

## Monitoring Program for Mercury in Precipitation in Indiana

### Why monitor mercury in precipitation?

#### To protect public health and wildlife.

Mercury in Indiana's environment 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 unborn children are as much as 10 times more susceptible than adults to methylmercury's detrimental effects.

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, 2000).

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

#### To understand conditions in Indiana.

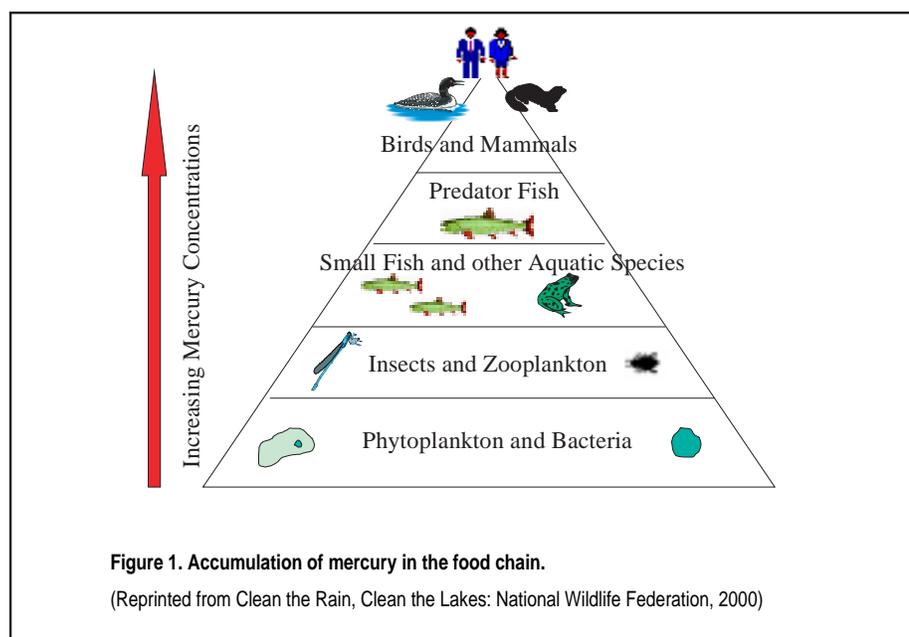
Precipitation (wet deposition) is the primary mechanism for transporting airborne gaseous or particulate mercury from the atmosphere to surface water and land (U.S. Environmental Protection Agency, 1997). Dry deposition such as dust is considered to be a less important source of mercury to surface water and is more difficult to measure (Sweet and Prestbo, 1999). Mercury in the atmosphere can be from manmade sources (coal-fired power plants, municipal incinerators, industrial boilers) or from natural

sources (forest fires, geologic formations, volcanoes). Manmade sources of mercury emissions to the atmosphere 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 (Sweet and Prestbo, 1999). Often, mercury concentrations in precipitation exceed the national freshwater toxic pollutant standard of 0.012 micrograms per liter (U.S. Environmental Protection Agency, 1999) Because the scientific methods to measure mercury in precipitation are new, only limited information is available about the atmospheric contribution 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), established and operates the precipitation-monitoring network for mercury in Indiana. The project is 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 collaborate to monitor mercury as it affects the Great Lakes.



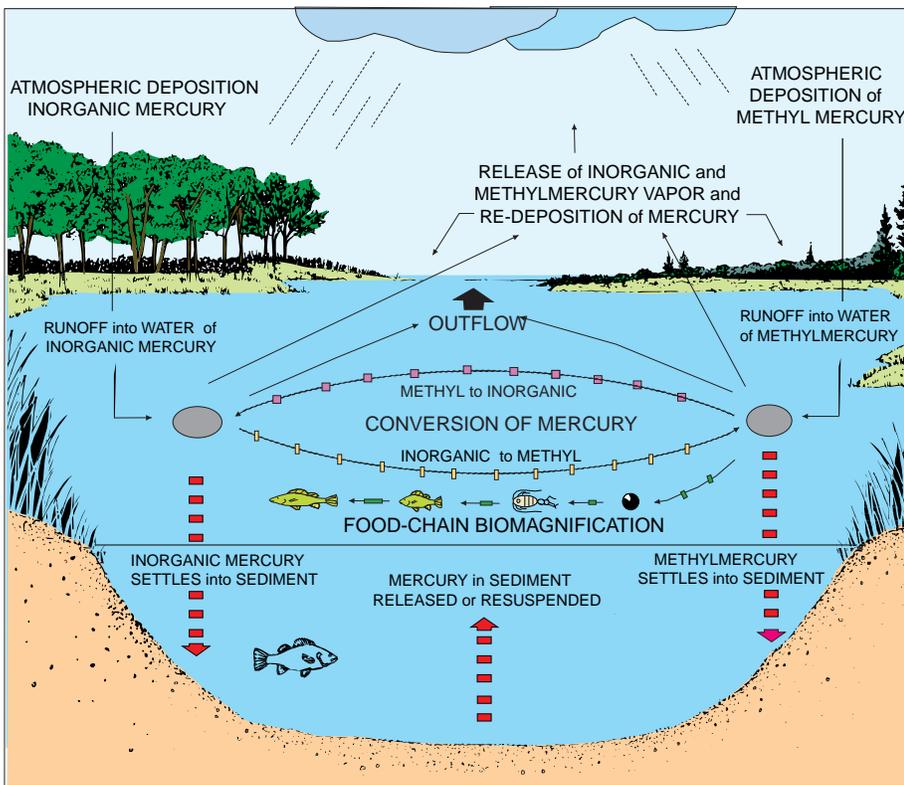


Figure 2. Deposition and cycling of mercury in aquatic ecosystems.

**What will be measured?**

The monitoring will measure

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

**What will be learned?**

Information from monitoring mercury in precipitation in Indiana could indicate:

- uniform distribution of mercury in precipitation within the state or patterns increased locally by mercury emission sources such as power plants, incinerators, or heavy industry;
- possible seasonal or annual trends in concentrations and deposition rates of mercury in precipitation;
- baseline mercury concentrations and deposition rates for precipitation prior to future regulatory controls; and
- mercury concentrations and deposition rates for comparison with other states.

**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 national Mercury Deposition Network (MDN) coordinated through the National Atmospheric Deposition Program (NADP). The NADP is an organization of federal agencies (including the USGS), state agencies, academic institutions, tribal governments, and private organizations.

For more than 20 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 January 2001) had 53 sites in the U.S. and Canada (fig. 4).

**Indiana monitoring stations.**

In 2001, four monitoring stations for mercury in precipitation were strategically located in the state, based on potential mercury sources and weather patterns (fig. 3). The locations selected by IDEM and rationale for their selection follow.

**The Porter County station (IN34)**

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

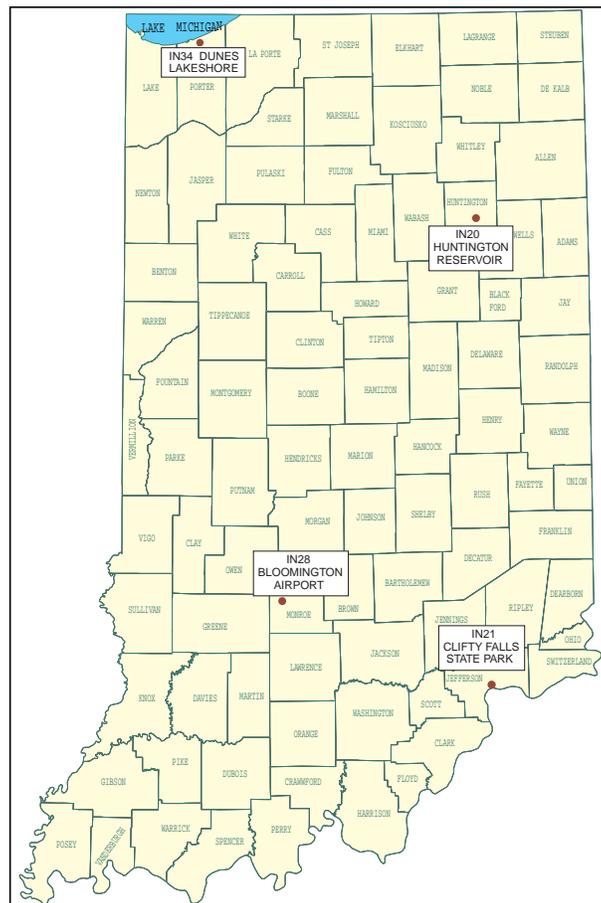


Figure 3. Monitoring stations for mercury in precipitation in Indiana.

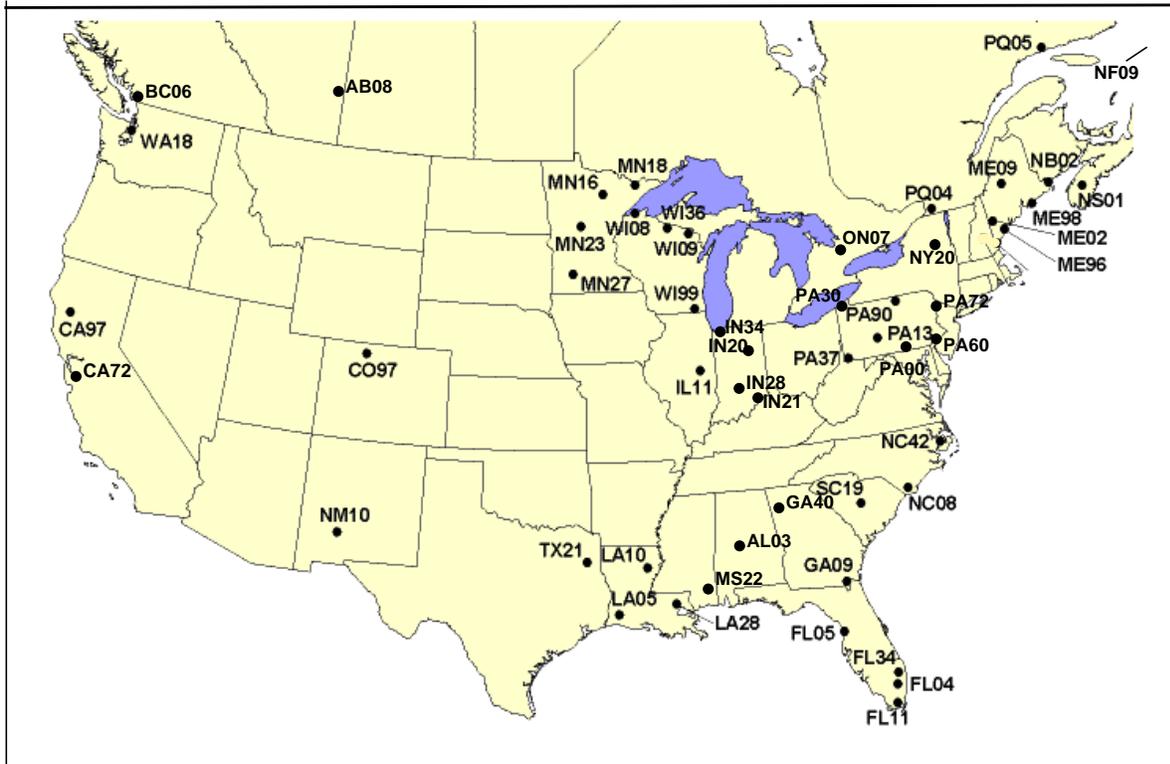


Figure 4. National Mercury Deposition Network monitoring stations in Indiana and other stations operating in North America in January 2001. (Modified from National Atmospheric Deposition Program, 2000)

**The Huntington County station (IN20)**

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

**The Monroe County station (IN28)**

- provides data regarding aggregate transport and atmospheric deposition from numerous power plants that are potential sources of air emissions of mercury in southwestern and western Indiana; and
- is the reference site for atmospheric deposition of mercury in central and southwestern Indiana.

**The Jefferson County station (IN21)**

- provides data near the largest potential source of air emissions of mercury from electric-power-generation in Indiana;
- provides data regarding multiple, large-scale potential sources of air emissions of mercury that may enter Indiana from Kentucky and Tennessee; and
- is the reference site for atmospheric deposition of mercury in southeastern Indiana.

**How is the monitoring done?**

**The monitoring station.**

A monitoring station has an automated precipitation collector (fig. 5) and a recording rain gage. 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 rainfall or snowfall or it may be a composite of two or more rainfalls or snowfalls in a week.

**Sample 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.

In Indiana during 2001, samples will be analyzed for total mercury and methylmercury. Methylmercury is being analyzed because it is the form of mercury that accumulates in the food chain. Although limited data from other states indicate methylmercury may be a small part of the total mercury in precipitation, the proportion of methylmercury is being quantified in Indiana through the monitoring program.

The analyses for total mercury and methylmercury are done by low-level methods 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).



Figure 5. Automated precipitation collector.

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

Indiana's monitoring data for mercury in precipitation will be summarized, interpreted, and published by the USGS. To obtain project status reports and summaries, visit the USGS website at <http://in.water.usgs.gov>.

The NADP also provides annual summaries and monitoring data from the MDN at <http://nadp.sws.uiuc.edu/mdn>.

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

The IDEM Office of Air Quality plans to use the monitoring data to determine:

- baseline concentrations and deposition rates for mercury in precipitation prior to the start of new regulatory controls; and
- concentrations and deposition rates for mercury in precipitation after new regulatory controls are in place.

The IDEM Office of Water Quality plans to use the monitoring data to calculate a Total Maximum Daily Load (TMDL) for mercury in selected watersheds. A TMDL is required when uses of the water are impaired because mercury levels in fish have caused fish consumption advisories to be issued for a watershed. Atmospheric deposition is a potential source of mercury that needs to be quantified for a TMDL. The first TMDL for mercury is planned for the Grand Calumet River in northwestern Indiana.

The IDEM Office of Planning and Assessment expects to use 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.

### **What are future monitoring plans?**

In 2002, plans call for the mercury-monitoring stations in Indiana to continue collecting weekly wet-deposition samples

for total mercury analysis. In addition, a second apparatus is planned for each station that will simultaneously collect a weekly wet-deposition sample for analysis of seven trace metals, including some that are classified as hazardous air pollutants. The seven trace metals are arsenic, beryllium, cadmium, chromium, lead, manganese, and zinc. The trace-metal data are expected to indicate some of the potential atmospheric chemistry associated with mercury deposition. Also, the trace-metal data will be used to evaluate and supplement IDEM air-monitoring programs.

In 2003, plans call for the mercury-monitoring stations in Indiana to continue collecting weekly wet-deposition samples for total mercury analysis. In addition, a second automated collector is planned to be installed to obtain a weekly sample of dry deposition to be analyzed for total mercury. With these additional data, it will be possible to estimate the total mercury load at each monitoring station as the sum of wet and dry atmospheric deposition.

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