-specific data for the fish are in tables 91 through 125. These tables are in the appendix to this report.

White River near Nora, Ind.

The Nora site (fig. 8), at 86th Street in Indianapolis, is at river mile 247.9; the drainage area is 1,219 mi^2 (Hoggatt, 1975). The annual mean discharge at USGS streamflow-gaging station 03351000 (fig. 1) is 1,134 ft^3/s for the period of record 1930 through 2001 (table 1). The annual mean discharge during the study period was 1,084 ft^3/s for 1999, 507 ft^3/s for 2000, and 960 ft^3/s for 2001 (Stewart and others, 2000, 2001, 2002). Benthic invertebrates were collected upstream from the station

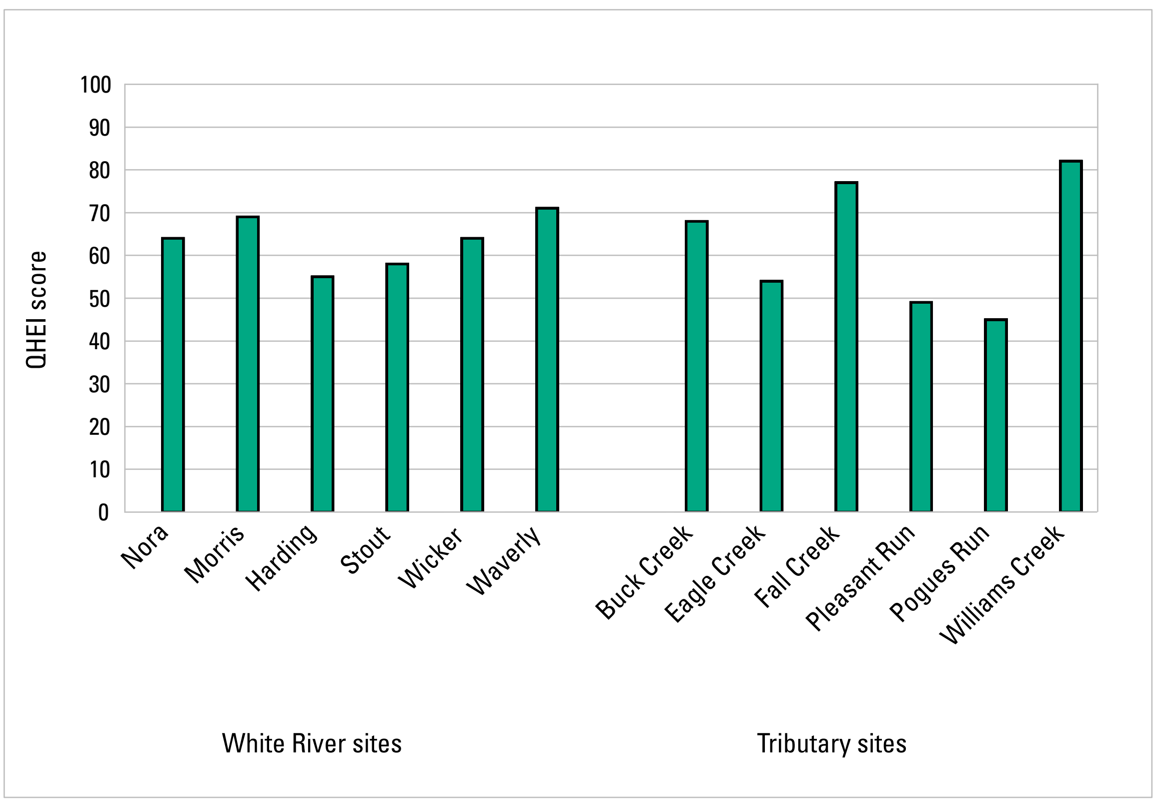


Figure 2. Qualitative Habitat Evaluation Index (QHEI) scores for sites sampled in the Indianapolis Metropolitan Area, Indiana, 2000.

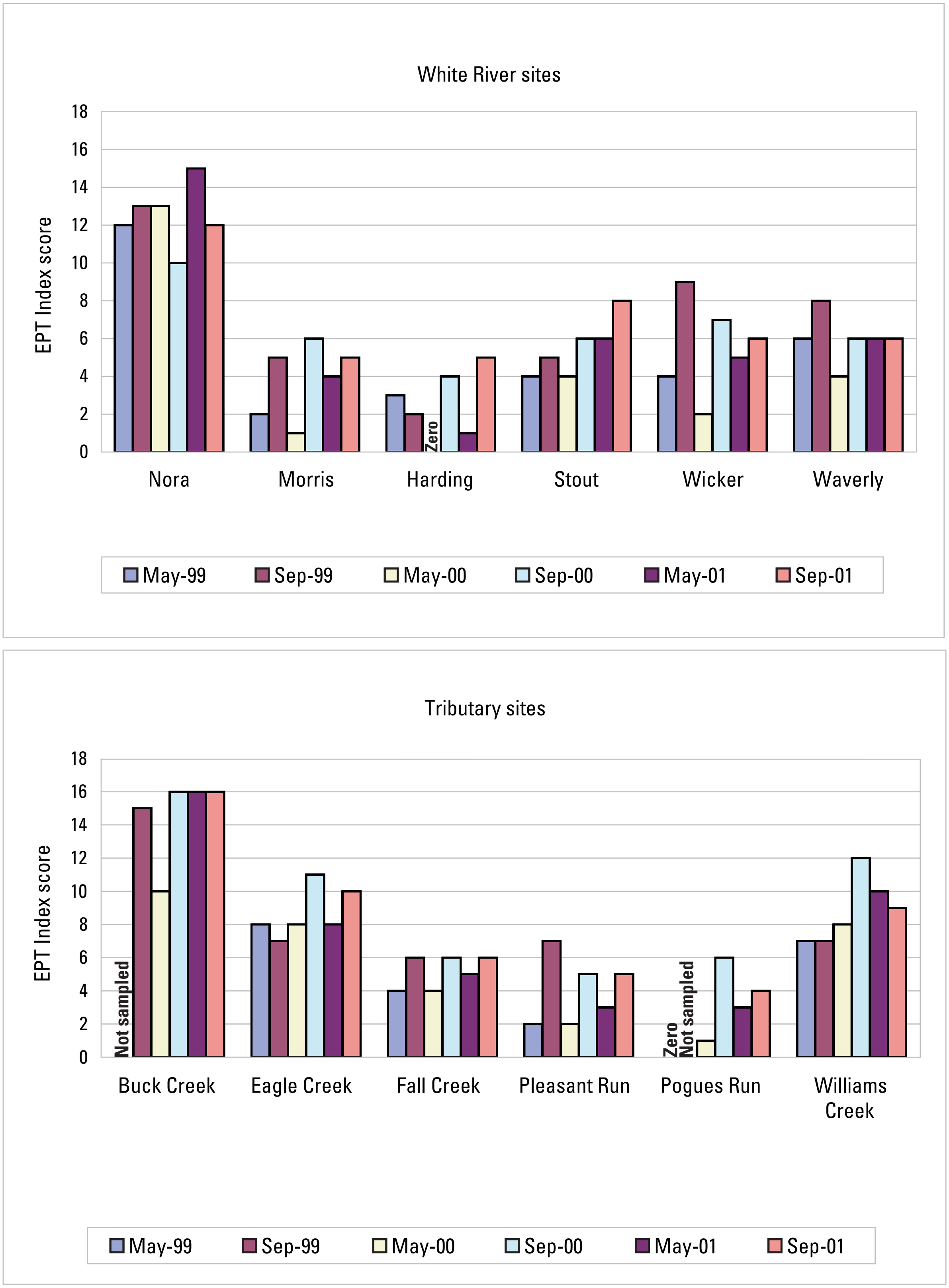
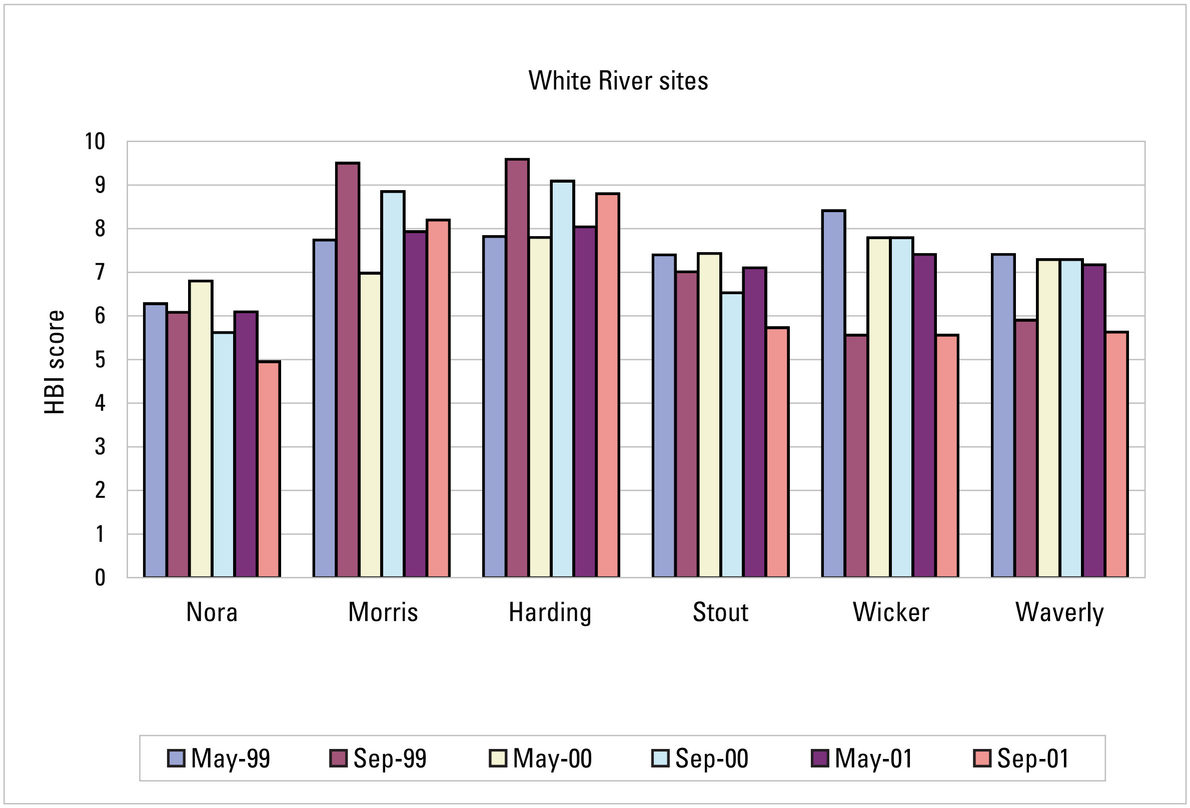


Figure 3. Ephemeroptera, Plecoptera, and Trichoptera (EPT) Index scores for sites sampled in the Indianapolis Metropolitan Area, Indiana, 1999–2001.



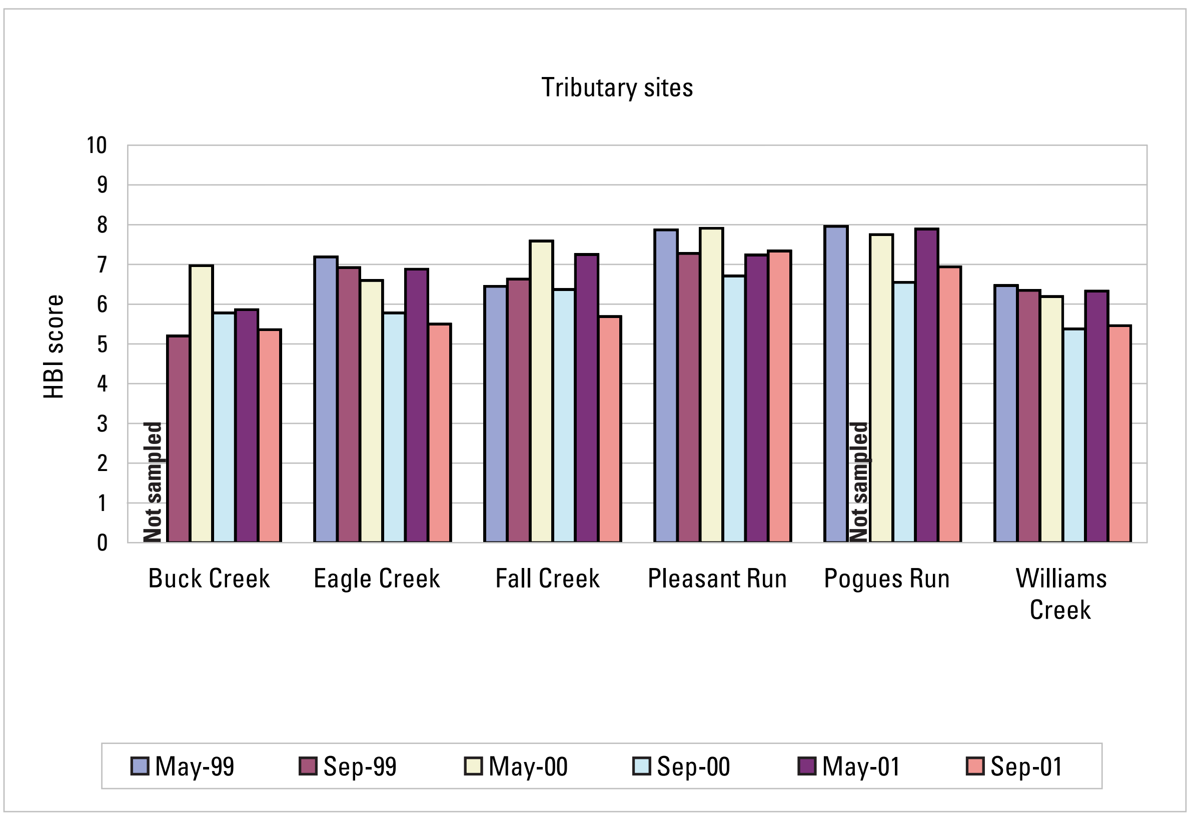


Figure 4. Hilsenhoff Biotic Index (HBI) scores for sites sampled in the Indianapolis Metropolitan Area, Indiana, 1999–2001.

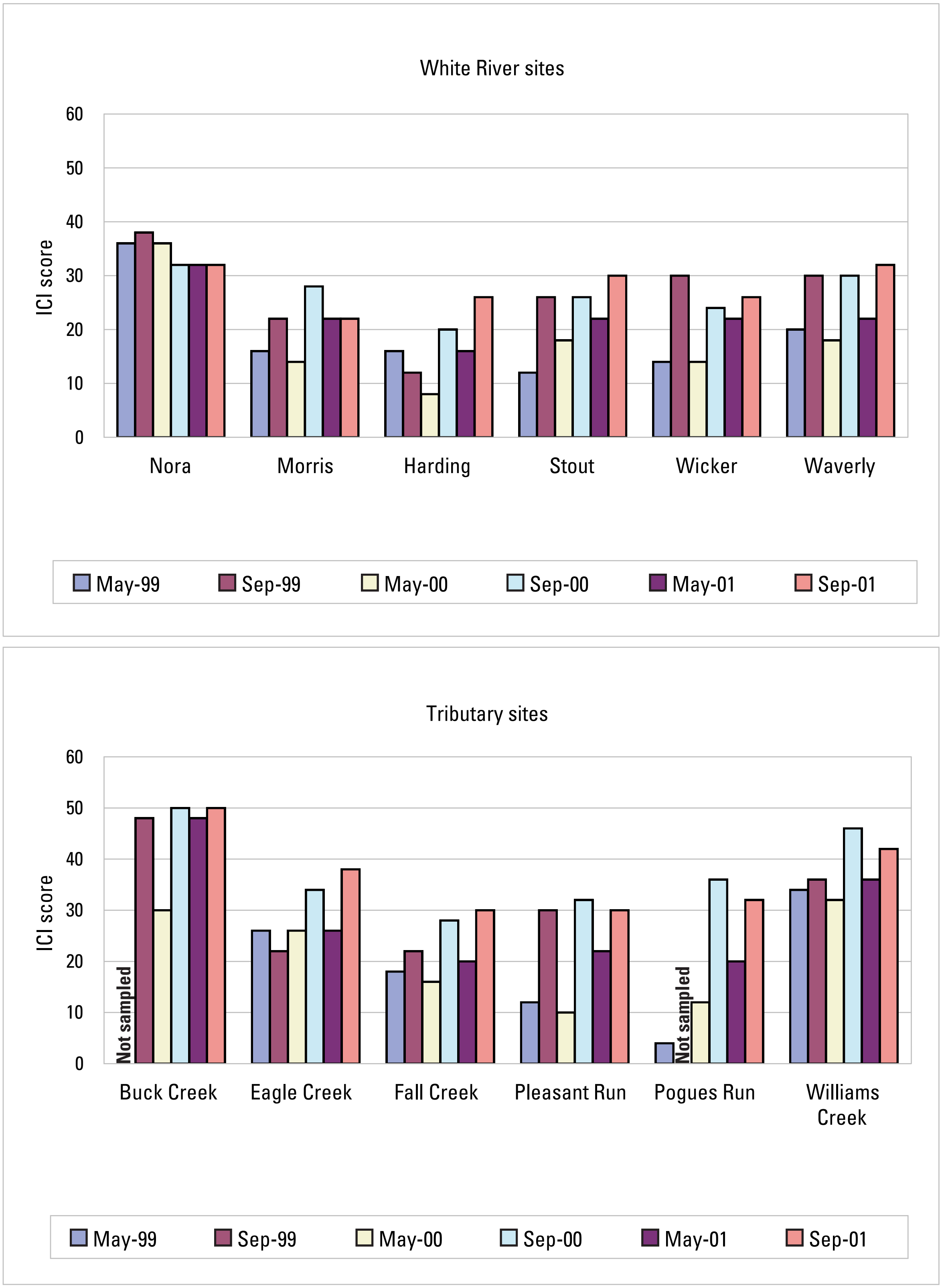


Figure 5. Invertebrate Community Index (ICI) scores for sites sampled in the Indianapolis Metropolitan Area, Indiana, 1999–2001.

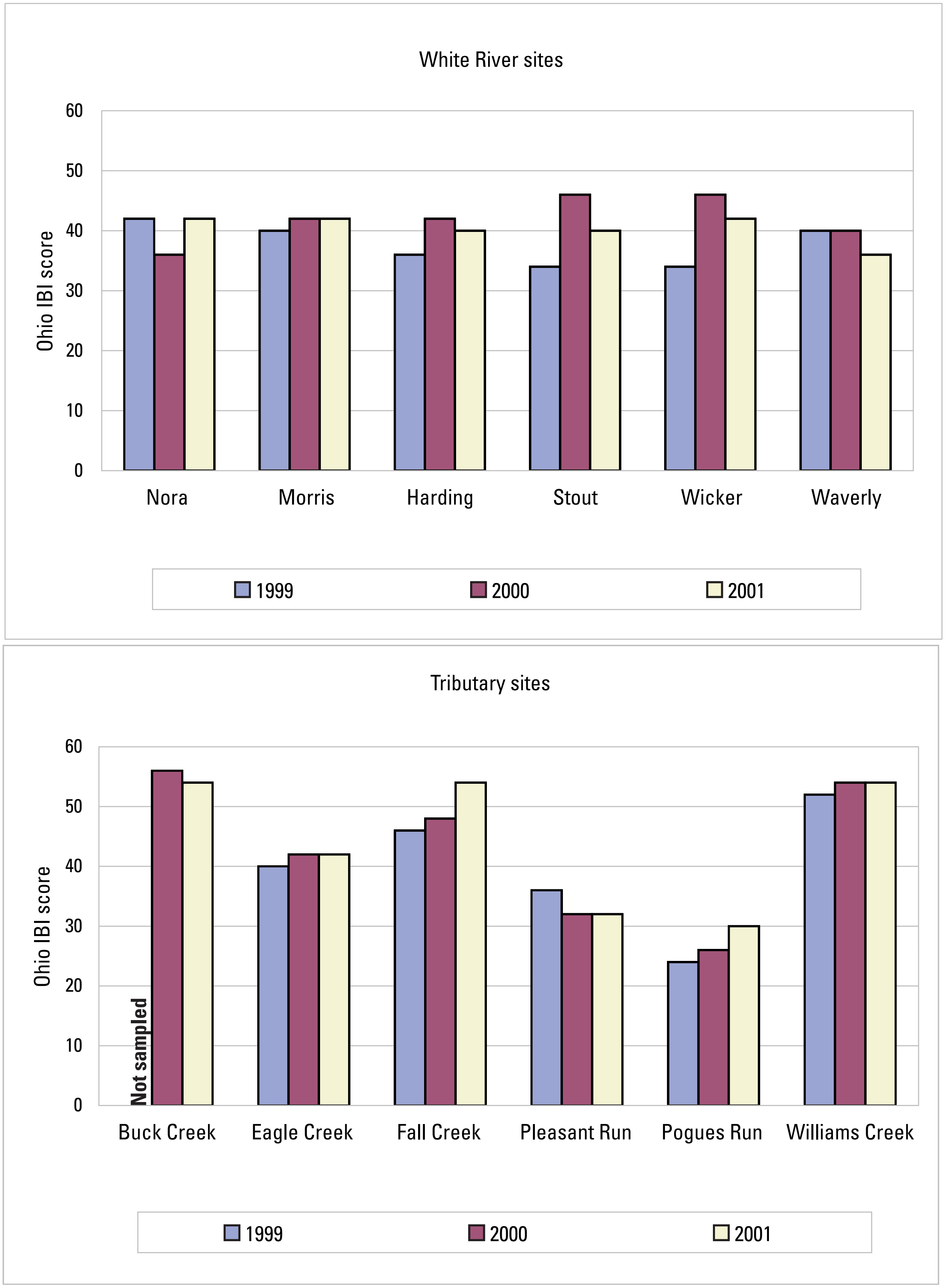


Figure 6. Ohio Index of Biotic Integrity (Ohio IBI) scores for sites sampled in the Indianapolis Metropolitan Area, Indiana, 1999–2001.

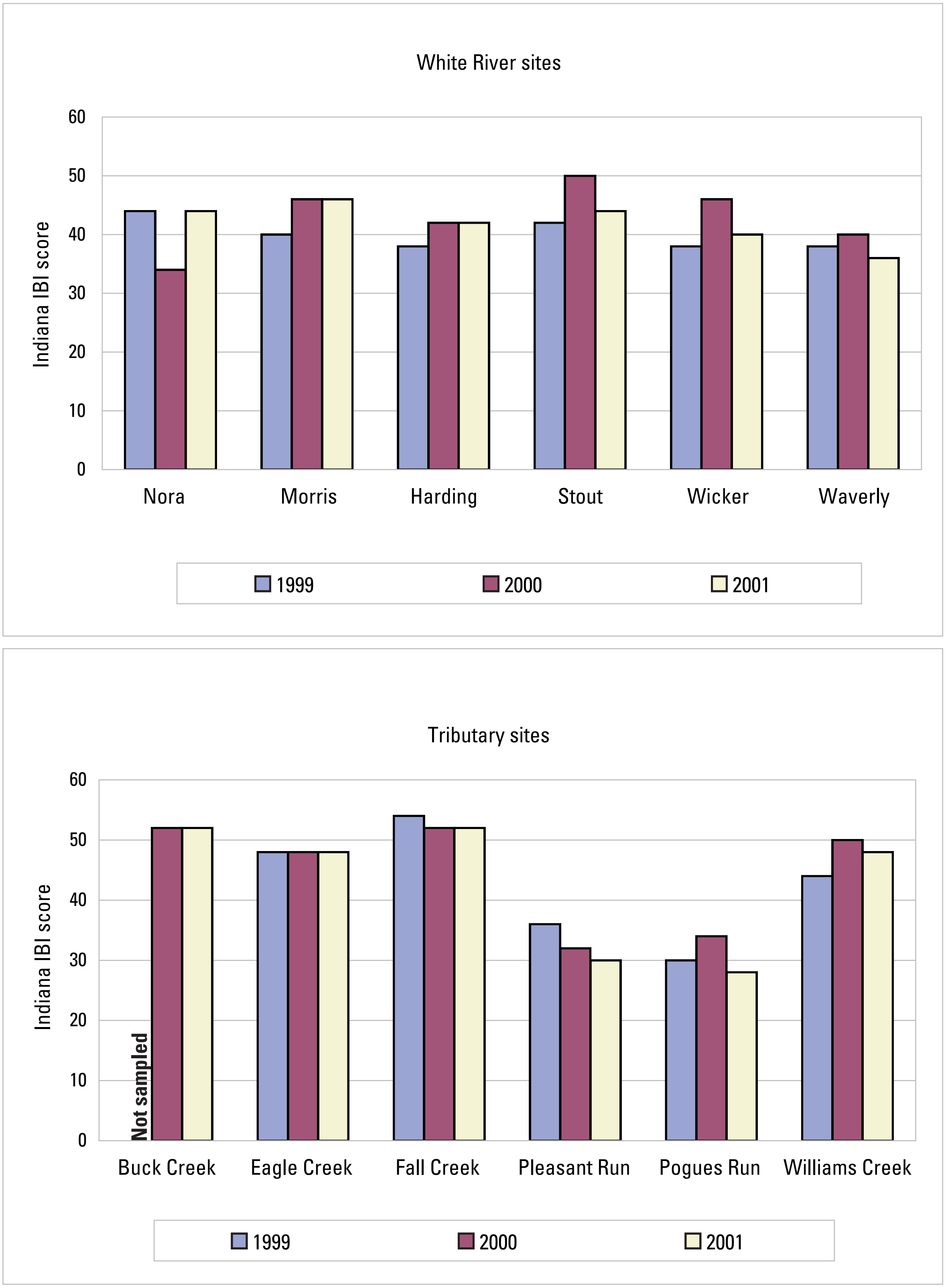


Figure 7. Indiana Index of Biotic Integrity (Indiana IBI) scores for sites sampled in the Indianapolis Metropolitan Area, Indiana, 1999–2001.

in an area dominated by cobble substrate and moderate, steady flow (table 3 at back of report). Fish were collected along a mean reach length of 2,008 ft downstream from the station. That reach was characterized by slow but even flows and a cobble and sand substrate. Depths in the downstream channel were fairly uniform across the river. The QHEI score of 63 (fig. 2) indicates that habitat conditions for this site were average, compared to the White River study sites.

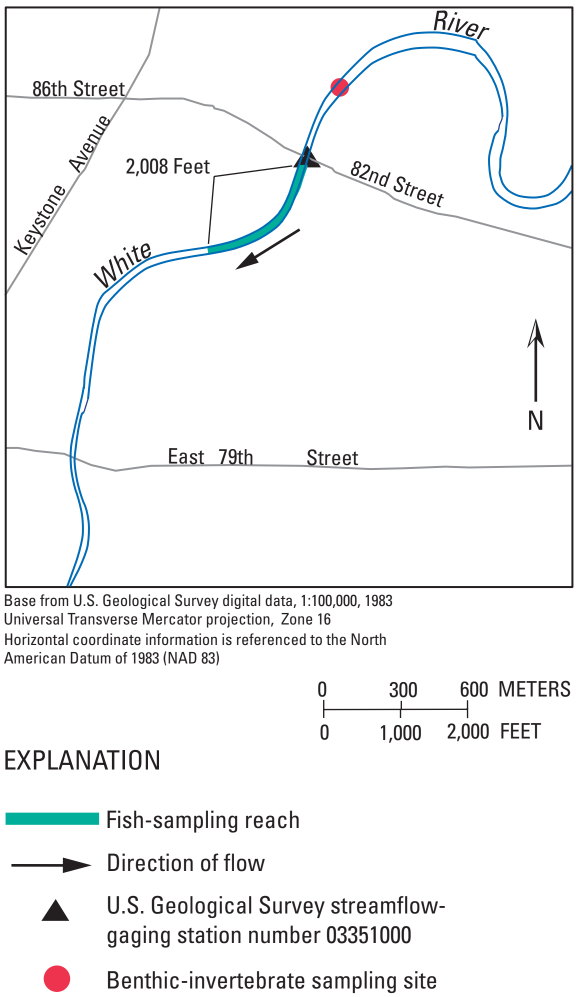


Figure 8. Sampling locations at White River near Nora, Ind.

This site was the most upstream study site on the White River. Although it is upstream from the area potentially affected by CSOs and the area of greatest urban runoff, it also was most vulnerable to the effects of the December 1999 fish kill. The ICI scores at this site (32–38) were consistently higher than those for other study sites on the White River (8–32; fig. 5). The Ohio (36–42) and Indiana (34–44) IBI scores for the Nora site were similar to the other White River sites (34–50; figs. 6 and 7). Both IBIs scored lowest at this site in 2000 (that sampling was done after the December 1999 fish kill and after initial restocking efforts to restore fish populations). The number of fish collected at the Nora site in 2000 was one-third of the number collected in 1999 (table 6 at back of report). Conversely, the abundance of benthic invertebrates at this site multiplied fourfold between the September 1999 and May 2000 sampling (table 5 at back of report). Although many intolerant species of benthic invertebrates were present in the May 2000 sample, there also was a large increase in the tolerant species. Spotfin shiners (*Cyprinella spiloptera*) and northern hog suckers (*Hypentelium nigricans*) predominated at the Nora site in 1999; they were virtually absent in 2000 when smallmouth bass (*Micropterus dolomieu*) and bluegills (*Lepomis macrochirus*) each consisted of about 20 percent of the 61 fish collected. Silver shiners (*Notropis photogenis*), black redhorse (*Moxostoma duquesnei*), and gizzard shad (*Dorosoma cepedianum*) were the predominant species at this site in 2001. EPT scores (10–15), HBI scores (4.9–6.8), and ICI scores (32–38) were the most favorable of the White River sites.

White River at Morris Street at Indianapolis, Ind.

The Morris site (fig. 9) at the Morris Street bridge in Indianapolis is at river mile 230.3; the drainage area is 1,635 mi^2 (Hoggatt, 1975). The annual mean discharge at USGS streamflow-gaging station 03353000 (fig. 1), downstream from the study site at river mile 229.2, is 1,433 ft^3/s for the 1931 through 2001 period of record[1]. The annual mean discharge during the study period was 1,261 ft^3/s for 1999; 621 ft^3/s for 2000; and 1,140 ft^3/s for 2001 (Stewart and others, 2000, 2001, 2002). Benthic invertebrates were collected under the bridge near the left bank in an area of slow flow and silty substrate. Fish collection was along a 2,726-ft mean reach length that extended downstream from the Morris Street bridge and upstream to the Kentucky Avenue bridge. This reach included shallows, riffles, and runs. Some instream vegetation was found along both banks. The QHEI score of 69 (fig. 2) indicates that this site scored better than average among the White River study sites.

The Morris site is in an area serviced by CSOs. This site is the most upstream White River study site affected by CSO discharges, and it is downstream from where Pogues Run enters the White River. EPT (1–6), HBI (6.9–9.5), and ICI scores (14–28) at this site were less favorable than at the Nora site (fig. 5). IBI scores (Ohio, 40–42; Indiana, 40–46; figs. 6 and 7) indicate no change from the upstream site, although the number of fish and fish species collected at this site was much higher than at the Nora site (table 6 at back of report). This difference in number and species was particularly noticeable during the 2000 sampling. Although gizzard shad (*Dorosoma cepedianum*) was the predominant species in 1999, this species almost disappeared from this site in 2000; its numbers, however, returned in 2001. The bluegill (*Lepomis macrochirus*) and longear sunfish (*Lepomis megalotis*) dominated the fish population at the Morris site during the 2000 and 2001 sampling.

[1]USGS streamflow-gaging station 03353000 was moved downstream to the Raymond Street bridge during the 1999 water year. Water-quality data collected at the Morris Street site are now stored under station-identification number 394505086103001.

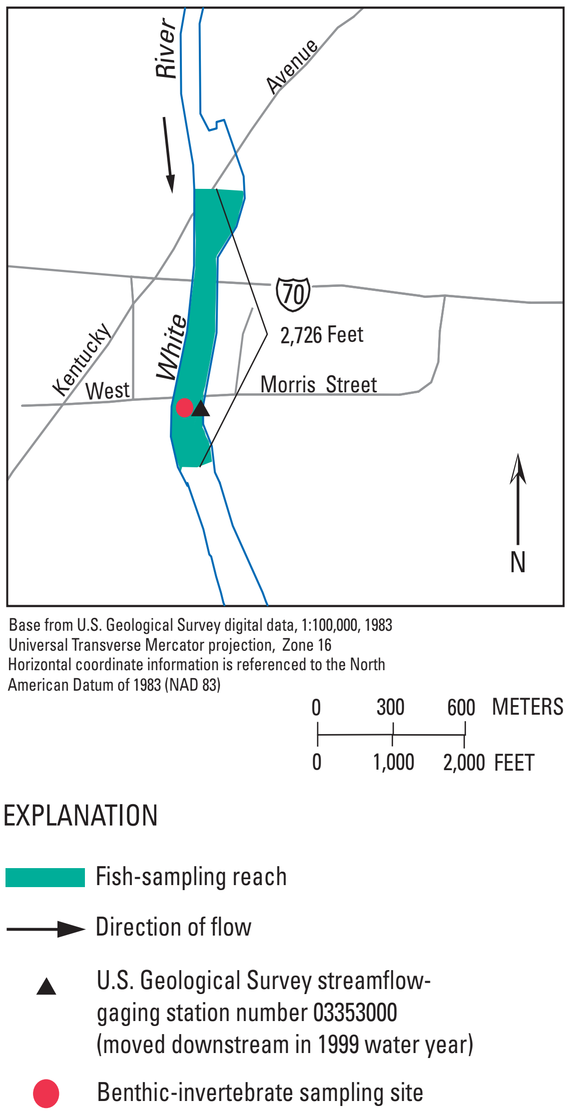


Figure 9. Sampling locations at White River at Morris Street at Indianapolis, Ind.

White River at Harding Street at Indianapolis, Ind.

The Harding site (fig. 10) is at river mile 227.9 in the vicinity of the Harding Street bridge over the White River. The drainage area at the site is 1,660 mi^2 (Hoggatt, 1975). During 1999 and 2000, benthic invertebrates were collected under the bridge along the right downstream bank. Because of bridge reconstruction, sampling for the benthic invertebrates was moved to the left downstream bank in 2001. The substrate from which the samples were collected was riprap that had been put in place for bank stability. Both areas where benthic-invertebrate samples were collected were in a pooled area affected by backwater from the dam downstream at the Stout Generating Station. This reach of the White River also receives treated and/or raw wastewater discharges from the Belmont wastewater-treatment facility. These discharge points enter the pool just downstream from the benthic-invertebrate sampling location. Fish collection was done along a 2,372-ft mean reach length upstream from the bridge. This fish-collection site included pool and run habitat, with some relatively large areas in silty shallows. The QHEI score (55) for this site indicates that habitat conditions were the poorest among the White River study sites (fig. 2).

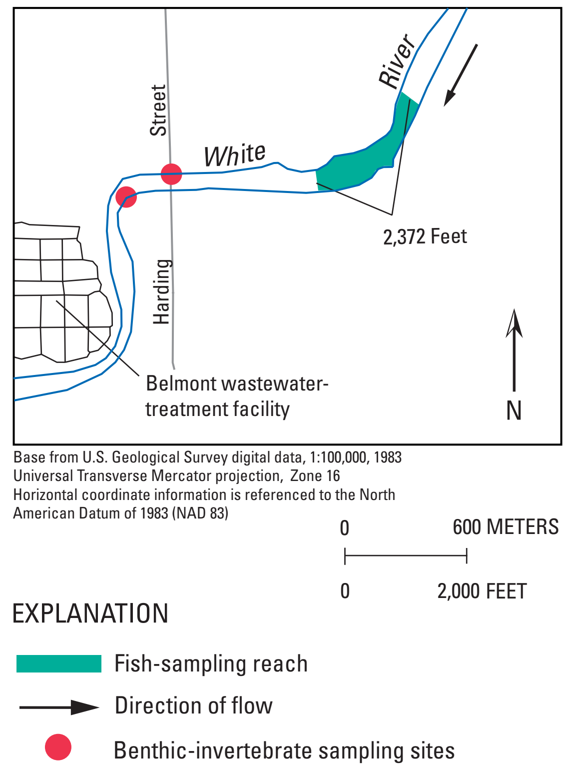


Figure 10. Sampling locations at White River at Harding Street at Indianapolis, Ind.

This site had conditions most similar to the Morris site. The most notable difference between this and other White River study sites was in the benthic-invertebrate community. EPT scores (0–5), HBI scores (7.8–9.6), and ICI scores (8–26) at this site were among the least favorable of all the White River study sites (figs. 3, 4, and 5). Invertebrate species collected at this site include ostracods and cladocerans, which reflect the limnetic, or slowly moving, characteristics of flow at this site. Ohio IBI scores (36–42; fig. 6) and Indiana IBI scores (38–42; fig. 7) were about average for sites on the White River. Gizzard shad (*Dorosoma cepedianum*), bluegill (*Lepomis macrochirus*), longear sunfish (*Lepomis megalotis*), and carp (*Cyprinus carpio*) were the dominant species of fish at this site, with the numbers of bluegill (*Lepomis macrochirus*) and longear sunfish (*Lepomis megalotis*) increasing dramatically in 2000 (table 6 at back of report). Almost five times as many largemouth bass (*Micropterus salmoides*) were collected in 2000, compared to 1999; almost three times as many as were collected in 2001.

White River below Stout Generating Station at Indianapolis, Ind.

The Stout site (fig. 11), at river mile 226.2, is approximately 300 ft downstream from the low-head dam at the Stout Generating Station. The dam is about 10 ft high and is constructed of large boulders and concrete slabs, with concrete box culverts to one side. The drainage area is 1,898 mi^2 (Hoggatt, 1975). Upstream from the sampling site at river mile 226.3 is USGS streamflow-gaging station 03353611 (fig. 1); the annual mean discharge for the period of record 1992 through 2001 is 1,821 ft^3/s. The annual mean discharge was 1,544 ft^3/s in 1999; it was 770 ft^3/s in 2000 and 1,442 ft^3/s in 2001 (Stewart and others, 2000, 2001, 2002). Benthic invertebrates were collected from a riffle area downstream from the dam, and fish were collected from that area and downstream along a mean reach length of 2,188 ft. Stream conditions along this reach included riffles and runs with cobble, gravel, and sand substrate, and silty shallows with pooled conditions. The QHEI score (58; fig. 2) for this site indicates that habitat quality was below average among the White River sites, yet slightly better than the Harding study site.

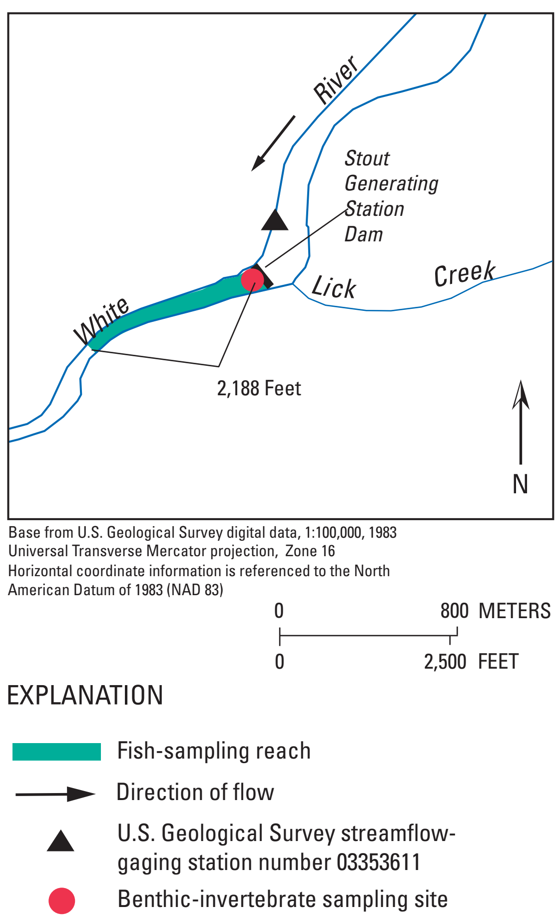


Figure 11. Sampling locations at White River below Stout Generating Station at Indianapolis, Ind.

Benthic-invertebrate conditions as noted in the EPT (4–8; fig. 3) and HBI (5.7–7.4; fig. 4) scores at this site indicate some improvement compared to the Morris and Harding sites. Although slight, some of this improvement may be attributed to less-silty bottom sediments or reaeration of the river as it flows over the low-head dam just upstream from the sampling site. ICI scores ranged from 12 to 30 at this site (fig. 5). The number of fish species collected at this site increased each year and, although the number of fish collected in 2000 was about twice that of 1999 (table 6 at back of report), the average weight of the fish was lower. River carpsucker (*Carpiodes carpio*), longear sunfish (*Lepomis megalotis*), and bluegill (*Lepomis macrochirus*) were the dominant species at this site in 1999. In 2000, northern hog sucker (*Hypentelium nigricans*), channel catfish (*Ictalurus punctatus*), bluegill (*Lepomis macrochirus*), shorthead redhorse (*Moxostoma macrolepidotum*), and river carpsucker (*Carpiodes carpio*) were the dominant species. About 20 percent of the catfish in 2000 had anomalies—more so than any other taxa at this site. In 2001, spotfin shiners (*Cyprinella spiloptera*) and river carpsuckers (*Carpiodes carpio*) were the dominant species at this site. IBI scores showed conditions were best during the 2000 sampling (figs. 6 and 7).

White River at Wicker Road near Southport, Ind.

The Wicker site (fig. 12) is at river mile 220.2 near a large gravel bar along the left bank of the White River, downstream from where an extension of Wicker Road would intersect the river. The drainage area at this site is 1,947 mi^2. Benthic invertebrates were collected near the upstream end of the gravel bar, and fish were collected from a 2,720-ft mean reach length of the river. The reach ranged from a riffle upstream from the gravel bar to just downstream from where a small unnamed tributary enters the White River on the left bank. This reach of the river consisted of a shallow run at the head that moved into a swift-flowing run with tree- and log-debris jams along the opposite bank from the gravel bar; the run opened to a deeper pool in the downstream area. The site scored about average in QHEI scores (63; fig. 2) among all the White River study sites.

The Wicker site had a lower abundance of benthic invertebrates (table 5 at back of report) than any of the other White River study sites, although the number of taxa were similar. EPT scores (2–9; fig. 3) at the site were slightly more variable than the HBI scores (5.6–8.4) at this site (fig. 4). ICI scores at Wicker (14–30), like those for the Stout and Waverly sites, indicate better conditions during the September sampling compared to the May sampling (fig. 5). Conditions of the fish community indicate that abundance was highest in 2000 for the 3-year sampling period. Gizzard shad (*Dorosoma cepedianum*) predominated in 1999 (table 6 at back of report); channel catfish (*Ictalurus punctatus*), northern hog sucker (*Hypentelium nigricans*), and shorthead redhorse (*Moxoxtoma macrolepidotum*) were the dominant species in 2000. In 2001, the spotfin shiner (*Cyprinella spiloptera*) was collected most frequently at this site. Like the Stout site, IBI scores for the Wicker site (figs. 6 and 7) indicate conditions were best during the 2000 sampling period.

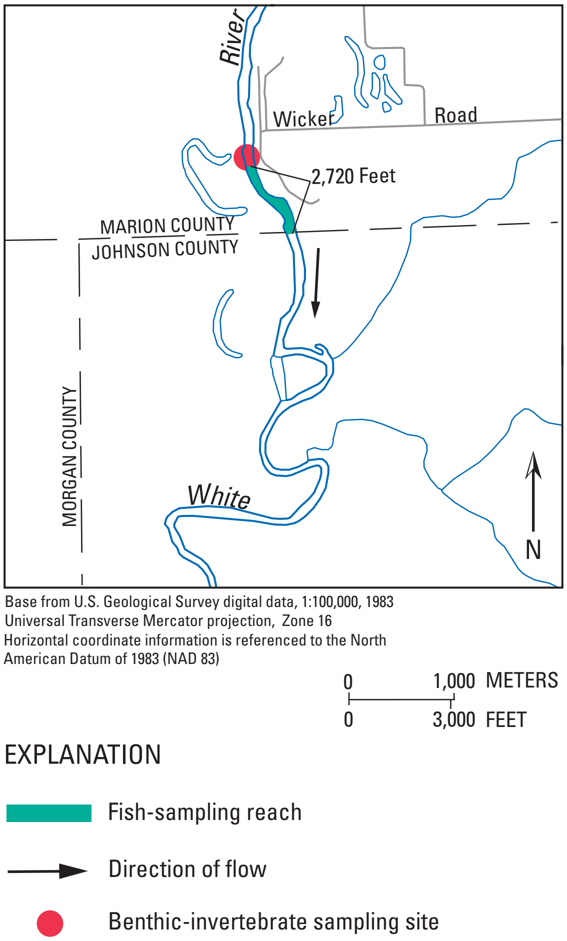


Figure 12. Sampling locations at White River at Wicker Road near Southport, Ind.

White River at Waverly, Ind.

The Waverly site (fig. 13) is in the vicinity of where State Road 144 crosses the White River. The bridge is at river mile 211.0, and the drainage area at the site is 2,026 mi^2 (Hoggatt, 1975). Benthic invertebrates were collected along the gravel bar that extended just upstream to downstream from the bridge. This gravel bar slowly had migrated downstream along the right bank during the study period. Fish were collected along a mean reach length of 2,956 ft, slightly farther downstream from where the benthic invertebrates were collected. The reach where fish were collected was characterized by riffles at the upstream end, with runs and pools in the downstream direction. Woody debris was noted sporadically along both banks. The QHEI score (71; fig. 2) at this site indicates that habitat conditions were the best of all the study sites on the White River.

The number of benthic-invertebrate taxa at Waverly remained consistent throughout the study, but the abundance varied (table 5 at back of report). EPT scores were fairly consistent at 6 (fig. 3); HBI scores ranged from 5.6 to 7.4 (fig. 4); ICI scores ranged from 18 to 32 (fig. 5). The number of fish (table 6 at back of report) collected at the Waverly site was the lowest of all the White River study sites, yet the average weight was the highest of all White River study sites. Sucker species were dominant—river carpsucker (*Carpiodes carpio*) and shorthead redhorse (*Moxostoma macrolepidotum*) in 1999; golden redhorse (*Moxostoma erythrurum*) in 2000. Suckers (Catostomidae) also dominated in 2001, although only 56 fish were collected. IBI scores (36–40) were similar to other sites on the White River.

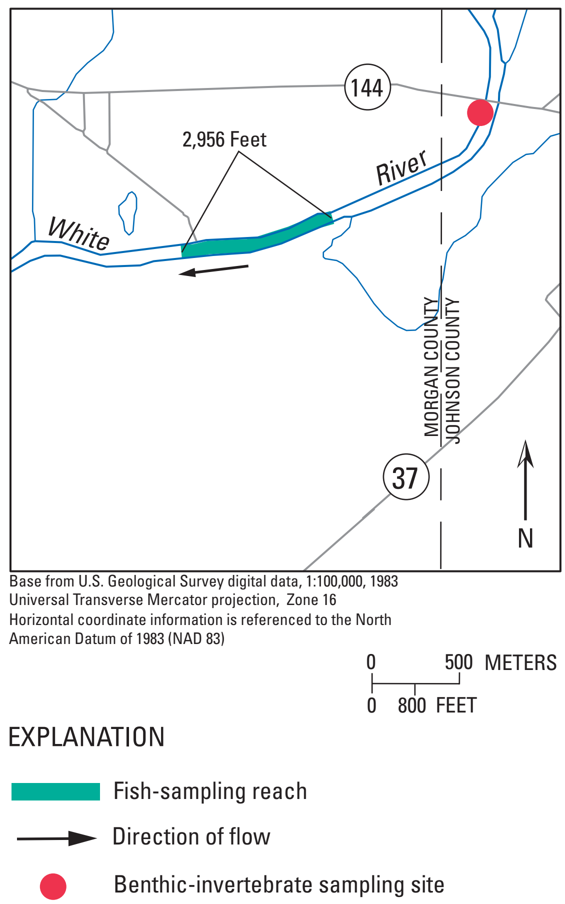


Figure 13. Sampling locations at White River at Waverly, Ind.

Buck Creek 1.2 miles downstream from Maze Road near Brookfield, Ind.

The Buck Creek site (fig. 14) was added after the first round of benthic-invertebrate sampling and fish electroshocking was completed. The site is in a remote area at about river mile 1.9; the drainage area is about 82 mi^2 (Hoggatt, 1975) and drains into the East Fork White River. Discharge data on Buck

Creek is from the USGS streamflow-gaging station at Acton (03361850; fig. 1) at river mile 4.1, with a drainage area of 78.8 mi^2. Annual mean discharge for the period of record (1968–2001) at the station was 91.5 ft^3/s; annual mean discharge was 60.1 ft^3/s during 1999, 42.8 ft^3/s for 2000, and 70.6 ft^3/s for 2001 (Stewart and others, 2000, 2001, 2002). Sampling for benthic invertebrates was done in a riffle near river mile 1.9, and fish collection extended from that riffle to a point about 732 ft downstream. This stream reach was characterized by steady flow along a lengthy run devoid of deep pools but with occasional boulders and woody debris that provided some protective habitat. An overhead forest canopy filtered sunlight along the stream reach. The habitat conditions at this site were slightly above the average among the tributary sites, based on the QHEI score (68; fig. 2) calculated in 2000.

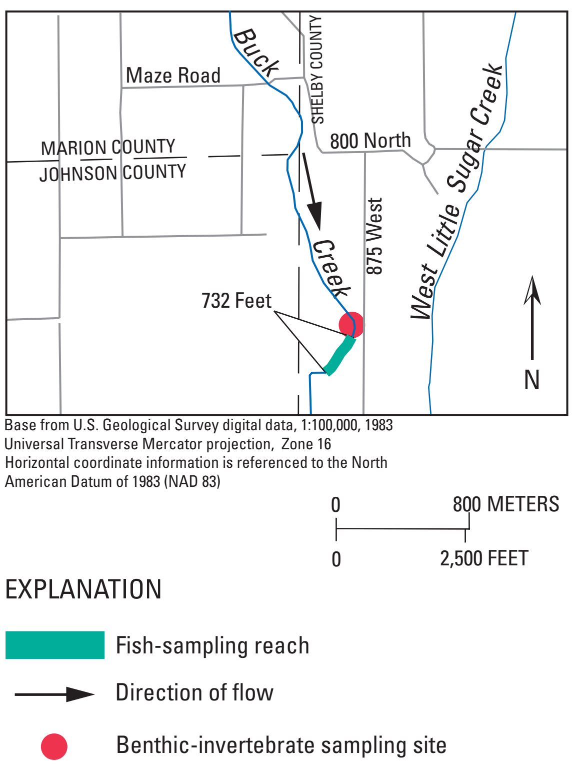


Figure 14. Sampling locations at Buck Creek, 1.2 miles downstream from Maze Road near Brookfield, Ind.

Buck Creek—the only study site that is part of the East Fork White River drainage area—consistently had the greatest diversity in benthic invertebrates and fish communities. EPT (10–16; fig. 3), HBI (5.2–7; fig. 4), and ICI (30–50; fig. 5) scores indicate that the best benthic-invertebrate conditions of all the tributary study sites were at Buck Creek. It was the only site with ICI scores that indicate exceptional water-quality conditions. Ohio IBI scores (54–56; fig. 6) and Indiana IBI scores (52; fig. 7) also indicate water-quality conditions were among the most favorable of all study sites. Although the numbers of fish species collected at this site exceeded the others, the number of fish collected was similar to the number at most of the other tributary sites. Central stonerollers (*Campostoma anomalum*), mottled sculpins (*Cottus bairdi*), and sand shiners (*Notropis stramineus*) were the predominant species in 2000; in 2001, the number of mottled sculpins (*Cottus bairdi*) decreased dramatically (table 7 at back of report). Three individuals of the species northern studfish (*Fundulus catenatus*), listed as an Indiana species of special concern (Indiana Department of Natural Resources, 2002), were identified at the Buck Creek site (table 6 at back of report); one was collected in 2000 and two in 2001.

Eagle Creek at Raymond Street at Indianapolis, Ind.

The Eagle Creek site (fig. 15) was near river mile 1.2; the drainage area is 209 mi^2 (Hoggatt, 1975). Discharge data are available for this stream from the USGS streamflow-gaging station 03353500, Eagle Creek at Indianapolis (fig. 1). The gage is at river mile 7.1, with a drainage area of 174 mi^2 (Hoggatt, 1975). Annual mean discharge for the period of record (1939–2001) is 155 ft^3/s; it was 116 ft^3/s during 1999, 20.2 ft^3/s for 2000, and 104 ft^3/s for 2001 (Stewart and others, 2000, 2001, 2002).

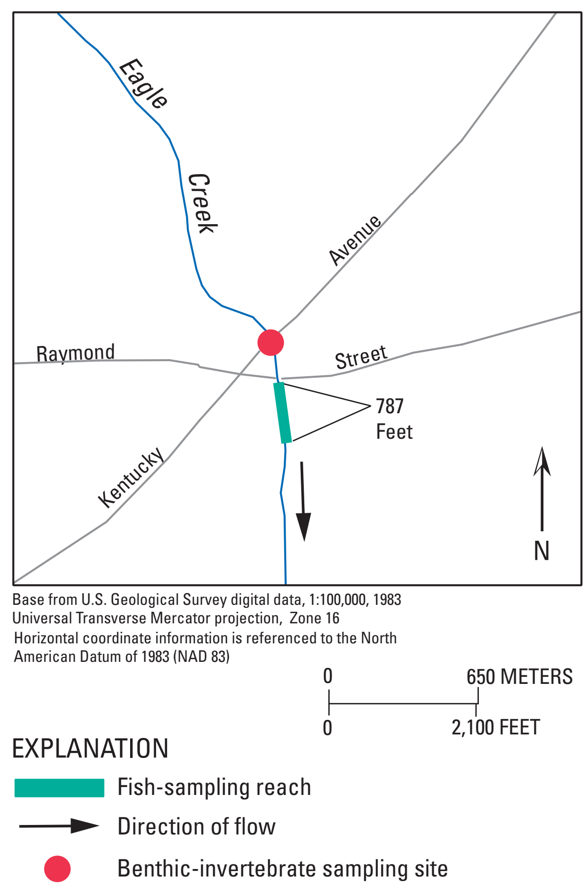


Figure 15. Sampling locations at Eagle Creek at Raymond Street at Indianapolis, Ind.

Benthic invertebrates were collected just downstream from the Kentucky Avenue bridge over Eagle Creek where some cobbles and boulders occurred along this sandy section of stream channel. Fish were collected along a mean reach length of 787 ft downstream from the Raymond Street bridge. This reach was characterized by riffles and runs of various depths. Sand and gravel were the predominant substrate, and some woody debris and instream vegetation provided cover along sections of both banks. The five CSOs that discharge into Eagle Creek are upstream from the study site. The QHEI score (54; fig. 2) at this site was below average among all the tributary sites (45–82).

The condition of the benthic-invertebrate and fish communities at the Eagle Creek site was similar to most other tributary sites. EPT scores ranged from 7 to 11 (fig. 3), HBI scores ranged from 5.5 to 7.2 (fig. 4), and ICI scores ranged from 22 to 38 (fig. 5). Ohio IBI scores ranged from 40 to 42 (fig. 6), and Indiana IBI scores were 48 for each year of the study period (fig. 7). IBI scores remained similar throughout the study period, indicating little change in overall conditions. Most notable at this site was the change in the predominant species of fish collected (table 7 at back of report). The three predominant species collected at this site were the longear sunfish (*Lepomis megalotis*), sand shiner (*Notropis stramineus*), and silverjaw minnow (*Notropis buccatus*). Longear sunfish (*Lepomis megalotis*) numbered 252 of the 569 fish collected in 1999; they were 314 of the 1,288 fish collected in 2000, and 115 of the 944 fish collected in 2001. In 1999, 49 sand shiners (*Notropis stramineus*) were collected; that number increased to 505 in 2000 and decreased to 291 in 2001. Thirty-six silverjaw minnows (*Notropis buccatus*) were collected in 1999; 72 were collected in 2000; 312 were collected in 2001.

Fall Creek at 16th Street at Indianapolis, Ind.

The Fall Creek site (fig. 16) is just downstream from the 16th Street bridge at river mile 1.3. The drainage area for the site is 317 mi^2 (Hoggatt, 1975). The nearest USGS streamflow-gaging station on the creek (Fall Creek at Millersville, 03352500; fig. 1) is at river mile 9.2; the drainage area is 298 mi^2 (Hoggatt, 1975). Annual mean discharge for the period of record 1930 through 2001 is 289 ft^3/s; it was 243 ft^3/s for 1999, 143 ft^3/s for 2000, and 253 ft^3/s for 2001 (Stewart and others, 2000, 2001, 2002). Benthic invertebrates were collected in the riffle area downstream from the bridge, and fish were collected from that point to a riffle about 830 ft downstream. The stream reach included swiftly flowing riffles to deep pools with occasional instream vegetation along the banks. This site scored the second highest QHEI (78; fig. 2) among all study sites, indicating that habitat conditions were better than at most other sites.

Based on the HBI scores (5.7–7.6; fig. 4), benthic-invertebrate conditions at this site are classified as fairly poor. The benthic-invertebrate community at this site was dominated by the dipterans (flies) and, in particular, the chironomids (midges), which resulted in decreased HBI scores. EPT scores ranged from 4 to 6 (fig. 3), and ICI scores ranged from 16 to 30 (fig. 5). As measured through the IBIs (Ohio IBI scores of 46–54 and Indiana IBI scores of 52–54; figs. 6 and 7), however, the fish conditions at this site rank among the best of the study's tributary sites. Although this site had some of the fewest fish collected (table 7 at back of report) compared to other tributary sites, it was second only to Buck Creek in the number of species collected. Spotfin (*Cyprinella spiloptera*) and sand shiners (*Notropis stramineus*) were the predominant species at this site in 1999; in 2000, approximately equal numbers of sand shiners (*Notropis stramineus*) and longear sunfish (*Lepomis megalotis*) were the most numerous species collected; slightly fewer yet equal numbers of spotfin shiners (*Cyprinella spiloptera*) and northern hog suckers (*Hypentelium nigricans*) also were collected. Northern hog suckers (*Hypentelium nigricans*) were the predominant species in Fall Creek in 2001, followed by bluntnose minnows (*Pimephales notatus*) and the two shiner species.

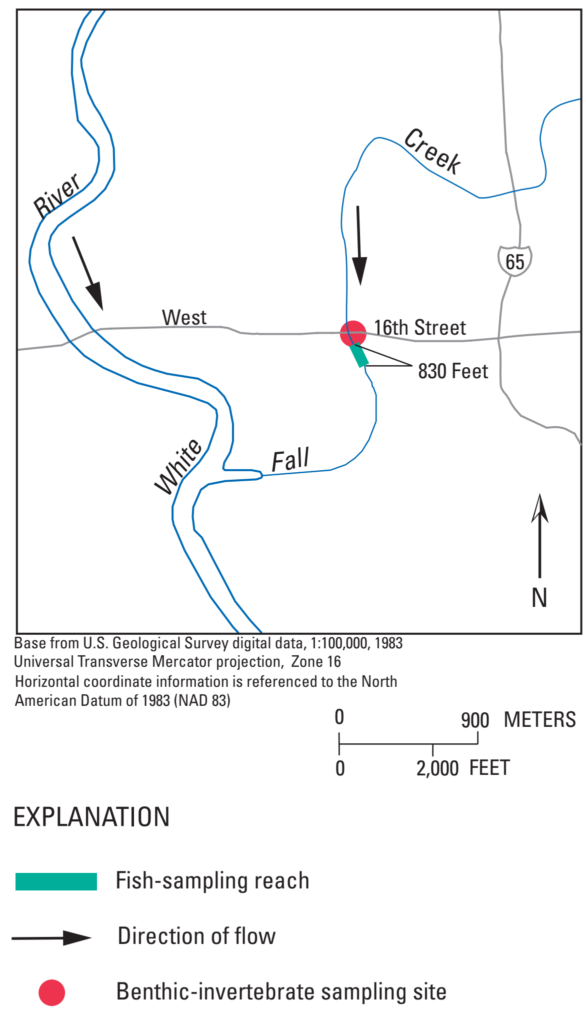


Figure 16. Sampling locations at Fall Creek at 16th Street at Indianapolis, Ind.

Pleasant Run near South Meridian Street at Indianapolis, Ind.

The Pleasant Run site (fig. 17) is in the vicinity of the footbridge upstream from South Meridian Street. The site is near river mile 1.2, with a drainage area of 20.8 mi^2 (Hoggatt, 1975). A USGS streamflow-gaging station on Pleasant Run at Arlington Avenue at Indianapolis (03353120; fig. 1) provided discharge information on the stream. The station is at river mile 7.9, and the annual mean discharge is 8.13 ft^3/s for the period of record 1960 through 2001. Annual mean discharge for the study period was 5.96 ft^3/s for 1999, 5.19 ft^3/s for 2000, and 6.63 ft^3/s for 2001 (Stewart and others, 2000, 2001, 2002). Benthic invertebrates were collected just upstream from the footbridge in an area characterized by a gravelly riffle. Fish were collected along a mean reach length of 581 ft that extended just downstream from the footbridge to a riffle area upstream. This reach was dominated by a sandy substrate, with alternating fairly shallow pools and riffles. Little vegetative cover occurred along the reach. Relative to other sites in the study area, Pleasant Run has the second least-favorable QHEI score (49; fig. 2).

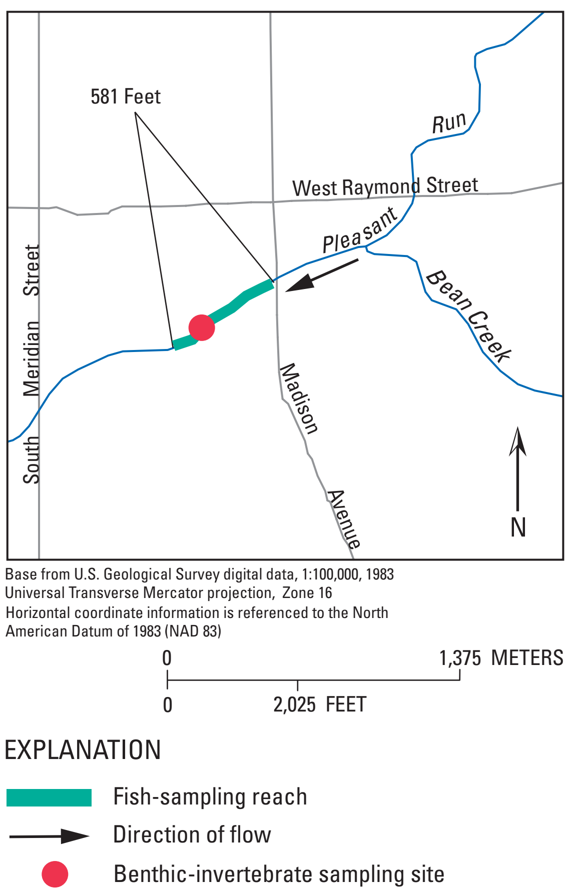


Figure 17. Sampling locations at Pleasant Run near South Meridian Street at Indianapolis, Ind.

Of all the sites sampled, the largest number of CSOs (49) discharge directly into Pleasant Run. This site had relatively poor scores, indicated by the benthic-invertebrate community dominated by the dipterans (flies). EPT scores ranged from 2 to 7 (fig. 3), HBI scores ranged from 6.7 to 7.9 (fig. 4), and ICI scores ranged from 10 to 32 (fig. 5). This site was slightly better than the Pogues Run site in the Ohio IBI scores (32–36; fig. 6) and Indiana IBI scores (30–36; fig. 7) used to describe the fish community. The predominant fish species at this site was the central stoneroller (*Campostoma anomalum*), followed by creek chubs (*Semotilus atromaculatus*).

Pogues Run at Vermont Street at Indianapolis, Ind.

The Pogues Run site (fig. 18) is at river mile 2.5, with a drainage area of 8.87 mi^2 (Hoggatt, 1975)—the smallest of all the study sites. Although there is no USGS streamflow-gaging station on this stream, periods of no flow were observed in September 1999. These no-flow periods were characterized by a dry streambed with intermittent pools of shallow depth. Benthic invertebrates were collected in the immediate vicinity of the Vermont Street bridge. Fish were collected upstream from that site, just downstream from the Michigan Street bridge to a riffle about 466 ft upstream. The stream is dominated by a sand and gravel substrate in very shallow waters. An overhead wooded canopy filtered sunlight, and there was very little protective cover for fish along the reach. Poor habitat conditions are reflected by the low QHEI score (45; fig. 2) at this site, the lowest among all sites in the study area.

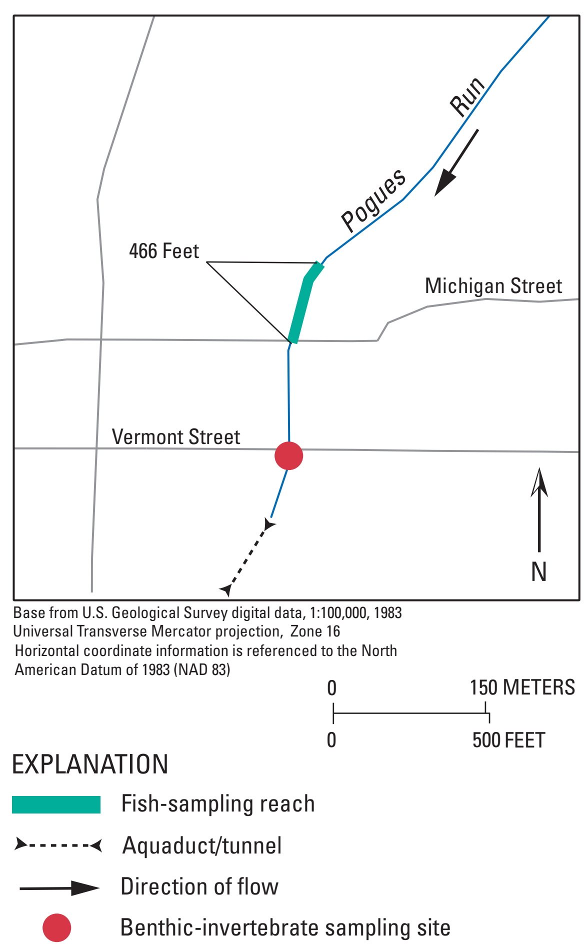


Figure 18. Sampling locations at Pogues Run at Vermont Street at Indianapolis, Ind.

Based on samples of benthic invertebrates and fish, water-quality conditions on Pogues Run consistently were among the poorest of all sites throughout the study. The combination of periods of no flow along with the 24 CSOs that could discharge into the stream during wet weather probably had the largest effect on water-quality conditions at this site. Relatively few benthic invertebrates (table 5 at back of report)—most of which were tolerant species—coupled with the least number of species (7) and low numbers of fish (312–808) collected during the study (table 7 at back of report) are indicative of the poor water-quality conditions at the site. EPT scores ranged from 0 to 6 (fig. 3), and HBI scores ranged from 6.6 to 8 (fig. 4). The ICI scores (4–36; fig. 5) and Ohio IBI scores (24–30; fig. 6), however, showed some improvement in biological conditions at the site during the study. Indiana IBI scores ranged from 28 to 34 (fig. 7).

Williams Creek at 96th Street at Indianapolis, Ind.

The Williams Creek site (fig. 19) at 96th Street, like the site at Pogues Run, is on an ungaged stream. The drainage area is approximately 17 mi^2 (Hoggatt, 1975) at about river mile 4.8. Benthic invertebrates were collected in a riffle area upstream from the bridge, and fish were collected along an 856-ft mean reach length downstream from the 96th Street bridge. This reach is characterized by riffles and runs that have cobble and gravel substrate and some deep pools with sandy substrate. Protective habitat cover includes woody debris, boulders, and instream vegetation; a mix of filtered and direct sunlight reaches the stream. The highest QHEI score (82; fig. 2) among the tributary and White River study sites was determined for this site, reflecting good habitat.

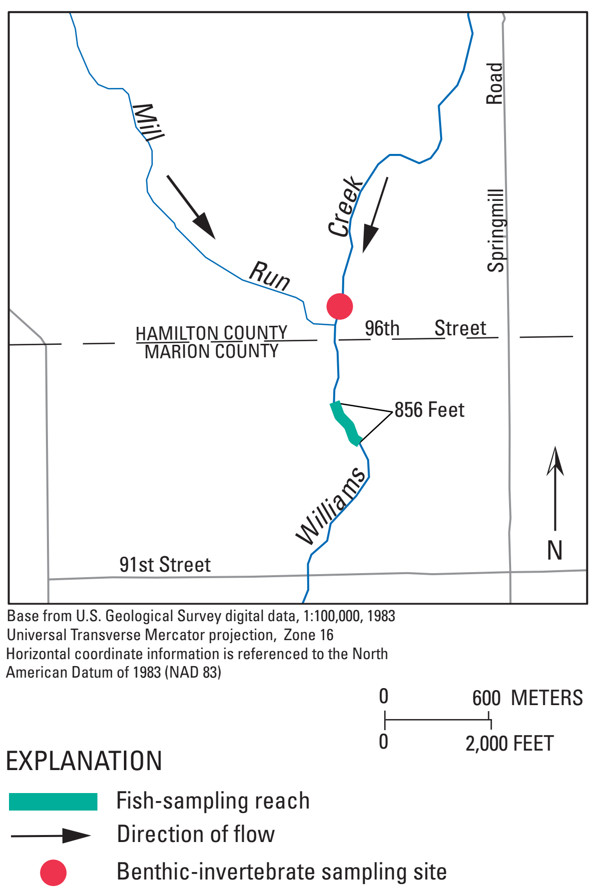


Figure 19. Sampling locations at Williams Creek at 96th Street at Indianapolis, Ind.

Williams Creek had the second smallest drainage area among the study sites. This site, however, rated among the best tributary study sites, as shown by the IBI (Ohio IBI, 52–54, and Indiana IBI, 44–50; figs. 6 and 7) and ICI (32–46; fig. 5) scores. The benthic-invertebrate community at this site had EPT (7–12; fig. 3), HBI (5.4–6.5; fig. 4), and ICI scores that were better than most tributary sites, with only the Buck Creek site surpassing it. The fish population at Williams Creek was fairly diverse, and the number of fish collected was usually higher than for the other sites (table 7 at back of report). Central stonerollers (*Campostoma anomalum*) were the dominant species collected.

Comparisons among Sites

In this section, sites are compared, based on the physical-habitat, benthic-invertebrate, and fish data. Biological-index scores are compared among all the sites, among the White River sites, and among the tributary sites as appropriate. Interpretation of the indices used in this study should be limited to comparisons among the study sites (U.S. Environmental Protection Agency, 1999).

Physical Habitats

The QHEI scores for sites on the White River ranged from 55 at Harding to 71 at Waverly; scores on the tributaries ranged from 45 on Pogues Run to 82 on Williams Creek (fig. 2). Average scores for both White River and tributary sites were 63. On the White River, the Harding and Stout sites scored lower than average and the Morris and Waverly scores were above average. Eagle Creek, Pleasant Run, and Pogues Run scored below average; Buck Creek, Fall Creek, and Williams Creek scored above average for the tributary sites. The QHEI was calculated on the basis of conditions during the 2000 fish electroshocking period. Habitat data are compiled in table 3 at the back of this report. No substantial changes in the physical habitat were observed at the sampling sites during the 3-year period; these were stable reaches of the streams, with no major floods during the study.

Benthic-Invertebrate Communities

During the 3-year study, 151 distinct taxon were identified. A summary list of all taxa identified is presented in table 4 (at back of report). A complete listing of the benthic-invertebrate data for each site is provided in the appendix to this report (tables 9–90). The total number of taxa was highest at the Buck Creek site, where 62 taxa were identified in the September 1999 sample (table 5 at back of report). The highest number of taxa of all the White River study sites generally was at the Nora site. The May 1999 samples at the Pogues Run and Wicker Road sites represented the lowest diversity in samples collected during the study, with 18 and 19 taxa, respectively. Diversity generally was low at the Pleasant Run and Pogues Run tributary study sites and at the Harding, Stout, and Waverly sites on the White River.

Benthic-invertebrate data, including general information such as total number of taxa, abundance (organisms per square meter), percent Diptera taxa, and percent Diptera organisms, are summarized in table 5 (at back of report). Total taxa richness reflects the community health by measuring the number of taxa present. Dipterans are important because they generally have the greatest range of pollution tolerances for the benthic invertebrates and often are the predominant organism present in a sample (Ohio Environmental Protection Agency, 1987).

Benthic-invertebrate abundance was highest in the May 2000 sampling at the Nora site (table 5 at back of report). The highest abundance of benthic invertebrates for all the tributary study sites was at the Fall Creek site (May 1999; table 5 at back of report). On the White River, benthic-invertebrate abundance was generally lowest at the Wicker site; of the tributary sites, it was generally lowest at the Pogues Run site.

Dipterans generally made up the highest percent of organisms in the samples, accounting for more than one-third of the taxa identified at study sites (table 5 at back of report). At the Stout, Wicker, and Waverly study sites on the White River, dipterans generally made up about 45 percent of the taxa collected and more than 70 percent of all organisms identified in the samples. On average, dipterans made up more than 55 percent of the taxa and more than 70 percent of all organisms in the Pleasant Run and Pogues Run tributary-site samples (table 5 at back of report).

Ephemeroptera, Plecoptera, and Trichoptera Index

In the White River, the EPT Index ranged from 0 in May 2000 at the Harding site to 15 in May 2001 at the Nora site, indicating the best conditions were observed at the Nora site (fig. 3). The lowest number of observations of these pollution-sensitive species was at the Morris and Harding sites; there was some recovery of these species in the downstream reaches. The low number indicates a negative effect on the benthic invertebrates in the most urbanized reaches of the White River. EPT scores for tributary sites ranged from 0 at Pogues Run in May 1999 to 16 at Buck Creek in September 2000 and May and September 2001 (fig. 3). The greatest number of intolerant species was at the Buck Creek site. A higher number of these species occurred at Eagle and Williams Creeks than at most of the White River sites. The lowest number of intolerant species identified in the samples was at the Pogues Run site.

Hilsenhoff Biotic Index

HBI scores for sites on the White River ranged from 4.9 (good water quality) at the Nora site in September 2001 to 9.6 (very poor water quality) at the Harding site in September 1999 (fig. 4). The lowest HBI scores, which indicate low numbers of tolerant species, were calculated for the Nora site, the most upstream site on the White River. The highest HBI scores, and therefore the least favorable water-quality conditions (fig. 4), were at the Morris and Harding sites. HBI scores at those sites ranked conditions in the poor to very poor range. Downstream at the Stout site, HBI scores reflected some improvement in water-quality conditions, probably resulting in part from the reaeration of water flowing over the low-head dam at the Stout Generating Station just upstream from the benthic-invertebrate sampling site. Although improvement was noted, the Stout site ranked in the fairly poor category, based on HBI values. The fairly poor ratings continued through the downstream reaches sampled.

HBI scores at the tributary study sites ranged from 5.2 (good) at the Buck Creek site in September 1999 to 8.0 (poor) at the Pogues Run site in May 1999. Tolerant species in Buck, Eagle, and Williams Creeks indicate fair water-quality conditions in those tributaries (fig. 4). The highest HBI scores of all tributary study sites were at the Pogues Run site, followed closely by the Pleasant Run and Fall Creek sites. These tributary-site scores were lower than scores at the Morris and Harding sites on the White River, indicating better water quality on the tributaries compared to the White River.

Invertebrate Community Index

ICI scores at the White River sites ranged from 8 (poor water quality) at the Harding site, May 2000, to 38 (good) at the Nora site, September 1999 (fig. 5). The highest ICI scores of the White River study sites were at the Nora site, again indicating that water-quality conditions were good as the river enters the Indianapolis Metropolitan Area. ICI scores at the remaining White River study sites, however, indicate that the waters were degraded as they moved through the downtown Indianapolis area and that conditions there were fair to poor. ICI scores showed slight improvement in the downstream reaches, indicating fair conditions.

The tributary sites ranged from 4 (poor) at Pogues Run, May 1999, to 50 (exceptional) at Buck Creek, September 2000 and 2001 (fig. 5). The Buck Creek tributary site was the only site to achieve scores that indicate exceptional water-quality conditions, although one sample from May 2000 indicated fair conditions. The Williams Creek site showed generally good conditions, with ICI scores ranging from 32 to 47. ICI scores for study sites on the tributaries that receive CSO flow (Fall Creek, Eagle Creek, Pleasant Run, and Pogues Run) ranged from 4 to 38, indicating fair conditions.

Fish Communities

Species of fish identified during this study are listed in table 6 (at the back of report) for sites on the White River and in table 7 (at back of report) for the tributary sites. A complete listing of the fish data for each site (tables 91–125) is provided in the appendix to this report. A greater number of fish were collected at tributary study sites, but these generally were made up of smaller-sized species. A total of 74 species plus 3 hybrids were identified at sites in the White River and selected tributaries during 1999–2001. Of these, 52 species and 1 hybrid were identified at White River study sites, while 61 species plus 3 hybrids were identified at tributary study sites. Thirty-nine species and one hybrid were common to both categories of sites.

Carps and minnows (Cyprinidae) were the largest group of fish identified during the study, consisting of more than half (53 percent) of all the fish collected (tables 6 and 7 at back of report). They constituted more than 68 percent of all fish collected at the tributary study sites yet were less than 15 percent of those collected on the White River. Fish collected at the White River study sites were dominated by the sunfishes (Centrarchidae), 41 percent, and suckers (Catostomidae), 31 percent. The sunfishes (Centrarchidae) were 16 percent of the fish collected in tributaries and 23 percent of all the fish collected.

The most numerous species identified was the central stoneroller (*Campostoma anomalum*)—collected only at tributary sites—which made up almost 25 percent of all specimens identified and more than 34 percent of the specimens collected on the tributaries. Bluegills (*Lepomis macrochirus*) and longear sunfish (*Lepomis megalotis*) each accounted for 8 percent of all specimens collected, followed by sand shiners (*Notropis stramineus*) (6 percent), creek chubs (*Semotilus atromaculatus*) (5 percent), and bluntnose minnows (*Pimephales notatus*) (9 percent). Fewer than 10 individuals of each of the following species were identified during the study: Ohio lamprey (*Ichthyomyzon bdellium*), bowfin (*Amia calva*), koi carp (*Cyprinus carpio*), golden shiner (*Notemigonus crysoleucas*), silverband shiner (*Notropis slumardi*), fathead minnow (*Pimephales promelas*), smallmouth buffalo (*Ictiobus bubalus*), bigmouth buffalo (*Ictiobus cyprinellus*), black buffalo (*Ictiobus niger*), black bullhead (*Ameiurus melas*), brindled madtom (*Noturus miurus*), northern studfish (*Fundulus catenatus*), western mosquitofish (*Gambusia affinis*), white bass (*Morone chrysops*), warmouth (*Lepomis gulosus*), redear sunfish (*Lepomis microlophus*), fantail darter (*Etheostoma caeruleum*), banded darter (*Etheostoma zonale*), sauger (*Stizostedion canadense*), and walleye (*Stizostedion vitreum*). Of these, the koi carp (*Cyprinus carpio*) and the western mosquitofish (*Gambusia affinis*) are nonnative species. The northern studfish (*Fundulus catenatus*) is classified as an Indiana species of special concern (Indiana Department of Natural Resources, 2002).

The number of fish species identified at each study site ranged from 7 at the Pogues Run site (1999–2001) to 41 at the Buck Creek site (2000) (table 7 at back of report). On the White River, the lowest number of fish species collected (14) was at the Nora site (2001) and the highest number (32) was at the Stout site (2001) (table 6 at back of report). The greatest number of individual fish collected at a site was 2,697 at Pleasant Run in 1999 (table 7 at back of report). At the Williams Creek site, 2,325 individual fish were collected in 1999. The lowest numbers of fish collected at any site were 56 at the Waverly site in 2001 and 61 at the Nora site in 2000. For the White River sites, the highest number of individuals collected was at the Morris site (1,012 in 2000).

Although the number of individual fish collected was much higher at the tributary sites than at the White River sites, fish-body size was greater at the White River sites. The total weight of fish collected at each of the White River sites ranged from 17 kg at the Nora site (2000) to 289 kg at the Stout site (2001) (table 6 at back of report). The mean total weight for all White River sites was 120 kg. At the tributary sites, total weight ranged from 1.6 kg at the Pogues Run site (2000) to 72.8 kg at the Fall Creek site (2001) (table 7 at back of report). Mean total weight of fish at all tributary sites was 25.4 kg.

Fish were checked for various anomalies while being measured and weighed. No incidence of anchor worms or ich was observed. Fungus was observed on one fish collected at the Williams Creek site during the 2000 sampling. The number of anomalies observed during the study was highest at the White River sites (table 8 at back of report). With the exception of the Nora and Waverly sites, anomalies were observed on fish from the White River study sites most frequently during the 2000 sampling period. Most tributary sites exhibited the highest number of anomalies during the first year of sampling, with decreases in subsequent years. At the Pleasant Run site, anomalies were fewest in 1999 and highest in 2000. The highest number of anomalies observed at Buck Creek was in 2001 (Buck Creek was not sampled in 1999).

Percentages of fish with anomalies generally were lower at tributary sites (less than 5.5 percent) than at White River sites (ranging from 1 to 27 percent). In the first year of the study, the highest percentage of fish with anomalies for the White River sites was observed at the Stout site. In subsequent years, there was a downstream shift in which site had the highest percentage of fish with anomalies: it was the Wicker site in 2000 and the Waverly site in 2001. It is unclear what caused this downstream change.

Occurrences of fish anomalies were higher in 2000 than in 1999 at most sites on the White River. The greatest increase was in the number of lesions and ulcers, followed by leeches, eroded fins, blindness, popeye, and deformities. Only the number of observations of leeches and popeye continued to increase in 2001, whereas the number of tumors and parasites decreased yearly from 1999 to 2001. Observations of deformities, eroded fins, lesions, and blindness were all highest in 2000 at the White River sites.

Variation in observed anomalies at the tributary sites was less dramatic than at the White River sites. The number of parasites, however, decreased markedly from 1999 to 2000. The number of occurrences of any other anomaly differed by five or less between sample years. Overall throughout the sampling period, the number of observed anomalies was lower at the tributary sites than at the White River sites.

Among the anomalies observed, blindness was most noticeably observed in the catfishes (Ictaluridae). During the 2000 sampling, when the incidence of blindness was highest, nearly every blind fish observed was a catfish. The cause for this is unknown; the fact that catfish are bottom dwellers, coupled with the movement of contaminants related to the December 1999 fish kill on the White River, may in part explain the findings.

Interpretation of the data—particularly the IBIs—in this study was complicated by the December 1999 fish kill. IBI scores at the Nora site dropped in 2000, yet downstream study sites showed increased IBI scores in 2000. The Nora site was the study site most affected by the chemical spill; it was the farthest upstream study site on the White River, and it was in the area where many dead fish were collected and where restocking efforts were made. Although it is uncertain, part of the improved scores in the downstream reaches may be the result of fish migrating downstream to escape the area most affected by the chemical spill. This may have resulted in greater numbers of fish and fish species collected at the downstream sites in 2000.

Ohio Index of Biotic Integrity

Scores for the Ohio IBI ranged from 34 (fair) to 46 (good) for sites on the White River and from 24 (poor) to 56 (excellent) for tributary sites (fig. 6). The average Ohio IBI score was 40 for the White River sites and 42.5 for the tributary sites.

Ohio IBI scores for study sites along the White River showed slight variations in fish-community structure among the White River sites and with time at each site (fig. 6). The 1999 data showed decreasing scores as the White River flows through Indianapolis, with some recovery downstream. In the year following the fish kill, scores decreased at the Nora site, the most upstream study site and the site that was most affected by the chemical spill. The Ohio IBI scores, however, indicate improved fish-community structure downstream in 2000. Only Waverly, the most downstream White River study site, remained the same as the previous year. One possible explanation for this may be that numerous fish moved downstream ahead of the spill until they could either move into tributaries or areas where water-quality conditions were favorable. This hypothesis is supported by the vastly higher abundance and higher total weights of fish (table 7 at back of report) collected at the Morris, Harding, and Stout sites during the second year of data collection. Ohio IBI scores for the 2001 White River sampling data were the most consistent, indicating that fish-community structures were similar throughout the study area.

Among the tributary sites, the fish communities at the Buck Creek, Fall Creek, and Williams Creek sites had the highest Ohio IBI scores, which were generally in the excellent range (fig. 6). The lowest scores were at the Pogues Run site, which rated poor to fair. The scores at that site, like those at the Fall Creek site, showed steady improvement in the fish community during the study. Ohio IBI scores at other tributary sites remained fairly stable during the 3-year study.

Indiana Index of Biotic Integrity

Indiana IBI scores ranged from 34 (poor) to 50 (good) on the White River and from 28 (poor) to 54 (good) for tributary sites (fig. 7). Average Indiana IBI scores were 42 for the White River sites and 43 for the tributaries. Indiana IBI scores for sites along the White River remained consistent (fig. 7), with only a slight decrease at the Harding site and at sites downstream from Indianapolis. There were no observable differences in scores among the White River sites.

Based on Indiana IBI scores, conditions were stable at the tributary sites of Buck Creek, Eagle Creek, and Fall Creek. The Williams Creek site showed improved conditions from the first to the second year, possibly the result of fish moving into the tributaries during the 1999 fish kill. Scores from the Pleasant Run and Pogues Run sites were lower than those from the other tributary sites (fig. 7). Both of these streams enter the White River upstream from the Harding site, and conditions at these two sites may be the result of streamflow, water-quality conditions, and inflow from point and non-point sources on those tributaries. Both sites have periods of low flow during which time fish would need to move to pools of sufficient size for survival. The Pogues Run site was observed to have no flow during September 1999 and was not sampled.

Comparisons to Previous USGS Studies

The USGS has collected biological data in the White River drainage basin in the past. Benthic-invertebrate studies by the USGS were conducted as early as 1981 at some of the same locations sampled for this study. Fish studies by the USGS have been completed in the basin but not at these locations.

Benthic Invertebrates

Since 1981, the USGS has collected benthic invertebrates intermittently at three sites on the White River within the current study area—Westfield Boulevard (downstream from the Nora site), Stout, and Waverly. Sampling was done annually from 1981 through 1987 (Crawford and others, 1992), biannually from 1994 through 1996 (Renn, 1998; Voelker and Renn, 2000), and biannually from 1999 through 2001 (this study). For this discussion, one annual sample—collected in the August through October time period—was plotted for comparison with the historical data. EPT scores (fig. 20) generally showed more-relative fluctuation over the period of record compared with the

HBI scores (fig. 21); however, the EPT and HBI scores oscillated throughout the historical period, with no well-defined improved or diminished conditions throughout the study area.

At the Nora site, EPT scores were consistently lowest during 1994–96 and consistently highest during 1999–2001. At the Stout site, scores were lowest during the early 1980s but showed improvement in the two most-recent sampling periods. The highest EPT scores at the Waverly site were in 1984, 1986, 1987, and 1999; the lowest scores at that site were in 1981 and 1982 (fig. 20).

Historically, HBI data at the Nora site indicate generally good conditions as the White River enters Marion County (fig. 21). At the Stout site, however, HBI scores consistently indicate fair to fairly poor conditions. At the Waverly site, HBI scores in the fair category indicate slightly better water quality compared to the Stout site, although the current study indicates fairly poor conditions in this reach. The data for all three study sites do not show any consistent trends in HBI scores throughout the historical period of sampling.

Results of sampling for benthic invertebrates, including the number of taxa and other characteristics of the benthic-invertebrate community, can be affected by differences in field-sampling crew and taxonomists or even variation in application of the same protocols (M.S. Gurtz, U.S. Geological Survey, written commun., 2003). This may affect the EPT analysis over time. Therefore the EPT Index to total taxa ratio was calculated to compare EPT conditions over time (fig. 22). Using this method of analysis, the historical data indicate that ratios for the Stout site were consistently lower over time than for the Nora or Waverly sites, indicating more degraded water-quality conditions at the Stout site.

Fish

Crawford and others (1996) presented a compilation of fish species historically found in the White River Basin. Two species collected during 1999–2001—the Ohio lamprey (*Ichthyomyzon bdellium*) and the banded darter (*Etheostoma zonale*)—were not reported in that compilation. One species collected during this study, the northern studfish (*Fundulus catenatus*), is listed as an Indiana species of special concern (Indiana Department of Natural Resources, 2002). Three individuals of this species were identified at the Buck Creek site (table 6 at back of report); one was collected in 2000 and two in 2001.

Summary

The U.S. Geological Survey, in cooperation with the Indianapolis Department of Public Works, Office of Environmental Services, conducted a study from 1999–2001 to assess biological invertebrates and fish communities in the White River and selected tributaries in the Indianapolis Metropolitan Area. Twelve sites (six on the White River and six on tributaries) were sampled biannually for benthic invertebrates and annually for fish. This sampling information complements the Department of Public Works' chemical monitoring of surface water in the area and is being used by the City of Indianapolis to determine control strategies to mediate the effect of combined-sewer overflows and other point and non-point sources of pollution on the water quality of receiving streams in the Metropolitan Area.

A total of 151 benthic-invertebrate taxon were identified in samples collected during 1999–2001 at sites on the White River and selected tributaries. Ephemeroptera, Plecoptera, and Trichoptera Index scores for White River study sites ranged from 0 at the Harding site to 15 at the Nora site. The Nora site consistently scored the highest of all White River sites. Sites in the immediate vicinity of downtown Indianapolis (Morris and Harding) scored the lowest and indicate a negative effect on benthic-invertebrate communities in that reach. Ephemeroptera, Plecoptera, and Trichoptera Index scores improved in the farthest downstream reaches, which indicate that water-quality conditions had improved. For the tributary sites, Ephemeroptera, Plecoptera, and Trichoptera Index values ranged from 0 at Pogues Run to 16 at Buck Creek.

Hilsenhoff Biotic Index scores ranged from 4.9 (good) to 9.6 (very poor) at the White River sites and from 5.2 (good) to 8.0 (poor) at the tributary sites. The lowest scores among the White River sites were at the Nora site, which indicate less-tolerant species as the White River enters Marion County. The highest Hilsenhoff Biotic Index scores were at the Morris and Harding sites, which indicate the least-favorable water-quality conditions of all White River sites. Of the tributary sites, Hilsenhoff Biotic Index scores for Buck, Eagle, and Williams Creeks indicate fair water-quality conditions. The highest Hilsenhoff Biotic Index scores, indicating relatively poor water-quality conditions, were at Pleasant Run and Pogues Run.

On the White River, the highest Invertebrate Community Index scores, which indicate the best benthic-invertebrate conditions, were at the Nora site. Conditions were fair to poor in the downtown Indianapolis area; scores indicate slight improvement in the downstream reaches of the study area. At the tributary sites, Buck Creek was the only site with exceptional water-quality scores. Williams Creek also had good scores. The remaining tributary sites, all of which have combined-sewer overflows, had fair conditions.

A total of 74 species and 3 hybrids of fish were identified during the study. The Cyprinidae (carps and minnows) was the largest group of fish identified, consisting of more than half of all fish collected. The most-numerous species was the central stoneroller (*Campostoma anomalum*), which made up almost 25 percent of the fish collected. Collected during the study were two nonnative species—the koi carp (*Cyprinus carpio*) and the western mosquitofish (*Gambusia affinis*)—and a species classified as an Indiana species of special concern—the northern studfish (*Fundulus catenatus*).

Figure 20. Ephemeroptera, Plecoptera, and Trichoptera (EPT) Index scores for selected sites in the Indianapolis Metropolitan Area, Indiana, 1981–2001.

Figure 21. Hilsenhoff Biotic Index (HBI) scores for selected sites in the Indianapolis Metropolitan Area, Indiana, 1981–2001.

Figure 22. Ratio of Ephemeroptera, Plecoptera, and Trichoptera (EPT) Index scores to total taxa for selected sites in the Indianapolis Metropolitan Area, Indiana, 1981–2001.

For study sites on the White River, the number of fish species identified ranged from 14 at the Nora site to 32 at the Stout site; the number of individual fish collected ranged from 56 at the Waverly site to 1,012 at the Morris site. The mean total weight of all fish collected at the White River sites for the 3-year study was 120 kg. For the tributary study sites, the number of species ranged from 7 at Pogues Run to 41 at Buck Creek; the number of fish collected ranged from 312 at Pogues Run to 2,697 at Pleasant Run. Fish collected at the tributary study sites were smaller (having a mean total weight of 25.4 kg) than those collected at the White River study sites.

Fish anomalies observed included deformities, eroded fins, lesions and ulcers, tumors, leeches, fungus, blindness, parasites, and popeye. The incidence of anomalies was observed more frequently at the White River sites. The percentage of anomalies was highest at the Stout site in 1999, at the Wicker site in 2000, and at the Waverly site in 2001. Anomalies were observed most frequently at the White River sites during the 2000 sampling. In general, most tributary sites exhibited the highest number of anomalies in 1999, with decreases in subsequent years. At Pleasant Run, however, anomalies were highest in 2000; at Buck Creek, most anomalies were observed in 2001.

Calculation of the Indiana Index of Biotic Integrity showed no apparent differences in scores among the White River sites. Among the tributary sites, however, scores from Pleasant Run and Pogues Run indicate conditions at those sites were less favorable than at the other tributary sites. Ohio Index of Biotic Integrity scores also showed small variations in fish-community structure for sites on the White River. During 1999, conditions degraded slightly downstream, with some recovery observed. In 2000, that trend was reversed, with conditions improving downstream. The exception was the Waverly site, which showed no change. In 2001, Ohio Index of Biotic Integrity scores remained consistent throughout the White River sites. Among the tributary sites, Pogues Run had the lowest Index of Biotic Integrity scores; Buck, Fall, and Williams Creeks rated the highest.

Interpretation of the fish data is complicated by the major fish kill of December 1999 that resulted from a chemical spill into the White River near Anderson, Indiana. That spill caused the death of an estimated 117 tons of fish. Fish were killed along more than 50 miles of the White River, extending from Anderson downstream to Indianapolis. Index of Biotic Integrity scores at the Nora site dropped in 2000, yet downstream study sites showed increased Index of Biotic Integrity scores in 2000. The Nora site was the study site most affected by the chemical spill; it was the farthest study site upstream on the White River, and it was in the area where dead fish were collected. Although it is uncertain, part of the improved scores in the downstream reaches may be the result of fish migrating downstream to escape the area most affected by the chemical spill. This may have resulted in greater numbers of fish and fish species collected at the downstream sites in 2000.

Since 1981, the U.S. Geological Survey has collected benthic invertebrates intermittently at or near three sites (Nora, Stout, and Waverly) on the White River. Historically, benthic-invertebrate data at the Nora site indicate generally good conditions as the White River enters the Indianapolis Metropolitan Area. At the Stout site, benthic-invertebrate data indicate that conditions were more degraded than at the other two sites. At the Waverly site, data indicate slightly better water quality than at the Stout site, although conditions were not as good as at the Nora site.

Fish data collected during this study also were compared to a compilation of fish species historically found in the White River Basin. Two species collected in this study—the Ohio lamprey (*Ichthyomyzon bdellium*) and the banded darter (*Etheostoma zonale*)—were not reported in that compilation.

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Tables 3–8

Table 3. Habitat characteristics[a] for benthic-invertebrate and fish-community sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.

[U, undercut banks; S, shallows; B, boulders; A, aquatic macrophytes; W, logs or woody debris; O, overhanging vegetation; P, pools; RW, rootwads; RM, rootmats; R, residential, park, newfield; Ur, urban or industrial; OP/R, open pasture/rowcrop; Sh, shrub or oldfield; P=R, pool width equals riffle width; P>R, pool width greater than riffle width; cm, centimeter; >, greater than; <, less than]

Site	Substrate		Substrate quality		Instream habitat cover	
	Dominant	Subdominant	Silt quality	Extent of embeddedness	Extent	Types present
White River sites						
Nora	Cobble	Sand	Normal	Normal	Sparse	U,S,B,A,W
Morris	Cobble	Silt	Moderate	Moderate	Moderate	U,O,P,RW,B,A,W
Harding	Silt	Cobble	Moderate	Moderate	Sparse	U,O,S,RM,P,RW,B,A,W
Stout	Gravel	Sand	Moderate	Moderate	Sparse	O,P,B,A,W
Wicker	Cobble	Gravel	Normal	Moderate	Moderate	U,S,B,A,W
Waverly	Cobble	Gravel	Moderate	Normal	Moderate	U,O,RM,P,RW,B,W
Tributary sites						
Buck Creek	Gravel	Cobble	Normal	Normal	Sparse	U,O,S,P,RW,B,A,W
Eagle Creek	Sand	Gravel	Normal	Extensive	Sparse	U,O,S,P,B,A,W
Fall Creek	Cobble	Sand	Normal	Normal	Moderate	U,O,RM,P,RW,B,A,W
Pleasant Run	Sand	Gravel	Normal	Moderate	Sparse	U,O,S,RW
Pogues Run	Sand	Gravel	Heavy	Normal	Normal	U,O,S,RW,A
Williams Creek	Cobble	Gravel	Moderate	Normal	Moderate	U,O,S,RW,B,A,W

Table 3. Habitat characteristics[a] for benthic-invertebrate and fish-community sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.—Continued

[U, undercut banks; S, shallows; B, boulders; A, aquatic macrophytes; W, logs or woody debris; O, overhanging vegetation; P, pools; RW, rootwads; RM, rootmats; R, residential, park, newfield; Ur, urban or industrial; OP/R, open pasture/rowcrop; Sh, shrub or oldfield; P=R, pool width equals riffle width; P>R, pool width greater than riffle width; cm, centimeter; >, greater than; <, less than]

Site	Channel morphology				Riparian width		Flood-plain land use	
	Sinuosity	Development	Channelization	Stability	Left bank	Right bank	Left bank	Right bank
White River Sites								
Nora	None	Fair	None	High	Very Narrow	Narrow	Rear	Rear
Morris	Low	Good	None	High	Moderate	Narrow	Ur	Ur
Harding	Low	Good	None	Moderate	Narrow	Narrow	Ur	Ur
Stout	Low	Good	None	Moderate	Moderate	Moderate	Ur	Ur
Wicker	None	Good	None	Moderate	Moderate	Moderate	OP/R	OP/R
Waverly	Low	Fair	None	Moderate	Moderate	Moderate	Sh	Sh
Tributary Sites								
Buck Creek	Moderate	Excellent	None	Moderate	Moderate	Moderate	OP/R	OP/R
Eagle Creek	Normal	Excellent	Recovering	High	Narrow	Narrow	Ur	Ur
Fall Creek	Moderate	Excellent	Recovered	High	Moderate	Moderate	R	Ur
Pleasant Run	Low	Fair	Recovered	Moderate	Very Narrow	Very Narrow	R	R
Pogues Run	Low	Fair	Recovering	Moderate	Very Narrow	Very Narrow	Ur	Ur
Williams Creek	Moderate	Excellent	None	Moderate	Narrow	Moderate	R	R

Table 3. Habitat characteristics[a] for benthic-invertebrate and fish-community sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.—Continued

[U, undercut banks; S, shallows; B, boulders; A, aquatic macrophytes; W, logs or woody debris; O, overhanging vegetation; P, pools; RW, rootwads; RM, rootmats; R, residential, park, newfield; Ur, urban or industrial; OP/R, open pasture/rowcrop; Sh, shrub or oldfield; P=R, pool width equals riffle width; P>R, pool width greater than riffle width; cm, centimeter; >, greater than; <, less than]

Site	Bank erosion		Pool/glide and riffle/run quality						
	Left bank	Right bank	Maximum depth	Morphology	Current velocity	Riffle depth	Run depth	Substrate	Riffle/run embeddedness
White River sites									
Nora	Moderate	Little	>1 meter	P=R	Moderate to slow	>10 cm	>50 cm	Stable	Low
Morris	None	None	>1 meter	P>R	Moderate to slow	>10 cm	>50 cm	Stable	Low
Harding	Moderate	Moderate	>1 meter	P>R	Slow	>10 cm	>50 cm	Stable	Low
Stout	Little	Little	>1 meter	P=R	Moderate to slow	5–10 cm	>50 cm	Stable	Moderate
Wicker	Little	Heavy	.7–1 meter	P=R	Fast to moderate	>10 cm	>50 cm	Moderate	Low
Waverly	Moderate	Little	.4 –.7 meter	P=R	Moderate to slow	>10 cm	>50 cm	Moderate	Low
Tributary sites									
Buck Creek	Little	Little	.7–1 meter	P>R	Fast to slow	>10 cm	>50 cm	Moderate	Low
Eagle Creek	Little	Little	>1 meter	P>R	Moderate	>10 cm	>50 cm	Unstable	Extensive
Fall Creek	Little	Little	>1 meter	P>R	Fast to slow	>10 cm	>50 cm	Stable	Low
Pleasant Run	Little	Little	.7–1 meter	P>R	Moderate to slow	<5 cm	>50 cm	Moderate	Moderate
Pogues Run	Little	Little	.2–.4 meter	P>R	Slow	<5 cm	>50 cm	Unstable	Moderate
Williams Creek	Moderate	Moderate	>1 meter	P>R	Fast to slow	5–10 cm	>50 cm	Stable	Normal

[a]Habitat characteristics based on the Qualitative Habitat Evaluation Index by the Ohio Environmental Protection Agency (1989).

Table 4. Benthic-invertebrate taxa collected at sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.

[w.h.c., with hair chaetae; w.o.h.c., without hair chaetae]

Phylum	Class	Order	Family	Taxon
COELENTERATA	Hydrozoa	Hydroida	Hydridae	*Hydra americana*
PLATYHELMINTHES	Turbellaria	Tricladida	Planariidae	*Cura foremanii*
PLATYHELMINTHES	Turbellaria	Tricladida	Planariidae	*Dugesia tigrina*
NEMATODA	unidentified	unidentified	unidentified	unidentified
MOLLUSCA	Bivalvia	Unionoida	Unionidae	*Lampsilis siliquoida*
MOLLUSCA	Bivalvia	Veneroida	Corbiculidae	*Corbicula fluminea*
MOLLUSCA	Bivalvia	Veneroida	Sphaeriidae	*Musculium* sp.
MOLLUSCA	Bivalvia	Veneroida	Sphaeriidae	*Musculium transversum*
MOLLUSCA	Bivalvia	Veneroida	Sphaeriidae	*Pisidium* sp.
MOLLUSCA	Bivalvia	Veneroida	Sphaeriidae	*Sphaerium* sp.
MOLLUSCA	Bivalvia	Veneroida	Sphaeriidae	*Sphaerium* cf. *simile*
MOLLUSCA	Gastropoda	Mesogastropoda	Pleuroceridae	*Elimia* sp.
MOLLUSCA	Gastropoda	Mesogastropoda	Pleuroceridae	*Pleurocera* cf. *canaliculata*
MOLLUSCA	Gastropoda	Mesogastropoda	Pleuroceridae	*Pleurocera* sp.
MOLLUSCA	Gastropoda	Basommatophora	Ancylidae	*Ferrissia rivularis*
MOLLUSCA	Gastropoda	Basommatophora	Lymnaeidae	*Fossaria* sp.
MOLLUSCA	Gastropoda	Basommatophora	Planorbidae	*Menetus dilatatus*
MOLLUSCA	Gastropoda	Basommatophora	Physidae	*Physella* sp.
ANNELIDA	Oligochaeta	Haplotaxida	Enchytraeidae	unidentified
ANNELIDA	Oligochaeta	Haplotaxida	Lumbricidae	unidentified
ANNELIDA	Oligochaeta	Haplotaxida	Naididae	*Chaetogaster* sp.
ANNELIDA	Oligochaeta	Haplotaxida	Naididae	*Dero* sp.
ANNELIDA	Oligochaeta	Haplotaxida	Naididae	*Nais* sp.
ANNELIDA	Oligochaeta	Haplotaxida	Naididae	*Nais bretscheri*
ANNELIDA	Oligochaeta	Haplotaxida	Naididae	*Nais communis*
ANNELIDA	Oligochaeta	Haplotaxida	Naididae	*Ophidonais serpentina*
ANNELIDA	Oligochaeta	Haplotaxida	Naididae	*Paranais* sp.
ANNELIDA	Oligochaeta	Haplotaxida	Naididae	*Pristinella* sp.
ANNELIDA	Oligochaeta	Haplotaxida	Naididae	*Slavina appendiculata*
ANNELIDA	Oligochaeta	Haplotaxida	Naididae	*Stylaria lacustris*
ANNELIDA	Oligochaeta	Haplotaxida	Naididae	*Vejdovskyella intermedia*
ANNELIDA	Oligochaeta	Haplotaxida	Tubificidae w.h.c.	unidentified
ANNELIDA	Oligochaeta	Haplotaxida	Tubificidae w.o.h.c.	*Limnodrilus cervix*
ANNELIDA	Oligochaeta	Haplotaxida	Tubificidae w.o.h.c.	*Limnodrilus hoffmeisteri*
ANNELIDA	Oligochaeta	Haplotaxida	Tubificidae w.o.h.c.	*Branchiura sowerbyi*
ANNELIDA	Oligochaeta	Lumbriculida	Lumbriculidae	*Lumbriculus* sp.
ANNELIDA	Hirudinea	Branchiobdellida	unidentified	unidentified
ANNELIDA	Hirudinea	Rhynchobdellida	Erpobdellidae	unidentified
ANNELIDA	Hirudinea	Rhynchobdellida	Glossiphoniidae	*Helobdella stagnalis*
ARTHROPODA	Arachnoidea	Acariformes	Hygrobatidae	*Atractides* sp.
ARTHROPODA	Arachnoidea	Acariformes	Lebertiidae	*Lebertia* sp.
ARTHROPODA	Arachnoidea	Acariformes	Sperchonidae	*Sperchon* sp.

Table 4. Benthic-invertebrate taxa collected at sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.—Continued

[w.h.c., with hair chaetae; w.o.h.c., without hair chaetae]

Phylum	Class	Order	Family	Taxon
ARTHROPODA	Crustacea	Ostracoda	unidentified	unidentified
ARTHROPODA	Crustacea	Cladocera	Bosminidae	*Bosmina* sp.
ARTHROPODA	Crustacea	Cladocera	Chydoridae	*Alona* sp.
ARTHROPODA	Crustacea	Cladocera	Daphnidae	*Ceriodaphnia* sp.
ARTHROPODA	Crustacea	Cladocera	Daphnidae	*Daphnia* sp.
ARTHROPODA	Crustacea	Cladocera	Sididae	*Sida crystillina*
ARTHROPODA	Crustacea	Copepoda	unidentified	unidentified
ARTHROPODA	Crustacea	Calanoida	unidentified	unidentified
ARTHROPODA	Crustacea	Cyclopoida	unidentified	unidentified
ARTHROPODA	Crustacea	Isopoda	Asellidae	*Caecidotea* sp.
ARTHROPODA	Crustacea	Isopoda	Asellidae	*Lirceus* sp.
ARTHROPODA	Crustacea	Amphipoda	Crangonyctidae	*Crangonyx* sp.
ARTHROPODA	Crustacea	Amphipoda	Talitridae	*Hyalella azteca*
ARTHROPODA	Crustacea	Decapoda	Cambaridae	*Orconectes* sp.
ARTHROPODA	Insecta	Collembola	Isotomidae	unidentified
ARTHROPODA	Insecta	Ephemeroptera	Baetidae	*Acentrella ampla*
ARTHROPODA	Insecta	Ephemeroptera	Baetidae	*Baetis* sp.
ARTHROPODA	Insecta	Ephemeroptera	Baetidae	*Baetis intercalaris*
ARTHROPODA	Insecta	Ephemeroptera	Baetidae	*Callibaetis* sp.
ARTHROPODA	Insecta	Ephemeroptera	Caenidae	*Caenis* sp.
ARTHROPODA	Insecta	Ephemeroptera	Heptageniidae	*Leucrocuta* sp.
ARTHROPODA	Insecta	Ephemeroptera	Heptageniidae	*Stenacron interpunctatum*
ARTHROPODA	Insecta	Ephemeroptera	Heptageniidae	*Stenonema* sp.
ARTHROPODA	Insecta	Ephemeroptera	Heptageniidae	*Stenonema femoratum*
ARTHROPODA	Insecta	Ephemeroptera	Heptageniidae	*Stenonema terminatum*
ARTHROPODA	Insecta	Ephemeroptera	Isonychiidae	*Isonychia* sp.
ARTHROPODA	Insecta	Ephemeroptera	Polymitarcyidae	*Ephoron leukon*
ARTHROPODA	Insecta	Ephemeroptera	Potamanthidae	*Anthopotamanthus* sp.
ARTHROPODA	Insecta	Ephemeroptera	Tricorythidae	*Tricorythodes* sp.
ARTHROPODA	Insecta	Odonata	Aeshnidae	unidentified
ARTHROPODA	Insecta	Odonata	Coenagrionidae	*Argia* sp.
ARTHROPODA	Insecta	Odonata	Gomphidae	*Erpetogomphus* sp.
ARTHROPODA	Insecta	Plecoptera	Perlidae	*Perlesta placida*
ARTHROPODA	Insecta	Plecoptera	Perlodidae	unidentified
ARTHROPODA	Insecta	Plecoptera	Taeniopterygidae	*Taeniopteryx* sp.
ARTHROPODA	Insecta	Hemiptera	Corixidae	unidentified
ARTHROPODA	Insecta	Megaloptera	Corydalidae	*Corydalus cornutus*
ARTHROPODA	Insecta	Megaloptera	Sialidae	*Sialis* sp.
ARTHROPODA	Insecta	Trichoptera	Glossosomatidae	*Protoptila* sp.
ARTHROPODA	Insecta	Trichoptera	Helicopsychidae	*Helicopsyche borealis*
ARTHROPODA	Insecta	Trichoptera	Hydropsychidae	*Ceratopsyche* sp.
ARTHROPODA	Insecta	Trichoptera	Hydropsychidae	*Ceratopsyche morosa*
ARTHROPODA	Insecta	Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.
ARTHROPODA	Insecta	Trichoptera	Hydropsychidae	*Hydropsyche* sp.

Table 4. Benthic-invertebrate taxa collected at sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.—Continued

[w.h.c., with hair chaetae; w.o.h.c., without hair chaetae]

Phylum	Class	Order	Family	Taxon
ARTHROPODA	Insecta	Trichoptera	Hydropsychidae	*Hydropsyche betteni* gp.
ARTHROPODA	Insecta	Trichoptera	Hydropsychidae	*Hydropsyche venularis*
ARTHROPODA	Insecta	Trichoptera	Hydropsychidae	*Potamyia flava*
ARTHROPODA	Insecta	Trichoptera	Hydroptilidae	*Hydroptila* sp.
ARTHROPODA	Insecta	Trichoptera	Leptoceridae	*Ceraclea* sp.
ARTHROPODA	Insecta	Trichoptera	Leptoceridae	*Nectopsyche* sp.
ARTHROPODA	Insecta	Trichoptera	Philopotamidae	*Chimarra* sp.
ARTHROPODA	Insecta	Trichoptera	Philopotamidae	*Chimarra obscurus*
ARTHROPODA	Insecta	Trichoptera	Rhyacophilidae	*Rhyacophila* sp.
ARTHROPODA	Insecta	Lepidoptera	Pyralidae	*Petrophila* sp.
ARTHROPODA	Insecta	Coleoptera	Dytiscidae	unidentified
ARTHROPODA	Insecta	Coleoptera	Elmidae	*Ancyronyx variegata*
ARTHROPODA	Insecta	Coleoptera	Elmidae	*Dubiraphia* sp.
ARTHROPODA	Insecta	Coleoptera	Elmidae	*Optioservus* sp.
ARTHROPODA	Insecta	Coleoptera	Elmidae	*Stenelmis* sp.
ARTHROPODA	Insecta	Coleoptera	Hydrophilidae	unidentified
ARTHROPODA	Insecta	Coleoptera	Psephenidae	*Psephenus herricki*
ARTHROPODA	Insecta	Diptera	Ceratopogonidae	*Bezzia/Palpomyia* gp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Ablabesmyia mallochi*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Ablabesmyia rhamphe* gp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Brillia flavifrons*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Cardiocladius obscurus*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Chironomus* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Cladotanytarsus* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Conchapelopia* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Corynoneura* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Cricotopus* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Cricotopus bicinctus*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Cricotopus sylvestris*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Cricotopus tremulus*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Cricotopus trifascia*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Cryptochironomus fulvus*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Dicrotendipes* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Dicrotendipes lucifer*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Eukiefferiella* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Eukiefferiella devonica* gp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Glyptotendipes* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Limnophyes* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Microtendipes* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Microtendipes pedellus* gp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Nanocladius* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Nilotanypus* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Orthocladius* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Parachironomus* sp.

Table 4. Benthic-invertebrate taxa collected at sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.—Continued

[w.h.c., with hair chaetae; w.o.h.c., without hair chaetae]

Phylum	Class	Order	Family	Taxon
ARTHROPODA	Insecta	Diptera	Chironomidae	*Parakiefferiella* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Parakiefferiella bathophila*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Paramerina* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Parametriocnemus lundbecki*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Paratanytarsus* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Phaenopsectra* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Polypedilum* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Polypedilum convictum*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Polypedilum fallax*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Polypedilum flavum (convictum)*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Polypedilum halterale*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Polypedilum illinoense*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Pseudochironomus* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Psectrocladius* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Rheocricotopus robacki*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Rheotanytarsus* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Saetheria tylus*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Stempellinella* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Stictochironomus* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Tanytarsus* sp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Thienemannimyia* gp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Thienemanniella xena*
ARTHROPODA	Insecta	Diptera	Chironomidae	*Tvetenia bavarica* gp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Tvetenia discoloripes* gp.
ARTHROPODA	Insecta	Diptera	Chironomidae	*Zavrelia* sp.
ARTHROPODA	Insecta	Diptera	Dolichopodidae	unidentified
ARTHROPODA	Insecta	Diptera	Empididae	*Hemerodromia* sp.
ARTHROPODA	Insecta	Diptera	Muscidae	unidentified
ARTHROPODA	Insecta	Diptera	Psychodidae	*Psychoda* sp.
ARTHROPODA	Insecta	Diptera	Simuliidae	*Simulium* sp.
ARTHROPODA	Insecta	Diptera	Stratiomyidae	unidentified
ARTHROPODA	Insecta	Diptera	Tipulidae	*Antocha* sp.
ARTHROPODA	Insecta	Diptera	Tipulidae	*Limonia* sp.
ARTHROPODA	Insecta	Diptera	Tipulidae	*Ormosia* sp.
ARTHROPODA	Insecta	Diptera	Tipulidae	*Tipula* sp.

Table 5. Summary data for benthic invertebrates collected at sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.

[m², square meter; Sept., September; --, not sampled]

Site	Total taxa						Abundance (organisms/m²)					
	May 1999	Sept. 1999	May 2000	Sept. 2000	May 2001	Sept. 2001	May 1999	Sept. 1999	May 2000	Sept. 2000	May 2001	Sept. 2001
White River sites												
Nora	41	40	43	46	48	42	36,084	33,655	129,778	21,205	30,864	16,401
Morris	40	33	28	43	36	45	5,145	49,755	6,021	28,865	14,621	32,303
Harding	38	23	31	43	33	29	18,873	22,009	7,675	70,300	20,344	30,717
Stout	23	28	39	29	38	39	17,370	64,864	10,434	11,962	73,281	20,017
Wicker	19	41	29	42	41	43	15,758	11,119	8,988	3,606	6,326	3,599
Waverly	32	32	33	29	38	31	14,621	46,454	13,807	1,224	6,448	6,706
Tributary sites												
Buck Creek	--	62	56	57	58	61	--	11,406	35,453	11,022	15,766	14,761
Eagle Creek	32	37	50	42	37	41	27,416	28,546	22,364	12,228	48,406	9,092
Fall Creek	30	32	34	40	32	35	79,140	46,095	39,568	30,990	15,109	15,726
Pleasant Run	20	34	25	32	37	34	26,031	29,694	27,391	5,070	13,218	3,513
Pogues Run	18	--	25	37	32	44	36,684	--	20,319	8,127	4,377	3,287
Williams Creek	51	37	43	48	48	42	24,388	7,380	65,610	9,400	20,010	29,425

Site	Diptera (percent taxa)						Diptera (percent organisms)					
	May 1999	Sept. 1999	May 2000	Sept. 2000	May 2001	Sept. 2001	May 1999	Sept. 1999	May 2000	Sept. 2000	May 2001	Sept. 2001
White River sites												
Nora	34.1	40	27.9	30.4	29.2	31	75.8	35.8	40.7	50.1	53.6	52.1
Morris	42.5	36.4	42.8	34.9	50	33.3	68.1	84.2	78.9	11.4	36.8	8.6
Harding	34.2	26.1	32.2	20.9	36.4	37.9	65.1	86.1	62.6	4.4	43.8	6.1
Stout	52.2	39.3	38.5	48.3	36.8	48.7	95.9	46.7	83.3	61.9	85.4	41.2
Wicker	63.2	39	44.8	42.8	48.8	41.9	97.7	58	88.2	61.9	83.8	63
Waverly	53.1	40.6	36.4	58.6	47.4	38.7	92.4	43.4	91.2	66	92.3	79.7
Tributary sites												
Buck Creek	--[1]	43.5	42.8	40.4	36.2	44.3	--[1]	44.2	52.5	54.9	76.1	34.3
Eagle Creek	50	43.2	40	39	40.5	39	92.3	82	88.2	46.6	79.9	54.4
Fall Creek	56.7	43.8	32.4	47.5	46.9	48.6	89.3	39.4	65.2	26.6	50.8	19.5
Pleasant Run	65	44.1	44	50	70.3	58.8	69.7	86.4	77.7	92.6	70.3	85.3
Pogues Run	50	--[2]	64	54	56.2	69.9	77.6	--[2]	69	82.9	56.7	75.4
Williams Creek	49	40.5	41.9	45.8	50	50	75.4	17.2	78.5	35	73.2	47.9

[1]Buck Creek was not sampled in May 1999; it was added to the second round of sampling after Pogues Run was found to have no flow.
[2]Pogues Run was not sampled in September 1999 because of no flow.

Table 6. Fish collected at the White River sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.

[**N**, nonnative species deliberately or accidentally introduced into the basin; --, not found; kg, kilogram]

Scientific name	Common name and status	White River, Nora			White River, Morris Street			White River, Harding Street			White River, below Stout			White River, Wicker Road			White River, Waverly		
		1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001
Amiidae	**(Bowfins)**																		
Amia calva (Linnaeus, 1766)[1]	Bowfin	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--
Clupeidae	**(Herrings)**																		
Dorosoma cepedianum (Lesueur, 1818)	Gizzard shad	1	12	25	109	5	101	55	10	36	27	36	56	100	16	6	7	1	--
Cyprinidae	**(Carps and minnows)**																		
Carassius auratus (Linnaeus, 1758)	Goldfish **N**	--	--	--	--	2	10	2	1	2	2	--	4	--	--	--	--	--	--
Cyprinella spiloptera (Cope, 1868)	Spotfin shiner	37	--	5	26	8	48	4	1	44	9	4	169	34	11	132	27	10	2
Cyprinella whipplei Girard, 1856	Steelcolor shiner	--	--	--	8	--	--	--	--	--	--	1	--	17	--	--	--	1	--
Cyprinus carpio Linnaeus, 1758	Koi carp **N**	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--
Cyprinus carpio Linnaeus, 1758	Common carp **N**	2	1	1	5	36	13	28	32	20	22	13	34	29	11	7	11	--	3
Luxilus chrysocephalus Rafinesque, 1820	Striped shiner	--	--	--	--	--	7	--	--	4	--	--	3	--	--	--	1	--	--
Notemigonus crysoleucas (Mitchill, 1814)	Golden shiner	--	--	--	--	--	5	2	--	--	--	--	--	--	--	--	--	--	--
Notropis amblops (Rafinesque, 1820)	Bigeye chub	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis atherinoides Rafinesque, 1818	Emerald shiner	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--
Notropis photogenis (Cope, 1865)	Silver shiner	--	5	35	--	--	2	--	--	--	--	--	1	--	--	--	--	--	--
Notropis stramineus (Cope, 1865)	Sand shiner	21	--	--	--	--	--	--	--	1	1	--	2	--	--	3	--	--	--
Phenacobius mirabilis (Girard, 1856)	Suckermouth minnow	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	1
Pimephales notatus (Rafinesque, 1820)	Bluntnose minnow	16	--	--	--	--	--	1	--	--	8	--	5	--	--	1	--	--	1
Semotilus atromaculatus (Mitchill, 1818)	Creek chub	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--

Table 6. Fish collected at the White River sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.—Continued

[**N**, nonnative species deliberately or accidentally introduced into the basin; --, not found; kg, kilogram]

Scientific name	Common name and status	White River, Nora			White River, Morris Street			White River, Harding Street			White River, below Stout			White River, Wicker Road			White River, Waverly		
		1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001
Catostomidae	**(Suckers)**																		
Carpiodes carpio (Rafinesque, 1820)	River carpsucker	--	4	--	31	9	40	11	28	14	58	53	160	27	10	35	36	6	13
Carpiodes cyprinus (Lesueur, 1817)	Quillback	--	1	--	17	2	11	2	3	4	--	26	15	7	12	35	11	1	--
Carpiodes velifer (Rafinesque, 1820)	Highfin carpsucker	--	--	--	--	--	--	--	--	--	--	4	5	--	--	--	1	--	--
Catostomus commersoni (Lacepede, 1803)	White sucker	--	1	--	--	2	4	--	--	1	--	1	--	2	--	1	--	--	--
Hypentelium nigricans (Lesueur, 1817)	Northern hog sucker	46	4	3	10	8	1	--	15	--	1	157	10	23	41	--	22	3	--
Ictiobus bubalus (Rafinesque, 1818)	Smallmouth buffalo	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--
Ictiobus cyprinellus (Valenciennes, 1844)	Bigmouth buffalo	--	--	--	--	--	--	--	--	1	--	2	--	--	--	--	1	1	--
Ictiobus niger (Rafinesque, 1819)	Black buffalo	--	--	--	--	--	--	--	--	1	--	--	2	--	--	--	--	--	1
Minytrema melanops (Rafinesque, 1820)	Spotted sucker	10	4	18	6	35	31	22	26	5	8	34	20	4	10	5	4	3	1
Moxostoma anisurum (Rafinesque, 1820)	Silver redhorse	1	--	2	3	17	12	--	3	--	--	17	12	19	7	22	18	4	9
Moxostoma duquesnei (Lesueur, 1817)	Black redhorse	7	2	31	25	38	2	1	6	2	8	15	4	4	8	13	25	10	2
Moxostoma erythrurum (Rafinesque, 1818)	Golden redhorse	2	1	--	32	23	20	11	--	2	11	17	7	20	19	9	15	23	8
Moxostoma macrolepidotum (Lesueur, 1817)	Shorthead redhorse	--	--	--	--	3	--	--	--	--	20	59	22	29	40	25	31	10	6
Ictaluridae	**(Bullhead catfishes)**																		
Ameiurus natalis (Lesueur, 1819)	Yellow bullhead	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--
Ictalurus punctatus (Rafinesque, 1818)	Channel catfish	--	--	1	6	5	1	7	5	--	5	72	23	5	45	7	2	2	4
Pylodictis olivaris (Rafinesque, 1818)	Flathead catfish	--	--	--	--	2	1	2	3	--	2	3	--	--	--	--	--	--	--
Atherinidae	**(Silversides)**																		
Labidesthes sicculus (Cope, 1865)	Brook silverside	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 6. Fish collected at the White River sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.—Continued

[**N**, nonnative species deliberately or accidentally introduced into the basin; --, not found; kg, kilogram]

Scientific name	Common name and status	White River, Nora			White River, Morris Street			White River, Harding Street			White River, below Stout			White River, Wicker Road			White River, Waverly		
		1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001
Percichthyidae	**(Temperate basses)**																		
Morone chrysops (Rafinesque, 1820)	White bass	--	--	--	--	--	--	--	--	--	--	--	--	7	--	--	--	--	--
Morone mississippiensis Jordan and Eigenmann, 1887	Yellow bass	--	2	--	3	2	--	3	--	--	1	2	--	6	3	--	--	--	--
Centrarchidae	**(Sunfishes)**																		
Ambloplites rupestris (Rafinesque, 1817)	Rock bass	--	--	--	--	1	1	--	--	--	1	--	--	--	--	--	--	--	--
Lepomis gibbosus (Linnaeus, 1758)	Pumpkinseed	--	--	--	--	--	--	--	--	--	--	14	17	--	1	--	--	--	--
Lepomis cyanellus Rafinesque, 1819	Green sunfish	--	--	--	--	8	1	1	3	--	--	--	2	--	--	--	--	--	--
Lepomis gulosus (Cuvier, 1829)	Warmouth	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--
Lepomis humilis (Girard, 1858)	Orangespotted sunfish	--	--	--	--	21	--	--	4	--	1	--	--	--	--	--	--	--	--
Lepomis macrochirus Rafinesque, 1819	Bluegill	2	6	15	34	386	171	52	294	18	41	67	23	6	12	6	3	--	2
Lepomis megalotis (Rafinesque, 1820)	Longear sunfish	6	1	8	32	280	110	31	244	19	49	36	51	12	20	9	4	2	--
Lepomis macrochirus X *Lepomis megalotis*	HYBRID bluegill X longear sunfish	--	--	1	1	36	7	--	64	7	--	29	--	--	4	--	--	--	--
Lepomis microlophus (Gunther, 1859)	Redear sunfish	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Micropterus dolomieu Lacepede, 1802	Smallmouth bass	28	14	8	8	9	6	--	3	1	1	13	4	7	11	6	6	4	1
Micropterus punctulatus (Rafinesque, 1819)	Spotted bass	3	--	--	11	33	42	16	18	10	4	11	9	1	14	7	4	2	1
Micropterus salmoides (Lacepede, 1802)	Largemouth bass	1	3	4	8	29	18	7	33	12	10	20	12	3	6	7	2	1	1
Pomoxis annularis Rafinesque, 1818	White crappie	--	--	--	1	--	--	3	1	--	6	1	3	2	1	--	--	--	--
Pomoxis nigromaculatus (Lesueur, 1829)	Black crappie	--	--	--	--	--	--	--	2	1	--	--	7	--	--	3	--	--	--

Table 6. Fish collected at the White River sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.—Continued

[**N**, nonnative species deliberately or accidentally introduced into the basin; --, not found; kg, kilogram]

Scientific name	Common name and status	White River, Nora			White River, Morris Street			White River, Harding Street			White River, below Stout			White River, Wicker Road			White River, Waverly		
		1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001
Percidae	**(Perches)**																		
Etheostoma zonale (Cope, 1868)	Banded darter	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Percina caprodes (Rafinesque, 1818)	Logperch	--	--	--	4	1	--	--	--	1	2	8	4	1	1	2	--	--	--
Stizostedion canadense (Smith, 1834)	Sauger	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--
Stizostedion vitreum (Mitchill, 1818)	Walleye	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--
Sciaenidae	**(Drums)**																		
Aplodinotus grunniens Rafinesque, 1819	Freshwater drum	--	--	--	2	8	5	--	6	2	--	2	2	1	--	--	1	--	--
	Total number of fish	184	61	157	382	1,012	672	264	805	208	299	719	690	366	304	341	233	84	56
	Number of taxa	16	15	14	22	29	27	22	23	23	25	30	32	24	23	21	22	17	16
	Total weight (kg)	25.3	17.0	23.9	110	233	176	109	167	95.2	127	199	289	163	114	113	125	33.2	39.4

[1]Authority and date of the original published proposal of the scientific name. The author's name follows the scientific name and without parenthesis if the species, when originally described, was assigned to the same genus in which it appears; if the species was described in another genus, the author's name appears in parenthesis (Robins and others, 1991).

Table 7. Fish collected at the White River tributary sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.

[**N**, nonnative species deliberately or accidentally introduced into the basin; **SC**, species is on the Indiana list of special concern; --, not found; kg, kilogram]

Scientific name	Common name and status	Buck Creek		Eagle Creek			Fall Creek			Pleasant Run			Pogues Run			Williams Creek		
		2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001
Petromyzontidae	**(Lampreys)**																	
Ichthyomyzon bdellium (Jordan, 1885)[1]	Ohio lamprey	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Clupeidae	**(Herrings)**																	
Dorosoma cepedianum (Lesueur, 1818)	Gizzard shad	--	--	10	--	1	2	--	--	--	--	--	--	--	--	3	--	--
Cyprinidae	**(Carps and minnows)**																	
Campostoma anomalum (Rafinesque, 1820)	Central stoneroller	349	169	2	21	18	20	32	41	1,781	747	459	428	253	129	1,100	294	252
Cyprinella spiloptera (Cope, 1868)	Spotfin shiner	10	11	--	46	29	172	73	80	3	--	1	--	--	--	12	2	8
Cyprinus carpio Linnaeus, 1758	Common carp **N**	1	1	5	2	2	11	4	9	--	--	5	--	--	--	6	5	--
Luxilus chrysocephalus Rafinesque, 1820	Striped shiner	12	22	--	--	--	--	--	--	--	1	--	--	--	--	124	45	42
Lythrurus umbratilis (Girard, 1856)	Redfin shiner	2	10	--	--	--	--	--	--	--	--	--	--	--	--	14	3	--
Nocomis micropogon (Cope, 1865)	River chub	--	--	--	--	--	4	--	10	--	--	--	--	--	--	--	--	--
Notemigonus crysoleucas (Mitchill, 1814)	Golden shiner	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--
Notropis amblops (Rafinesque, 1820)	Bigeye chub	21	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis atherinoides Rafinesque, 1818	Emerald shiner	--	10	--	--	--	9	49	16	--	--	--	--	--	--	--	1	--
Notropis boops Gilbert, 1884	Bigeye shiner	1	61	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Notropis buccatus (Cope, 1865)	Silverjaw minnow	4	3	36	72	312	--	--	--	211	52	16	53	12	11	2	--	--
Notropis photogenis (Cope, 1865)	Silver shiner	1	3	--	--	--	--	3	24	--	--	--	--	--	--	--	--	--
Notropis rubellus (Agissiz, 1850)	Rosyface shiner	15	1	--	--	--	--	--	2	--	--	--	--	--	--	--	1	--
Notropis slumardi (Girard, 1856)	Silverband shiner	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--
Notropis stramineus (Cope, 1865)	Sand shiner	109	125	49	505	291	132	95	76	130	76	26	--	--	--	--	--	--

Table 7. Fish collected at the White River tributary sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.—Continued

[**N**, nonnative species deliberately or accidentally introduced into the basin; **SC**, species is on the Indiana list of special concern; --, not found; kg, kilogram]

Scientific name	Common name and status	Buck Creek		Eagle Creek			Fall Creek			Pleasant Run			Pogues Run			Williams Creek		
		2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001
Phenacobius mirabilis (Girard, 1856)	Suckermouth minnow	5	2	--	--	--	3	5	2	--	--	--	--	--	--	--	--	--
Cyprinidae continued	**(Carps and minnows)**																	
Pimephales notatus (Rafinesque, 1820)	Bluntnose minnow	45	29	27	5	7	25	20	80	77	21	8	133	2	21	239	279	4
Pimephales promelas Rafinesque, 1820	Fathead minnow	--	--	--	--	3	--	--	--	--	--	--	--	1	--	--	--	--
Rhinichthys atratulus (Hermann, 1804)	Blacknose dace	--	--	--	6	--	--	--	--	135	82	32	8	35	--	--	--	--
Semotilus atromaculatus (Mitchill, 1818)	Creek chub	82	49	7	1	22	--	2	4	303	134	103	112	137	101	102	47	35
Catostomidae	**(Suckers)**																	
Carpiodes carpio (Rafinesque, 1820)	River carpsucker	--	--	17	--	--	6	4	3	--	--	--	--	--	--	--	--	--
Carpiodes cyprinus (Lesueur, 1817)	Quillback	--	--	2	--	--	4	--	9	--	--	--	--	--	--	--	--	--
Carpiodes velifer (Rafinesque, 1820)	Highfin carpsucker	--	--	--	--	--	1	5	--	--	--	--	--	--	--	--	--	--
Catostomus commersoni (Lacepede, 1803)	White sucker	11	55	31	63	35	1	1	--	48	19	28	--	--	--	26	16	16
Hypentelium nigricans (Lesueur, 1817)	Northern hog sucker	78	99	21	20	8	35	71	109	1	3	--	--	--	--	35	50	30
Minytrema melanops (Rafinesque, 1820)	Spotted sucker	4	--	1	--	--	--	--	1	--	--	--	--	--	--	--	--	--
Moxostoma anisurum (Rafinesque, 1820)	Silver redhorse	7	2	--	--	--	12	33	22	--	--	--	--	--	--	6	2	--
Moxostoma duquesnei (Lesueur, 1817)	Black redhorse	25	25	11	2	1	8	22	23	--	--	--	--	--	--	30	28	31
Moxostoma erythrurum (Rafinesque, 1818)	Golden redhorse	22	9	--	--	--	6	7	21	--	--	--	--	--	--	--	1	--
Moxostoma macrolepidotum (Lesueur, 1817)	Shorthead redhorse	7	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ictaluridae	**(Bullhead catfishes)**																	
Ameiurus melas (Rafinesque, 1820)	Black bullhead	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--
Ameiurus natalis (Lesueur, 1819)	Yellow bullhead	2	2	2	5	1	--	--	2	1	--	1	--	--	--	3	7	4
Ictalurus punctatus (Rafinesque, 1818)	Channel catfish	--	--	8	2	2	3	4	12	--	--	--	--	--	--	--	--	--
Noturus miurus Jordan, 1877	Brindled madtom	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 7. Fish collected at the White River tributary sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.—Continued

[**N**, nonnative species deliberately or accidentally introduced into the basin; **SC**, species is on the Indiana list of special concern; --, not found; kg, kilogram]

Scientific name	Common name and status	Buck Creek		Eagle Creek			Fall Creek			Pleasant Run			Pogues Run			Williams Creek		
		2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001
Pylodictis olivaris (Rafinesque, 1818)	Flathead catfish	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--
Cyprinodontidae	**(Killifishes)**																	
Fundulus catenatus (Storer, 1846)	Northern studfish **SC**	1	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Poeciliidae	**(Livebearers)**																	
Gambusia affinis (Baird and Girard, 1853)	Western mosquitofish **N**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--
Atherinidae	**(Silversides)**																	
Labidesthes sicculus (Cope, 1865)	Brook silverside	--	--	--	--	1	2	--	14	--	--	--	--	--	--	--	1	--
Cottidae	**(Sculpins)**																	
Cottus bairdi Girard, 1850	Mottled sculpin	175	53	--	--	--	4	5	--	--	--	--	--	--	--	283	201	75
Percichthyidae	**(Temperate basses)**																	
Morone mississippiensis Jordan and Eigenmann, 1887	Yellow bass	--	--	--	--	--	9	3	--	--	--	--	--	--	--	--	--	--
Centrarchidae	**(Sunfishes)**																	
Ambloplites rupestris (Rafinesque, 1817)	Rock bass	7	5	1	3	6	8	6	9	--	--	--	--	--	--	3	1	1
Lepomis gibbosus (Linnaeus, 1758)	Pumpkinseed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2
Lepomis cyanellus Rafinesque, 1819	Green sunfish	23	19	31	56	5	3	11	5	--	--	--	70	34	43	17	24	8
Lepomis gulosus (Cuvier, 1829)	Warmouth	1	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Lepomis humilis (Girard, 1858)	Orangespotted sunfish	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--	--
Lepomis macrochirus Rafinesque, 1819	Bluegill	7	8	11	69	10	24	34	58	1	5	5	--	--	--	138	326	178
Lepomis megalotis (Rafinesque, 1820)	Longear sunfish	54	67	252	314	115	30	94	37	2	--	3	--	--	--	68	83	17
Lepomis macrochirus X *Lepomis megalotis*	HYBRID bluegill X longear sunfish	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lepomis macrochirus X *Lepomis gibbosus*	HYBRID bluegill X pumpkinseed	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--

Table 7. Fish collected at the White River tributary sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.—Continued

[**N**, nonnative species deliberately or accidentally introduced into the basin; **SC**, species is on the Indiana list of special concern; --, not found; kg, kilogram]

Scientific name	Common name and status	Buck Creek		Eagle Creek			Fall Creek			Pleasant Run			Pogues Run			Williams Creek		
		2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001
Micropterus dolomieu Lacepede, 1802	Smallmouth bass	4	--	2	9	31	18	16	14	--	--	--	--	--	--	3	12	14
Centrarchidae continued	**(Sunfishes)**																	
Micropterus punctulatus (Rafinesque, 1819)	Spotted bass	3	2	35	50	31	26	16	3	--	4	3	4	--	6	17	13	1
Micropterus salmoides (Lacepede, 1802)	Largemouth bass	2	1	4	--	12	10	16	17	2	--	--	--	--	--	--	21	10
Percidae	**(Perches)**																	
Etheostoma blennioides Rafinesque, 1819	Greenside darter	67	62	--	1	1	1	9	43	--	--	--	--	--	--	7	5	8
Etheostoma caeruleum Storer, 1845	Rainbow darter	10	37	--	5	--	--	--	--	--	--	--	--	--	--	--	5	--
Etheostoma flabellare Rafinesque, 1819	Fantail darter	--	--	--	2	--	--	--	--	--	--	--	--	--	--	4	--	--
Etheostoma nigrum Rafinesque, 1820	Johnny darter	16	3	--	--	--	2	--	2	--	--	--	--	--	--	22	4	3
Etheostoma spectabile (Agassiz, 1854)	Orangethroat darter	21	--	1	29	--	--	--	--	2	5	7	--	--	--	--	7	16
Etheostoma zonale (Cope, 1868)	Banded darter	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Percina caprodes (Rafinesque, 1818)	Logperch	4	16	--	--	--	1	4	33	--	--	--	--	--	--	--	--	--
Percina maculata (Girard, 1859)	Blackside darter	12	2	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Etheostoma caeruleum X *Etheostoma spectabile*	HYBRID rainbow X orangethroat darter	19	--	--	--	--	--	--	--	--	--	--	--	--	--	61	--	--
Sciaenidae	**(Drums)**																	
Aplodinotus grunniens Rafinesque, 1819	Freshwater drum	--	--	--	--	--	--	--	6	--	--	--	--	--	--	--	--	--
	Total number of fish	1,241	969	569	1,288	944	594	658	787	2,697	1,151	697	808	474	312	2,325	1,487	755
	Number of taxa	41	36	25	23	23	33	30	32	14	14	14	7	7	7	25	30	21
	Total weight (kg)	34.7	23.2	34.1	28.5	24.6	46.6	60.0	72.8	6.2	4.9	3.7	2.9	1.6	3.2	34.3	33.7	17.6

[1]Authority and date of the original published proposal of the scientific name. The author's name follows the scientific name and without parenthesis if the species, when originally described, was assigned to the same genus in which it appears; if the species was described in another genus, the author's name appears in parenthesis (Robins and others, 1991).

Table 8. Number of anomalies observed on fish collected at sampling sites in the Indianapolis Metropolitan Area, Indiana, 1999–2001.

[DE, deformities; ER, eroded fins; LE, lesions and ulcers; TU, tumors; CL, leeches; FU, fungus; NE, blind; PA, parasites; PE, popeye; --, not sampled]

Site name	Anomalies observed																										
	1999									2000									2001								
	DE	ER	LE	TU	CL	FU	NE	PA	PE	DE	ER	LE	TU	CL	FU	NE	PA	PE	DE	ER	LE	TU	CL	FU	NE	PA	PE
White River sites																											
Nora	0	0	0	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Morris	1	1	0	0	0	0	2	6	0	3	2	4	2	2	0	5	3	4	1	0	1	1	0	0	0	1	3
Harding	0	0	2	2	0	0	0	13	0	1	7	7	1	0	0	2	8	3	0	0	0	0	0	0	0	3	4
Stout	1	10	2	1	0	0	0	15	0	0	12	15	1	4	0	3	5	2	0	13	1	0	8	0	6	2	7
Wicker	1	11	1	1	0	0	0	3	4	1	21	2	0	9	0	1	3	2	0	9	0	0	8	0	3	1	1
Waverly	0	13	0	1	0	0	0	2	0	0	6	0	1	0	0	0	0	0	0	2	3	0	5	0	0	1	2
Totals	**3**	**35**	**5**	**6**	**0**	**0**	**3**	**39**	**5**	**6**	**48**	**28**	**5**	**15**	**0**	**11**	**19**	**11**	**1**	**24**	**5**	**1**	**21**	**0**	**9**	**8**	**18**
Tributary sites																											
Buck Creek	--	--	--	--	--	--	--	--	--	0	0	0	1	0	0	0	0	0	0	3	0	1	0	0	0	0	0
Eagle Creek	0	2	0	3	0	0	1	1	1	1	3	1	0	0	0	1	1	0	0	0	0	0	1	0	2	1	0
Fall Creek	1	1	1	0	0	0	1	7	2	3	1	2	0	3	0	0	0	0	0	5	0	2	0	0	1	0	2
Pleasant Run	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Pogues Run	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Williams Creek	0	2	4	0	0	0	0	9	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Totals	**1**	**7**	**5**	**3**	**0**	**0**	**2**	**17**	**3**	**5**	**5**	**5**	**2**	**3**	**1**	**1**	**1**	**0**	**0**	**9**	**0**	**3**	**1**	**0**	**3**	**2**	**2**