



# Monitoring Program for Mercury in Precipitation in Indiana

by Martin Risch    December 2006

## ***Why monitor mercury in precipitation?***

### ***To protect public health and wildlife.***

Mercury in aquatic ecosystems is a public health and environmental concern. Mercury—especially in its organic form, methylmercury—can affect the central nervous system of adults and children. The primary route of human exposure to methylmercury is dietary, and children are more susceptible than adults to methylmercury's detrimental effects (National Research Council, 2000).

Fish living in aquatic ecosystems with extremely low concentrations of inorganic mercury are known to accumulate substantial amounts of methylmercury in their tissue (Krabbenhoft and Rickert, 1995). Mercury has been detected in nearly all fish tissue samples collected in Indiana since 1983 (Stahl, 1997). Concentrations of mercury in some fish caught from Indiana waters have prompted health officials to issue advisories that warn about human consumption of these fish (Indiana State Department of Health and others, 2000 through 2005).

In addition, adults and embryos of fish-eating wildlife can suffer damage to the central nervous system from mercury contamination (Krabbenhoft and Weiner, 1999). Figure 1 illustrates how small amounts of mercury increase through the food chain.

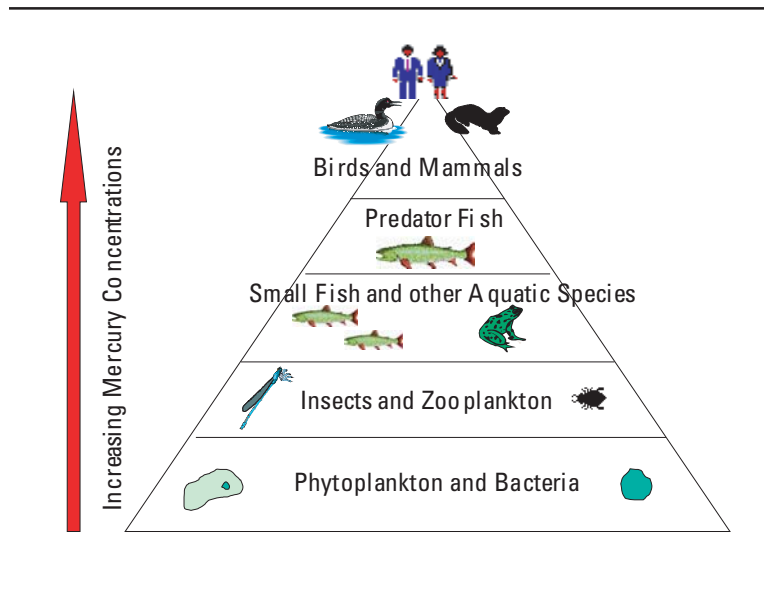
### ***To understand conditions in Indiana.***

Precipitation is a primary mechanism for transporting airborne gaseous or particulate mercury from the atmosphere to surface water and land (U.S. Environmental Protection Agency, 1997). Mercury in the atmosphere can be from human activities (electric-power generation, waste incinerators, steel mills) or from natural processes (forest fires, volcanoes). Mercury emissions to the atmosphere from human activities have been implicated for causing the increased concentrations of methylmercury found in fish (U.S. Environmental Protection Agency, 1997). The connection between mercury in fish and mercury in precipitation is illustrated in figure 2.

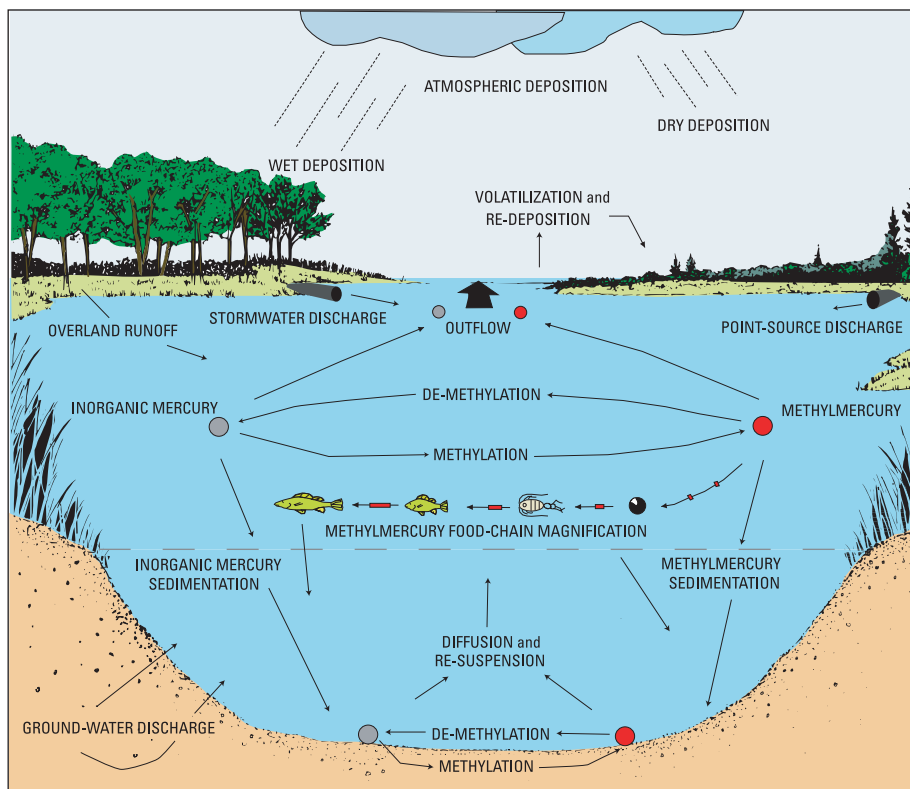
Mercury has been detected in precipitation at monitoring stations throughout North America (National Atmospheric Deposition Program, 2006). Often, mercury concentrations in precipitation exceed the national freshwater toxic pollutant standard of 0.012 micrograms per liter (U.S. Environmental Protection Agency, 1999). Until the monitoring program for mercury in precipitation was implemented, limited information was available about the atmospheric deposition of mercury to Indiana's aquatic ecosystems.

## ***Who is doing the monitoring in Indiana?***

The U.S. Geological Survey (USGS), in cooperation with the Indiana Department of Environmental Management (IDEM), operates the monitoring program for mercury in precipitation in Indiana. The project has been funded by USGS and IDEM's Office of Air Quality and Office of Water Quality. The monitoring program is coordinated through the IDEM Mercury Work Group and is one of several initiatives to measure and reduce mercury in Indiana's environment. The USGS has joined with the U.S. Environmental Protection Agency (USEPA) to promote and communicate mercury research for application to national policy decisions (U.S. Environmental Protection Agency, 2000). The USEPA, USGS, and IDEM also have collaborated to monitor mercury as it affects the Great Lakes and surface water in Indiana.



**Figure 1.** Accumulation and magnification of mercury in the food chain.  
 (Adapted from National Wildlife Federation, 2000)



**Figure 2.** Mercury inputs and mercury cycling in the aquatic ecosystem.

### **What does the monitoring measure?**

The monitoring measures

- the amount of mercury in precipitation (rain, snow, and ice), which is the concentration (mass per volume of water) and
- the volume of precipitation, which will allow the wet-deposition rate to be computed (mass of mercury per unit area per time period).

### **What is being learned?**

Information from monitoring mercury in precipitation in Indiana can indicate:

- the distribution of mercury in precipitation within the state related to mercury emission sources such as electric-power generation, steel mills and foundries, or cement and gypsum manufacturing (2002 Regional Air Pollutant Inventory System for Indiana, 2004, Office of Planning and Assessment, Indiana Department of Environmental Management, unpublished data);
- seasonal or annual trends in mercury concentrations in precipitation and mercury wet-deposition rates;
- mercury concentrations and wet-deposition rates for comparison with other states and a national summary; and
- changes in mercury concentrations and wet-deposition rates after new regulatory controls are implemented.

### **Where is the monitoring being done?**

#### **Indiana—part of a national network.**

Monitoring stations in Indiana (fig. 3) are being operated as part of the Mercury Deposition Network (MDN) in North America, coordinated by the National Atmospheric Deposition Program (NADP). The NADP is an organization of federal agencies (including the USGS), state agencies, academic institutions, tribal governments, private organizations, and the environmental agencies from Canada and Mexico. For more than 25 years, NADP has provided consistent, accurate, quality-assured atmospheric-deposition data about acid rain to researchers, policy makers and the general public. The MDN started in 1996 and, as of late 2005, had nearly 100 stations (fig. 4).

#### **Indiana monitoring stations.**

In 2001, four monitoring stations for mercury in precipitation were strategically located in the state (fig. 3), based on potential mercury sources and weather patterns. A fifth station (in Marion County) was added in 2003. The locations, with the MDN identifications (north to south), were selected by IDEM and the rationale for their selection follow.

#### **The Indiana Dunes station (IN34) in Porter County**

- provides data near large-scale industries and power plants that are potential sources of air emissions of mercury;
- is collocated at a NADP long-term acid-rain monitoring station; and
- is the reference site for atmospheric deposition of mercury in northwestern Indiana.

#### **The Roush Lake station (IN20) in Huntington County**

- provides background data in a rural location, near few large-scale potential sources of air emissions of mercury;
- is collocated at a NADP long-term acid-rain monitoring station; and
- is the reference site for atmospheric deposition of mercury in northeastern Indiana.

#### **The Fort Harrison station (IN26) in Marion County**

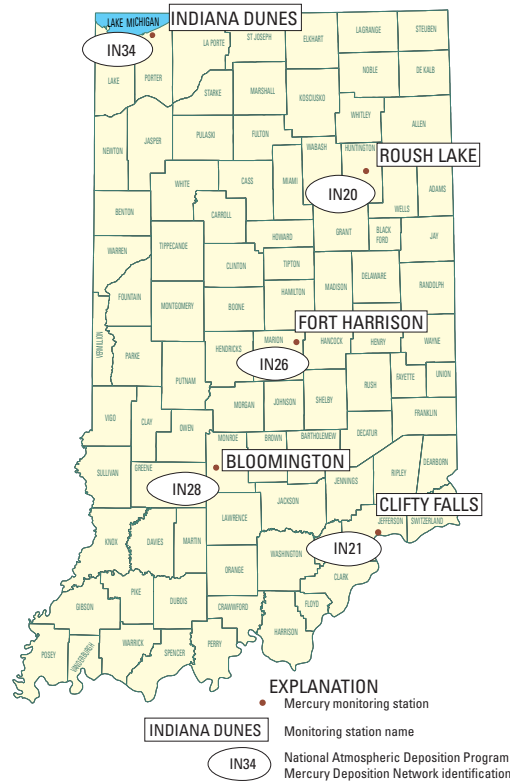
- provides data near a large metropolitan area with multiple types and numerous potential sources of air emissions of mercury; and
- is the reference site for atmospheric deposition of mercury in central Indiana.

#### **The Bloomington station (IN28) in Monroe County**

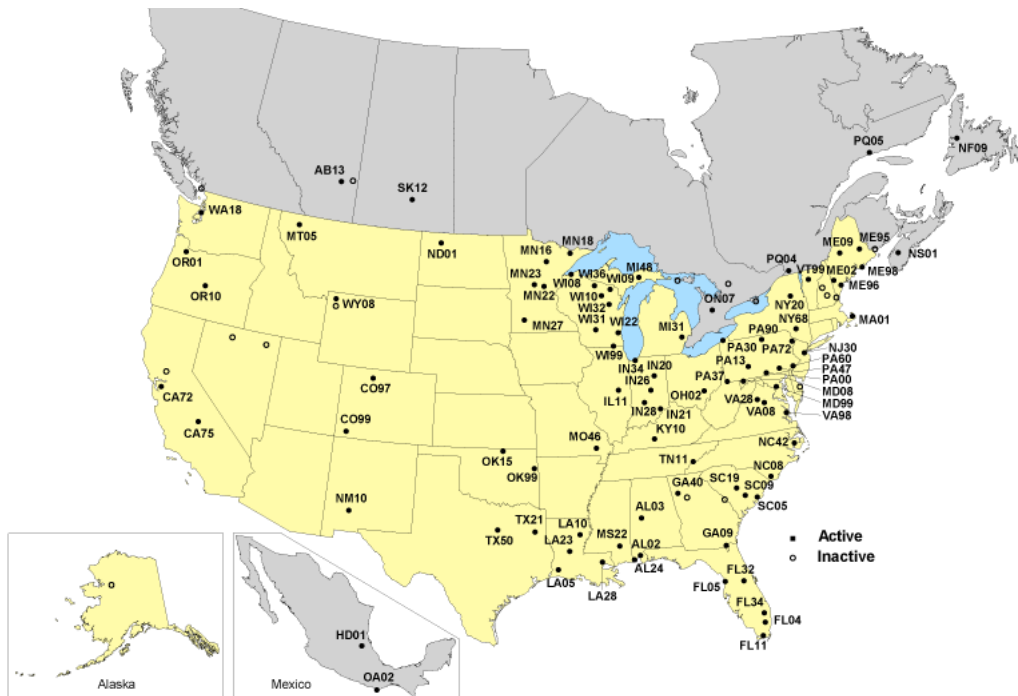
- provides data near power plants and industries that are potential sources of air emissions of mercury in the Wabash River and Ohio River valleys in Indiana, Illinois, and Kentucky; and
- is the reference site for atmospheric deposition of mercury in southwestern Indiana.

#### **The Clifty Falls station (IN21) in Jefferson County**

- provides data near power plants and industries in the Ohio River valley in Indiana, Kentucky and Ohio that are potential sources of air emissions of mercury; and
- is the reference site for atmospheric deposition of mercury in southeastern Indiana.



**Figure 3.** Locations of monitoring stations for mercury in precipitation in Indiana, January 2001 through December 2005.



**Figure 4.** Locations of National Atmospheric Deposition Program Mercury Deposition Network monitoring stations in North America during 2005. (Adapted from National Atmospheric Deposition Program, 2006)

## ***How is the monitoring done?***

### ***The monitoring station.***

A monitoring station has an automated precipitation collector and a recording rain gage (fig. 5). The collector has internal temperature controls and operates year round. It has a sensor and motor that opens and closes a retractable lid for each rainfall or snowfall. Precipitation that is rain or melted snow and ice accumulates in a sample bottle previously fortified with a preservative for mercury. The precipitation amount and collector openings/closings are recorded by the rain gage. The glass sampling supplies (funnel, tube, and bottle) are pre-cleaned and quality assured. The sampling supplies are exchanged weekly on the same day at every MDN station in North America. A weekly sample may be from a single precipitation event or it may be a composite of two or more events in a week.



**Figure 5.** Automated precipitation collector and rain gage for monitoring station.

### ***Mercury analysis.***

Weekly samples from the Indiana monitoring stations—because they are part of a national network—are analyzed by one MDN laboratory to maintain consistency and comparability of results. The lab also prepares the sampling supplies. All samples are analyzed for total recoverable mercury by a low-level method capable of quantifying concentrations as small as 0.1 nanograms per liter (generally equivalent to 0.0001 micrograms per liter or one-tenth part per trillion). In Indiana during 2001 through 2003, samples also were analyzed for methylmercury. Methylmercury was analyzed because it is the form of mercury that accumulates in the food chain.

### ***Supplemental analysis.***

In 2002, at Roush Lake, Bloomington, and Clifty Falls, a second weekly precipitation sample was collected for analysis of seven trace metals, including those classified as hazardous air pollutants (arsenic, beryllium, cadmium, chromium, lead, manganese, and zinc.)

In 2004, at the Roush Lake, Forth Harrison, and Clifty Falls stations, a second automated collector obtained a weekly air sample that was analyzed for reactive gaseous, particulate-bound, and elemental mercury. Concentrations of mercury in air and meteorological data were recorded at the monitoring stations for use in estimating mercury dry deposition. These additional dry deposition data make it possible to estimate the total mercury load from atmospheric sources at these monitoring stations as the sum of wet and dry deposition.

### ***Data management and reporting.***

Data summaries for Indiana are posted on the USGS website for Indiana <http://in.water.usgs.gov/ongoing.shtml>. The NADP archives the monitoring data from the entire MDN at <http://nadp.sws.uiuc.edu/mdn>.

## **Who will use the monitoring data?**

The IDEM Office of Air Quality uses the monitoring data

- for discussions of new mercury-emissions controls in Indiana and
- to compare mercury concentrations in precipitation and mercury wet deposition before and after new regulatory controls are implemented.

The IDEM Office of Water Quality uses the monitoring data

- to evaluate mercury loads in surface water attributable to atmospheric deposition and
- to assess changes in mercury levels in fish that may be related to changes in atmospheric deposition.

The IDEM Office of Planning and Assessment uses the data:

- to evaluate progress on reducing mercury emissions; and
- to identify future needs for protecting human health and wildlife from mercury exposure.

The USGS, USEPA, and IDEM Mercury Work Group intends to use the data to understand mercury cycling in the environment—to determine relationships among air emissions, atmospheric deposition, concentrations in aquatic ecosystems, levels in fish tissue, and associated risks to human health and wildlife. The NADP data archive for the MDN includes Indiana data for comparisons among states, as the basis for national summaries, and in evaluations of large-scale models for atmospheric transport and deposition of mercury.

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