CLEAN THE RAIN, CLEAN THE LAKES

Mercury in Rain is Polluting the Great Lakes

NATIONAL WILDLIFE FEDERATION®

People and Nature: Our Future is in the Balance

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National Wildlife Federation

Founded in 1936, the National Wildlife Federation (NWF) is the nation's largest conservation education organization. NWF's mission is to educate, inspire, and assist individuals and organizations of diverse cultures to conserve wildlife and other natural resources while protecting the earth's environment in order to achieve a peaceful, equitable, and sustainable future.

Great Lakes Natural Resource Center

The Great Lakes Natural Resource Center (GLNRC), established in 1982, unites people throughout the eight-state Great Lakes region, the United States, and Canada to protect the world's greatest freshwater seas, the surrounding ecosystem, and the benefits they provide people and wildlife.

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Foreword

One of my favorite lakes is Gun Lake in Michigan. It's a beautiful place to take out a canoe and cast for bass or sunfish. But there's a problem that hangs over Gun Lake like a thundercloud. My family can't safely eat the fish I catch because the lake is contaminated with mercury, and so are its fish.

Gun Lake is not the only lake contaminated by mercury **B** not by far. In Michigan, Ohio, Indiana, and several other states mercury contamination has forced health officials to issue advisories warning people to restrict or entirely avoid eating fish caught from every one of their thousands of inland lakes and streams. Minnesota and Wisconsin have such advisories for hundreds of their lakes. All told, forty states have fish consumption advisories due to mercury contamination.

Mercury is of such concern because it can cause severe damage to people and wildlife at very low levels. Once in a lake or stream, it becomes more and more concentrated as it moves up the food chain into fish and the people and wildlife who consume them. Children of women who ate contaminated fish during pregnancy suffer developmental and nervous system problems. Fish-eating birds show reproductive problems. This is a terrible and unacceptable toll.

For decades, the National Wildlife Federation has worked to stem the flow of toxic chemicals like mercury into our nation's waterways, and we've had tremendous success. Industrial and municipal discharge pipes that once spewed, unchecked, millions of gallons of poisons into our waters have largely been shut off. But the job remains unfinished.

In this report, we shed light on another pathway for mercury pollution into our waterways: contaminated rain. Rain that is supposed to cleanse our lakes and streams and sustain our wildlife instead is carrying high concentrations of mercury from the sky into our waters, poisoning the very waters we have worked so hard to protect. Our report traces the mercury-contaminated rain back to its sources, the coal-fired power plants, incinerators and other industries that release mercury pollution into the air. And although this report focuses on the contaminated rain of the Midwest, the problem is national in scope. Wherever there are power plants and incinerators spewing mercury into the air, the rain will carry that poison back to earth.

This report and our *Clean the Rain* campaign are part of a larger National Wildlife Federation initiative to tackle the many diffuse sources of pollution that still poison waterways across America. This *Saving Our Watersheds* effort reveals the problems of contaminated rain, polluted runoff, and other little-controlled pollution sources, and helps concerned people take action to solve them.

Our goal is simple: to make all our waters safe for swimming, drinking, fishing, and to make those fish safe to eat for all. That's the only way to protect people and wildlife. With this report, the National Wildlife Federation hopes to move closer to that final destination.

Mark Van Putten, President

Table of Contents

Executive Summary

Rain. It is a favorite of songwriters and moviemakers. It is nourishing and replenishing. It is often described as romantic, life-supporting, and cleansing. It may be all these things. Unfortunately, in the Great Lakes region, it is something more:

It is contaminated by mercury.

Scientists from the U.S. EPA and major universities have sampled rain (and snow), and discovered that this region's precipitation contains mercury in concentrations that exceed the EPA safe level for mercury in the Great Lakes. This mercury contamination of rain has been documented near urban centers such as Detroit (as high as 65 **times** the EPA-safe level), Chicago (as high as 41 times the safe level), the Illinois/Wisconsin border (as high as 73 times the EPA safe level in Kenosha, Wisconsin), and Duluth (a six-year average of almost six times the EPA safe level). It also has been documented in more remote locations such as Sleeping Bear Dunes, Michigan (as high as 35 times the EPA safe level) and Devil's Lake, Wisconsin (as high as 23 times the safe level).

The impacts of this mercury-contaminated rain are enormous. Mercury is a potent neurotoxin in people and wildlife. It can cause subtle but permanent neurological and brain damage at very low doses; at higher levels, it can cripple and kill. In wildlife, it is a reproductive hazard. Already, the public health departments in each of the Great Lakes states have issued formal advisories warning people to limit their consumption or avoid eating entirely certain species of fish caught from lakes and streams in the states -- because of mercury contamination. Michigan, Ohio and Indiana have statewide fish consumption advisories; Wisconsin and Minnesota have advisories on hundreds of lakes. The fish are contaminated by the mercury in the water. And now we know that the water is contaminated by the rain itself.

Rain's contamination by mercury completely reverses what we believe to be true about the pollution of our lakes and streams. Before, we assumed that nature had mechanisms to clean up contamination, to dilute pollution. Before, we assumed that rain was nature's way of cleansing our waterways. Now we know the opposite is true: rain itself is so contaminated by mercury that it adds pollution to our lakes and streams.

This mercury contamination of rain is a call to action. Mercury in rain comes from mercury pollution of the air. The leading sources of mercury emissions in this region are well-known: emissions from coal-fired power plants, incinerators, and manufacturers of chlorine and caustic soda. These industries must drastically cut mercury emissions, eventually eliminating them altogether. If they refuse to reduce emissions voluntarily, then local, state, and federal governments must take steps to force those reductions.

The challenge is before us: we must do no less than clean the rain. The National Wildlife Federation, in cooperation with a coalition of 21 conservation and environmental organizations (see Box 1), has launched an initiative, the "Clean the Rain Campaign". Through the Clean the Rain Campaign, this coalition will push state and federal governments to do more monitoring of mercury in rainfall. In key locations, NWF itself will sponsor sampling of rain if the governments fail to do so. NWF is working with research scientists at the University of Michigan and the University of Minnesota to track and, if necessary, implement the sampling of rain for mercury. The first cities targeted for additional monitoring are Chicago, Cleveland, Detroit, Duluth, and Gary, Indiana.

Box 1: Organizations participating in the Clean the Rain Campaign

Citizens for a Better Environment, Illinois	Citizens for a Better Environment, Wisconsin
Clean Water Action, Michigan	Clean Water Action, Minnesota
Environmental Law and Policy Center	Hoosier Environmental Council
Illinois Public Interest Research Group	Izaak Walton League Midwest Office
Lake Michigan Federation	Lake Superior Alliance
Michigan Environmental Council	Michigan United Conservation Clubs
National Wildlife Federation	Ohio Environmental Council
Ohio Public Interest Research Group	Save Lake Superior Association
Save the Dunes Council, Indiana	Sierra Club Midwest Program Office
Wisconsin's Environmental Decade	Wisconsin Wildlife Federation

The Clean the Rain Campaign also will press for the control and eventual elimination of the mercury emissions that are contaminating the rain. It will call for the implementation of the following actions:

- Coal-fired power plants must cut and eventually eliminate their combustion of coal (a major source of mercury, as well as smog- and acid rain-producing pollutants).
- Hospitals and other medical facilities should practice "mercury-free medicine" by eliminating mercury from their medical waste streams and substituting technologies like autoclaving for incineration. Over 100 hospitals have pledged to go mercury-free in the past year.
- Municipal incinerators must separate and remove mercury from their wastestreams before burning it.
- Plants that use mercury to produce chlorine and caustic soda must phase out the process that uses mercury, by employing other processes now used by the majority of such manufacturers in the U.S.
- If these industries fail to act voluntarily, EPA and the Great Lakes states must step in and require these measures.
- The public should conserve energy, avoid purchasing consumer products that contain mercury, and recycle the mercury-containing items already purchased.

Mercury: Serious Harm From Tiny Amounts

Mercury is a highly volatile, naturally occurring metal found in trace quantities throughout the environment: in rocks, soils and the oceans. Mercury is an element; it never breaks down, but persists in the environment. It cycles from land to air to water, never leaving the environment. See Figure 1. In lakes, it may take decades for mercury to be covered by sediments and removed from this cycle. Although a naturally-occurring metal, mercury's presence in our air and water has increased dramatically in the past 100 years due to industrial activity -- particularly the combustion of coal and burning of mercury-bearing wastes -- in the Great Lakes region.[1]

Mercury takes many forms in the environment. These can be categorized into three "species," inorganic, organic, and elemental mercury. Inorganic mercury often takes the form of mercury metal, mercuric chloride, and mercuric sulfide. Combustion of coal and mercury-bearing waste produces inorganic and elemental mercury. Organic mercury (such as methylmercury and dimethylmercury) is produced in the environment by bacteria and other organisms from the inorganic mercury species. Much of the inorganic mercury that enters a lake or stream can be converted to the organic species.

Inorganic and elemental mercury can be very dangerous if inhaled or ingested. However, organic mercury is most harmful to people and wildlife due to its ability to take part in biochemical reactions and build up in the food chain. Plankton take up the organic mercury. As larger aquatic organisms eat the plankton, the mercury concentrates in their tissue. The concentration of mercury increases in the tissue of succeeding species in the food chain. The top predator fish, such as salmon, lake trout, or walleye can have mercury concentrations over a million times higher than the surrounding water.

It takes a surprisingly small amount of mercury in the water to contaminate fish to unsafe human consumption levels. A typical 100 megawatt coal-burning power plant would emit approximately 25 pounds of mercury a year. That doesn't sound like much until you consider that it could take the addition of only .002 pounds of mercury -- 1/70th of a teaspoon -- to contaminate a 25 acre lake to the point that the fish in that lake are unsafe to eat.[2]

Harm to People

Mercury is a potent neurotoxin. Even at very low levels, it can cause subtle but permanent damage to the brain and the central nervous system. At higher levels it can damage the lungs and kidneys. Acute mercury poisoning in the United States is rare, but it still occurs; because of mercury's unique appearance and behavior, unwary children can be drawn to it in school laboratories or broken thermometers and suffer acute exposure.[3]

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[1] Wisconsin Department of Natural Resources, 1996. AMercury in Wisconsin=s Environment, A Status Report.@

[2] Raloff, Jo., 1991. Mercurial Risks From Acid=s Reign, *Science News*, 130:152-166.

[3] Agency for Toxic Substances and Disease Registry, National Alert: A Warning About Continuing Patterns of Metallic Mercury Exposure, June 26, 1997.

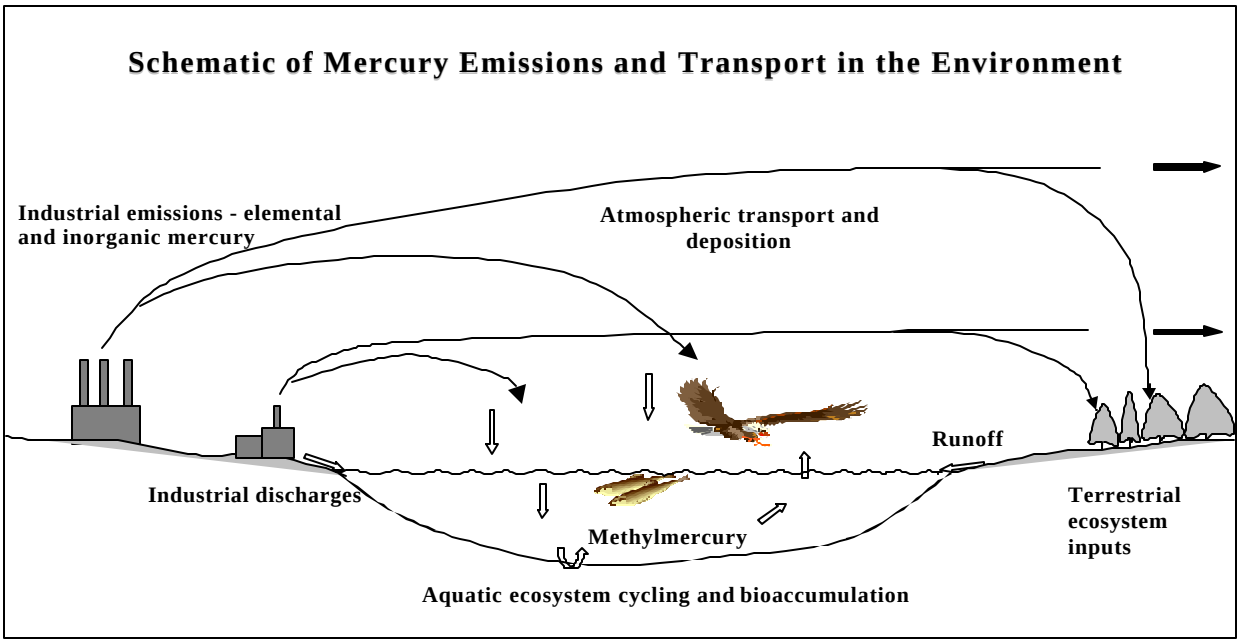

Figure 1. Schematic of Mercury Emissions and Transport in the Environment

The more common exposure is through the consumption of fish contaminated with mercury. Forty states now have fish consumption advisories due to mercury. Due to limited distribution of advisory information in many states, Native American subsistence anglers, low-income or minority anglers, sport anglers, children and fetuses remain at risk. The following impacts have been documented:

- Infants exposed to elevated levels of methylmercury often show greater signs of intoxication than the mother, with effects including cerebral palsy, mental retardation, and delayed walking and speech.[4]

- As many as 85,000 U.S. women of childbearing age in a given year have been exposed to elevated mercury levels sufficient to affect the in utero brain development of their babies, and as many as 3 million children in the U.S. have elevated blood mercury levels.[5]

- A recent report of an ongoing study in the Faroe Islands in the North Atlantic found that children exposed to methylmercury as fetuses (due to pilot whale meat consumption by their mothers) showed mercury-related problems in the areas of language, attention, and memory. The researchers concluded that these effects are due to prenatal methylmercury exposure and were occurring at exposure levels currently considered to be "safe" by the U.S. EPA.[6]

[4] Reviewed in Rice, D.C., 1995, Neurotoxicity of Lead, Methylmercury, and PCBs in Relation to the Great Lakes, *Environmental Health Perspectives*, V. 103 (Suppl. 9):71-87

[5] EPA Mercury Report to Congress, Vol. VII, December, 1997.

[6] Grandjean, Pl, Weihe, P., White, R.F., Debes, F.; Araki, S. Yokoyama, K., Murata, K., Sorensen, N., Dahl,R., Jorgensen, P.J., Cognitive Deficit in 7-Year-Old Children with Prenatal Exposure to Methylmercury, *Neurotoxicology and Teratology*, 19(6):417-428.

Research on the effects of mercury on humans continues. Another ongoing study in the Sychelles Islands has found less significant effects due to mercury contamination. Other recent research among indigenous populations in the Amazon exposed to mercury used in gold mining industries reported mercury-related neurological deficits in motor function, attention, and visualspatial performance. The Seychelles study appears to conflict with the Faroe Islands study and with earlier studies done in Iraq. The U.S. EPA has not used its findings to set the reference dose. However, even in the unlikely event that the Seychelles study is the only one that is correct, the levels of mercury contaminating the Great Lakes region's rain would still be many times higher than any safe level set by EPA.

Harm to Wildlife

Mercury has a wide range of harmful effects on wildlife. These include:

- growth inhibition in algae;
- high embryo-larval mortality in frogs;
- reduced hatching success and egg deposition in zebra fish;
- impaired sperm generation in guppies;
- growth inhibition in rainbow trout;
- high mortality of embryos and larvae in rainbow trout;
- reduced hatching success and duckling survival in mallard ducks;
- high embryo and duckling mortality in American black ducks in a captive colony;
- reduced hatching in a wild population of common terns living in a contaminated system;
- reduced hatching success among common loons in a wild population in a contaminated system.[7]

Mercury levels associated with reproductive impairment and toxicity were recently reported for emaciated loons found dead or in a weakened state in eastern Canada, and these levels were higher than in apparently healthy loons.[8] Other research has observed apparent mercury-related effects on behavior of young loons that may effect their survivability.[9] One study has found that mercury levels in loons were recently observed to increase generally from west to east across North America.[10]

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[7] Summarized in Zillioux, E.J., Porcella, D.B., Benoit, J.M., 1993, Mercury Cycling and Effects in Freshwater Ecosystems, *Environmental Toxicology and Chemistry*, 12:2245-2264.

[8] Scheuhammer, A. M.; Wong, A. H. K.; Bond, D. "Mercury and selenium accumulation in common loons (*Gavia immer*)and common mergansers (*Mergus merganser*) from Eastern Canada", *Environ. Toxicol. Chem.* **1998**, 17(2), 197-201.

[9] Nocera, J. J.; Taylor, P.D. "In situ behavioral response of common loons associated with elevated mercury (Hg) exposure." *Conserv*. *Ecol.* **1998**, 2(2), Internet version at: http://www.consecol.org/Journal/vol2/iss2/art10(.) (Accessed 8/13/99)

[10] Evers, D. C.; Kaplan, J.D.; Meyer, M.W.; Reaman, P.S.; Braselton, W.E.; Major, A.; Burgess, N.; Scheuhammer, A.M. "Geographic trend in mercury measured in common loon feathers and blood", *Environ. Toxicol. Chem.* **1998**, 17(2), 173-183.

The Great Lakes Region: Contaminated Rain and Other Signs of Mercury Poisoning

The Great Lakes region is being poisoned by the mercury in rain, snow, and other precipitation. Since about 1990, research scientists from several midwestern universities have been sampling rain in the Great Lakes region. U.S. EPA and the state of Wisconsin also have conducted sampling. The sampling and analyses can only be done by special "clean" laboratories because the levels of mercury in the rain are at the parts per trillion level. The laboratory analyses conducted on these samples have found levels of mercury in the rain at trace levels, which nevertheless are far higher than the EPA wildlife and human health standards for mercury in Great Lakes waters (see Box 2).

Box 2: The EPA safe-level for mercury in lakes and streams

The EPA has set standards for mercury in the Great Lakes and all the waters in the Great Lakes basin. These standards were developed during the Great Lakes Water Quality Initiative ("GLI") process and promulgated in regulations. Each Great Lakes state now is required to implement those regulations.

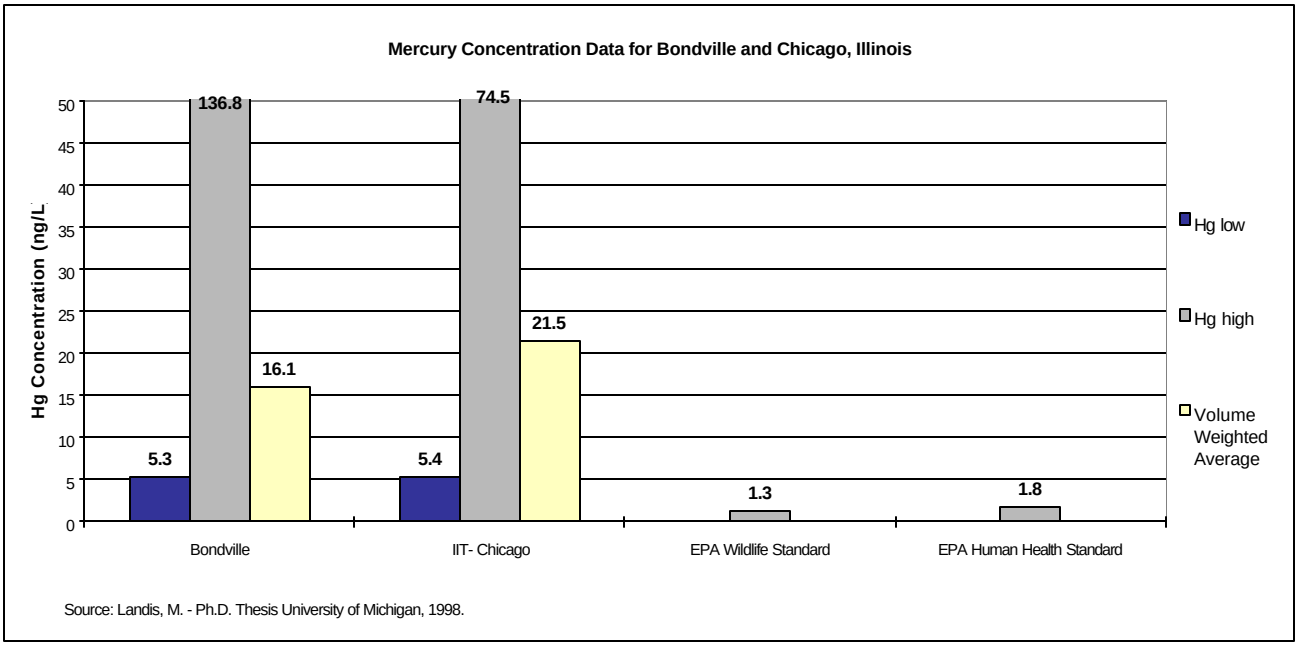
The GLI establishes two standards for mercury: one to protect people, and one to protect wildlife. The wildlife standard requires that lakes and streams contain no more than 1.3 parts per trillion (ppt or ng/L) mercury in their water. The human health standard sets a limit of 1.8 ppt mercury in water.

These standards were set to protect people and wildlife who eat the fish caught from Great Lakes basin waterways. Fish that live in waterways with mercury below these concentrations will be safe to eat without restriction. Fish living in waterways with mercury above these levels may be unsafe to eat. These standards are set so low because mercury bioaccumulates in fish tissues so readily – up to a million times its concentration in water.

Source: 40 CFR part 132.

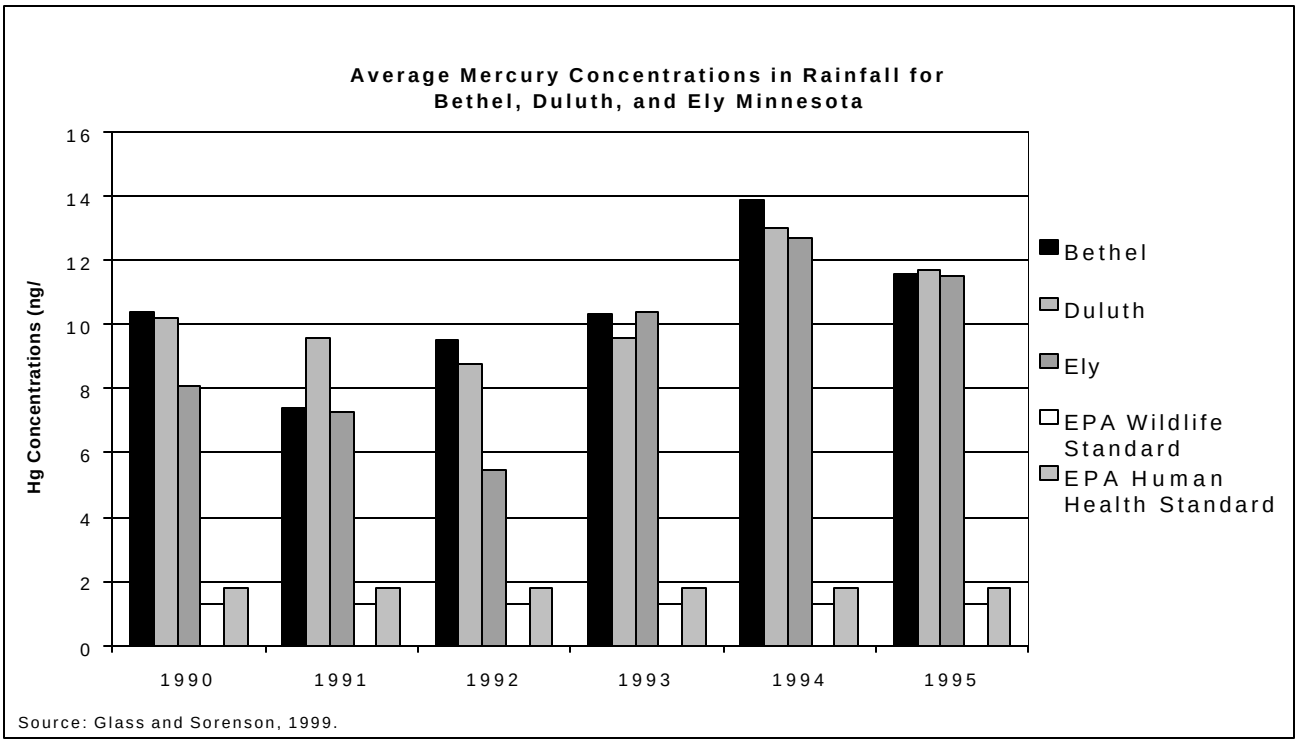
This report compiles the data from that sampling and analyses. It lays out four different sets of data, each derived from a different sampler and laboratory. Each of these data sets is independent; none can be compared directly to any other set because different laboratories collected the samples, different laboratories did the analyses, and each of the data sets covers different time periods. The different laboratories and their sampling locations are listed in Appendix 1. Summaries of all the data are provided graphically, by data set, in Appendix 2. Summary data from these data sets showing low, high, and volume-weighted mean values (where samples are averaged based on the amount of precipitation in the sample) are presented on the following pages.

Mercury Concentration in Rain: Illinois



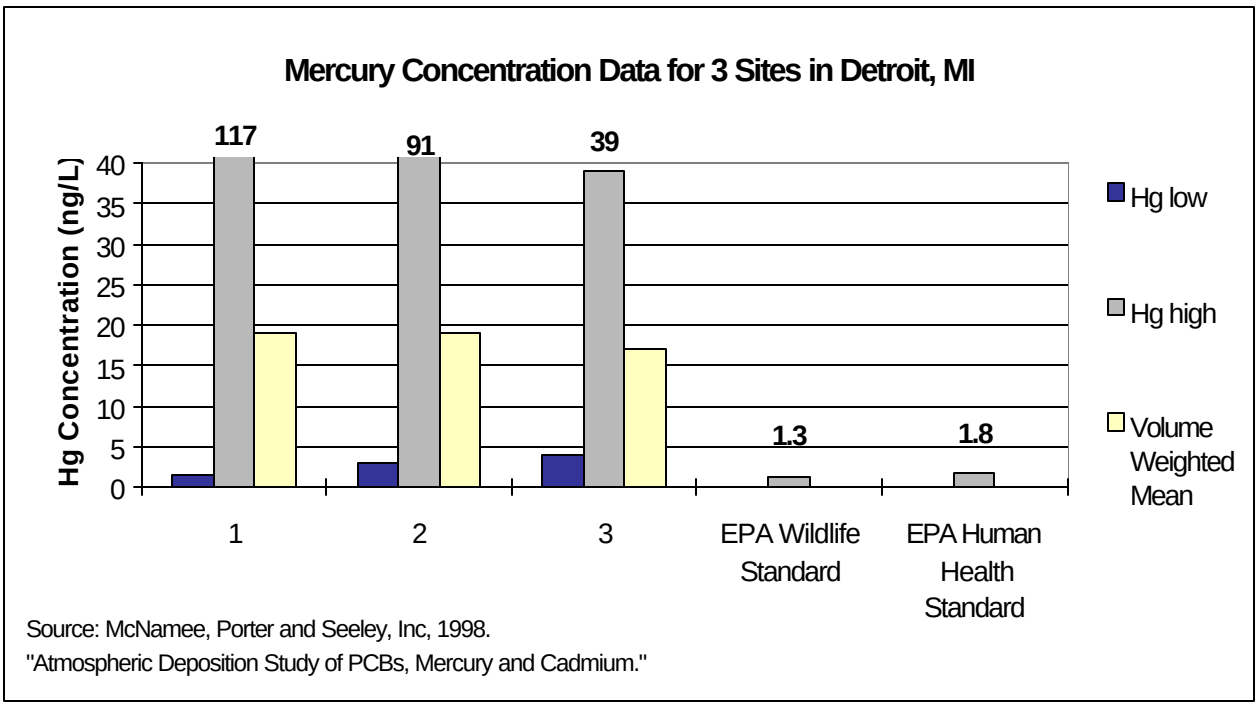
Source: Landis, M. - Ph.D. Thesis University of Michigan, 1998.

Mercury Concentration in Rain: Minnesota

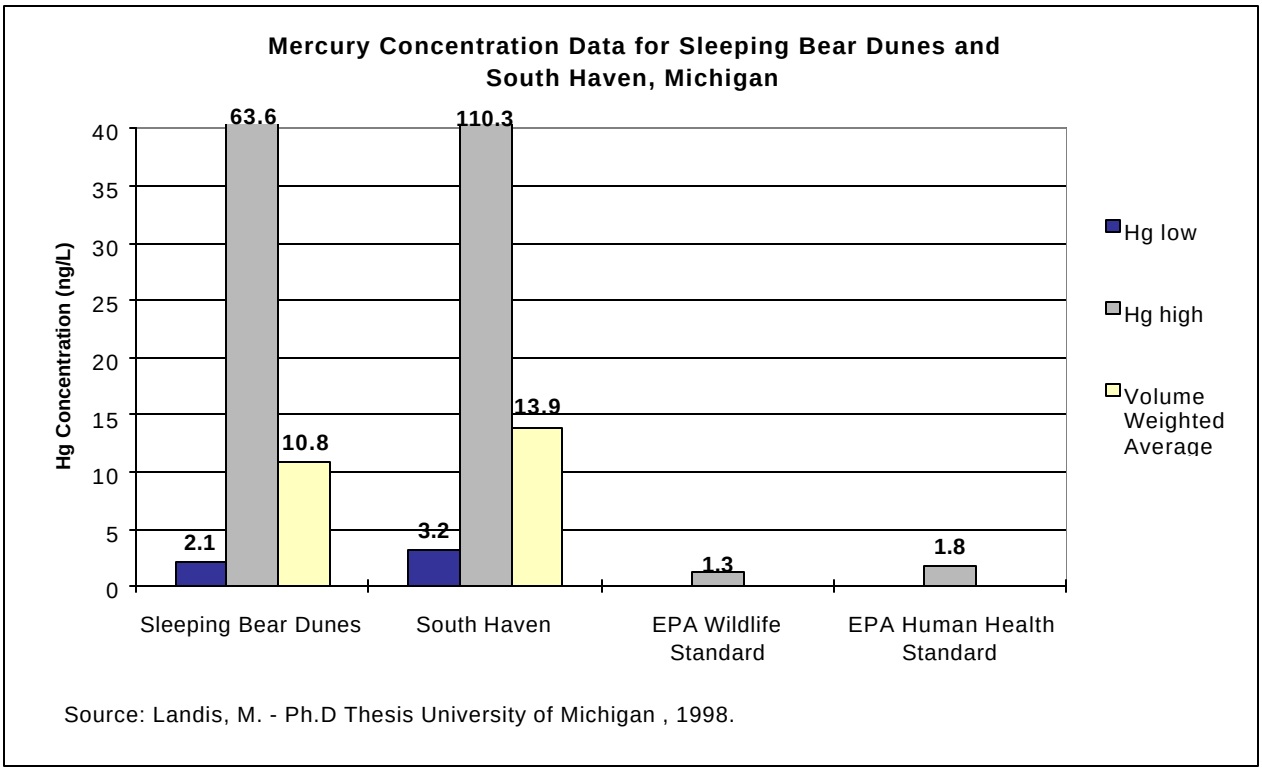


Source: Glass and Sorenson, 1999.

Mercury Concentration in Rain: Michigan

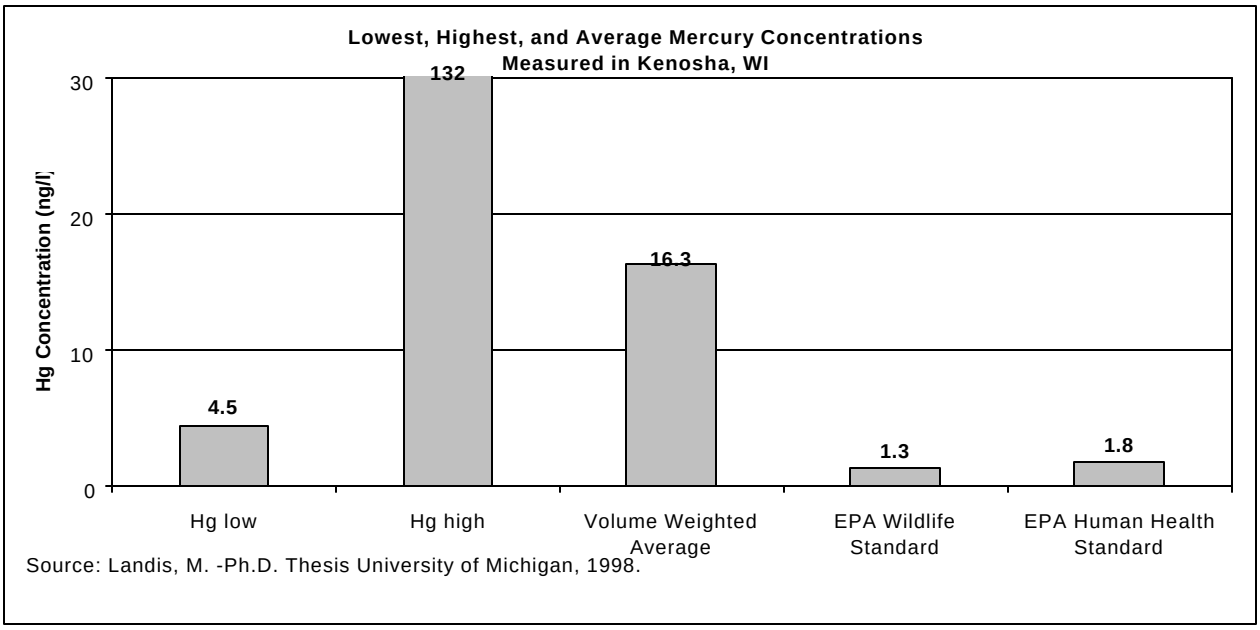


Source: McNamee, Porter and Seeley, Inc, 1998.
"Atmospheric Deposition Study of PCBs, Mercury and Cadmium."

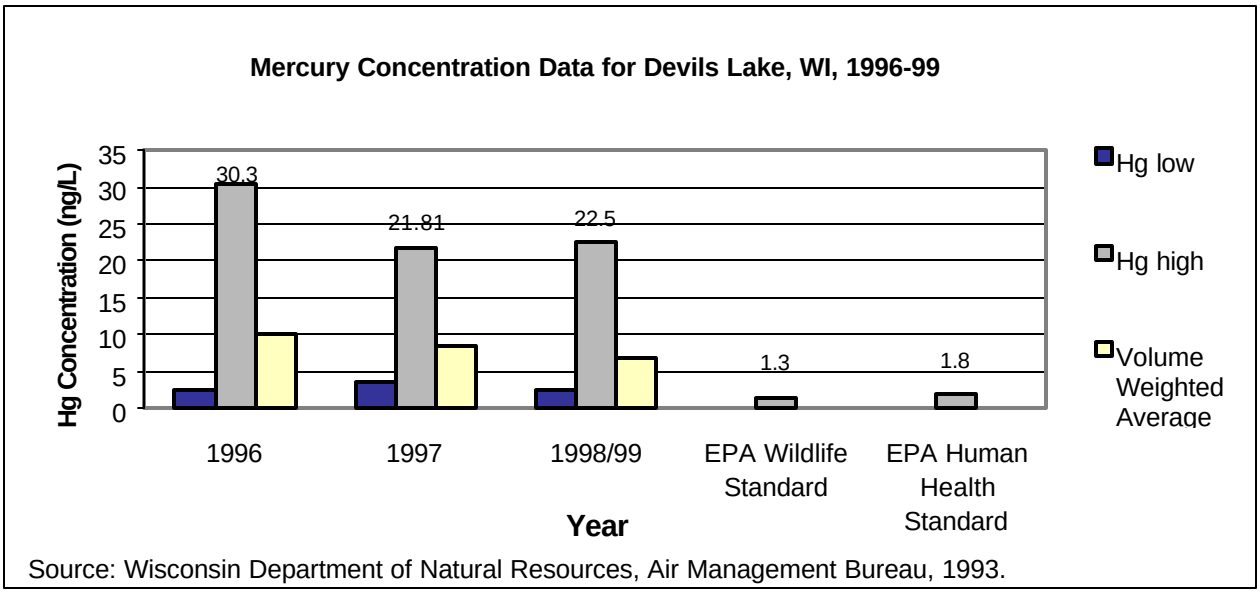


Source: Landis, M. - Ph.D Thesis University of Michigan , 1998.

Mercury Concentration in Rain: Wisconsin



Source: Landis, M. -Ph.D. Thesis University of Michigan, 1998.



Source: Wisconsin Department of Natural Resources, Air Management Bureau, 1993.

These samples document the dangerous levels of mercury in rain, snow and other precipitation. Mercury contamination of rain in Chicago is as high as 41 times the EPA human health standard for water in the Great Lakes; in Detroit, as high as 65 times the EPA standard; in Kenosha (Wisconsin), as high as 73 times the EPA standard. The long-term average mercury concentrations are equally alarming. In Duluth, the 1990-95 average concentration of mercury in precipitation is 10.5 parts per trillion (ppt), or almost six times the EPA human health standard. In Chicago, the one-year average was 21.5 ppt, or 12 times the EPA standard; in Detroit, the six-month average in one sampling location was 25 ppt, or 14 times the EPA standard; for Kenosha, the 18-month average was 16.3 ppt, or nine times the EPA standard. For each location sampled, the exceedance of the EPA standard to protect wildlife is even greater.

These mercury levels in the Great Lakes states are far higher than the global background for mercury from natural and human sources. The global background is a baseline level; regional and local sources add to that level. In more remote locations, scientists have measured mercury as low as 0.4 parts per trillion, with many measurements below 2.0 parts per trillion. (See Appendix 2). These data strongly suggest that the measurements above these levels are due largely to local and regional sources, not global sources.

By transporting mercury pollution from the air, rain is making mercury pollution in our lakes and streams worse, not better. The mercury levels in the open waters of Lake Superior are approximately one part per trillion (ppt); in the open waters of Lake Michigan, less than one ppt, and even in near-shore Lake Michigan, mean values are 8 ppt. Rather than cleansing these lakes, rain is polluting them because the rain itself is contaminated by air pollution.

We can already see the impacts of mercury-contaminated rain. Certain species of fish in waterways in the Great Lakes region are highly contaminated with mercury -- so high, in fact, that many are unsafe to eat. Every one of the Great Lakes states in the region has fish consumption advisories due to mercury. (See Box 3 for a description of how states decide to issue fish consumption advisories). Indiana, Michigan, and Ohio have issued advisories for every one of those states' inland waterways. Minnesota's advisory is for 761 lakes; Wisconsin's advisory is for 330 lakes. Illinois has advisories for only two lakes -- however, much of the mercury generated in Illinois is near Lake Michigan and its bordering states, and so the effects of Illinois mercury emissions show up downwind. Also, it is possible that more thorough monitoring and a different advisory protocol would result in more fish advisories in Illinois.

BOX 3: State standards for mercury contamination of fish

In addition to the GLI standards for mercury in water, states also calculate the level of mercury in fish below which the fish are safe to eat without restriction. The Great Lakes states use an EPA guideline for mercury in human diet called a "Reference Dose." EPA has set that level at consumption of .1 micrograms (one-millionth of a gram) of mercury per kilogram of body weight per day. Even with this standard guideline, however, the states have established different levels of contamination at which fish become dangerous to eat. The variations are based on a number of factors, including different assumptions about how much fish people eat and how much people weigh. The states then measure the actual contamination in fish, compare it to the calculated level, and issue fish consumption advisories accordingly.

The Sources of Mercury Pollution in the Rain

The largest source of mercury emissions on a national level are coal-fired power plants (33%), municipal waste incinerators (18%), and medical waste incinerators (10%).[11] Incinerators emit mercury when they burn wastes containing mercury. For medical waste incinerators, waste mercury comes from medical devices like thermometers and blood pressure cuffs. For municipal waste incinerators, mercury is in discarded appliances like fluorescent lights, lamps, and thermostats. Coal-fired power plants produce mercury by burning coal; the coal contains trace amounts of mercury that are released during combustion.

In addition to these industries, it is likely that mercury-cell chlor-alkali facilities (plants that manufacture caustic soda and chlorine) are one of the top mercury emitters nationally. Although these plants are estimated to produce 4.5% of the nation's annual mercury emissions, that estimate is certain to be very low. These plants use enormous, heated baths of mercury in their manufacturing processes. In 1995 they used in aggregate 165 tons of mercury – and reported emitting only 7.1 tons.[12] Because these plants do not incorporate mercury into their products or release mercury in byproducts, they cannot account for the 100-plus tons they used but did not emit. Although these plants cut their usage to 104 tons by 1998, the missing mercury, if emitted into the air, would make the industry – only 12 plants – the largest source in the nation.

In the Great Lakes region, coal-fired power plants, incinerators, and chlor-alkali plants are major contributors of mercury emissions. A state-by-state analysis of the sources is in the following section of this report. This analysis shows that power plants play an even larger role in the region than they do nationally. A 1994 Michigan inventory estimates that 41% of mercury emissions are from coal-fired power plants. In a 1997 study, *Ohio's Mercury Menace*, NWF calculated that 54.8% of the state's mercury emissions were from coal plants. Wisconsin and Minnesota inventories estimate that coal plants produce 39% and 30% of the mercury emissions, respectively, in those states. The chlor-alkali industry also is likely to be a significant contributor in this region. Two of the nation's 12 chlor-alkali plants are in Great Lakes states: one each in Port Edwards, Wisconsin; and Ashtabula, Ohio.

Coal-fired power plants are predicted to contribute an even higher percentage of the basin's mercury in the future. All the other industrial sectors are subject to new air regulations that should reduce their mercury emissions at least to some extent. U.S. EPA has issued final rules requiring the installation of new controls for medical waste and municipal incinerators. Over one hundred hospitals have made pledges to go mercury -free, and a number have shut down their incinerators. The chlor-alkali industry has voluntarily pledged to cut its mercury use and emissions by 50%, and at least one chlor-alkali company has pledged to cut its emissions to zero.

[11] U.S. EPA Mercury Report to Congress, 1997, Volume I.

[12] Report by the Chlorine Institute to U.S. EPA, May 14, 1999; U.S. EPA Mercury Report to Congress, 1997, Volume I.

In contrast, power plants are exempt from new clean air act regulations; they have no requirements to control emissions of mercury. Nor have they pledged to reduce their mercury emissions. In fact, they are planning to burn more coal and emit more mercury.

The only way to reduce power plant emissions is to burn less coal. Although there are pollution control technologies to capture mercury from coal plants, they have never been used in North America because they are not required and they are very expensive. They also are not really effective; the mercury they capture has to be treated as waste and can re-enter the environment. The better alternative is for utilities to burn less coal, which will reduce not only emissions of mercury, but also of pollutants that cause smog, acid rain, and global climate change. In the short-term, that may mean shifting to natural gas. Over the long term, it means conserving energy and using clean renewable energy sources.

Actions Needed to Clean up Mercury Emissions

We can no longer depend on the natural processes – rainfall and snowfall– to cleanse our lakes and streams. Air pollution is fouling the rain with mercury. Until we act, this rain will poison our streams, lakes, and the fish, birds and people whose lives depend on them. All of us in the region are connected to the Great Lakes and their health. If the rain, lakes, streams and fish are poisoned, all of us are at risk.

The remedy is clear: major sources of mercury must cut their mercury emissions by the maximum amount possible, as soon as possible. The United States and Canada have made a commitment in the Great Lakes Water Quality Agreement to virtually eliminate mercury in the Great Lakes. Virtual elimination of mercury in the Great Lakes will require virtual elimination of mercury emissions. No single policy or technology will achieve reductions of that magnitude. Voluntary actions, federal and state policies, and consumer changes by the public all will be necessary to achieve that goal:

Industry actions: Coal-fired power plants must cut and eventually eliminate their combustion of coal. This means promoting energy conservation by consumers, developing new sustainable energy sources, and in the interim, switching to natural gas fuels. Utilities also should inform their customers of the mercury emissions created by their production of energy.

Hospitals and other medical facilities should practice “Mercury Free Medicine” by eliminating mercury from medical waste streams or substituting technologies like autoclaving for incineration of medical wastes. Over 100 hospitals have pledged to go mercury-free in the past year.

Municipal incinerators must separate and remove mercury from their wastestreams and must install state-of-the-art emissions controls on their stacks. The best alternative is for manufacturers to stop using mercury in products. The next best alternative is for consumers to reduce, reuse, and recycle consumer products containing mercury so they never enter the wastestream.

Chlor-alkali plants should phase out their mercury-cell processes. The majority of chlor-alkali facilities in the U.S. have done so already, and use diaphragm or membrane cell processes that do not require mercury.

Federal actions: EPA must control coal-fired power plant mercury emissions under the Clean Air Act. These plants currently are exempt from controls for mercury. Such controls also would reduce other harmful pollutants from these power plants, including pollutants that cause smog, acid rain, and global climate change.

EPA should mandate pollution prevention for all major sources of mercury under the sections of the Clean Air Act designed to protect people, wildlife and the Great Lakes: the residual risk and Great Waters provisions of the Act.

Congress should enact legislation, introduced by Vermont's Senator Patrick Leahy and Maine's Representative Tom Allen, that would require a 95 percent reduction of mercury emissions from all major sources in ten years.

Regional actions: The six midwestern Great Lakes states should commit to a timetable to virtually eliminate mercury emissions in the region. State leaders should develop an action plan to meet that timetable.

State actions: States should require all major sources to install state-of-the-art controls on mercury sources.

States should set and enforce pollution caps of mercury emissions to protect state waterways under the Clean Water Act (the Total Maximum Daily Load, or TMDL, provision). If the states fail to set and enforce these caps, then the U.S. EPA must take over.

State energy commissions should determine the true costs of coal-burning power plants – including their pollution costs – on the industry. Determining the pollution costs will make energy conservation and fuel conversion more cost effective. If utilities fail to so do voluntarily, the state commissions should require them to inform their customers of the amount of mercury they emit in generating power, and to finance other initiatives that reduce mercury emissions, such as collection and recycling of mercury-bearing products.

Individual actions: Conserve energy by, for example, purchasing energy-efficient appliances and weatherizing your home.

Avoid purchasing consumer products that contain mercury. Those that are purchased should be recycled.

Call on industries, EPA, Congress, and state officials to take the actions described above that are necessary to clean the rain.

A Call to Action: A Campaign to Clean the Rain

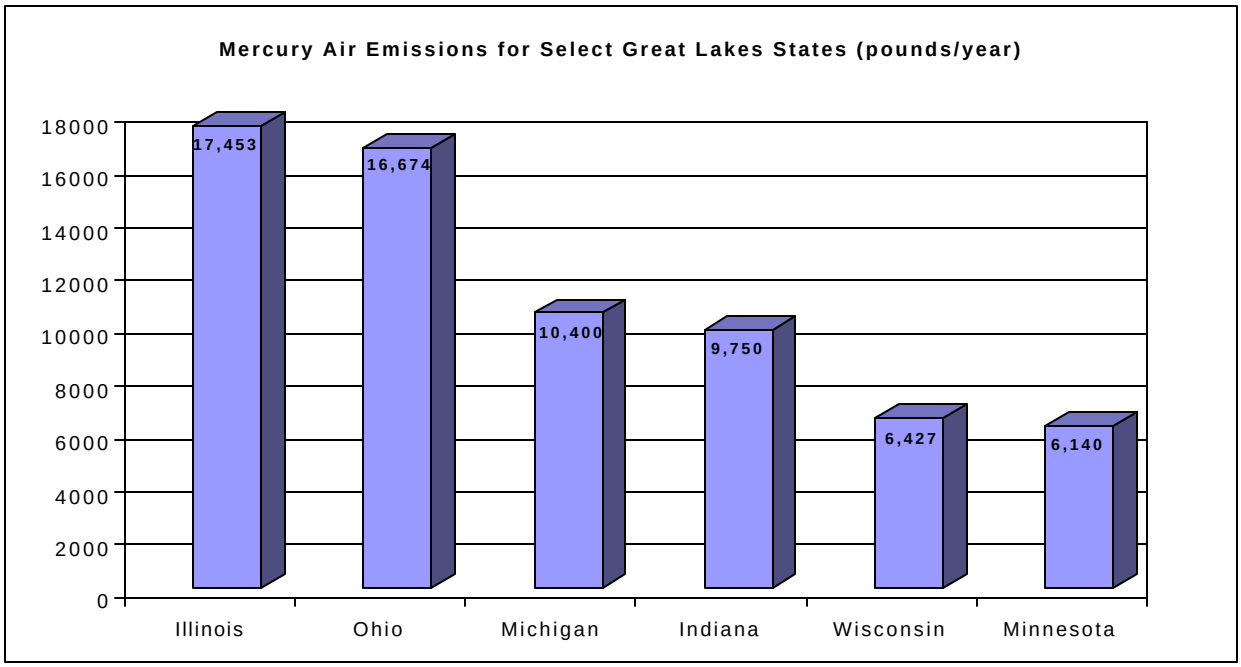
The challenge is before us: we must dramatically reduce, and eventually eliminate, mercury emissions to clean our rain and our lakes. The National Wildlife Federation, in cooperation with a coalition of conservation and environmental organizations, has launched the "Clean the Rain Campaign" to press the virtual elimination of mercury emissions. The Clean the Rain Campaign will push state and federal governments to do more monitoring of mercury in rainfall. In key locations, NWF will itself sponsor sampling of rain if the governments fail to do so. NWF is working with research scientists at the University of Michigan and the University of Minnesota to track and, if necessary, implement the sampling of rain for mercury. The first cities targeted for additional monitoring are Chicago, Cleveland, Detroit, Duluth, and Gary, Indiana.

The need for action on mercury pollution is urgent. Governments, industries, and the public must act together to reduce mercury emissions. To save our lakes, our wildlife, and ourselves, we must do no less than clean the rain.

State-By-State Analyses

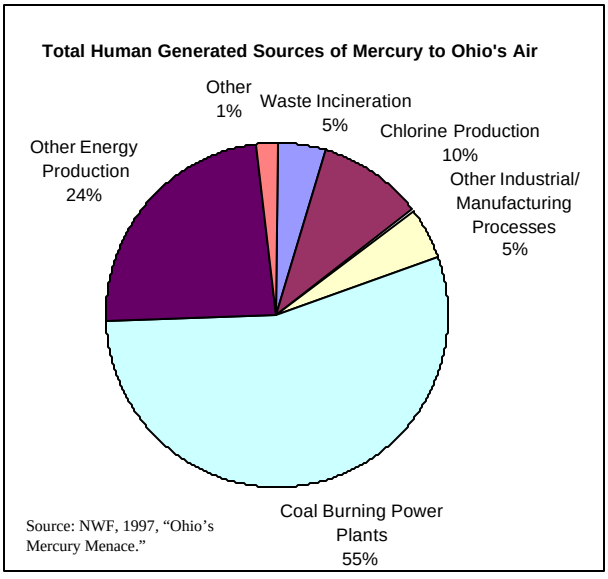
Mercury in Ohio

Mercury was recognized as a pollutant of concern in Ohio in 1997 when the state issued a statewide advisory warning people to restrict their consumption of fish caught in Ohio waters due to mercury contamination. Most of Ohio's mercury contamination comes from air pollution. Ohio mercury emissions to the air are much higher than most other Great Lakes basin states. For example, Ohio mercury air emissions are more than two times higher than the emissions of both Wisconsin and Minnesota. Much of this difference is due to coal-burning utilities, which account for over half of the mercury being released to Ohio's air.



Total Mercury Emissions to Ohio's Air

Overall, Ohio mercury emissions to the air from human-generated sources total approximately 16,674 pounds per year. The biggest sources of mercury to Ohio's air are fossil fuel combustion, industrial processes, diffuse sources, and waste incineration (see pie chart). Fuel combustion, waste incineration, and industrial processes account for 91 percent of total human-generated mercury loadings into Ohio's air. Of all these sources, the largest sector of mercury emissions is fossil fuel combustion (67.6 percent). Of the estimated 11,277 pounds of mercury released from fossil fuel combustion, 94 percent is attributed to coal combustion. In 1994, coal-burning utilities in Ohio released 54.8 percent of the overall emissions of mercury to Ohio's air.



Mercury in Ohio

Ohio also has one of the twelve remaining chlor-alkali plants (chlorine production) remaining in the United States. The chlor-alkali industry can account for less than 10 percent of the mercury it uses each year; the fate of the other 90-plus percent is unknown. The twelve chlor-alkali plants in the United States that still use mercury are documented to contribute 4.5 percent of the mercury emissions without the missing mercury. With it, actual emissions may be an order of magnitude higher than are currently reported, according to specialists in EPA. In Ohio, Ashta Chemicals chlor-alkali plant reported releasing 1,653 pounds of mercury into the air for 1997 (Toxic Release Inventory data).

Spotlight on…
The Lake Shore Powerplant, Cleveland, Ohio

The Lake Shore Powerplant is a coal-fired power plant located on the shore of Lake Erie near Cleveland, Ohio. Constructed over 50 years ago, the plant has little or no pollution control equipment because the stricter emission standards required of new coal plants under federal law are not required of this grandfathered unit. Because of this loophole in the law, the Lake Shore Plant and other old, coal-burning power plants are able to pollute at significantly higher rates than new coal plants.

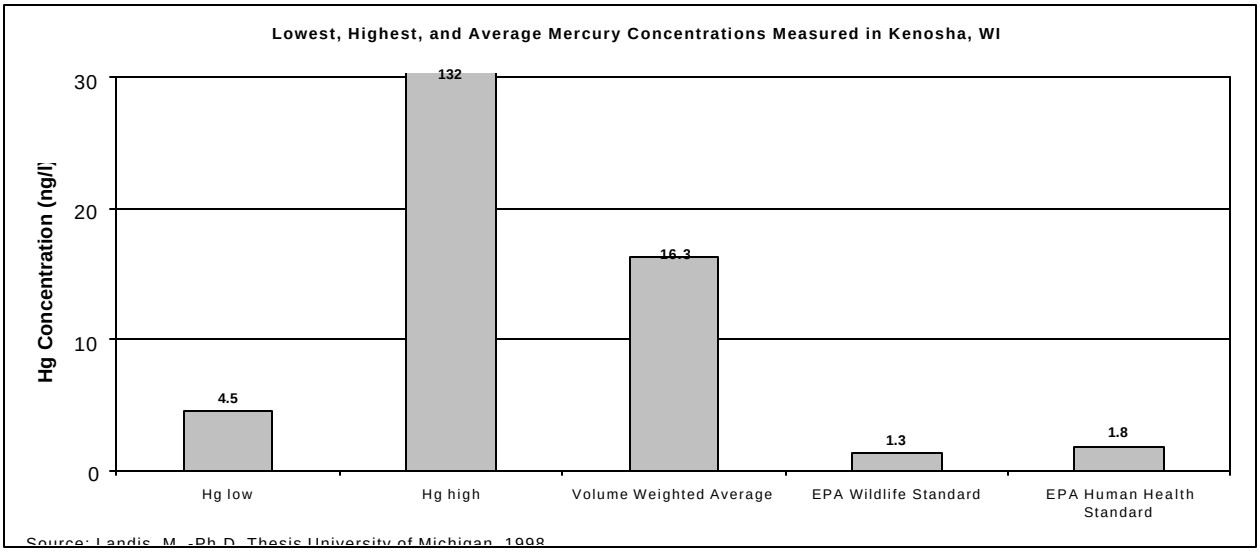
If a plant makes any modifications that increase the amount of air pollution it emits, the Clean Air Act does require that plant to comply with the more strict standards adhered to by newer sources. The Lake Shore Plant recently asked the State of Ohio to increase its hours of operation so that it may produce electricity around the clock. Because continuous operation means the plant is planning to change its method of operation in a way that will increase emissions, under the Clean Air Act, the Lake Shore plant should be considered a new plant. A plant built today would not be allowed to operate without pollution controls. Neither should the Lake Shore plant.

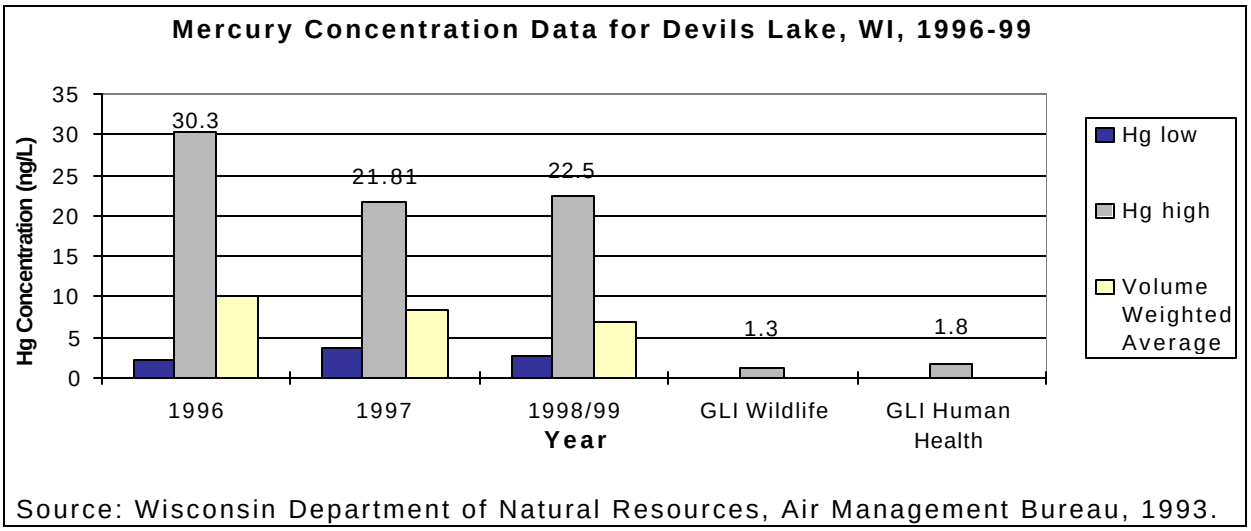
Mercury in Wisconsin

Wisconsin has issued fish consumption advisories due to mercury contamination in 330 lakes. According to the Wisconsin Department of Natural Resources (WDNR), significant progress has been made in reducing the direct discharge of mercury to the state's waterways by industrial and municipal sources. Most of the mercury now entering the waters of Wisconsin is coming from the air.

Mercury in Wisconsin's Rain

Wisconsin's rain is highly contaminated with mercury. In Kenosha, scientists measured mercury in rain as high as 73 times the EPA human health standard for water in the Great Lakes. Even in remote areas, like Devil's Lake, the mercury in rain has been measured as high as 17 times the EPA standard.



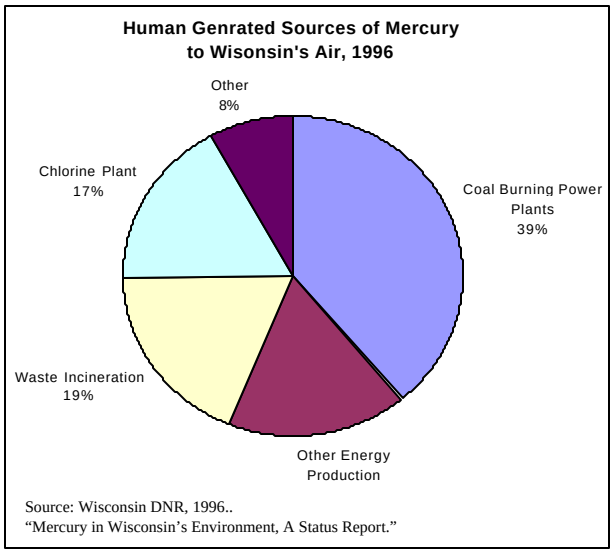


The impact of the mercury-contaminated rain is serious: the state has had to issue fish consumption advisories due to mercury in Wisconsin lakes. The rain contaminated the lakes, which contaminated the fish. Now people and wildlife that eat the fish are in danger.

Mercury in Wisconsin

Total Mercury Emissions to Wisconsin's Air

Significant progress has been made in reducing the direct discharge of mercury to the state's waterways by industrial and municipal sources, according to the Wisconsin DNR. But air emissions of mercury remain high -- and those are the sources of mercury in the rain. The WDNR's Air Emissions Inventory estimated 1996 mercury air emissions at approximately 6,427 pounds, by far the majority of all mercury emissions in the state.



There are a variety of mercury air pollution sources in Wisconsin, including energy production, waste incineration, and chlorine production (see pie chart). The greatest amount of mercury emissions comes from energy production, which accounted for 56 percent of the state's total mercury air emissions in 1996. The largest portion of energy emissions comes from burning coal for electricity. About 2,000 pounds of mercury, or roughly one third of the state total, enters the air from the smokestacks of utility-owned coal burning power plants.

Wisconsin mirrors other states in that coal burning power plants are the lead sources of mercury emissions. What differentiates Wisconsin from most states, though, is that they have one of twelve mercury cell chlor-alkali plants (chlorine production) in the United States. In Wisconsin, Vulcan Chemicals chlor-alkali plant releases 1,143 pounds of mercury into the air annually (Toxic Release Inventory data, 1996). Chlor-alkali plants could, and should, eliminate mercury emissions by switching to a non-mercury cell process technology.

Spotlight on…
WDNR's Strategy for Mercury Reductions

The WDNR recently issued the final draft of its White Paper on a mercury reduction strategy for the state of Wisconsin. The purpose of the paper was to stimulate meaningful discussion and movement toward real reductions in mercury air emissions in Wisconsin and nationally.

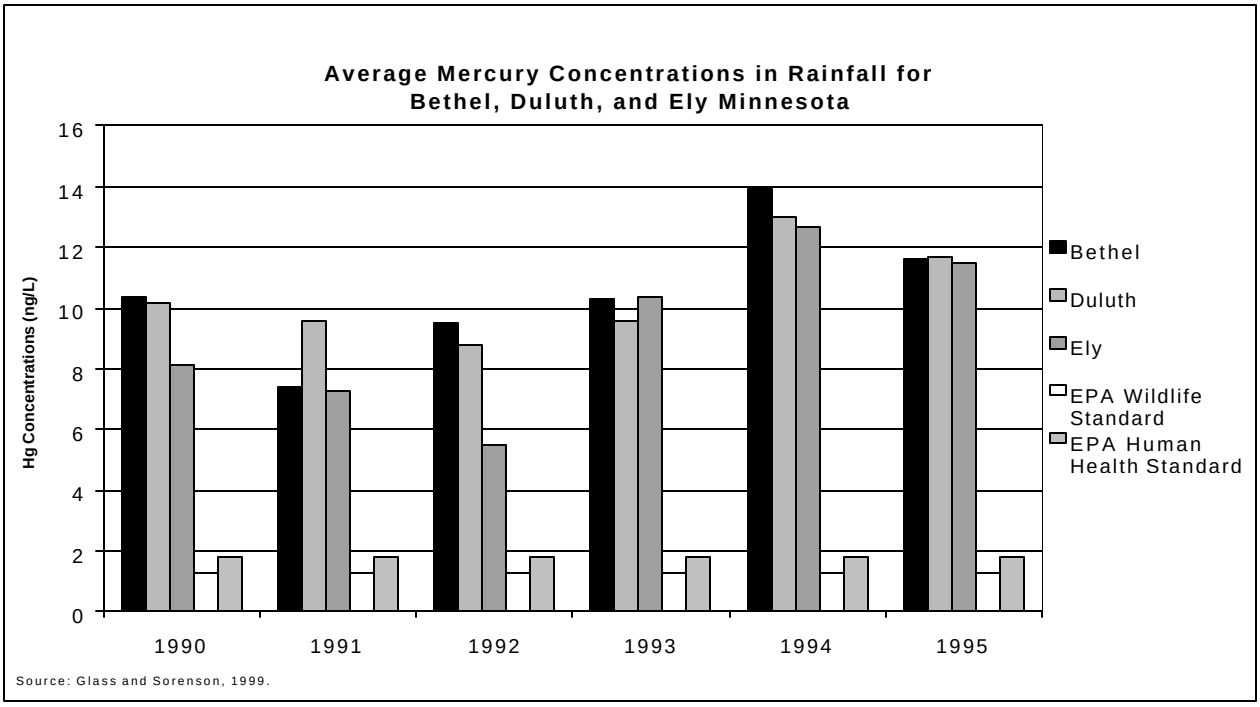
The initiative's goal is to achieve, from 1999 levels, a 20 percent reduction in Wisconsin mercury emissions by the year 2005, a 35 percent reduction by 2010 and a 50 percent reduction by 2015. The paper presents guiding principles toward attaining these goals, including that air emission reduction should be accomplished cost-effectively, that reductions must be real and result in reduced deposition of mercury to water bodies, that the system should have a "check" phase built in, that society as a whole should bear some of the responsibility to reduce mercury levels, and that the issue of long term storage of mercury be addressed in any reduction of discharge recommendations.

Mercury in Minnesota

Minnesota is a state of many pristine lakes, rivers and other natural areas. The state has recently been taking steps to reduce mercury pollution, resulting in a 40 percent reduction in mercury air emissions from 1990 levels. Unfortunately, not all mercury air pollution sources are doing their fair share.

Mercury in Minnesota's Rain

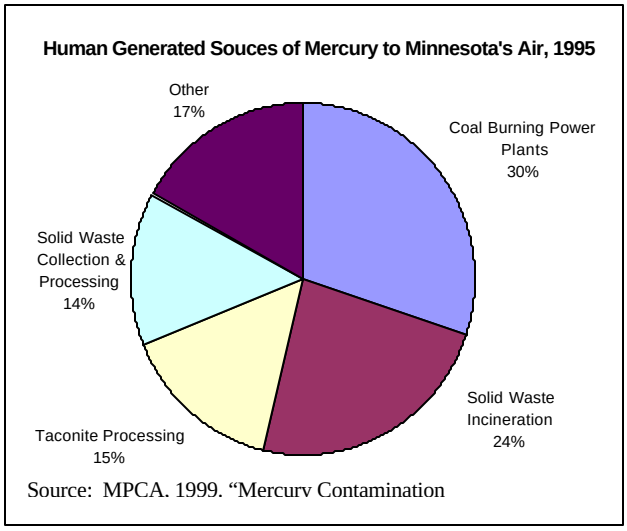
The mercury in Minnesota's rain has been measured since 1990. Hundreds of samples taken in Duluth, Bethel (near the Twin Cities), Ely, and other locations demonstrate that the mercury concentrations in rain are high, and getting higher. The six-year **average** concentration of mercury in Duluth's rain in 10.5 nanograms per liter -- or almost six times higher than the EPA human health standard for mercury in Great Lakes water. The six-year average concentration is Bethel is the same. One study concludes that Minnesota's mercury contamination is getting worse; it estimates that from 1990 to 1995, the deposition of mercury in precipitation increased eight percent per year.



The consequences of the contaminated rain are clear in Minnesota: the state has issued fish consumption advisories for 780 lakes that have been tested for mercury, and has advised restricted fish consumption for the remainder of Minnesota's lakes. The rain has contaminated the water, which has contaminated the fish. To clean the lakes and the fish, Minnesota must first clean the rain. That means controlling air emissions of mercury.

Total Mercury Emissions to Minnesota's Air

In March of 1999, the Minnesota Pollution Control Agency issued its "Report on Mercury Contamination Reduction Initiative Advisory Council's Results and Recommendations." The inventory of mercury emissions contained within this report estimated that as much as 6,140 pounds were released into Minnesota's air in 1995. The sources of these emissions include energy production, waste incineration and taconite (raw material for steel production) processing (see pie chart).



Source: MPCA. 1999. "Mercury Contamination

Powerplants are the largest source of mercury emissions in Minnesota, and have done almost nothing to control mercury pollution. While mercury emissions from almost all sources is expected to decline in Minnesota, emissions from power plants are expected to rise. For example, between 1990 and 1995, municipal solid waste incinerator emissions in Minnesota were cut by 65 percent, and new federal regulations will result in even deeper reductions. There are no comparable regulations that require power plants to reduce their mercury emissions. According to the MPCA's Mercury Contamination Reduction Initiative, mercury emissions from power plants have been steady since 1990, and are projected to rise to 40 percent of Minnesota's total mercury air emissions by 2005.

Spotlight On…
MPCA's Mercury Contamination Reduction Initiative

The State of Minnesota recently introduced a statewide mercury-reduction initiative. The initiative's goal is to reduce mercury emissions in Minnesota from 1990 levels 60 percent by the year 2000 and 70 percent by 2005. A statewide effort to reduce mercury pollution is only a beginning. Much of the mercury that enters Minnesota's lakes comes from the air that blows into Minnesota. For that reason, the MPCA and environmentalists around the region are exploring ways that Minnesota can cooperate with other Great Lakes states in a regional effort to reduce mercury pollution.

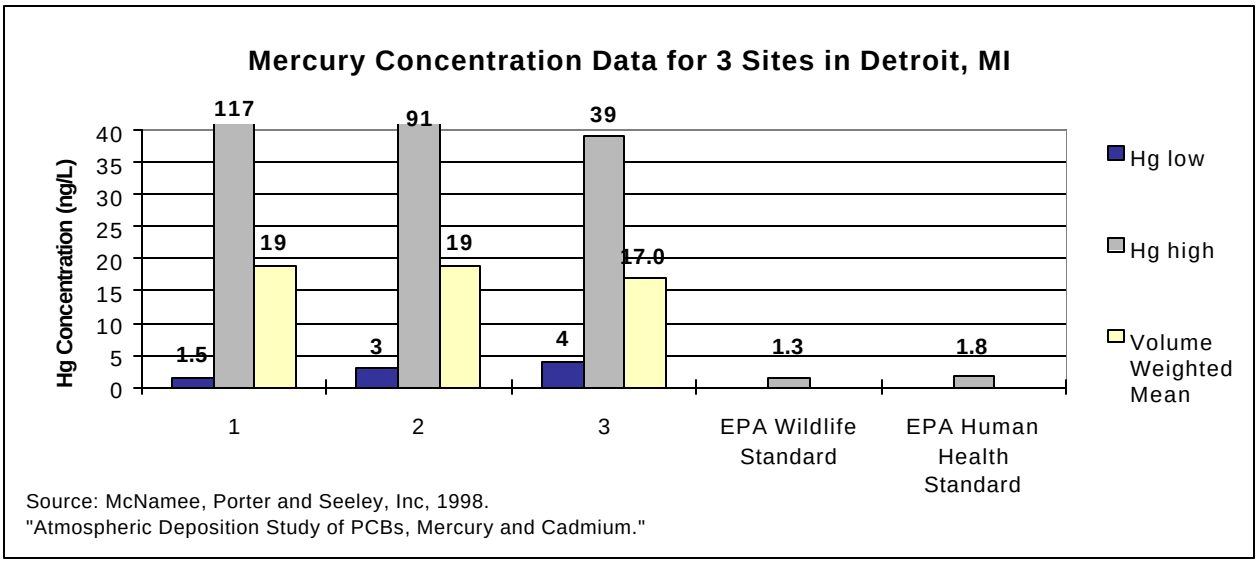
Minnesota's mercury reduction strategy is a critical step in reducing mercury emissions within the state, but it is also important in that it will help the governments of Canada and the United States achieve the goals they established under the Binational Program to Restore and Protect the Lake Superior Basin, which includes zero discharge of mercury and other toxic chemicals to Lake Superior.

Mercury in Michigan

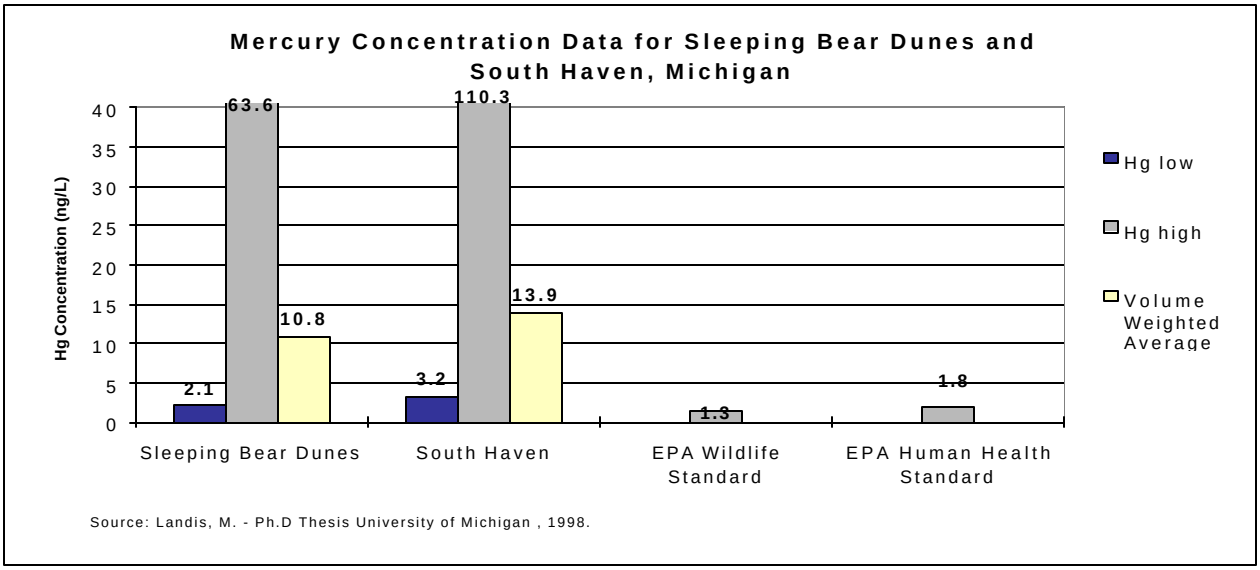
The state of Michigan has identified mercury as one of the primary pollutants of concern for decades. Since 1988, mercury-contaminated fish have resulted in the Michigan Department of Public Health issuing state-wide fish advisories for all of Michigan's 11,000 inland lakes. This is a devastating situation, considering Michigan's economic dependence on its anglers, who spend over $1.8 billion per year, and the large overall economic impact of sport fishing on Michigan's economy ($3.7 billion). Every year tourism is one of the top three income generators in the state (the other two are the auto industry and agriculture). Much of the tourism industry relies on the Great Lakes and the inland lakes to draw tourists. The health of Michigan's waters affects the health of Michigan's economy.

Mercury in Michigan's Rain

Michigan's rain is heavily contaminated with mercury. In Detroit, scientists measured mercury in the rain at levels that were as high as 65 times the EPA human health standard for mercury in Great Lakes water. In South Haven, mercury contaminated the rain at levels as 61 times the EPA human health standard. Even in remote locations like Sleeping Bear Dunes, the rain contained mercury at levels as high as 35 times the EPA human health standard.



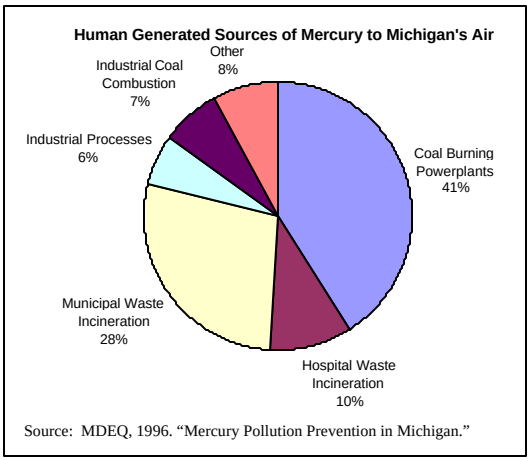
Source: McNamee, Porter and Seeley, Inc, 1998.
"Atmospheric Deposition Study of PCBs, Mercury and Cadmium."



Source: Landis, M. - Ph.D Thesis University of Michigan , 1998.

Total Mercury Emissions to Michigan's Air

Air pollution has contaminated Michigan's rain with mercury to these unsafe levels. According to the Mercury Pollution Prevention Task Force, it is estimated that as much as 10,400 pounds of mercury are released into the atmosphere annually. Combustion sources account for a majority of the mercury that is released into the environment both within the state of Michigan and nationally. Electric utilities that burn coal for fuel and incinerators that burn medical and municipal waste for disposal comprise the top source categories of mercury contributors to Michigan's air.



Source: MDEQ, 1996. "Mercury Pollution Prevention in Michigan."

Coal burning powerplants are the largest source of mercury in Michigan, accounting for 41 percent of the state's total anthropogenic mercury emissions. Waste incinerators are also a major source of mercury air emissions in Michigan. There are different types of waste that are incinerated for disposal, including municipal waste, waste from hospitals, and hazardous waste. All of these types of incineration combined account for 40 percent of the mercury released into Michigan's air annually. The Michigan Department of Environmental Quality is in the process of promulgating new emission standards for medical and hazardous waste incinerators. While the regulations call for tighter standards than the Federal government requires for mercury, the standard is still not as tough as is economically and technologically possible.

Spotlight On…*Electric Utility Restructuring in Michigan*

Nationally, the electric industry is in transition – moving away from the traditional vertically integrated monopoly utility provider towards an industry structure that reflects some deregulation and competition, particularly within the generating sector. Michigan is particularly feeling the heat of oncoming competition. It is anticipated that the legislature will take action in its fall 1999 session.

Michigan's impending transition to price competition has led to cuts in programs like energy efficiency and Demand Side Management because they are no longer seen as profitable in the short term. The cuts in spending have compounded the need for more power, contributed to the power supply shortages that have plagued the state in the last few summers, and created additional markets for older, dirtier coal plants. These plants enjoy economic advantages over newer plants because they are exempt from Clean Air Act requirements for meeting stricter air pollution standards.

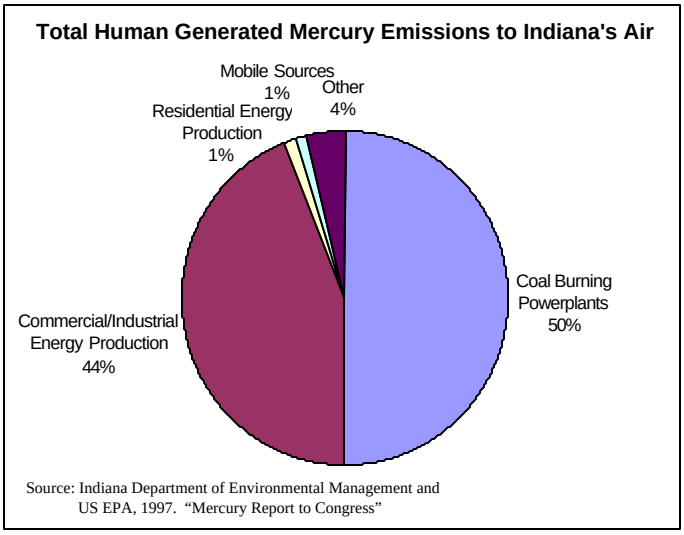
With the advent of competition, Michigan must true-up the costs of electric generation to reflect the environmental costs of electric generation. Any deregulation proposal must include mechanisms to fund energy efficiency programming, incorporate renewable resources, and provide billing disclosure information. Environmental groups in Michigan are currently working to see that these changes are included in any deregulation package that is considered by the legislature.

Mercury in Indiana

While Indiana does not stand out as the largest producer of mercury air emissions when compared to other Great Lakes states, it does have the fourth highest among states with the highest mercury emissions from power plants in the nation. Trailing only Texas, Pennsylvania, and Ohio, Indiana power plants spew 7,964 pound of mercury into Indiana's air annually, according to the U.S. EPA.

Total Mercury Emissions to Indiana's Air

The Indiana Department of Environmental Management (IDEM) is in the process of finalizing a regional inventory of mercury emissions. While this number may change in the final report, it is estimated that 9,750 pounds of mercury are released into Indiana's air annually. Municipal waste incineration, hospital incineration and steel manufacturing all contribute to the mercury contamination problem in Indiana, but the major contributor is energy production – particularly coal burning power plants. Coal burning power plants are the largest source of mercury contamination in the United States. National estimates from U.S. EPA indicate that 32.6 percent of the total mercury released into the air comes from this source. Regionally, the Great Lakes Commission estimates that in 1993, 54 percent of mercury emissions came from the electricity generation sector. In Indiana, Hoosiers rely on coal-fired utilities to supply most of their electricity. In fact, 98 percent of Indiana's electricity is generated from the burning of coal. It is no surprise to find that 50 percent of Indiana's mercury emissions come from coal burning power plants.



Source: Indiana Department of Environmental Management and US EPA, 1997. "Mercury Report to Congress"

Top three coal-fired utilities closest to these seven lakes and reservoirs

Lake	Closest Utility/Plant	Coal burned in '96 (tons)	Mi.	2nd Closest Utility/Plant	Coal burned in '96 (tons)	Mi.	3rd Closest Utility/Plant	Coal burned in '96 (tons)	Mi.
Lake James	NIPSCO Michigan City	1,460,880	85	NIPSCO Schafer	4,404,555	100	NIPSCO Bailly	1,272,046	100
Olin Lake	NIPSCO Schaffer	1,460,880		NIPSCO Michigan City	4,404,555	90	NIPSCO Bailly	1,272,046	90
Oliver Lake	NIPSCO Schaffer	1,460,880	85	NIPSCO Michigan City	4,404,555	80	NIPSCO Bailly	1,272,046	90
Lake Wolsaw	NIPSCO Michigan City	1,460,880	55	NIPSCO Schaffer	4,404,555	60	NIPSCO Bailly	1,272,046	60
Lake Wawasee	NIPSCO Michigan City	1,460,880	60	NIPSCO Schaffer	4,404,555	65	NIPSCO Bailly	1,272,046	65
Eagle Creek* Reservoir	IP&L CO Stout	1,345,179	15	Electric L&P Crawfordsville	9400	35	Cinergy Cayuga	2,378,664	60
Patoka** Lake	Jasper Municipal	Not required to report	12	IP&L CO Petersburg	5,104,997	90	Hoosier Energy Rents Station	3,188,071	30

*Indianapolis's high mercury levels are also due in part to a municipal waste incinerator and medical waste incinerators that are located within Marion County. **Cinergy's Edwardsport plant 35 miles away used 154,178 tons of coal in 1996, Cinergy's Gibson plant 60 miles away used 7,640,597 tons of coal in 1996, and AEP's Rockport plant 80 miles away used 10,100,285 tons of coal in 1996. These all are potential contributors to mercury air deposition in Patoka Lake.

Source: Hoosier Environmental Council, 1999. "Air Raid: Mercury Falling into Indiana's Lakes."

The Hoosier Environmental Council (HEC) recently released a report illustrating how the burning of coal contributes to mercury contamination of lakes in Indiana. Based on national computer modeling of mercury emission source locations, wind, and precipitation, HEC concluded that a large part of the mercury in those lakes studied came from the stacks of local power plants.

Under the Clean Air Act, there are no requirements to monitor or control mercury emissions at coal-fired power plants. Power plants are the largest source of mercury emissions that are not regulated. Because Indiana ranks fourth in the nation for mercury emissions from power plants, the state needs to play a larger role in controlling mercury emissions from this sector.

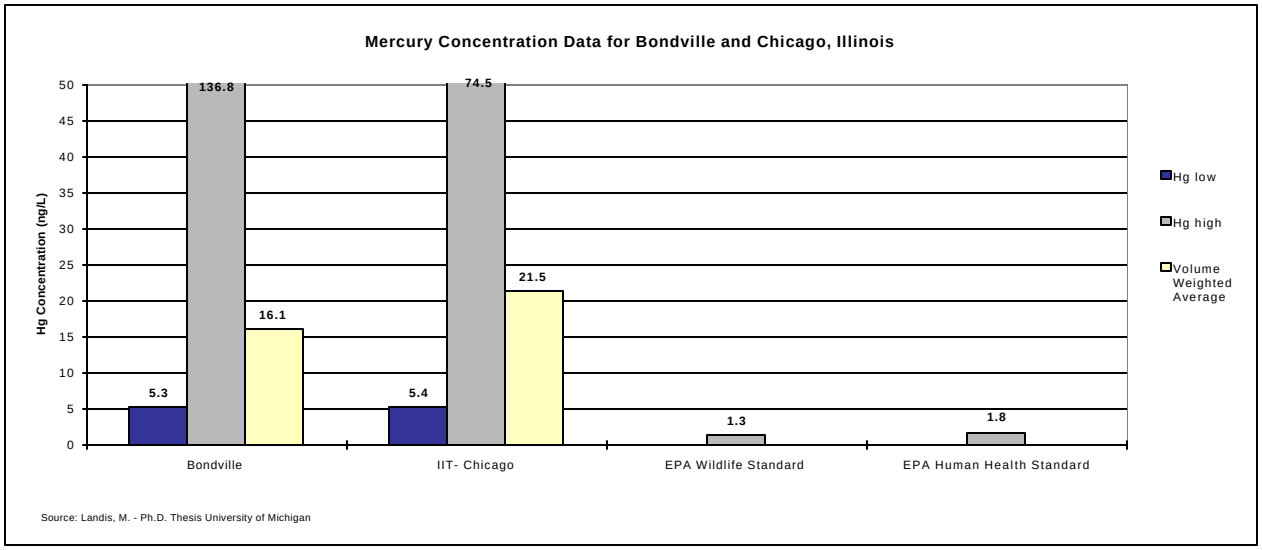
Spotlight on…
The Fish Consumption Advisory, Indiana

The Indiana Department of Health began warning people about the levels of mercury in the late 1970's and have increased the warnings every year. Consumption restrictions are based on a person weighing 150 pounds who eats an 8 ounce meal and has an unlimited diet of fish (225 meals per year). The levels assigned are based on a reference dose: the recommended daily dose of mercury that can be safely consumed over a lifetime. This reference dose is established by factoring in the amount of mercury in an 8 ounce meal per pound of body weight. The Indiana Department of Health's epidemiologists extrapolate the levels of safety based on the levels of mercury in the fish and the health risk related to the types of people that are at risk when eating fish, such as women and children, and establish separate categories for those special populations.

Today, the fish consumption advisory includes the whole state, putting all fish (211 species) under a general advisory. However, a more detailed advisory for fish consumption is produced that specifically cites lakes and specific fish. That booklet from the Health Department lists 47 specific lakes and includes 15 species of fish.

Mercury in Illinois

Those who live in Illinois, particularly those located in the city of Chicago, love to recreate in Lake Michigan. Whether enjoying the many beaches along the Lake Michigan shoreline, taking the kids for a swim, or setting sail in the lake's deep waters, those that live near Lake Michigan have a deep appreciation for what it provides. What these people may not know is that every time it rains or snows, mercury is falling down into Lake Michigan and contaminating the lake they love.

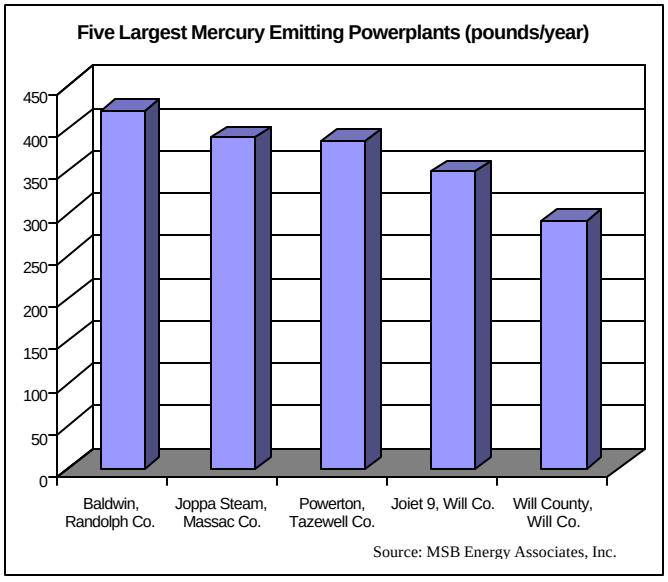


Mercury in Illinois' Rain

The rain in Illinois is highly contaminated by mercury. Chicago's rain was measured as having an average mercury concentration that is 12 times higher than the EPA human health standard for mercury in Great Lakes water. Some Chicago rain contained mercury that was 41 times higher than the EPA safe level. Even rain in southern Illinois contains high levels of mercury: in Bondville, the average concentration of mercury in the rain was nine times the EPA level. The high mercury concentrations in Bondville rain indicate that mercury pollution can travel several hundred miles before it falls to earth in rain.

Total Mercury Emissions into Illinois' Air

Mercury emission data for Illinois is limited. The only information on the amount of mercury that is released into Illinois' air annually was found in the Great Lakes Commission's "Great Lakes Regional Air Toxic Emissions Inventory." The purpose of this inventory was to quantify and manage the toxic air emissions that impact the waters and communities of the Great Lakes basin. This inventory, based on 1993 data, includes data from all eight Great Lakes sates and the province of Ontario. The data for Illinois indicated that 17,452 pounds of mercury were emitted in Illinois in 1993. When asked, the Illinois Environmental Protection Agency (IEPA) stated that they were comfortable

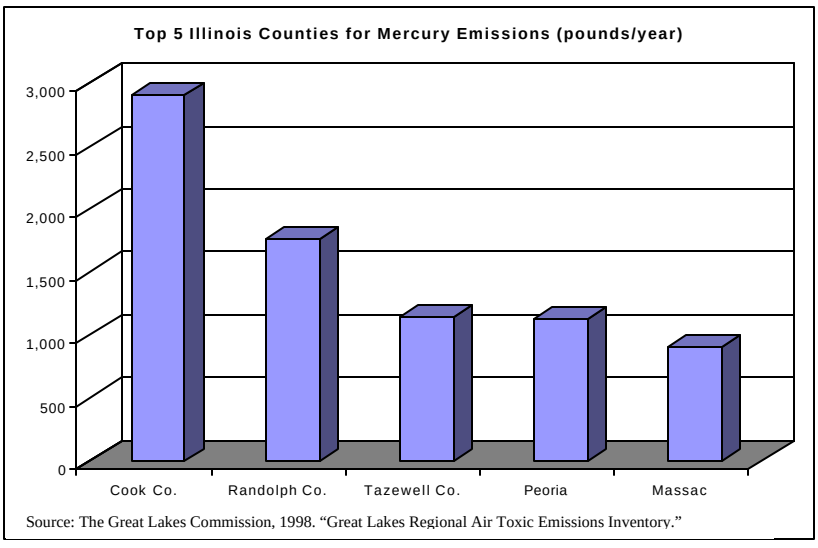


with the accuracy of that estimate, and believe it has not changed significantly over the past six years.

Because of the data gaps that exist within IEPA regarding mercury emissions, it is not clear how much each source contributes to the grand total. A briefing on mercury developed by the U.S. EPA for the Binational Toxic Strategy stated that most of the mercury in the Great Lakes is the result of air emissions. This briefing also included a mercury emission inventory of the different sources of mercury emissions nationwide, and the contribution they make to the total amount of mercury emitted in the United States in 1994. According to this inventory, the largest measured human-caused air sources in the United States are combustion of fossil fuels by electric utilities (33 percent) and industry (18 percent), and the incineration of mercury-containing products found in municipal (19 percent) and medical wastes (10 percent). The IEPA indicated it believes the sources and percent contributions calculated for nationwide estimates are indicative of Illinois.

Illinois Top Mercury Emissions

The Great Lakes Commission's "Great Lakes Regional Air Toxic Emissions Inventory" contained an inventory of mercury emissions for every county in Illinois. Cook County led the pack with 2,913 pounds of mercury annually spewed into the air, which is no surprise since Chicago and its many industries are located within the county's borders. Randolph County ranked second with 1,765 pound, which also is not surprising since the largest mercury emitting power plant in Illinois is located in that county. The county with the third largest mercury emissions was Tazewell with 1,146 pounds, the home of the state's third most polluting coal-fired power plant in terms of mercury. Ranking fourth is Peoria County with 1,125 pounds, which can be attributed to the combustion of fossil fuels by electric utilities (E.D. Edwards powerplant) and industries in that area. Fifth out of Illinois' 102 counties was Massac County with 910 pound of mercury emitted annually. Illinois' second largest mercury emitting powerplant, Joppa Steam, is located in Massac County.



Source: The Great Lakes Commission, 1998. "Great Lakes Regional Air Toxic Emissions Inventory."

Spotlight on…*The Illinois Clean Energy Community Trust*

The Illinois Clean Energy Community Trust is a new $250 million foundation established to encourage the development of energy efficiency and renewable energy in Illinois. It is a national model of cooperation between environmentalists, utilities, and legislators. The Trust will be funded by a one-time payment of $250 million by Commonwealth Edison as a public interest environmental condition of its proposed coal plant sale and as part of legislation approved by the Illinois General Assembly in May 1999 and signed by Governor Ryan on June 30, 1999. Although the start-up capital will be provided by Commonwealth Edison, the Trust will be established as an independent foundation governed by a group of trustees appointed by the Illinois General Assembly, the Governor, and Commonwealth Edison.

Appendix 1: Sources of Data on Mercury Deposition in Rain

Data for this report were obtained from several sources, including publicly available databases, peer-reviewed literature, a contract project, and work from a University research group that is undergoing peer review. Brief descriptions of the methodology used to handle the data follow; details of methodology used to collect the data are available from the original sources.

Detroit Wastewater and Sewerage District

Mercury in precipitation data were collected as part of an effort to determine the contribution of atmospheric loadings of certain toxic chemicals to surface runoff, as it relates to the Detroit Wastewater Treatment Plant processes. Samples were taken at three sites within the City of Detroit - Livernois Center (LV), St. Maron's Church (SMC) in a light industrial area, and Rouge River Park (RRP) in a residential area. Modified MIC wet-only collectors were used to collect precipitation. Collection and analysis was done by the Air Quality Laboratory at the University of Michigan. Volume-weighted means, medians, and ranges were presented for precipitation mercury data.

Glass and Sorensen, 1999

Precipitation mercury data were collected at six Upper Midwest sites for a period of six years, 1990 - 1995. MIC wet-only collectors were used for weekly integrated sampling. The paper presents seasonal and annual total mercury concentrations and deposition rates, along with other more limited data for methylmercury in precipitation. Volume-weighted mean concentrations obtained on an annual basis are presented in this report.

Landis, M.

Data were obtained from the University of Michigan Air Quality Laboratory from the dissertation of Dr. Matt Landis. Modified MIC wet-only collectors were used for event sampling for mercury at five sites, including Bondville in central Illinois and the IIT campus in Chicago, Kenosha, Wisconsin, and Sleeping Bear Dunes and South Haven, Michigan. Event data are presented in plots in this appendix, and volume-weighted means and ranges were obtained directly from Dr. Landis' dissertation.

Mercury Deposition Network

The Mercury deposition Network (MDN) is a subnetwork of the National Atmospheric Deposition Program (NADP), formally begun in 1996. The purpose is to develop a national database of precipitation concentrations of mercury based on weekly integrated wet-only samples. The network utilizes Aerochem Metrics wet-only collectors operated by local partners, and analyses are done at Frontier Geosciences. Data are presented with quality ratings of A, B or C, based on problems with sample collection or analysis, with "A" samples indicating no problems with sample collection or analysis. For this report, data were downloaded for the four sites in Minnesota and Wisconsin (mostly rural sites in the northern sections of the states), and only data from "A" samples were used in presentations and data summaries. Mercury minima, maxima, and volume-weighted mean values were calculated based on all "A" data for each site.

Wisconsin Department of Natural Resources

Data for Devil's Lake, Wisconsin was obtained from the Wisconsin Department of Natural Resources (DNR). Total mercury concentrations were obtained via a passive bulk collector, with samples collected on a weekly basis. Samples were classified into five categories based on sample condition. Only "A" category samples were used for presentations and data summaries in this report. Mercury minima, maxima, and volume-weighted mean values were calculated based on all "A" data for the periods 1996, 1997, and 1998-99.

Data References

Detroit Wastewater and Sewerage District, Atmospheric Deposition Study of PCBs, Mercury, and Cadmium, Phase I Final Report: Project Summary and Recommendations, Dec. 1998.

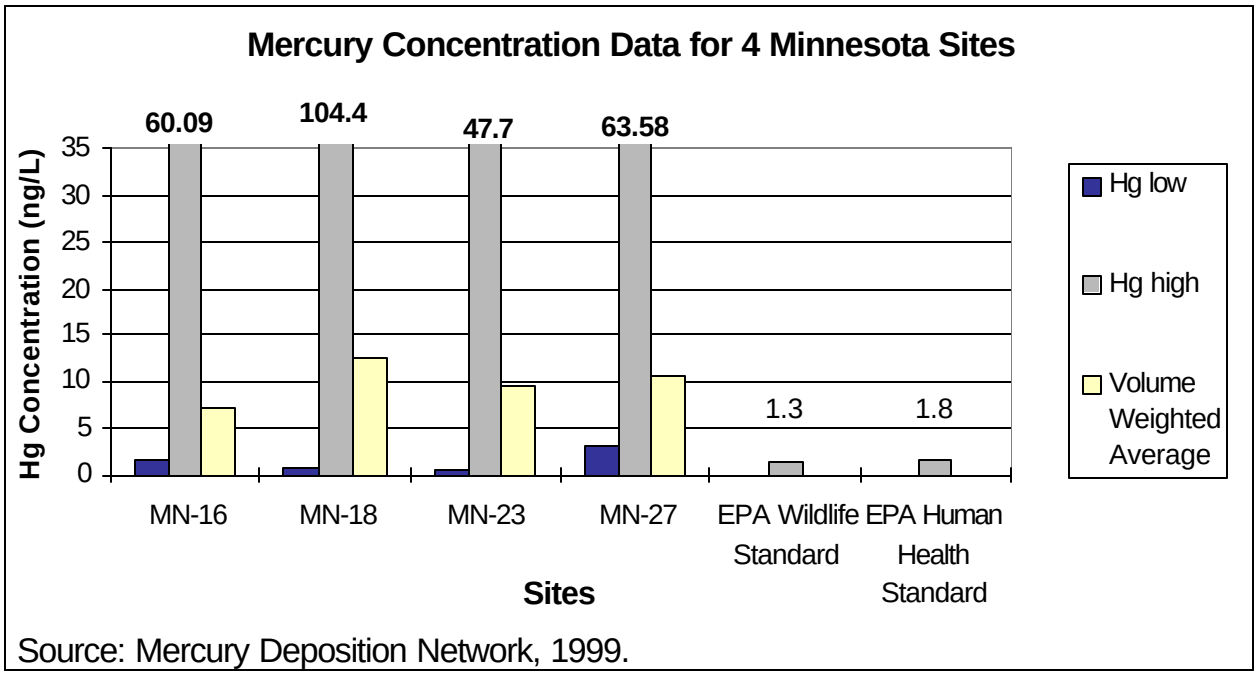
Glass, G.E. and Sorensen, J.A., *Environmental Science and Technology*, to be published in V. 33, N. 20, (Oct. 15, 1999). Available online prior to print publication date, with permission of authors.

Landis, M. Ph.D. Thesis, University of Michigan, Ann Arbor, MI, 1998.

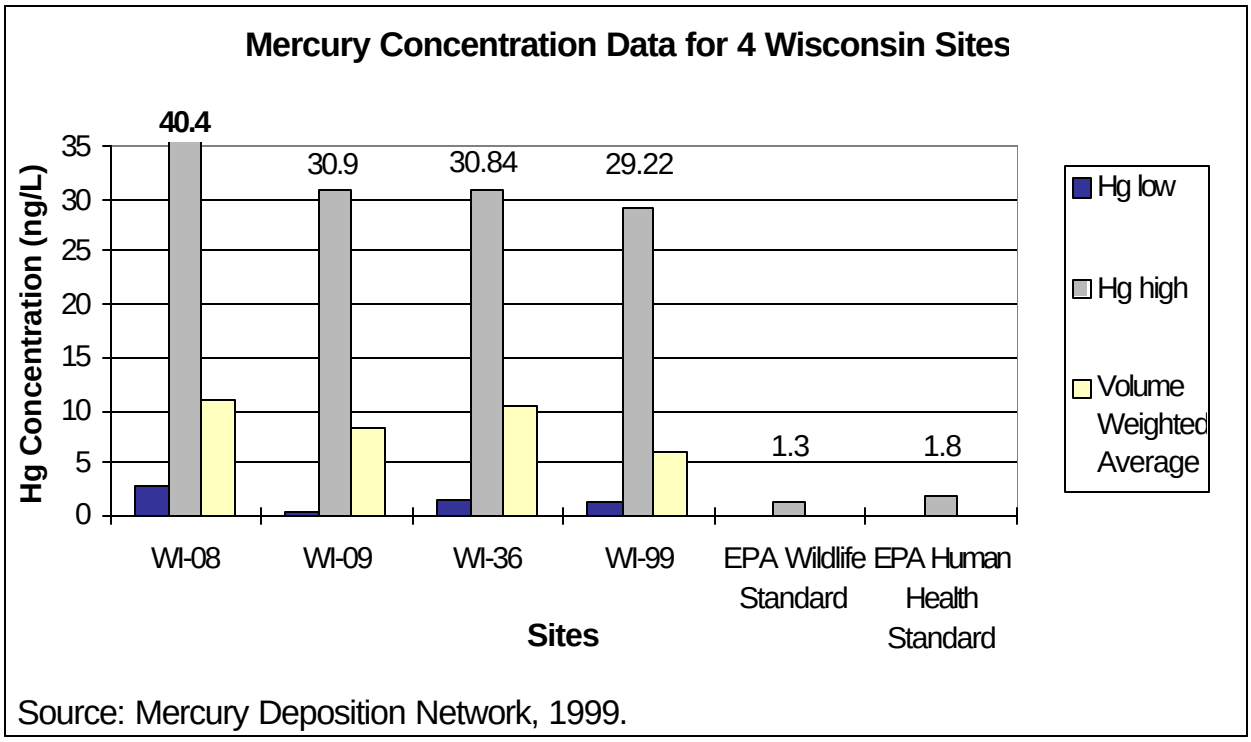
Mercury Deposition Network: National Atmospheric Deposition Program (NRSP-3)/Mercury Deposition Network. (1999). NADP Program Office, Illinois State Water Survey, 2204 Griffith Drive, Champaign, IL 61820. (http://nadp.sws.uiuc.edu/mdn/)

Wisconsin Department of Natural Resources, Bureau of Air Management data, 1999.

Appendix 2: Summary of Additional Rainfall Data



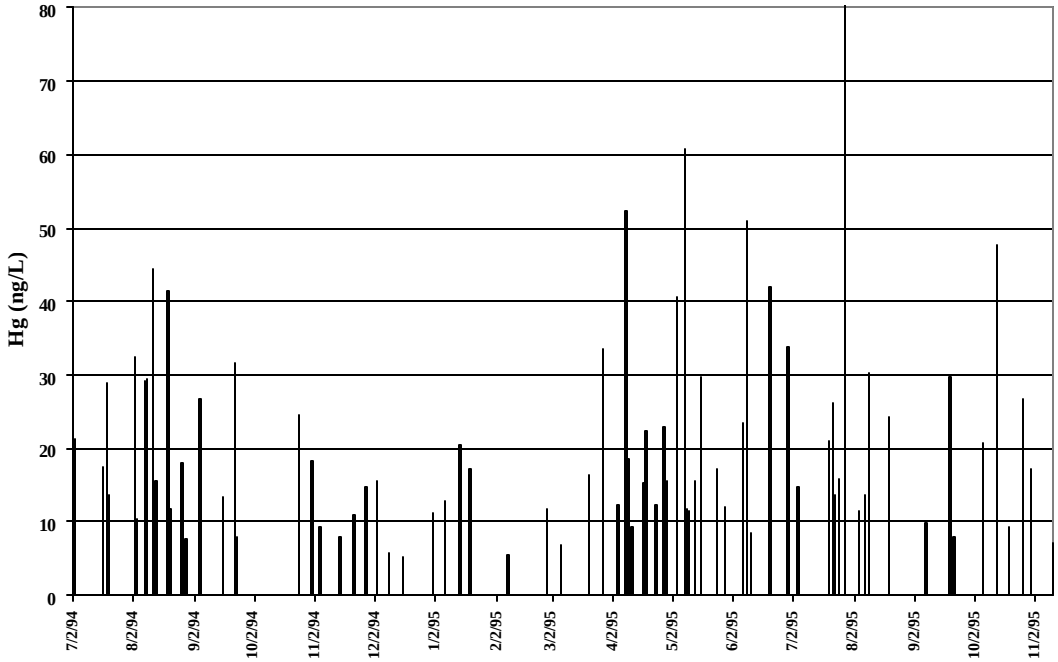
Source: Mercury Deposition Network, 1999.



Source: Mercury Deposition Network, 1999.

University of Michigan Air Quality Laboratory

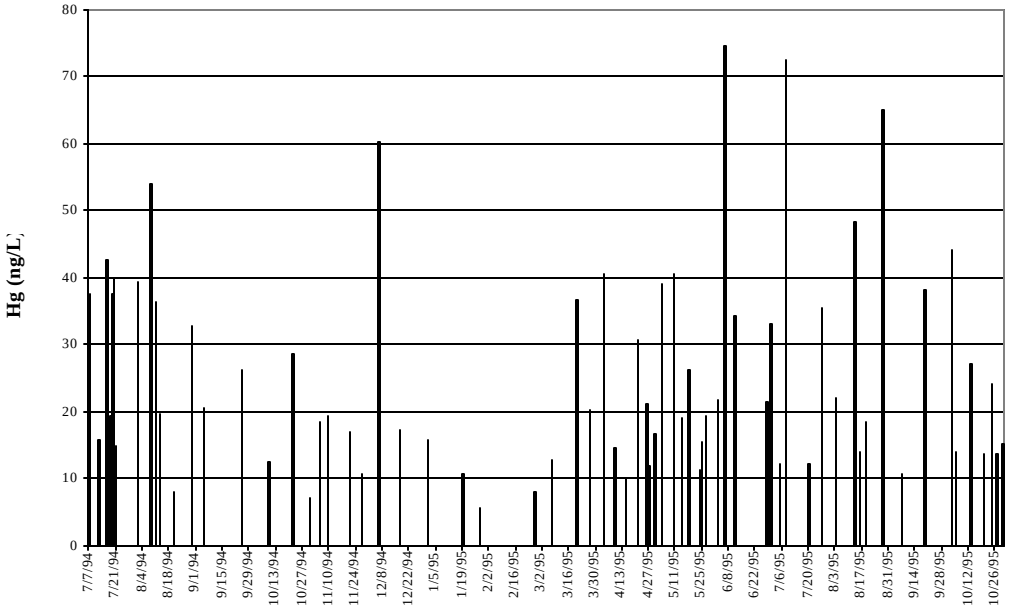
Bondville, IL Hg in Precipitation



Source: Landis, M.S.- Ph.D. Thesis University of Michigan

University of Michigan Air Quality Laboratory

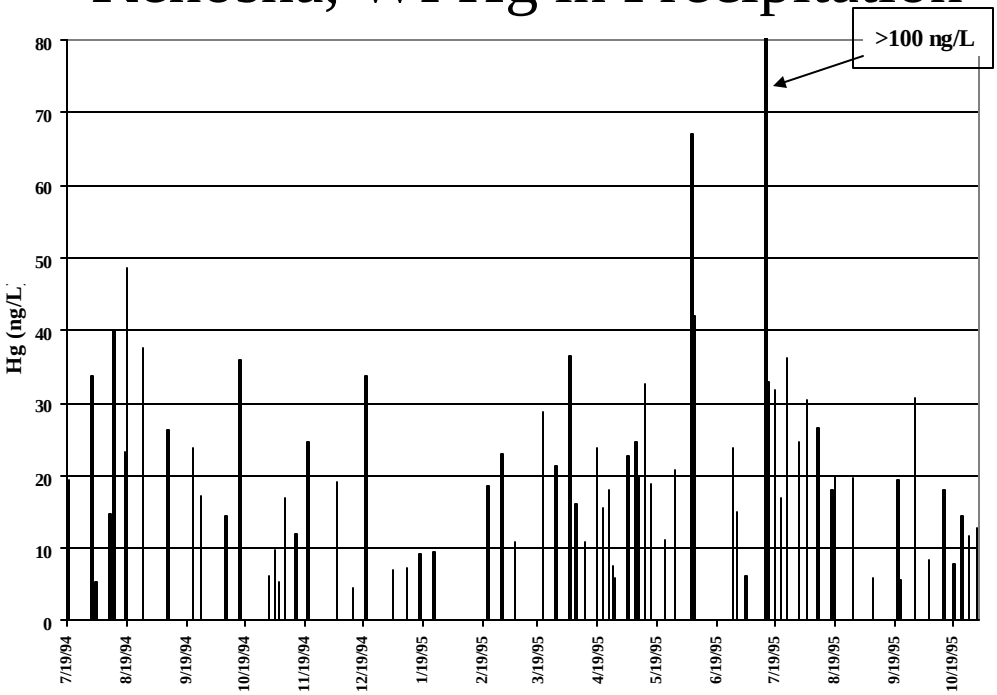
IIT-Chicago Hg in Precipitation



Source: Landis, M.S.- Ph.D. Thesis University of Michigan

University of Michigan Air Quality Laboratory

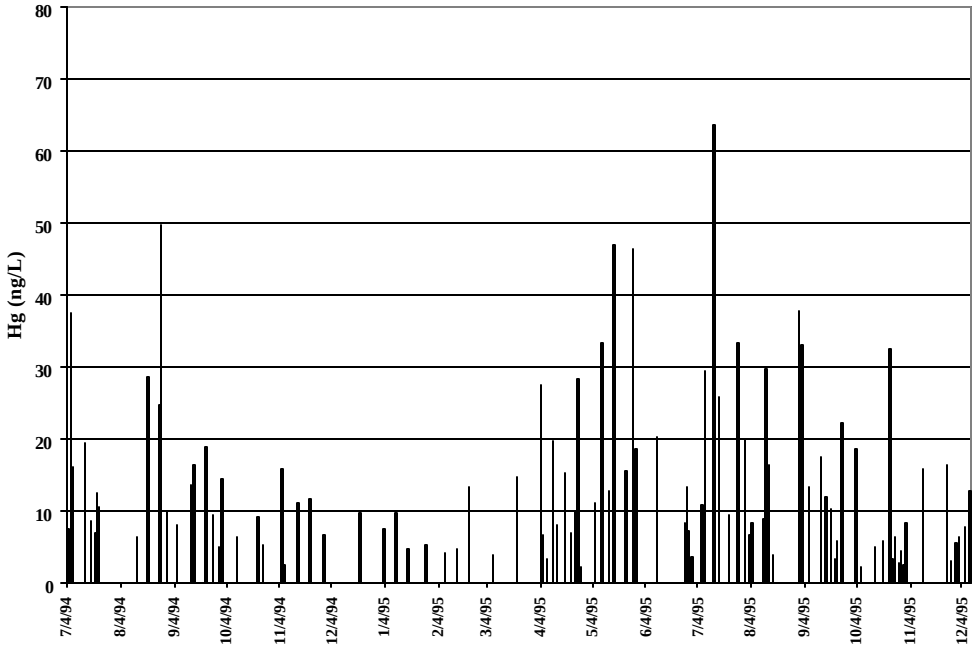
Kenosha, WI Hg in Precipitation



Source: Landis, M.S.- Ph.D. Thesis University of Michigan

University of Michigan Air Quality Laboratory

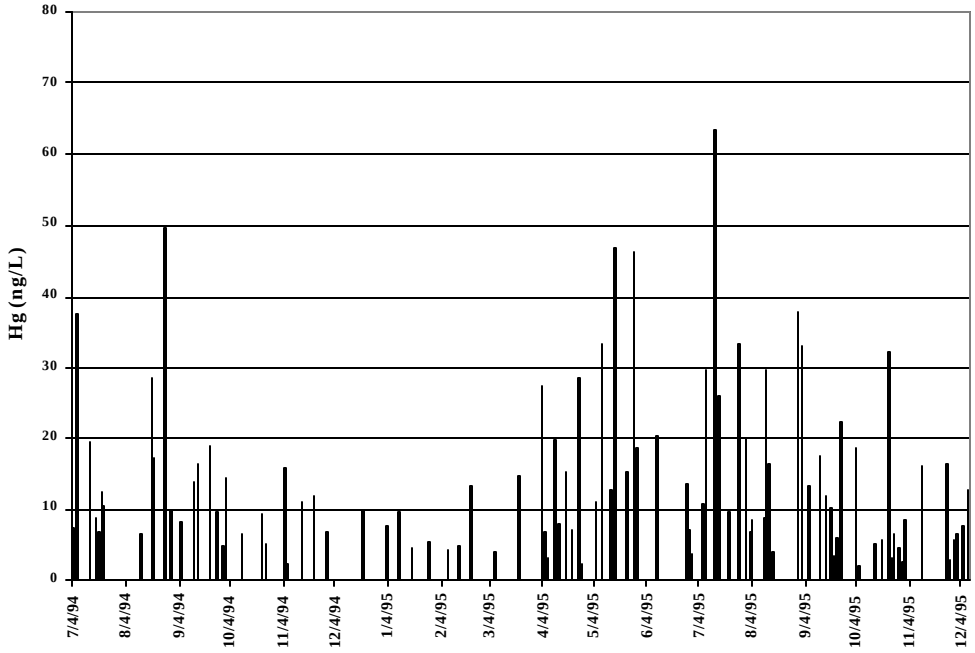
South Haven, MI Hg in Precipitation



Source: Landis , M.S.- Ph.D. Thesis University of Michigan

University of Michigan Air Quality Laboratory

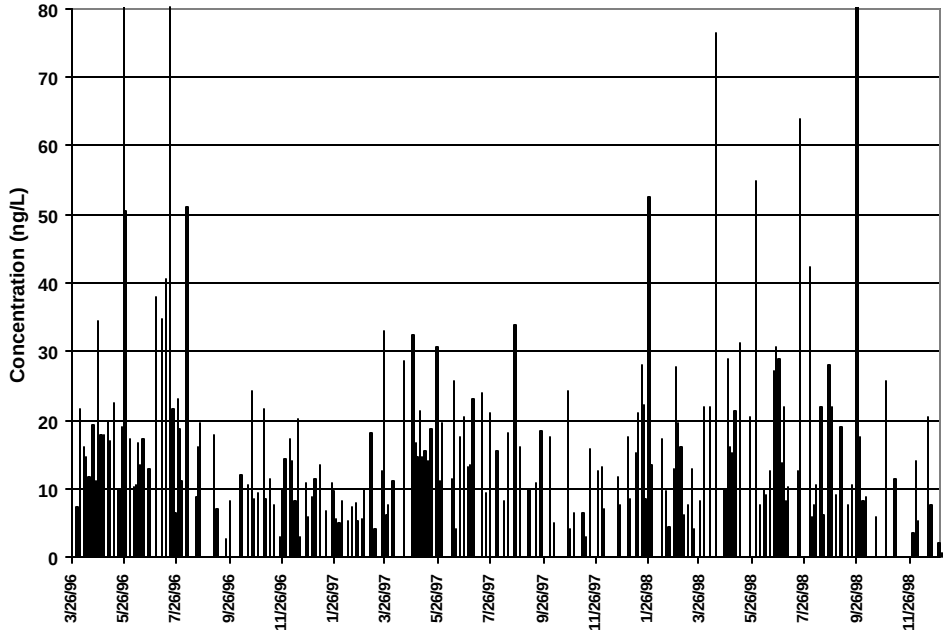
Sleeping Bear Dunes, MI Hg in Precipitation



Source: Landis, M.S.- Ph.D. Thesis University of Michigan

University of Michigan Air Quality Laboratory

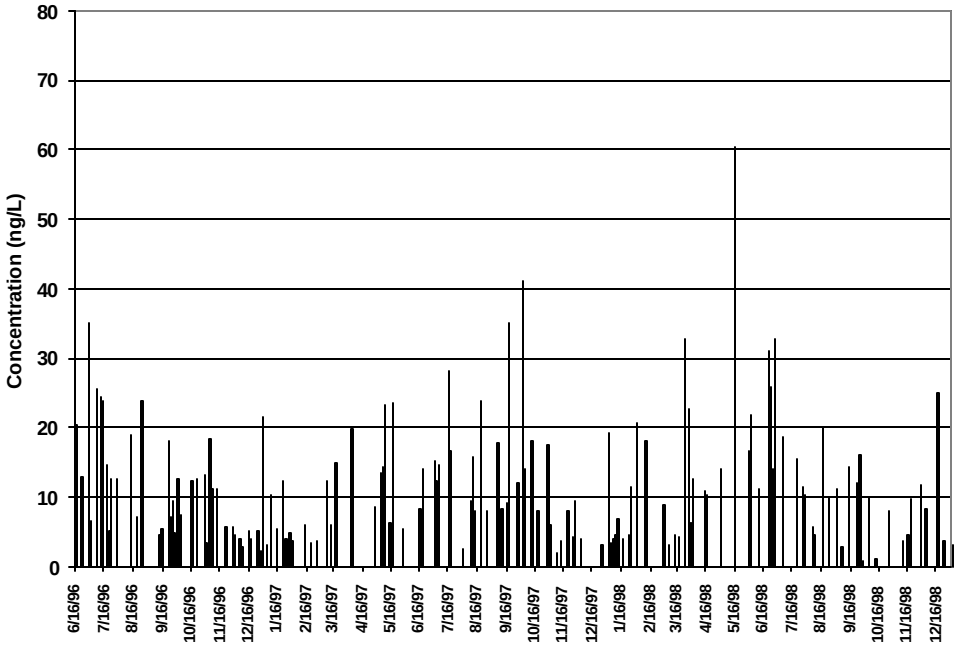
Dexter, MI - Hg in Precipitation



Source: Keeler, G.J. - University of Michigan

University of Michigan Air Quality Laboratory

Pellston, MI - Hg in Precipitation



Source: Keeler, G.J. - University of Michigan