

Overview

The U.S. Geological Survey (USGS) has an ongoing monitoring program for mercury in streams in Indiana, in cooperation with the Indiana Department of Environmental Management (IDEM). The monitoring program provides data about mercury concentrations and mercury loads in the major watersheds of Indiana. The data are used by IDEM to assess changes resulting from rules and educational programs to reduce mercury in Indiana’s environment. The continued partnership between IDEM and USGS supports interpretation of mercury data from 2002-2006 stream monitoring in Indiana and the data collection program in 2007--2009.

Risks to Humans and Wildlife from Mercury in Indiana’s Fish

Aquatic ecosystems receive mercury from atmospheric deposition and through wastewater discharge. The State of Indiana has designated mercury a “bioaccumulative chemical of concern” (Indiana Administrative Code 2007). Low concentrations of inorganic mercury in aquatic ecosystems can be converted to organic methylmercury by microorganisms. Methylmercury is highly absorbable and concentrations accumulate and magnify in food webs. The greatest concentrations arise in fish and in fish-eating mammals and birds at the top of the food web. Methylmercury is a potent neurotoxin and potential endocrine disruptor which can slow nervous-system and cognitive development in humans and wildlife. Methylmercury can interfere with reproduction in vertebrates and has been linked to congenital birth defects, increased risk of heart attack, renal damage, and blood pressure dysfunction (National Research Council, 2000).

Mercury has been detected in nearly all fish-tissue samples collected in Indiana since 1983 (Indiana Assessment Information Management System, 2006, unpublished data). Concentrations of mercury in some tissue samples from fish caught in Indiana waters have prompted State health officials to issue advisories that warn about human consumption of these fish (Indiana State Department of Health, 2007). The Indiana annual fish consumption advisories are based on a safe exposure limit of 0.1 µg/kg and the concentrations of methylmercury in fish-tissue samples collected throughout the state. These advisories recognize a greater risk to some members of the population. The advisories can be summarized generally with the following statements. If safety is unknown, women (pregnant, breast-feeding, or planning pregnancy) and children less than 15 years of age may assume that one meal of Indiana sport fish per month is safe. Women and children in this group should not eat any large carp, flathead catfish, walleye, sauger, or striped bass. Adult men and women not in the previous group may assume that one meal of Indiana sport fish per week is safe; however, some Indiana rivers and streams have “do not eat” advisories for all fish.



As of 2006, mercury advisories affected 3,113 mi of streams, 40,628 acres of lakes, and 59 mi of Great Lakes shoreline in Indiana (Indiana Department of Environmental Management, 2006). According to IDEM, 524 Indiana stream segments were classified as having impaired beneficial use because of fish-consumption advisories for mercury. Each year, some 833,000 resident anglers 16 years and older spend 15.5 million days and \$469 million for fishing as recreation. An estimated 286,000 more resident anglers were 6 to 15 years old (U.S. Department of the Interior, 2003). Based on these numbers, fish-consumption advisories affect approximately 1 of 6 Indiana residents.¹



¹ The sum of 833,000 Indiana resident anglers over 16 years in age and an estimated 286,000 resident anglers 6 to 15 years in age is approximately 1 million Indiana anglers out of 6.2 million Indiana residents (Indiana Business Research Center, 2004).

Mercury Reduction Efforts in Indiana

Indiana mercury reduction efforts were elevated to an agency-wide priority in 1997. Focusing on children's health issues and the widespread occurrence of mercury in water and fish, IDEM has worked in regulatory and non-regulatory ways to prevent additional mercury from being released into the environment and to clean up mercury contamination. The Indiana Water-Quality Standards for mercury in water list three criteria. Statewide, the chronic aquatic criterion for mercury is 12 nanograms per liter (ng/L) to protect aquatic life from chronic toxic effects (Indiana Administrative Code, 2007). For water in Indiana in the Great Lakes system, the water-quality criterion for mercury (including methylmercury) is 1.8 ng/L to protect human health from possible non-cancer effects resulting from consumption of aquatic organisms (Indiana Administrative Code, 2007). Also for water in Indiana in the Great Lakes system, the water-quality criterion for mercury (including methylmercury) is 1.3 ng/L to protect avian and mammalian wildlife populations from adverse effects which may result from consumption of aquatic organisms (Indiana Administrative Code, 2007).

The Need for Monitoring of Mercury in Streams in Indiana



Monitoring data are needed to determine the geographic distribution and temporal trends in mercury levels in Indiana's streams resulting from:

- (a) implementation of state programs to prevent water pollution from mercury—the Streamlined Mercury Variance and Total Maximum Daily Load for wastewater discharges;
- (b) state implementation of new federal rules for air pollution control that affect mercury emissions—the Clean Air Interstate Rule and the Clean Air Mercury Rule, and
- (c) state rules and educational programs to remove mercury from schools, homes, hospitals, dental offices, auto salvage, and their associated waste disposal to the water or the land.

Recent Monitoring for Mercury in Streams in Indiana

The USGS collected water samples on a seasonal schedule from 25 locations on Indiana streams from August 2004 through September 2006. IDEM collected grab samples of water from 24 of these 25 locations, 3 to 4 times a year, from February 2002 through February 2004. All these water samples were analyzed for total mercury and methylmercury and the samples were collected near USGS streamflow gages so that total mercury and methylmercury loads can be computed. These 4 years of mercury monitoring in Indiana streams served as a reconnaissance of mercury in watersheds draining 80 percent of Indiana.

Objectives for Monitoring of Mercury in Streams in Indiana

- Determine long-term trends of mercury concentrations and loads in the major watersheds of Indiana.
- Identify factors that explain differences in mercury concentrations and loads among the major watersheds of Indiana.
- Compare mercury concentrations and loads in the major watersheds to mercury in fish tissue, atmospheric deposition, and wastewater effluent.
- Design and operate a monitoring network to support these three objectives.
- Communicate the results and interpretation from the monitoring.



Monitoring Stations

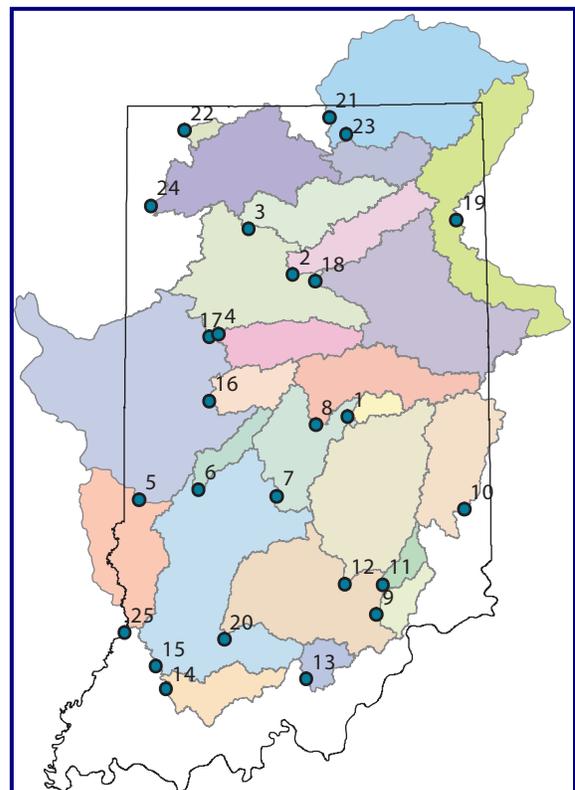
The statewide network of 25 monitoring stations includes the major watersheds of Indiana (table 1 and fig. 1). Stations are at active USGS streamflow gages at confluences of contributing stream basins for the major watersheds. The network includes stations with mercury data for 2002-2006 and stations near Indiana's atmospheric mercury deposition-monitoring stations. Analytical data and sample information from the monitoring program are archived in the USGS National Water Information System.

Table 1. Characteristics of stations in the statewide network for monitoring mercury in Indiana streams, 2007.

[latitude and longitude in decimal degrees; mi², square mile]

Station Number	Station Name	Latitude	Longitude	USGS Station ID	Drainage area (mi ²)
1	Fall Creek near Fortville	39.954762	-85.867480	03351500	169
2	Eel River near Adamsboro	40.781985	-86.263886	03328500	789
3	Tippecanoe River at Winimac	41.049763	-86.599176	03331753	942
4	Wildcat Creek near Lafayette	40.440591	-86.829175	03335000	794
5	Wabash River at Terre Haute	39.475870	-87.418909	392801087251301	12,263
6	Big Walnut Creek at Reelsville	39.535877	-86.976124	03357500	326
7	W Fork White River at Centerton	39.497548	-86.400550	03354000	2,444
8	West Fork White River at Nora	39.910595	-86.105542	03351000	1,219
9	Muscatatuck River at Deputy	38.804223	-85.673855	03366500	293
10	Whitewater River at Brookville	39.406718	-85.012737	03276500	1,224
11	Vernon Fk Muscatatuck R at Vernon	38.976443	-85.619690	03369500	198
12	East Fork White River at Seymour	38.982553	-85.899144	385823085554501	2,341
13	Blue River at Fredericksburg	38.433950	-86.191645	03302800	283
14	Patoka River at Winslow	38.380328	-87.216675	03376300	603
15	White River at Petersburg	38.510882	-87.289458	03374000	11,125
16	Sugar Creek at Crawfordsville	40.048931	-86.899452	400301086542501	509
17	Wabash River at Lafayette	40.421980	-86.896954	402531086534801	7,267
18	Wabash River at Peru	40.743097	-86.095826	404501086035901	2,686
19	Maumee River at New Haven	41.085049	-85.022190	04183000	1,967
20	East Fork White River at Shoals	38.666996	-86.791943	03373500	4,927
21	St. Joseph River at Elkhart	41.691716	-85.975000	04101000	3,370
22	Little Calumet River at Porter	41.621705	-87.086978	04094000	66
23	Elkhart River at Goshen	41.593383	-85.848606	413511085502801	594
24	Kankakee River at Shelby	41.182813	-87.340310	05518000	1,779
25	Wabash River at Vincennes	38.705325	-87.520577	384156087310701	13,706

Figure 1. Locations of stations in statewide network for monitoring mercury in Indiana streams, 2007, showing upstream drainage areas (numbers correspond with station descriptions in table 1).



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Water-Sample Collection and Analysis for Low-Level Mercury

The USGS provides low-level mercury sampling, analysis, reporting, and data management for a statewide network of 25 monitoring stations in Indiana. Sampling, analysis, and quality-assurance for the monitoring program follow a Quality-Assurance Program Plan (2004). Measures are taken to avoid, to detect, and to quantify unintentional mercury in samples because the concentrations of interest typically are less than 30 ng/L.

Sampling is done on a quarterly schedule using ultra-clean protocols (figs. 2-5), isokinetic samplers, and stream width and depth-integrating techniques (U.S. Geological Survey, 1998). Water samples are analyzed for particulate and dissolved mercury and particulate and dissolved methylmercury at the USGS Mercury Research Laboratory using low level methods equivalent to EPA Methods 1631 and 1630 (U.S. Environmental Protection Agency, 1999 and 1998, Olson and DeWild, 1997; DeWild, Olson, and Olund, 2002). Additional monitoring constituents include sulfate, organic carbon, and suspended sediment analyzed at USGS laboratories, along with field measurements of the water-quality properties pH, specific conductance, dissolved oxygen, turbidity, and water temperature.



Figure 2. Sample collection from bridge showing bridge crane.

Figure 3. Sample collection while wading.



Figures 4 and 5. Sample collection and processing with ultra-clean protocols.



References

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