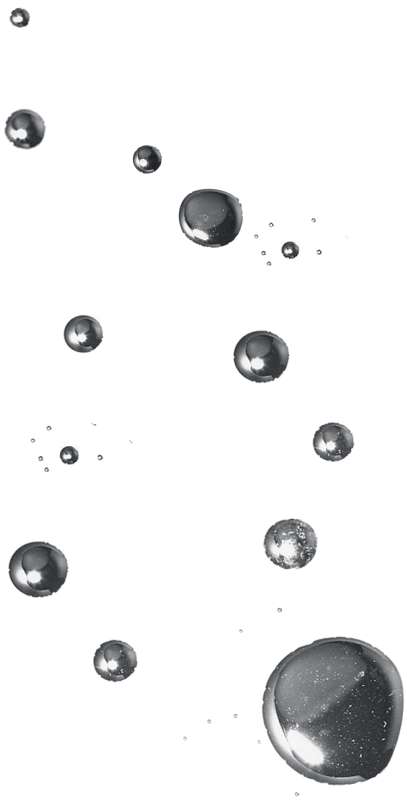
# **Mercury** In The Environment

## A Primer



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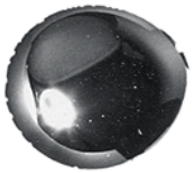


**A cup of mercury is nearly fourteen times heavier than a cup of water.**

SOURCE: Zyra's website. www.zyra.org.uk

**POLLUTION PROBE IS A NON-PROFIT CHARITABLE ORGANIZATION THAT WORKS** in partnership with all sectors of society to protect health by promoting clean air and clean water. Pollution Probe was established in 1969 following a gathering of 240 students and professors at the University of Toronto campus to discuss a series of disquieting pesticide-related stories that had appeared in the media. Early issues tackled by Pollution Probe included urging the Canadian government to ban DDT for almost all uses, and campaigning for the clean-up of the Don River in Toronto. We encouraged curbside recycling in 140 Ontario communities and supported the development of the Blue Box programme. Pollution Probe has published several books, including *Profit from Pollution Prevention*, *The Green Consumer Guide* (of which more than 225,000 copies were sold across Canada) and *Additive Alert*.

Since the 1990s, Pollution Probe has focused its programmes on issues related to air pollution, water pollution and human health, including a major programme to remove human sources of mercury from the environment. Pollution Probe's scope has recently expanded to new concerns, including the unique risks that environmental contaminants pose to children, the health risks related to exposures within indoor environments, and the development of innovative tools for promoting responsible environmental behaviour.

Since 1993, as part of our ongoing commitment to improving air quality, Pollution Probe has held an annual Clean Air Campaign during the month of June to raise awareness of the relationships among vehicle emissions, smog, climate change and related human respiratory problems. The Clean Air Campaign helped the Ontario Ministry of the Environment develop a mandatory vehicle emissions testing programme.

Pollution Probe offers innovative and practical solutions to environmental issues pertaining to air and water pollution. In defining environmental problems and advocating practical solutions, we draw upon sound science and technology, mobilize scientists and other experts, and build partnerships with industry, governments and communities.

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June 2003

The purpose of Pollution Probe's **Mercury Primer** is to provide an overview of the presence and effects of mercury in the environment and its impacts on human health. The primer identifies where mercury is being used and released, the risks associated with exposure to mercury, and ways to help prevent mercury pollution. The primer also describes what governments, businesses and individuals are doing to eliminate the use of mercury and prevent its release to the environment.

Pollution Probe has done extensive work on mercury in the environment for nearly a decade. It is an important issue that requires ongoing attention by industry, governments and consumers. This primer is intended to inform and educate the public, as well as industry and governments, in the hope that knowledge will lead to further action at all levels. Much progress has been made in Canada on reducing human sources of mercury emissions, but more remains to be done. Mercury is a significant global issue and a threat to human and ecosystem health around the world.

**Ken Ogilvie**
Executive Director
Pollution Probe

**June 2003**

Developing and managing Pollution Probe's Mercury Programme has been one of the most challenging, interesting and rewarding activities of my career. Challenging, when one realizes how difficult it is to change institutions and policies, even though the solutions appear so obvious. Interesting, in the extraordinary story that mercury has played, and continues to play in commerce, ecosystems and human health. Rewarding, when one looks at how far we have managed to come over the past eight years in raising awareness, contributing to new standards, and identifying and delivering solutions with real mercury reductions in Canada.

In addition to the formal acknowledgements that follow, I am taking this opportunity to express my personal gratitude to the many individuals who had faith in our ideas from the beginning and supported our work despite the barriers and challenges that, at times, seemed overwhelming. **Ken Ogilvie** is the first person I must thank, for his formidable insight throughout our work, and also for providing space for our ideas and strategies to develop. **Ian Smith** (Ontario Ministry of the Environment), and **Jim Smith** and **Bob Krauel** (Environment Canada) facilitated the initial funding and early trust, and **Luke Trip** (formerly Environment Canada) supported several very important research activities. **Margaret O'Dell** and **Jimmy Seidita** of the **Joyce Foundation**, and **Nan Shuttleworth** of the **Salamander Foundation** provided the grants that allowed us to go far beyond the constraints of our other funding to take a leadership role in provincial, national and international standards and agreements related to mercury. Without this combination of supporters, our work would not be possible. Finally, I must thank **Leah Hagreen** for her intelligent and dynamic research and management on all aspects of our mercury work.

**The Mercury Primer** has been a work in progress for nearly two years. Even in that short timeframe, international health researchers have moved mercury to the forefront of public health concerns, by identifying evidence of serious risk to infants and the unborn from even minute amounts of methylmercury in their bodies.

I am confident that public demand for a healthy ecosystem, together with the actions of forward looking corporations, will eventually convince our political leaders that small investments in a cleaner environment will pay huge dividends in the long-term health and well-being of our children.

I am hopeful that this publication will be a helpful and informative contribution to ongoing efforts to phase out the uses and industrial emissions of mercury in Canada and globally.

Yours truly,

**Bruce Lourie**
Mercury Programme Director
Pollution Probe

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Pollution Probe is solely responsible for the contents of this report. All information contained in this primer is accurate as of the date of printing. For updated information, readers should check the websites and other references cited in this report.

This publication was written for Pollution Probe by **Bruce Lourie** and edited by **William Glenn.** We appreciate the work of staff members **Ken Ogilvie** for giving the primer an editorial policy-level review, **Elizabeth Everhardus** for managing the project and **Krista Friesen** for coordinating the logistics of the primer.

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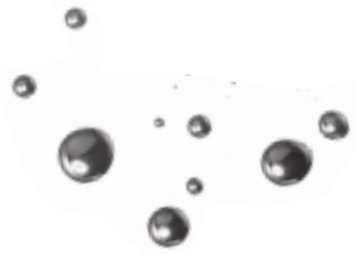


# Introduction

Mercury has a number of unique and fascinating properties. It is the only metal that, in its pure form, is a liquid at room temperature. Liquid mercury is volatile, meaning that it evaporates easily to form a poisonous vapour. Mercury conducts electricity and expands at a constant rate in response to changes in pressure or temperature. Electrical switches, barometers and thermometers take advantage of these properties. In its vapour state, mercury can combine with other gases to form more complex molecules that emit light when charged with electricity, hence the use of mercury in fluorescent and neon lights. Mercury combines easily with most metals to form malleable alloys, such as dental filling amalgam. This particular property of attaching to other metals, together with the ease of separating and distilling the amalgams, led to mercury's widespread use in gold mining. Mercury has been widely used in household products, as well as commercial, medical and industrial applications.

Methylmercury is the most toxic form of mercury. The environmental and health consequences of unintended or accidental mercury exposures have drawn international attention to dangerous levels of this toxic substance in the environment. Several catastrophic poisoning events that occurred between the 1950s and 1970s highlighted the seriousness of industrial mercury pollution and mercury misuse. Today, we know that even relatively low concentrations of mercury in the environment may lead to elevated methylmercury levels in fish, levels that present a real risk to individuals that consume fish regularly. This knowledge and concern has led many countries to begin the controlled phase-out of mercury use.

## 1.1 Mercury use has a long history

Mercury is thought to be one of the first metals used by humans. Historical records provide evidence of mercury use by ancient Chinese and Hindu civilizations. Archaeologists have also found traces of mercury in an Egyptian tomb dating from 1500 BC and in the writing of a Chinese alchemist around 4500 BC. Both the Egyptians and Chinese may have been using the mercury ore, cinnabar, as a pigment to paint their tombs, anoint their statues and even preserve their dead.

Many civilizations believed mercury had mystical properties and the power to prolong life. Alchemists tried for ages to transmute base metals into gold through the action of mercury. Others used mercury to ward off evil spirits and purify the blood. Mercury was also thought to exhibit healing properties and was used as a laxative, an antiseptic, and to cure diseases, such as syphilis and ringworm, from the 15th and into the 20th century.

Spain was (and still is) the largest producer of mercury in the world. Stories of Spanish galleons carrying tonnes of gold and silver looted from Central and South America back to Spain are well documented. Less well known is the fact that many tonnes of mercury were shipped from Spain to the "New World." The Spanish conquistadors used that mercury to process precious metals. Parts of Mexico are still heavily contaminated from the thousands of tonnes of mercury that were brought from Spain during the four-hundred-year period of Spanish rule.

Tales of the toxic effects of mercury are also littered throughout history. The human health hazards associated with exposure to mercury were probably first identified in Spain during Roman times. Slaves sentenced to work in the Spanish mercury mines received the equivalent of a death sentence. Very few survived more than three years in the poisonous atmosphere of the mines. Later, convicts were used, and at one time the Spanish government offered an exemption from military service to men who had worked two years in the mercury mines.

By the 18th century mercury was being used to preserve the beaver felt hats that were so popular. The workers in the beaver felt factories of the time would, in fact, go mad as a result of breathing the toxic mercury fumes, the effects of which are irreversible. The Mad Hatter, made famous in Lewis Carrol's Alice in Wonderland, was "mad" as a result of mercury poisoning. Irritability is one of the early symptoms of mercury poisoning, and this may also account for the description of mad hatters.

## 1.2 The Minamata tragedy

The hazards of methylmercury poisoning received modern international attention in 1956 when many of the residents of Minamata, Japan, became seriously ill, or died, after eating the fish and shellfish in Minamata Bay. A chemical plant that used methylmercury to manufacture plastic (acetaldehyde) was dumping methylmercury-contaminated wastes into Minamata Bay. The mercury built up or bioaccumulated in the fish and shellfish, which were a major part of the residents' diets. A similar tragedy unfolded in the nearby town of Nigata, Japan. Eventually, hundreds of people died, including many stillborn children, and thousands were made severely ill from eating the contaminated seafood. The official Japanese government estimate of those affected by the mercury poisoning was set at 2,265, more than half of whom have now died. Local citizens dispute this number, and new research from Kumamoto University suggests that some 35,000 people were affected.

The Minamata poisoning episode provided local researchers with the hard evidence that first linked mercury discharges to its bioaccumulation in the environment. Cats in Minamata were the first to show signs of mercury poisoning, although at the time the unusual behaviour exhibited by the cats was unexplained. The disease was known locally as "dancing cat disease" in reference to the uncontrollable muscle spasms and tremors seen in the poisoned cats. Further research on the cats led scientists to the conclusion that mercury contamination in the fish and shellfish was the cause of this strange and lethal disease. Unfortunately for the people of Minamata, government officials waited nearly ten years before accepting the evidence of the local medical researchers, leaving thousands more to suffer. The symptoms of severe mercury poisoning are still referred to as "Minamata Disease." Today, much of Minamata Bay has been filled in with clean soil, and locals are again permitted to eat the fish.

**figure 1:** The Minamata Memorial
SOURCE: Bruce Lourie

## 1.3 The Iraq poisoning incident

Another modern mercury tragedy occurred in Iraq in 1971, when 6,500 people were hospitalized and more than 400 died after eating wheat grain treated with a methylmercury fungicide. The grain was intended for planting, but the residents mistook it as edible. They ground it into flour, unaware that the bread they were making was deadly poisonous. Most of what we know today about the effects of mercury poisoning comes from studies of the people who were poisoned in Japan and Iraq.

box 1

### Key Findings from the 2003 UNEP Study

Environmental mercury levels have increased considerably since the onset of the industrial age. Mercury is now present in various environmental media and food (especially fish) all over the globe at levels that adversely affect humans and wildlife. Widespread exposures are occurring due to human-generated sources, and past practices have left a legacy of mercury in landfills, mine tailings, contaminated industrial sites, soils and sediments. Even regions with no significant mercury releases, such as the Arctic, are adversely affected due to the transcontinental and global transport of mercury.

SOURCE: UNEP. 2003. Global Mercury Assessment.

## 1.4 Mercury pollution in Canada

Several serious incidents of mercury contamination occurred in Canada soon after the Minamata and Nigata cases. In 1969, a pulp and paper mill contaminated the English-Wabigoon River system near Dryden in northwestern Ontario. The mill's chlor-alkali plant used mercury to manufacture chlorine that, in turn, was used to bleach paper. Eventually the mercury was discharged to the local waterway, polluting the fish in the English-Wabigoon River system, making them unfit to eat and threatening the health and disrupting the livelihood of the local population that depended on the fish. Testing showed that the White Dog and Grassy Narrows First Nations people exhibited high levels of mercury in their blood and hair. Since the closure of the chlor-alkali plant, mercury levels in local fish species have dropped, but remain, for the most part, above the limit considered

**figure 2:** Powerhouse at Hydroelectric Dam
SOURCE: © Royalty-Free/CORBIS/MAGMA

safe for human consumption. Similar contamination incidents occurred near Sarnia, Ontario, where in 1970 all commercial fishing was banned from the St. Clair River, Lake St. Clair and the Detroit River. About the same time, commercial fishing was closed on the Saskatchewan River in Manitoba due to high mercury levels caused by a chlor-alkali plant.

A new source of mercury pollution was identified in Canada in the late 1970s and continues unabated today in many parts of Canada, notably Manitoba, Ontario, Quebec, Labrador and Newfoundland. Fish in reservoirs created for hydroelectric power plants were found to contain elevated mercury levels. It was determined that the natural mercury found in the underlying rock and soil was being released by the increased bacterial activity associated with the decomposition of the plant life in the flooded areas. The First Nations in these regions who rely on subsistence fishing have been the most affected, due to restrictions placed on their traditional fish diet.


2

# Mercury: A Complex Metal

## 2.1 What is mercury and what do we use it for?

The shimmering liquid metal mercury is one of the basic natural elements that make up the Earth's composition. While a relatively scarce element — comprising less than one one-millionth of the Earth's crust — mercury may be found at much higher concentrations in certain regions. As is the case with any element, mercury can neither be created nor destroyed (outside of certain radioactive processes). Mercury is known as a "heavy metal" because it is very dense. A cup of mercury, for example, weighs more than three kilograms; that's nearly fourteen-times heavier than a cup of water.

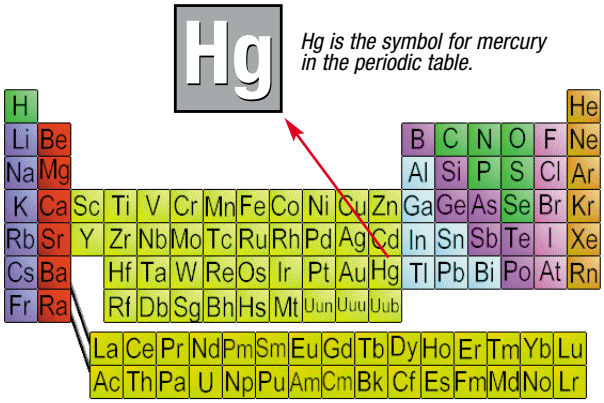



**figure 3:** Periodic Table

SOURCE: www.chemicalelements.com.

## 2.2 What are some of the concerns about mercury?

Mercury can exist in many different chemical and physical forms in the environment (see Box 2). Those different forms are called "species." In this document, we will use the general term "mercury" to refer to all forms of the element, while "methylmercury" will be used to distinguish organometallic mercury compounds (essentially those that contain carbon) from inorganic forms of mercury. Pure mercury is known as elemental mercury or metallic mercury. Ionic mercury (both mercuric and mercurous) combines with other substances to form different chemical compounds (such as salts) in water, soil and rock.

Mercury is present in the atmosphere mainly as a metallic vapour. It occurs in various organic forms, mainly in aquatic ecosystems and in the plants and animals found there. Organic mercury compounds "bioaccumulate" or "biomagnify," building up in the ecosystem so that the predators at the top of the food chain may have much more mercury in their bodies than plants and simple microorganisms at the bottom level of the food chain (see Figure 4 and Box 3).

**box 2**

### Types of Mercury

There are three general types of mercury — inorganic, elemental and organic mercury, mainly in the form of methylmercury. The most widely recognized form of elemental mercury is called "metallic mercury" and is the shiny liquid metal used in thermometers. Inorganic mercury is primarily bound to particulates and may not be available for direct uptake by organisms.

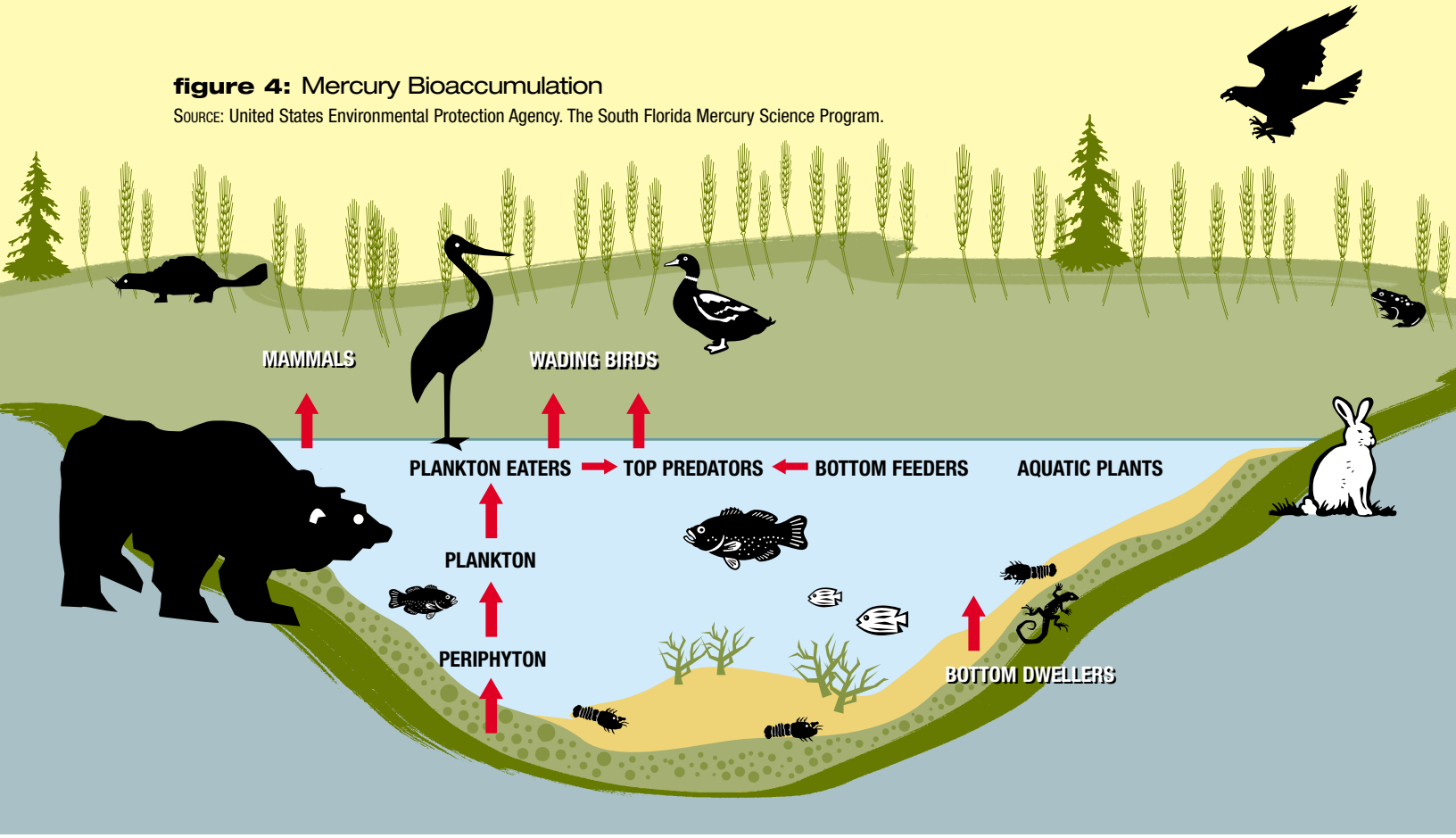
The process of methylation of inorganic mercury to organic mercury is important to the fate of mercury in the environment. Organic mercury more readily collects in living organisms, becoming concentrated up the food chain. The majority of mercury found in fish is organic mercury, or methylmercury, which binds tightly to the proteins of all fish tissue, including muscle. Methylmercury is of particular concern because it can build up in fish tissue to levels that are many times greater than the levels in the surrounding water.

Mercury released into the environment can change between organic and inorganic forms. For example, some or all released organic mercury will slowly break down to become inorganic mercury, and some released inorganic mercury will also slowly be changed into organic mercury in soil and water by reaction with substances produced by microorganisms and various chemical processes.

Sources: www.atsdr.cdc.gov and www.vdh.state.va.us.

**figure 4:** Mercury Bioaccumulation

SOURCE: United States Environmental Protection Agency. The South Florida Mercury Science Program.



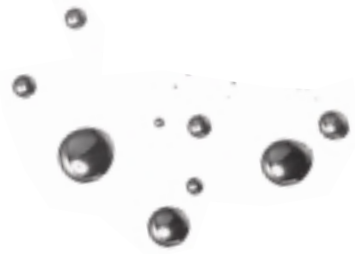

**box 3**

## Bioaccumulation and Biomagnification

Bioaccumulation is the process by which organisms (including humans) take up contaminants more rapidly than their bodies can eliminate them, thus the amount of mercury in their body accumulates over time. Biomagnification is the increase in concentration of a contaminant at each level of a food chain. Even at very low input rates to aquatic ecosystems, biomagnification effects can result in mercury levels of toxicological concern.

SOURCE: http://water.usgs.gov.


3



# The Mercury Cycle

Many of the Earth's elements travel or cycle through the natural environment. This means that they are transported from the soil into nearby lakes and rivers, and then evaporate from the water into the air, to be transported by wind and eventually re-deposited to the surface where the cycle starts over again. Mercury cycles through the environment in this way (see Figure 5). An atom of mercury may begin its journey by being eroded from rocks on the shore of a lake or by being vented into the atmosphere as mercury vapour from a volcanic eruption. These are natural emissions. However, more than half of the mercury that now cycles through our ecosystems is believed to be released during human activities, such as mining, smelting, burning coal, incinerating waste or disposing of products that contain mercury (UNEP, 2003). Mercury is also present in the liquid wastes from industrial facilities and sewage treatment plants. Mercury emitted from these and other human activities adds to the mercury cycle. A recent study (Munthe et al., 2001) suggests that total mercury levels in the atmosphere have tripled as a result of anthropogenic activities.

Once mercury enters the ecosystem it can cycle indefinitely. Mercury can be transported thousands of kilometres through the atmosphere, evaporate out of oceans, be absorbed or released by trees and plants, and accumulate in the bodies of fish, animals and humans. These complex and long-range movements make mercury a global pollutant.

Figure 5 illustrates the three basic steps in the mercury cycle: 1) the release of the mercury from its sources; 2) its transport and deposition; and, 3) its biological conversion and uptake by living organisms. These processes are explained in more detail below. In addition, there are many other complicated transformations that may take place that are not described in this brief overview. For example, a small portion of the mercury cycling through the environment may enter sediments and become buried, eventually re-entering the geologic storage stage. There are many aspects of the mercury cycle that are well understood, but there are other aspects for which scientists are still seeking answers. Understanding these complex events is an important challenge for scientists around the world.

### KEY TO FIGURE 5

**1.** Mercury enters the air, from both human activities and natural sources, as a gas and a particle.

**2.** Approximately half of the mercury released falls out locally. The other half of the mercury travels, and while doing so, changes in chemical and physical form. Most local deposition occurs as dry particles, while global deposition occurs mainly with rain and snow.

**3.** The long-range fallout impacts both terrestrial and marine ecosystems. Approximately half of the global deposition lands on terrestrial ecosystems. The rest goes into marine ecosystems.

**4.** Once in the marine ecosystem, mercury is converted to its organic form by bacteria through a chemical reaction.

**5.** The mercury in lakes bioaccumulates through the food chain, concentrating in sport fish that often find their way to dinner tables, as well as to predatory marine animals.

**figure 5:** The Mercury Cycle

ADAPTED FROM: Mason and Sheu. 2002. *Role of the ocean in the global mercury cycle.*

## 3.1 Where does mercury in the environment come from?

Mercury that exists in a stable state in the Earth's crust is referred to as "geologic" mercury. The active mercury cycle begins when mercury is released from this stable form to the environment through natural processes or human intervention. There are four principal pathways releasing mercury to the environment. First is through natural processes; for example, mercury that was once in the Earth's crust could be released through a volcanic eruption or other geological activity. Second is the release of mercury that is incidental to some other activity; for example, the natural mercury found in coal is released when the coal is burned in a power plant to produce electricity. The third way mercury may be released is during the manufacture, breakage or disposal of products that have mercury put into them deliberately. For example, if the mercury from a broken fever thermometer is emptied down the drain, it may end up in a lake, river or ocean. Finally, mercury enters the environment when it is used directly in industrial settings, such as chemical factories or in small-scale gold-mining operations. The mercury used in products and industrial applications originates from mercury mined from the Earth's crust.

## 3.2 Natural sources versus releases by human activities

There has been considerable debate in Canada on the relative contributions of mercury from natural sources versus releases to the environment from human activity. One of the challenges with this debate is the lack of accurate information on mercury emissions, past and present. Scientists have analyzed sediment cores and determined that the levels of mercury in the environment today are more than double what they were in pre-industrial times. They have also measured mercury in the atmosphere and found that it continues to increase globally at more than one per cent per year. Total global mercury emissions are estimated to be 5,000 tonnes per year. Recent scientific studies have concluded that fifty to eighty per cent of this mercury is emitted as a result of human activities and the remainder is from natural sources (see the UNEP report *Global Mercury Assessment*).

The deposition and re-emission, or "leap-frogging," of mercury makes it difficult to distinguish between mercury that originated from a natural source and mercury released from human activity. The goal of many international environmental agreements is to return mercury levels in the environment to pre-industrial levels, which are also referred to as natural background levels.

### 3.2.1 Natural sources of mercury

Low levels of mercury can be found everywhere in the environment — in rocks, plants, animals, water and the air. However, several natural processes can result in higher concentrations of mercury in certain compartments within the natural environment. Mercury in the Earth's crust is concentrated in "hot spots," often associated with volcanic activity. It is released through natural vents and hot springs, as well as volcanic eruptions. Mercury in bedrock can be released by weathering and then converted to organic methylmercury in lakes and rivers.

Mercury also concentrates in plants and sediments rich in organic matter. Fossil fuels, such as coal and oil, are prehistoric plant matter and often contain elevated mercury concentrations. Mercury can be taken up by the roots of trees and later released to the environment when that wood is burned in a stove or a forest fire. Oceans are a major focus for mercury movement since they receive mercury deposited from the atmosphere, rivers and land runoff, as well as mercury that is released from vents in the ocean floor and mercury that has been dumped or deposited into the oceans from human activity. This mercury may be re-emitted in vapour form from the surface of the oceans.

**box 4**

## Mercury and Plants

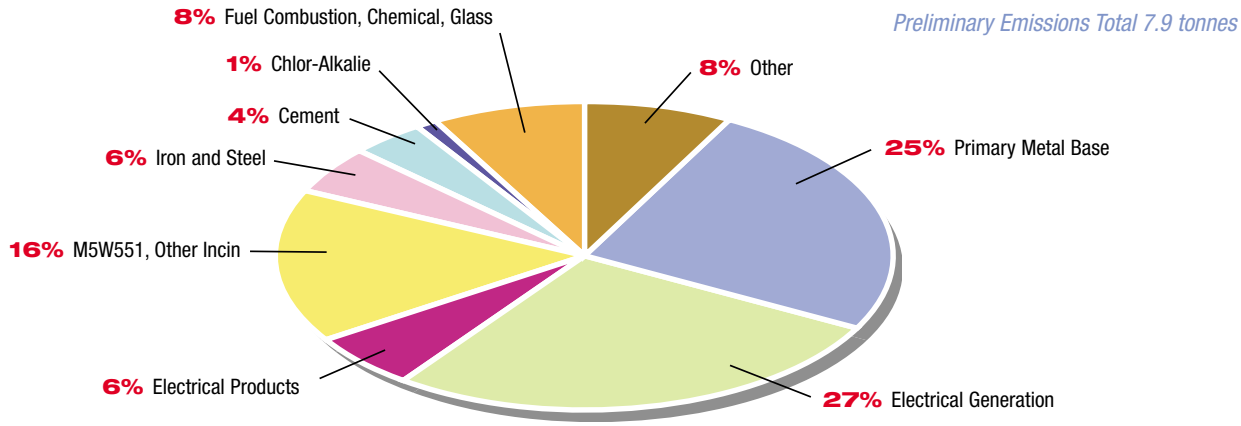
Mercury can either be deposited directly on plants and trees, in rainfall or as dry dust, or can enter plants from the soil through the roots. In turn, trees and plants can re-emit the mercury to the atmosphere, either directly through evapo-transpiration of the leaves, or when trees are burned in forest fires or in wood stoves. Mercury that re-enters the air from plants is therefore a combination of natural mercury and mercury from human activities. The mercury may have entered the leaves from the soil via the roots or may have fallen onto the leaves from the air.

**figure 6:** Lava Fountain at Kilauea Volcano in Hawaii
SOURCE: United States Department of Interior, United States Geological Survey.

### 3.2.2 Mercury releases from human activities — incidental releases

Incidental emissions occur when the mercury present in natural substances is released to the environment as a result of human activity. These emissions occur as a result of an industrial activity that does not involve the direct or deliberate use of mercury. Since mercury is found naturally in rock, coal and oil, when these substances are processed or burned, mercury is released into the environment.

**figure 7:** National Pollutant Release Inventory (NPRI) Data on Atmospheric Mercury
SOURCE: NPRI. 2001. www.ec.gc.ca/pdb/npri/npri_home_e.cfm.




Burning coal and processing metals, such as copper and zinc, are the most significant examples of incidental mercury releases in Canada.

Controlling these emissions can be costly for some sources, but in certain circumstances mercury emissions may be significantly reduced as a side benefit of other industrial improvements. This has been the case with the mining sector in Canada. Several of Canada's largest mercury emitters used to be mining companies. When they invested in new technology to improve the efficiency of their smelting operations, one of the side benefits was a significant drop in mercury emissions. These facilities have allowed Canada to meet its goal of a fifty

**box 5**

## Mercury Emission Reductions from Canadian Base Metal Smelters

Canadian base metal smelters and refineries reduced sectoral emissions of mercury by more than 93 per cent between 1988 and 2000. Sectoral emissions now represent about 20 per cent of estimated Canadian emissions from anthropogenic sources, as compared to more than 60 per cent in the late 1980s.

SOURCE: Fraser and Surges. 2002. *Mercury Emission Reductions from Canadian Base Metal Smelters.*

per cent mercury emission reduction, at little or no additional cost to government or industry.

Mercury released by coal-fired power plants may not be as easy to address. As the largest point source of atmospheric mercury emissions to the North American environment, coal plants have been the target of much debate. Energy companies have several options to reduce mercury emissions. They can invest in expensive control technologies for coal plants. Alternatively, they can generate electricity from energy sources other than coal, although some other fossil fuels, such as natural gas and oil, may also contain trace levels of mercury. Or they can invest in helping people to use less energy. Energy conservation offers the greatest overall benefits for the environment and the public.

The removal of mercury from utility coal-fired boilers presents a challenge for several reasons. Mercury concentrations are very low, but are present in very high volumes in flue gas. There is variability in the mercury content within the same coal and between different coals, and commercially available mercury control technology is still

**figure 8:**
Ontario Power Generation's Lakeview Generating Station
SOURCE: John Wellner

under development. Fortunately, utilities and governments are investing in the development and demonstration of control technologies that will lead to commercially available solutions for existing coal-fired boilers. This may take several years and will require government intervention to ensure that timelines are adhered to.

In the meantime, the electric power sector has measures available today that could lead to mercury reductions of between twenty and eighty per cent. Two of the most important immediate steps include the adoption of the best available control technologies and investments in energy efficiency. Mercury control devices are being introduced successfully at regulated waste incinerators in Canada; however, these technologies are still in the early stages of development for coal-fired power plants. Further commercial testing and a supportive regulatory environment are required in order to advance the introduction of this technology in coal-fired plants.

Improving the efficiency of electricity use in Canada would lead to reductions in mercury emissions, as well as other emissions associated with electricity generation. During the past decade, most utilities in Canada dramatically reduced their energy efficiency investments, leading to emissions that are now much higher than they otherwise would be.

Finally, there are many alternative sources of electricity generation that emit little or no mercury and these may be considered as part of the solution. For more information, see Pollution Probe's Primer on the Technologies of Renewable Energy (www.pollutionprobe.org/Publications/Energy. htm).

### 3.2.3 Mercury releases from human activities — deliberate use of mercury

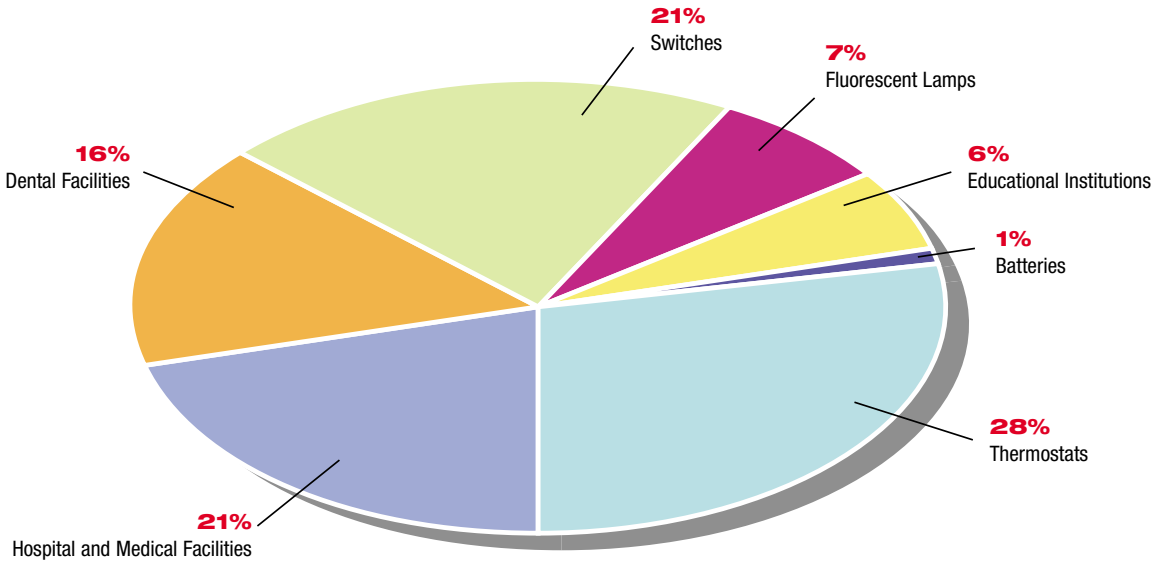
Mercury may also be released as a result of the deliberate use of mercury in products and processes. Mercury continues to be used in electrical switches (including vehicle switches), thermostats, dental amalgam, thermometers and chlor-alkali plants, both in Canada and worldwide. Mercury used in products may be released to the environment at any stage in a product's "life cycle." Mercury may be released during manufacturing; from applications where the mercury is exposed to air; when products are broken while in use; when products are crushed in garbage trucks; and, when products are dumped in landfills, burned in incinerators or discharged to sewer systems.

The quantities of mercury being handled by Canada's waste management sector are very large. According to the most recent data (2001) from Canada's National Pollutant Release Inventory, five of the top ten companies reporting were waste management companies. These companies reported mercury releases and transfers of 28,674 kg in one year. When one considers that mercury pollution is often measured in milligrams, and methylmercury levels in fish are measured in micrograms, the NPRI data suggest that Canada still has a long way to go in achieving mercury use reductions that protect ecosystems.

It was once thought that mercury used in products posed no risk, because it did not enter the environment. This is not the case; some or all of the mercury used in products eventually makes its way into the environment. For example, when products containing mercury are disposed of improperly, the mercury is released to the environment. An old thermostat thrown in the garbage may break in the back of a garbage truck or be incinerated. In the latter case, most of the mercury evaporates in the

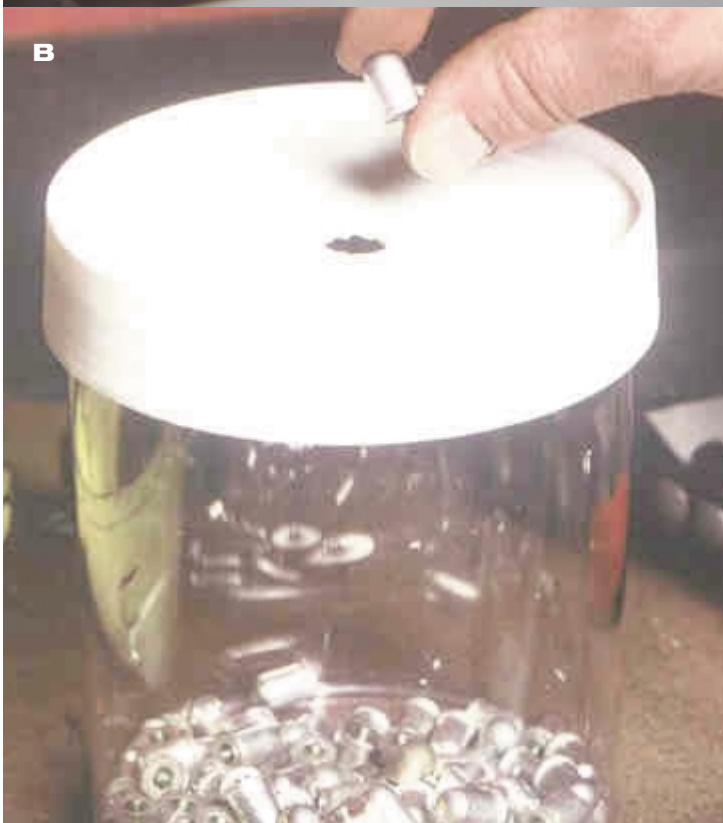
**figure 9:** Presence of Mercury from Deliberate Uses

SOURCE: Obenauf and Skavroneck. 1997.



incinerator stack and enters the air. Canada has recently developed guidelines on the amount of mercury that can be emitted to the air from incinerators.

Waste incinerators fall somewhere between the two categories of incidental and deliberate emissions. Similar to a coal plant, they burn a feedstock — in this case garbage — and mercury is released as an incidental emission. The difference is that most of the incidental emissions from waste incinerators are a result of mercury that is deliberately put into products. These may include fluorescent lamps, old batteries, dental office waste, electrical switches or thermostats. Some of the mercury emitted by incinerators may be incidentally released from the burning of organic matter, including paper and yard waste, although much of this waste in Canada is separated from the waste stream and recycled. There are no mandatory disposal requirements in Canada to prevent the mercury from household products entering the general waste stream. Source separation is considered to be the most effective means for reducing waste-related emissions. There are stringent handling and disposal requirements for industrial uses and for the proper disposal of large quantities of mercury in waste.


**figures 10A & 10B:**
A: Vehicle Switch Containing Mercury;
B: Switch Repository
SOURCE: Pollution Probe MERC Programme

box 6

## Mercury Sunrise

A phenomenon called "mercury sunrise" was discovered in 1995 by Canadian atmospheric researcher Bill Schroeder working in the Arctic. The phenomenon occurs when the sun first returns after the long dark winter, producing high levels of one form of mercury, called reactive gaseous mercury. In fact the highest levels of this form of mercury ever recorded were found in the Canadian Arctic. At the same time, levels of elemental mercury drop dramatically. When he first saw the mercury readings on his instruments fluctuate wildly, Dr. Schroeder assumed the instruments were not working properly. Scientists are just beginning to understand what is causing this phenomenon and why it is seen in the Arctic (and recently in the Antarctic too). One theory is that long-range atmospheric transport brings mercury-contaminated air to the Arctic, where it accumulates during the sunless winter. When the sun returns in the spring, a chemical chain reaction is set in motion, causing sea salts (bromine and chlorine) to react with the mercury in the atmosphere and the ozone layer, ultimately causing the mercury to convert into a form that allows it to easily deposit onto snow and ice surfaces.

Steel mills that recycle scrap metal face a similar incidental emissions problem. North American automobile manufacturers have used hundreds of thousands of kilograms of mercury in vehicle switches and other applications, such as headlights. Much of this mercury enters the atmosphere when the scrapped cars are melted down to make new steel, while some of it contaminates the ground in the yards where the cars are crushed or shredded. Nearly all of the mercury found in cars enters the environment. European and Japanese car companies stopped using mercury switches in the early to mid-1990s, and North American car companies are expected to stop most uses of mercury by 2003. The problem of disposing of the nearly 200 tonnes of mercury currently in use in North American cars will remain for the next fifteen to twenty years.

The safe disposal of mercury-containing products presents a challenge. Some municipalities are beginning to accept mercury products in their household hazardous waste programmes. Since there are few options in Canada for "proper" disposal, however, significant quantities of mercury are entering the environment from these products each year.

## 3.3 The transport and deposition of mercury

Once mercury has been released to the natural environment it can be transported long distances, either through the air or via watercourses. Mercury is "volatile," meaning it can readily evaporate from a lake or river, enter the air and drift downwind where it may be deposited and contaminate the land.

Mercury released through sewage plants and storm sewers often contaminates the sediments of lakes and rivers on a local scale. However, most of the human-generated mercury that enters the aquatic system is deposited through the atmosphere in rain, snow or attached to small dust particles. Mercury also enters lakes directly from natural geologic sources. In lakes that have been created by hydro dams, very high levels of mercury are often found as a result of natural bacterial processes that become greatly accelerated by the flooding of land and decomposition of vegetation.

Atmospheric emissions are a major concern with respect to the mercury entering the environment. Mercury released to the atmosphere — either directly or indirectly — may do one of three things. It may fall out near the point where it is emitted; this is referred to as local deposition if it occurs within a 50-kilometre radius from the source. The portion of the mercury emitted from an incinerator, base metal smelter or coal-fired plant that is deposited locally can vary widely, depending on the form, or "species," of mercury released.

**box 7**

### The Grasshopper Effect

Mercury emissions from industrial point sources may remain localized in the environment, or may be transported regionally or even globally. In addition, mercury is thought to participate in a global distillation phenomenon that transfers mercury and other chemical emissions from equatorial, subtropical and temperate regions to the Polar regions via the "grasshopper effect." When this phenomenon takes place, the emitted substances re-enter the atmosphere by volatilizing after initial deposition, and continue over time to "hop" through the environment until there is insufficient solar energy to re-volatilize the substances. This favours contaminant accumulation in the colder Polar regions.

Another portion of the airborne mercury is transported long distances before it is deposited at some point downwind. If this takes place within several hundred kilometres, it is considered as regional deposition. High levels of mercury in eastern North America, for instance, are due in part to the downwind deposition of mercury emissions from a large number of major industrial sources in the American Midwest and Ontario, mostly coal-fired electric power plants.

The final portion of the airborne mercury is transported great distances and enters what is known as the global atmospheric mercury pool. This refers to mercury that circles the globe for a year or more within the Earth's major weather systems. Mercury from the global pool may be transported for thousands of kilometres before being deposited. In Canada, high levels of mercury deposition in the Arctic are thought to be a result of mercury from the global pool, together with regional emissions from northern Europe and Asia. The mercury in the atmosphere appears to be concentrated over the Arctic and is being deposited there, resulting in elevated mercury levels in wildlife and the environment.

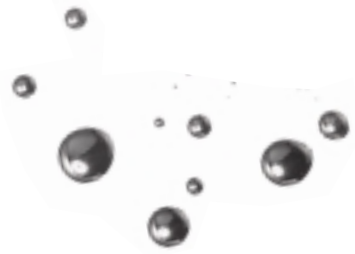
## 3.4 Biological conversion and uptake of mercury

One of the most critical components of the mercury cycle is the conversion of inorganic forms of mercury to the organic compound methylmercury. This process, known as "methylation," is undertaken by bacteria that live in lakes, rivers, wetlands and marshes. Understanding how and where methylmercury forms is very important because methylmercury is more toxic to humans than the inorganic forms of mercury. For instance, mercury deposited from the atmosphere can be transformed into methylmercury within the wetlands surrounding a lake and transported to the aquatic environment; but methylmercury can also be produced directly in the sediments of the lakes from mercury that has come from the atmosphere or that was transported by streams and runoff from watersheds.

Inorganic mercury is toxic when humans or wildlife are exposed to high levels for a short period of time. Organic methylmercury has a greater tendency to accumulate in the body over time, eventually causing harm, even in small amounts. Methylmercury has the three properties that make substances particularly harmful to humans and other organisms — it persists, it bioaccumulates, and it is toxic to most life forms. The health effects of mercury are described in more detail in the next chapter of this primer.

The terms "biological uptake" and "bioaccumulation" describe the processes whereby methylmercury can enter the food chain — either directly from the water or through the consumption of small organisms, insects or fish — and then build up or accumulate in organisms over time. Bioaccumulation occurs when the rate of mercury accumulated exceeds the metabolic capability of an organism to excrete or eliminate it. For example, small aquatic organisms, such as plankton, absorb the methylmercury created by the bacteria in water and, over time, mercury levels increase in their systems. Methylmercury also "biomagnifies," meaning that the levels of methylmercury become much more concentrated higher up in the food chain as a result of eating contaminated food. For example, pike, pickerel and other predatory fish will have much higher concentrations of methylmercury in their bodies than in the aquatic insects or the smaller fish at the bottom of the food chain. Birds, animals or humans that eat predatory fish are then at risk of methylmercury poisoning. Methylmercury is thought to have a greater power of biomagnification than almost any other substance known. Fish may have high levels of methylmercury, even in waters in which background levels are low and where there are no nearby sources of mercury pollution. A large predatory fish may have one hundred thousand to one million times more concentrated methylmercury in its body than is contained in the water in which it swims.


4



# Why is Mercury a Problem?

Mercury, in its elemental form, is a liquid metal that can form a vapour at room temperature. Inhaling mercury vapours or ingesting mercury can cause serious injury or death. The body is able to excrete mercury slowly; if the level of exposure is not too high, recovery can take place following accidental or short-term exposure. High levels of exposure may cause birth defects, permanent brain or kidney damage, and death.

Mercury becomes more poisonous when it is converted to methylmercury (the principal form found in fish) because it is able to enter blood and organs, especially the brain. Mercury can damage the brain and nervous system, and is therefore referred to as a neurotoxicant. Methylmercury accumulates to high levels in the tissue of fish, with the result that most of the lakes in central, northern and eastern North America have "fish advisories" in effect, which identify the kinds and sizes of fish that should be avoided. Among those at greatest risk are people who regularly eat fish high in methylmercury (e.g., native Abo-

riginal populations for whom fish is a constant in their diet) and, more particularly, pregnant women (or women planning to have children), since it is the developing baby that is most at risk.

Children are also at higher risk from the effects of methylmercury. For instance, the intake of air, water and food for children is greater per kilogram of body weight than for adults, which could result in far greater exposure to the different forms of mercury. Also, children have different behaviours than adults, including direct contact with surfaces that may be contaminated (such as when crawling and when mouthing surfaces and toys). These factors, in combination with a more rapid metabolic rate than adults (that allows for a greater absorption of methylmercury into the bloodstream), as well as a cellular repair mechanism that is not fully developed, place young children at higher risk than adults to the potentially toxic effects of mercury.

**box 8**

## Is Mercury Poisoning the Loon?

Loons are being studied extensively so that scientists can learn more about the effects of mercury on a species with a fish diet. Many loons in eastern Canada and the northeastern United States have high mercury levels that are causing reproductive problems. In 1999, a loon with very high mercury levels was found dead in Nova Scotia's Kejimkujik National Park. Canadian scientists believe that high levels of mercury contributed to the bird's death.

*"The mercury levels in common loons in [eastern] North America are probably some of the highest levels in living animals anywhere in the world,"* said Mark Pokras, a veterinarian who runs the wildlife clinic at Tufts University Veterinary School in North Grafton, Massachusetts.

Source: www.nationalgeographic.com/tv/channel/today.html

**figure 11:** The Common Loon
SOURCE: Patrick Coin

## 4.1 Ecological and wildlife effects

Most of the concern about mercury focuses on lakes and other aquatic ecosystems, such as rivers, streams, wetlands and oceans. The levels of mercury found in terrestrial environments are usually not high enough to threaten the health of wildlife and humans. But some aquatic environments favour the transformation of mercury into its more poisonous form — methylmercury — and it is the bioaccumulation of methylmercury in fish and marine mammals that presents a potential problem when they are consumed by humans. In addition to human health effects, many predatory species of fish and wildlife, which rely on fish for food, are at risk of mercury poisoning. Otters, loons, mink and osprey are all examples of fish-eating species in Canada that are potentially at risk.

**figure 12:** Elevated Mercury Levels in Loons

SOURCE: Lourie, B. and L. Hagreen. 2001. *The Science-Policy Interface in Setting Mercury Emission Control Standards for Fossil Fuel Power Plants.* Presentation To The International Conference on Mercury as a Global Pollutant, Minamata, Japan.

The presence of mercury in hydro reservoirs has been a serious issue in Canada, particularly in northern Manitoba, Labrador and Quebec, where some of the world's largest hydro reservoirs are located. Hydro reservoirs that flood hundreds or thousands of square kilometres of land and forest become the perfect environment for mercury methylation to occur. The decomposing organic matter creates an ideal environment for microorganisms to convert the natural mercury in the bedrock and soil, together with the mercury deposited by human activities, into methylmercury. The methylmercury accumulates in aquatic species, making certain fish unsafe for wildlife and humans to eat. Scientists are still trying to understand the complex changes and chemical reactions that happen after these flooding events, and it may take decades before a "balanced" ecosystem is re-established.

box 9

### Are Vulnerable People at Risk?

Mercury contamination in wildlife presents a major ecological and health dilemma for Canadian First Nations people, many of whom depend on fish or marine mammals as the primary source of protein in their diet. In many areas of Canada, these species contain elevated concentrations of mercury; in some cases, the mercury levels may be in the range capable of causing subtle changes in learning abilities and other observable effects on children. Studies on Canadian children have so far not observed this occurring. A common conclusion arrived at by health professionals is that the risk of eating the mercury-contaminated fish is lower than the health benefits to be gained from the important proteins and essential fatty acids found in fish and marine mammals. For this reason, health professionals recommend that people should continue to eat fish, while being careful to limit their intake of large predator species. Clearly, the best situation for ensuring the health of frequent fish consumers over the long-term is to reduce the release of mercury to the environment to the point at which fish are safe to eat.

## 4.2 Human health and the science of mercury poisoning

Mercury and methylmercury are referred to as nerve toxicants or neurotoxicants. They affect the central nervous system, causing a number of serious disorders. The impact will depend on the level of exposure specific to each individual, but studies by Philippe Grandjean and other scientists have demonstrated early symptoms of health alteration from regular exposure to very small amounts of methylmercury.

In order to understand the health effects of mercury, it is important to distinguish between "acute" exposure (exposure to high levels of mercury for a short period of time) and "chronic" exposure (exposure to small amounts of mercury for an extended period of time). Usually, acute exposure occurs through accidental contact with high amounts of mercury following isolated incidents, as was the case in the mass poisonings that occurred in Japan and Iraq. Chronic exposure occurs through frequent and continued ingestion of a food source (such as fish) contaminated with methylmercury. Ongoing exposure to low levels of mercury and its compounds in the environment is less well understood than acute toxicity, but has recently received increased attention from medical researchers. This is now one of the most critical areas of mercury health research, since many people are exposed to methylmercury levels that are higher than background levels — mainly through fish consumption — but not high enough to cause obvious signs of poisoning.

### 4.2.1 Acute toxicity of mercury

Exposure to high levels of mercury or its compounds can cause permanent brain damage, central nervous system disorders, memory loss, heart disease, kidney failure, liver damage, loss of vision, loss of sensation and tremors. It is also a suspected "endocrine disruptor," meaning it damages the reproductive and hormonal development and growth of fetuses and infants. Some studies suggest that mercury may be linked to neurological diseases, such as Alzheimer's and Parkinson's, but the evidence of this is far from conclusive (see www.unites.uqam.ca, www.atsdr.cdc.gov, Pendergrass et al. (1997), Basun et al. (1991), Hock et al. (1998) and Clarkson (1997)).

A recent study by Canadian medical researchers at the University of Calgary identified the process of mercury damage to the brain (http://commons.ucalgary.ca/showcasetv/mercury). Mercury tends to concentrate in major organs, such as the brain and kidney. When in the brain, mercury attacks and dissolves the neurons in certain parts of the brain, leading to various nervous system disorders and organ damage.

Metallic mercury, in the form of liquid or vapour, can be poisonous when ingested through water, food or air. It is especially hazardous when mercury vapours are inhaled. Individuals exposed to mercury spills in the workplace, home or school may be exposed to dangerous levels of mercury.

In 2001, a dentist in British Columbia died after heating mercury on his stove (www.vancourier.com/05201/news/05201N3.html). The mercury vapours released required the evacuation of the apartment building.

In 1989, a Michigan boy spilled less than one fluid ounce of mercury in a bedroom of his home early in the summer. Later that summer, his sister was admitted to the hospital because she had difficulty walking. She was diagnosed with a viral illness and sent home. Three weeks later, she could no longer walk and was returned to the hospital. Another sister developed similar symptoms and was taken to the hospital. During this visit, their condition was properly diagnosed as mercury poisoning, and they were treated. The problem was created by the spilled mercury in the carpet, which was slowly releasing toxic vapours into the home. The situation may have been made worse when mercury was picked up by the vacuum cleaner; each time it was used, mercury fumes were released into the air (http://ace.orst. edu/info/extoxnet/newsletters/n114_91.htm).

Each year, there are incidences of mercury spills across North America and around the world that send children to hospitals and, in some cases, cause fatal poisonings (www.mercury-k12.org/hglistings.htm). Until mercury use is curtailed, these accidents will continue to take place, posing a risk to anyone who is exposed.

There are rare forms of mercury that are highly toxic, even through contact with the skin. One tiny drop of dimethylmercury on the skin is enough to kill a human. A researcher in the United States died this way in 1997 when a drop of dimethylmercury seeped through her latex glove.

### 4.2.2 Chronic exposure to mercury

Children and developing fetuses are most at risk to low-level methylmercury exposure, particularly if a family regularly consumes fish that have high levels of methylmercury in them. The health effects of low-level exposure include neurological damage, reproductive system damage, behavioural problems and learning disabilities. Some recent medical research indicates that there may be no "safe level" of methylmercury in a child's body. Medical researchers have also noted that mercury is one of the only natural elements with no known biological benefit at any concentration in humans.

A small portion of the population is particularly sensitive to mercury in their bodies — in essence they are allergic to it. For these people, even very small amounts of mercury entering their bodies, such as the mercury in dental fillings, present a health problem, often causing symptoms resembling multiple sclerosis. For more information, see the studies by Ganser and Kirschner (1985), International Labor Organization (1983), Siblerud (1992 and 1994) and Windebank (1986).

Health warnings from governments, medical and scientific organizations have increased as a result of new research indicating that health effects occur at lower mercury levels than previously thought (see www.hc-sc.gc.ca/english/protection/warnings/2002/2002_41e.htm and www.cfsan.fda.gov).

### 4.2.3 Emerging medical consensus

Two major health studies have been conducted on populations that consume fish in an attempt to determine whether or not ongoing consumption of low levels of methylmercury causes observable health problems in children. The two studies were done on remote island populations where fish are consumed on a regular basis. One study was undertaken in the Seychelle Islands in the Indian Ocean and the other was in the Faroe Islands in the North Atlantic Ocean. While both studies identified health effects in children associated with exposure to mercury, there was an important difference in their findings. The study in the Seychelle Islands identified a threshold below which no observable effects were noticed, suggesting that low levels of mercury in the environment (typical of what we find in North America) do not pose a health risk. On the other hand, the Faroe Islands study identified observable developmental problems even when fish with very low levels of methylmercury were consumed.

**box 10**

## Little or No Margin of Safety

The National Academy of Sciences (NAS) in the United States, at the request of the United States government, completed a major review of mercury health studies (www.nap.edu). In a report released in 2000, NAS confirmed a number of important issues:

"(I)ndividuals with high methylmercury exposures from frequent fish consumption might have little or no margin of safety."

"The population at highest risk is the children of women who consumed large amounts of fish and seafood during pregnancy."

"...the committee estimated that each year about 60,000 children may be born in the United States with neurological problems that could lead to poor school performance because of exposure to methylmercury in utero."

"Chronic, low-dose prenatal methylmercury exposure from maternal consumption of fish has been associated with ... poor performance on neurobehavioral tests, particularly on tests of attention, fine-motor function, language, visual-spatial abilities (e.g., drawing), and verbal memory."

Following the NAS Study (see Box 10), the United States Food and Drug Administration issued a Consumer Advisory with "an important message for pregnant women and women of child-bearing age who may become pregnant about the risks of mercury in fish." The United States Centers for Disease Control also interpreted the findings of the health studies and issued an important report in 2001, noting that as many as 375,000 children born each year in the United States are at risk of neurological development problems resulting from maternal fish consumption (www.cdc.gov/exposurereport). In July of 2001 the American Academy of Pediatrics released a report stating that mercury "should not be present in the home or other environments of children."

These reports represent a growing consensus among health professionals that low levels of mercury in the environment, elevated only a small amount above natural mercury concentrations, may pose a serious health risk to children.

## 4.3 Health guidelines and fish restrictions

In response to the known hazards of consuming mercury-contaminated fish, many governments provide fish consumption guidelines and issue fish advisories. These guidelines and advisories are based on scientific assessments of the risks associated with exposure to mercury. Risk assessment for toxic substances is a complex undertaking and it is sometimes difficult to reconcile the information that results from these assessments. Moreover, different jurisdictions interpret the health risks in different ways. Therefore, it is not an easy task explaining to the public how best to protect themselves from ingesting unsafe quantities of mercury.

In the case of fish consumption, there are two kinds of mercury guidelines (see www.hc-sc.gc.ca/english/protection/warnings/2001/2001_60e.htm). There are guidelines for the concentration of methylmercury in fish described in parts per million (ppm). This helps to identify fish that have mercury levels that are too high to be safely eaten. In Canada, it is recommended that fish not be eaten if there is more than 0.5 ppm of methylmercury. The United States allows 1.0 ppm, which is double the amount recommended for fish in Canada.

**box 11**

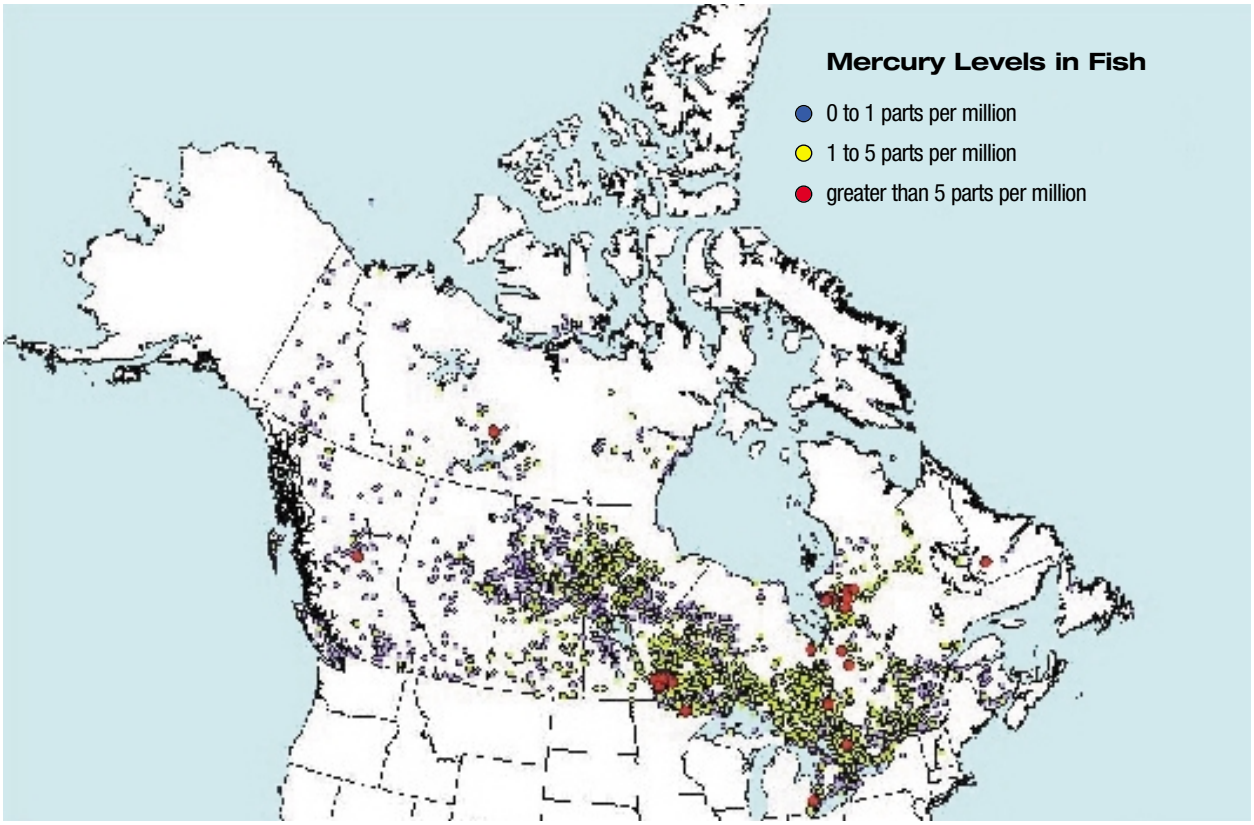
### A Small Amount Goes a Long Way

It is hard to imagine how tiny one-tenth of a microgram is, but if you cut a paper clip into 1 million pieces, one of these pieces, if it were methylmercury, would be enough to contaminate a serving of fish for a 20 kg child.

The second type of guideline describes the total amount of methylmercury one can safely consume over a period of time, by relating the fish concentration information to a person's bodyweight and amount of fish eaten daily. This is also known as the provisional tolerable daily intake (pTDI). Health Canada recommends that the daily consumption of methylmercury be no more than 0.47 micrograms per kilogram of body weight per day (µg/kg bw/day) for the general population. The pTDI introduced for young children and women of childbearing-age for methylmercury is 0.2 µg/kg bw/day.

The United States has more stringent standards. The United States Environmental Protection Agency (EPA) and the European Union have adopted a reference dose for the general population of 0.1µg/kg bw/day. By comparison, the Health Canada guideline of 0.47 µg/kg bw/day for the general population allows nearly five times this amount of mercury. The EPA estimates that three million children in the United States exceed the reference dose. Similar estimates have not been done for Canada.

**figure 13:** Mercury Levels in Freshwater Fish in Canada
SOURCE: Environment Canada. 2001. *Draft Status and Trends Report.*




The Canadian National Database for Mercury Levels in Freshwater Fish has information for more than 3,200 locations. Many areas have naturally high levels of mercury due to local geology or other factors. Areas without coloured dots have not been sampled for mercury.

Health Canada acts as an advisor to the provinces and territories that prepare "fish advisories" to guide people who catch fish about the amount of fish of different species they can safely eat. These fish advisories cover typical fish species caught in Canadian inland waters. Fish advisories exist for lakes and rivers in Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia, Yukon, Nunavut and the Northwest Territories. Methylmercury accounts for 99 per cent of fish advisories in inland lakes. In Ontario, 39 per cent of sports fish in inland water bodies — normally the predatory species, such as bass and walleye/pickerel — require consumption restrictions. The 1999 Report of the Commissioner of the Environment and Sustainable Development to the House of Commons noted a Health Canada study that found that nearly two-thirds of anglers ignore or don't know about fish advisories for mercury.

### 4.3.1 Concerns about saltwater fish

Ocean predatory fish, such as swordfish, shark, king mackerel, tilefish and fresh or frozen tuna, have even higher levels of mercury than freshwater fish. Health Canada recommends that the general population should not consume more than one meal per week of these fish. Women of childbearing-age and children should not consume more than one meal per month, according to Health Canada advisories. The United States Food and Drug Administration goes further, advising pregnant women and children not to eat the first four of these fish at all. Many other species do not contain as much mercury and can be consumed more frequently.

**box 12**

## How Much Fish Can I Eat?

Translating the sometimes conflicting information contained in fish consumption guidelines can be very confusing. Taking the most stringent guideline of 0.1 µg/kg bw/day means that a 60 kg woman (132 lbs) should eat no more than 46 grams of an average fish in a day. This is equivalent to one tuna sandwich. One good-sized fish serving (322 grams) is the maximum safe amount recommended in a week. Having both a tuna sandwich and fish for dinner in the same week could, therefore, put you above the level considered to be safe by the EPA.

Certain species of ocean fish — shark, marlin, swordfish and fresh tuna — are exempted by the Canadian Food Inspection Agency from having to meet Health Canada's mercury guidelines. As a result, these commercially available fish are being sold with levels of mercury that are known to be dangerous to the developing foetus. Since there are no standards in place and there are no warnings posted in fish shops, pregnant women need to be especially cautious in their purchases and should avoid these fish altogether.

The most prudent advice may be for pregnant women to be aware of their fish consumption habits and avoid species high in mercury. As a general rule, pregnant women are advised to eat no more than 340 grams of fish per week. That works out to a limit of two or three average fish servings per week, including canned tuna. Ideally, fish that are low in mercury (non-predatory species) can be consumed in higher amounts to take advantage of the health benefits, while predatory species should be eaten less often. Few people buying fish in a market know which fish are predatory, and without clear public health information or warnings, consumers are not in a position to make informed choices about the health benefits and safety of the fish they eat. Catfish (farmed), haddock, trout (farmed), salmon (wild Pacific) and flounder are examples of fish that typically have lower mercury levels (see www.schs.state.nc.us/epi/fish/whatfisharesafe.pdf).

**box 13**

## The Healthy Fish Dilemma

Fish is a nutritious food and provides an excellent source of animal proteins and other nutrients. For subsistence fishers, it is often the only source of low-cost protein. Fish and shellfish are low in saturated fats and they provide cancer-fighting antioxidants, such as selenium and vitamin E. They also offer beneficial omega-3 polyunsaturated fatty acids. These important acids are not found in many foods and are important in the development of motor skills, the brain, and vision — ironically, three areas that are attacked by methylmercury. Recent studies have also shown that fish oils protect against heart attacks and help reduce blood pressure.

Mercury accumulates in the flesh of fish, so it cannot be cut away and does not disappear when the fish is cooked. It is still recommended that the fat and skin be separated from fish before eating it to

**figure 14:** Fresh Tuna Dinner
SOURCE: Pollution Probe MERC Programme

reduce exposure to other toxic substances found in the fatty tissue.

Health professionals agree that the solution is not to eat less fish, but to make sure elevated levels of mercury do not contaminate the fish in the first place. However, this is a problem because naturally occurring mercury cannot be eliminated from the ecosystems of the fish. Human contributions of mercury to the environment, on the other hand, can be lowered significantly by reducing mercury use and preventing releases. This message was re-stated in the recent National Academy of Sciences study:

> ***"Because of the beneficial effects of fish consumption, the long-term goal needs to be a reduction in the concentrations of methylmercury in fish rather than a replacement of fish in the diet by other foods."***

This is the crux of the issue in Canada, where First Nations people and sports anglers continue to consume large amounts of fish, and thus elevated health risks from methylmercury may be present. Yet the health benefits of eating fish are thought to outweigh the health risks of mercury contamination. Moreover, there may exist important cultural and economic factors associated with gathering and eating fish and marine mammals. The solution, therefore, is to prevent mercury from entering the ecosystem and contaminating the fish, not to stop eating fish. In the interim, fish consumers must be well informed.

## 4.4 Dental fillings and health

Dental amalgams are soft alloys of mercury, silver and other materials that harden when placed as a filling in a patient's tooth. A 1995 Health Canada study entitled "Assessment of Mercury Exposure and Risks from Dental Amalgam" suggested that adults should have no more than four mercury amalgam fillings placed in their teeth per year, and that for children and pregnant women, alternatives to mercury amalgam fillings should be used. After consultations with stakeholders and a review of toxicological studies, Health Canada concluded that the information on mercury vapour exposure from dental amalgam was not sufficient to quantify health effects.

According to Health Canada, dental amalgam contributes detectable amounts of mercury to the body and is the largest single source of mercury exposure for the average Canadian. This exposure is not thought to be causing illness in the general population, although a small portion of the population has heightened sensitivity to mercury and can suffer severe health effects from low exposure. Health Canada recommends that amalgam fillings not be placed in or removed from the teeth of pregnant women or placed in patients with impaired kidney function (see "The Safety of Dental Amalgam" www.hc-sc.gc. ca/english/media/releases/1996/96_63e.htm for more information).

A number of countries in Europe, including Austria, Denmark, Germany and Sweden, have placed restrictions on dental amalgam use including, in some cases, bans on the sale of amalgam, total bans on amalgam use, or bans on amalgam use in pregnant women. In California, a Bill has been introduced calling for a ban on mercury amalgam use.

There are no restrictions on the use of mercury dental amalgam in Canada, although a voluntary standard for the capture of mercury dental waste in dentists' offices has been introduced. This is to prevent mercury from, literally, going down the drain and getting into aquatic ecosystems. It says nothing of the potential health risks of dental amalgam to the dental patient. Many dentists in Canada no longer use mercury fillings, given the availability of substitutes and the preference expressed by patients. It is advisable to discuss with your dentist the use of non-mercury alternatives or to seek out a dentist who provides mercury-free fillings.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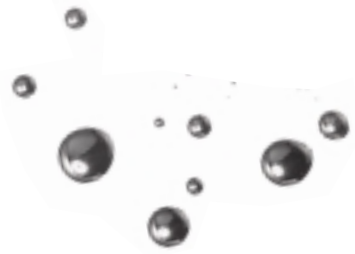


# Mercury Use Today

## 5.1 Where mercury comes from

Despite the known hazards, several thousand tonnes of mercury are used each year in commercial applications. Mercury is put into hundreds of different consumer products manufactured in all parts of the world. Even though mercury is often thought of as a substance used in "old" technology, mercury applications can be found in notebook computers, modern telephones, new lighting technologies and anti-lock brakes in new cars.

New or "virgin" mercury used in products originates from mines. The principal mercury ore is called cinnabar, a soft red sulphide mineral (HgS). The mercury ore is processed to remove impurities and sold to manufacturers to be put into many types of consumer products. Spain is the largest primary producer of mercury, followed by Kyrgyzstan, China and Algeria. Together the four countries produce 90 per cent of the world's total mined mercury. Canada no longer mines mercury — the last mercury producing mine in Canada closed in 1975.

As programmes to recover mercury have started to work, much of the mercury used today comes from recycled sources, thus reducing demand for virgin mercury. Furthermore, the closures and conversions of mercury cell chlor-alkali plants have made large quantities of mercury available for resale and reuse. Canada, for example, exported 137 tonnes of mercury in 1996. This figure has declined dramatically and, in 1999, Canada exported less than two tonnes of mercury. In the United States, the secondary production of mercury now exceeds annual demand, and mercury is no longer mined there.

## 5.2 Mercury and gold mining

Mercury has been used for thousands of years in gold mining operations to separate gold from other rocks and metals. This practice was not used extensively in Canada, because mercury was too heavy to ship to the distant mining locations. While it has been nearly eliminated from the Canadian mining sector, its use is widespread in small gold mining operations throughout the world. The continuing use of mercury in gold mining in the Amazon River basin is on the verge of becoming an ecological and human health disaster. Cases of "Minamata disease" (severe mercury poisoning) were recently reported among Amazon Indians eating contaminated fish.

**box 14**

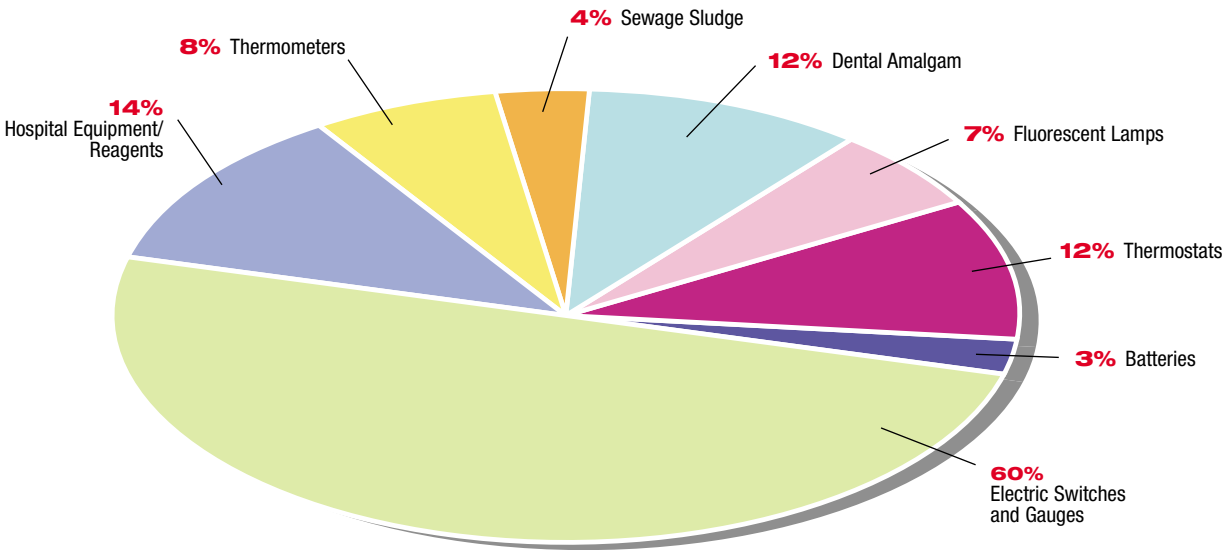
### Ancient Rites Cause Modern Problems

In countries where the mystical properties of mercury are still valued, some of the ancient practices continue. In Mexico and other Spanish-speaking countries, for example, amulets containing liquid mercury are still widely available. Worn around the neck, they are thought to protect the wearer from ill health. In some cultures, liquid mercury is sprinkled in homes, or even around children's cribs to help ward off evil spirits. A lack of awareness of the potential harm, combined with cultural and historic factors, makes this a challenging problem to address.

## 5.3 Mercury in consumer products

Hundreds of tonnes of mercury continue to be put into consumer products every year throughout the world to measure temperature and pressure, make fluorescent light bulbs operate, conduct electricity, act as an anti-fungal agent or serve as the primary component in dental fillings (see Figure 15). Canada imported over nine tonnes of mercury in 1999, mainly to be used in electrical products and measuring devices. This is much less than the 50 tonnes per year imported in the late 1970s and early 1980s. Thermometers, thermostats, fluorescent lamps, electrical switches, pharmaceuticals and dental fillings are examples of products in which mercury is still being used. Mercury is also used in many specialty medical applications, such as blood pressure cuffs and in vaccines (where it acts as a preservative).

**figure 15:** Mercury in Products
SOURCE: Hagreen, L. and B. Lourie. 2002. *Mercury in Canada and Estimating the Release of Mercury from these Sources at Electric Arc Furnaces.* Report prepared for the Canadian Council of Ministers of the Environment.

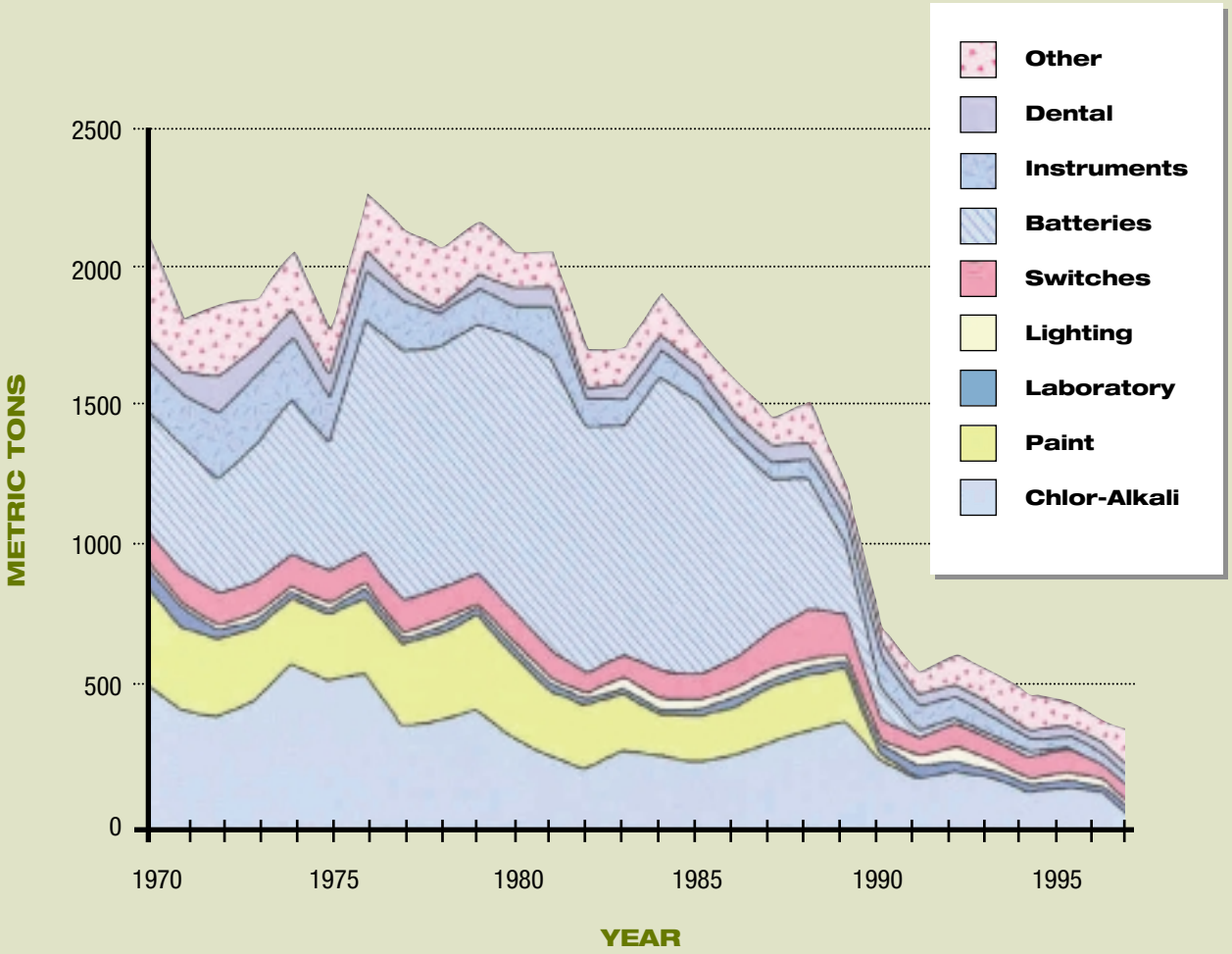


Mercury's unique physical and chemical properties have many commercially valuable applications. One of the most common and simplest is the tilt switch: liquid mercury is contained in a small glass or metal capsule that, when tilted, causes the mercury to roll down the capsule touching a metal contact that closes an electrical circuit. These switches are used in thermostats to turn furnaces off and on, to turn the lights on in chest freezers and under car hoods, and to stop washing machines from spinning when the lid is opened, among other uses.

Mercury use worldwide peaked in the 1970s, and has been declining ever since. In the United States and Europe, governments have banned the use of mercury in a number of products and placed strict disposal restrictions on products containing mercury. As a result of these actions, mercury is no longer used as a fungicide in paint and it has been all but eliminated from batteries manufactured in these countries. Figure 16 illustrates the dramatic reductions that have taken place in these sectors in the United States. Mercury use in pesticides has also been reduced dramatically as a result of stricter regulations. Canada has benefited from the regulations in the United States and Europe, since the mercury-free products produced for their markets are also sold in Canada.

There are a few restrictions on mercury use in Canadian consumer products; for example, mercury cannot be used in coated surfaces of children's toys. But Canada lags the United States and Europe in banning a number of uses of mercury in products. There are also few disposal requirements for mercury-containing products in Canada. One exception is industries in Ontario that have generated more than 5 kg/month of mercury-containing devices, or that have in storage more than 5 kg of mercury-containing devices. These industries are required to register with the Ontario Ministry of the Environment and receive a "generator registration." All such wastes must be sent to a hazardous waste facility using a licensed hauler.

**figure 16:** United States Industrial Reported Consumption of Mercury (1970—1997)
SOURCE: Sznopek, J.L. and T.G. Goonan. *The Materials Flow of Mercury in the Economies of the United States and the World.* US Geological Survey Circular 1997.



## 5.4 Chlor-alkali plants

In general, major mercury reductions have been achieved in the chlorine chemical industry. However, mercury cell chlor-alkali plants continue to represent one of the largest intentional uses of mercury worldwide. The mercury acts as a catalyst in the chemical reaction that separates chlorine from sodium in salt. These are the kind of facilities that caused mercury pollution in the English-Wabigoon River and Lake St. Clair in Ontario. A mercury cell chlor-alkali plant in Cornwall, Ontario, contaminated much of the soil in the plant's vicinity, to the point where the government of Ontario recommended that residents not eat vegetables from their own gardens. Even though mercury cell chlor-alkali plants have been nearly phased out in Canada, one remains in New Brunswick. Approximately one hundred mercury cell chlor-alkali plants are still operating worldwide, although this number is declining. A non-mercury based process is now used in the remaining chlor-alkali facilities in Canada and an increasing number of plants elsewhere.

**box 15**

### The Mercury-Energy Connection

Mercury and energy production are connected in many interesting ways. We often control energy use with mercury thermostats. Many energy-using products are turned on or off with mercury switches. We measure the heating and cooling produced by the energy we use with mercury thermometers. Mercury-containing fluorescent lights are a major source of energy use in Canada, and the generation of electricity from fossil fuel combustion is one of the largest human-caused sources of mercury emissions.

There is a good news side to this story. Widely available programmable electronic thermostats contain no mercury and save on energy use, creating a double bonus of dollar savings and mercury reductions. The most efficient fluorescent lamps contain less mercury and use less electricity than standard fluorescent lamps. Fluorescent lamps are also far more efficient than incandescent light bulbs, leading to lower energy-related air emissions of mercury and other substances. Cleaner-burning fuels, such as natural gas, reduce the amount of mercury emitted and reduce the other pollution generated during fossil fuel combustion. Using energy wisely saves money, conserves valuable resources and helps prevent mercury pollution, smog, acid rain and climate change.

## 5.5 Mercury and cars

Mercury in cars is used primarily in switches that operate convenience lights under the hood and trunk, and in anti-lock brake mechanisms. This use of mercury has been the focus of recent attention for several reasons. First, cars represent one of the largest continued uses of mercury, with estimates of between 13 and 15 tonnes of mercury currently in use in Canadian vehicles and up to 200 tonnes of mercury in North American cars and trucks on the road today. The second important concern is that much of that mercury will be released to the atmosphere when the cars are recycled to make new steel. Mercury emissions to the atmosphere, such as from steel recycling, are considered to be a more serious environmental problem than the disposal of mercury products to landfill sites.

## 5.6 Controlling mercury use

Mercury is still being used for several reasons. It is an inexpensive, reliable material that has been used for centuries. Occurrences of acute mercury poisoning have declined with improved industrial practices, and the mercury used in consumer products was, in the past, not considered to pose a risk because it was contained in the product until discarded. The health effects of low-level exposure to mercury have only recently been confirmed and have not been widely publicized, leaving people with the impression that small amounts of mercury are not hazardous. The lack of public awareness is compounded by the fact that, in Canada, most of the mercury used in products goes down drains, into garbage dumps, or is burned in incinerators, so that people do not see or handle the mercury directly. Finally, most companies that use mercury have been unwilling to change their practices if it means having to spend money to modify their products, unless they are regulated to do so. In most cases, mercury reductions in products sold in Canada have occurred as a direct or indirect result of government regulation in the United States and Europe.


FUCHS
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Controlling the release of mercury from many different kinds of consumer products can be difficult — mercury tends to be used in small quantities in any particular product and, in many cases, the mercury is concealed inside the product or is used as a chemical additive. People using many of these products are generally unaware of the fact that they contain mercury. Regulations requiring the labelling of mercury-containing products in order to inform consumers exist in Vermont. Industry opposition to the regulation was strong, but the United States Supreme Court defeated industry challenges, permitting the state of Vermont to implement consumer labelling requirements.

The most successful strategy for protecting human health and the environment from mercury is "pollution prevention," an approach that focuses on reducing the use of mercury, as opposed to technologies that attempt to trap and recycle mercury before it reaches the environment. Since there are safe and cost-effective alternatives to mercury for almost all applications, there are no reasons why mercury cannot be almost completely phased out of use in Canada.

**figure 17:** Electric Arc Furnace
SOURCE: Dofasco Inc.


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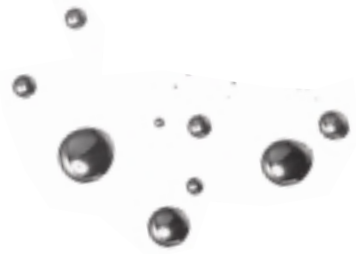

# Alternatives to Mercury Use

Mercury-free alternatives are available for virtually all products that currently contain mercury. The availability of safe and cost-effective alternatives to mercury is good news for the environment and human health. This means that the only challenge ahead is to convince or require companies still using mercury to adopt the alternatives available to them.

One exception is the fluorescent light. Mercury is used in all fluorescent light tubes, including compact fluorescent bulbs and neon lights. The metallic mercury vapour inside the tube conducts electricity through the gaseous substance, causing fluorescent particles to "light up." There is no commercial alternative to mercury, although international lamp manufacturers have reduced the amount of mercury needed to make a light operate by nearly 75 per cent over the past decade.

The fluorescent light problem does have a positive side. A compact fluorescent light uses 70 to 90 per cent less energy to create the same amount of light as a traditional incandescent light bulb. This means that if electricity comes primarily from coal-fired power plants, as is the case in Alberta and Saskatchewan, the highly efficient fluorescent light reduces the mercury emissions associated with electricity production. Research is underway to produce a mercury-free fluorescent lamp that is still energy efficient.

In many cases, mercury-free products offer consumers a number of benefits besides the fact that they are mercury-free. Electronic thermostats are generally programmable, so that the temperature of a house can be adjusted automatically at night or during the day if the house is empty. For homes and buildings with central air conditioning, the ability to cool only when needed saves energy. In addition to saving hundreds of dollars in energy costs, emissions of mercury and the many other pollutants associated with coal-based electricity production are also reduced.

Fever thermometers are another example in which mercury-free digital alternatives provide the added benefits of being easy to use, easy to read and unbreakable. In many cases, the mercury-free alternatives are simple and cost no more than the mercury-based products. Mercury tilt switches used in cars are an example in which simple and inexpensive mechanical or ball bearing switches have been available for many years and used by most of the Japanese and European manufacturers.

Table 1 provides a list of some common consumer products that may contain mercury, together with a list of the mercury-free alternatives. Some of the items listed are no longer manufactured with mercury, but may still be present in homes and, therefore, may be discarded in an inappropriate manner.

**table 1:** Consumer Products Known to Contain Mercury and Mercury-Free Alternatives

Modified from "Mercury Awareness for Michigan Citizens." (Revised December 2000).

| Products known to contain mercury | Pollution prevention alternatives |
|---|---|
| **Thermometers** | **Alcohol Thermometers** (red bulb) and **Digital Electronic Thermometers** |
| **Thermostats** (round, non-electric models) | **Electronic Models** and **Snap Switches** |
| **Button Batteries** (some) | **Mercury-Free Button Batteries** (zinc air type) |
| **"Silver" Dental Amalgam** | **Non-mercury Composites** or **Gold** |
| **Quicksilver Maze Toy** | **Mercury-Free Toys** |
| **Old Latex Paints** (in the United States, mercury was banned from interior latex paints in 1990 and from exterior latex paints in 1991) | **New Latex Paint** |
| **Some Running Shoes that Light Up** | **Mercury-Free Shoes** (consult label) |
| **Switches** (including "silent" light switches, tilt switches in appliances, float switches in pumps, industrial switches, etc.) | **Mechanical** or **Pressure Switches** |
| **Contact Lens Solution** (containing Thimerosal, a mercury-containing preservative) | **Mercury-free Solutions** |
| **Nasal Spray** (with Thimerosal/phenylmercuric acetate) | **Mercury-free Sprays** |
| **Flame Sensor** (used in some residential and commercial gas ranges) | **Hot Surface Ignition System** (for devices or products that have electrical connections) |
| **Fluorescent** and **High Intensity Discharge (HID) Lamps** | **Low-mercury, Energy-efficient Fluorescent Lamps** (T5s and T8s). (All fluorescent lights contain some mercury, however, they conserve energy, reducing mercury emissions from coal and oil combustion.) |


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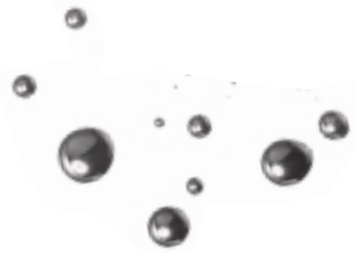

# Mercury Policy in Canada

Governments in Canada and elsewhere have responded to the mercury problem by developing mercury management programmes. Specific mercury reduction programmes are implemented domestically and, in some countries, restrictions are being placed on the emission, use and disposal of mercury in consumer goods.

Canada has signed three international agreements that outline various mercury management programmes, including the North American Regional Action Plan on Mercury (with the United States and Mexico), the Great Lakes Binational Toxics Strategy (with the United States) and the UNECE Heavy Metals Protocol (International). This last agreement has been signed by 36 countries and ratified by 14 countries including Canada, the United States and the European Community. In addition, the five eastern provinces of Canada signed the Eastern Canadian Premiers/New England Governors Mercury Action Plan. All of these agreements call for measures to reduce mercury use and/or emissions.

Canada and Ontario have completed a six-year programme to reduce mercury uses and emissions under the 1994 Canada-Ontario Agreement, which was renewed in 2002. Many industries also participated in the Accelerated Reduction/Elimination of Toxics (ARET) Programme, which was a voluntary, non-regulatory initiative with a 50 per cent reduction target for mercury. The renewal of this programme was being discussed at the time this primer was prepared.

The Canadian government and all of the provinces (Quebec does not participate, but has agreed to implement the standards) are participating in a process to set Canada-Wide Standards for certain uses or emissions of mercury, using the Canadian Council of Ministers of the Environment (CCME) as the forum for programme development. Under this process, guidelines have been set for mercury emissions from base metal smelters and waste incinerators, the capture of mercury from dental offices, and the disposal of fluorescent lamps. A standard for mercury emissions from coal-fired electric power plants is under development.

Currently, Canada has fewer regulations on the use and release of mercury than are generally found in Europe and the United States. There is one federal regulation in Canada that restricts the emission of mercury, promulgated under the Canadian Environmental Protection Act (CEPA), and which applies to mercury cell chlor-alkali plants. A second regulation, under Health Canada's Hazardous Products Act, restricts the use of mercury in paint or other coatings on children's toys. There are also federal and provincial restrictions on the storage, transport and disposal of mercury waste.

**figure 18:** Aquatic Environment
SOURCE: Comstock

# The Mercury Situation in Canada

## 8.1 How are we doing?

More than forty years have passed since the deadly effects of mercury pollution first came to light in Japan. In that time, mercury uses and releases have been significantly reduced across North America and Europe. What was once a major source of mercury pollution in Canada — chlor-alkali plants — has nearly been eliminated. Major mercury use reductions have been made in batteries, paints, residential light switches, fungicides and fluorescent lamps. Reductions of close to 100 per cent have been achieved in the first four products, and 75 per cent less mercury is used in a typical fluorescent light tube today than in 1985. This represents important progress, demonstrating the relative ease of phasing out mercury in product manufacturing.

Thermostats, fever thermometers and electrical switches remain the major intentional mercury uses in Canada, even though simple and cost-effective alternatives exist. Mercury use reductions in these applications are underway with the increased availability of low-cost alternative products. Electronic programmable thermostats are increasing in popularity, and Honeywell, the largest manufacturer of thermostats, has announced a plan to stop producing mercury thermostats in 2006. Several major drug store chains in the United States have stopped selling mercury thermometers as a result of consumer pressure. In Canada, Jean Coutu, Shoppers Drug-mart and Walmart have stopped selling mercury thermometers. North American automobile manufacturers are expected to discontinue mercury use in convenience lighting switches by 2003.

## 8.2 Working together to reduce the risk

In addition to the efforts of governments and industry, non-government organizations have been active on mercury pollution issues. Pollution Probe has played a leadership role in Canada, undertaking inventory research, convening workshops, developing

**box 16**

### Mercury Reduction at The Hospital for Sick Children

The Hospital for Sick Children signed a Memorandum of Understanding with the Ontario Ministry of the Environment in 1996 to eliminate all of the mercury containing devices from the facility. The hospital is now a mercury-free environment. The hospital even goes so far as to remove 100 per cent of the mercury with an amalgam separator installed below the dentistry department (see Figure 19).

On February 18, 2003, the Hospital for Sick Children conducted a mercury thermometer exchange in conjunction with The Canadian Coalition for Green Health Care, the Sustainability Network and six Ontario hospitals. The Thermometer Round-Up, a one-day event, invited staff to bring mercury thermometers from home and exchange them for new (free) digital thermometers and learn about the hazards of mercury. The exchange was an incredible success, bringing in approximately 500 mercury thermometers.

The Hospital for Sick Children is always on the leading edge concerning environmental issues and prides itself in being an industry leader.



policy solutions and delivering mercury pollution prevention programmes in partnership with business and governments. In 1995, Pollution Probe developed the Mercury Elimination and Reduction Challenge (MERC) programme. An initial success under MERC was Pollution Probe's leadership in the signing of Canada's first Memorandum of Understanding to reduce mercury use in hospitals. Pollution Probe's groundbreaking work with hospitals contributed to Canada's signing of the Canada-Wide Standard for mercury emissions from hospital incinerators.

In 1999, Pollution Probe created Canada's first programme to remove mercury switches from cars. The purpose of the programme is to prevent mercury in old cars from entering the atmosphere when the cars are melted down to make new steel. The "Switch Out" programme was launched in partnership with the Ontario Automotive Recyclers Association, Fluorescent Lamp Recyclers and Comus International, with financial support from Ontario Power Generation Inc., Environment Canada and the Ontario Ministry

**figures 19A & 19B:**
Amalgam Separators at
The Hospital for Sick Children
SOURCE: The Hospital for Sick Children

of the Environment. The Switch Out pilot programme was highly successful and is being expanded across Canada as a programme of the Clean Air Foundation.


**figure 20:**
Switch Out Logo
SOURCE: Clean Air Foundation

## 8.3 There is still room for improvement

Despite the number of successful examples in which mercury use has been reduced, studies by the United Nations Environment Programme (UNEP) and the United States Geological Survey demonstrate that mercury levels in the global atmosphere are still increasing. This is due to the fact that mercury is a persistent substance, so mercury that is emitted from coal-fired plants, incinerators, steel-making and product disposal around the world is added to the mercury that has been released over the past several hundred years. The mercury that is cycling through the environment is removed (mainly through sedimentation processes) at an extremely slow pace, so even after the polluting activity ceases, most of the released mercury remains in the environment. Increasing economic activity, together with population growth, is adding to the mercury emissions from coal plants, mining operations and product uses in many countries, and is contributing to increasing global mercury levels.

Mercury levels in the fish, marine mammals and native residents of Canada's Arctic continue to rise, posing a threat to their health. A major international study of the Arctic found that, during the past twenty years, mercury levels in Arctic marine wildlife have increased two to three-fold. Mercury concentrations in loons and other fish-eating species have reached levels causing concern in some areas of eastern Canada. Mercury fish advisories continue to expand across North America. Mercury emissions from coal-fired power plants — North America's largest source — are projected to rise in Canada and the United States until new regulations come into effect.

Though new uses of mercury are uncommon, there are no regulations in Canada that prevent a company from putting mercury in a product and selling it to the public. In one instance, a proposed new use of mercury was met with such skepticism by government officials that the manufacturer voluntarily withdrew it. However, it has come to light that high mercury content batteries imported from China are being sold illegally under common brand names in Canada. This activity cannot be prevented with our existing environmental laws, although consumer fraud regulations could be used to prosecute the offending companies. This situation requires governments and individuals to take action, wherever they can, to prevent the use and release of mercury to the environment.


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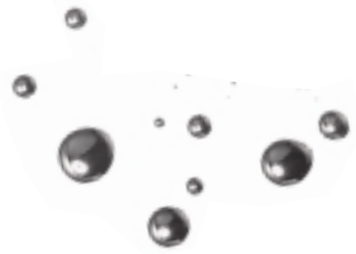

# What You Can Do About Mercury

There are many convenient, inexpensive, yet very effective steps that consumers can take to prevent mercury from contaminating our children and our lakes, rivers, fish and wildlife. First and foremost, do not buy products that contain mercury. Thermometers and thermostats are the two most obvious consumer products for which mercury-free alternatives exist. If you are not sure, you should consult the manufacturer, since many sales staff are unaware of the presence of mercury in products. There are no requirements in Canada to label products that contain mercury and the public often assumes that mercury is no longer being used.

It is usually easy to tell whether or not thermometers and thermostats contain mercury. In thermometers, the shiny silver liquid mercury can be seen in the glass bulb at the base of the thermometer, although on rare occasions non-mercury thermometers have liquid metal compounds that resemble mercury; these are always labeled as mercury-free. Many other products are more difficult to identify as containing mercury. Generally speaking, electronic thermometers and thermostats do not contain mercury. The well-known round household thermostats do contain mercury and this can be easily seen in the glass bulb inside the thermostat. Electronic programmable thermostats are mercury-free, and save money and energy.

There are also things that can be done to protect yourself and your family from exposure to mercury. Eating the right fish, being conscious of dental fillings, and being aware of the dangers posed by mercury in household products are important matters for everyone to consider. This is especially important for families with young children and pregnant mothers.

**figure 21:**
Thermometer Exchange
SOURCE: Canadian Coalition for Green Health Care.

**box 17**

# Five Easy Things You Can Do to Help Prevent Mercury Pollution and Protect Yourself

## 1. Buy Mercury-Free

►Choose products that do not contain mercury. Look for digital thermometers and electronic thermostats. Ask store staff to assist you or contact the manufacturer's toll-free number directly.

►Ask your dentist if he or she will employ mercury-free composites for any dental work, and enquire if your insurance company will pay for the mercury-free materials (if not, speak with your employer or insurance company).

►Ask your local pharmacy or hardware store to consider phasing-out the sale of mercury-containing products.

## 2. Discard Products Safely

►Separate mercury-containing products, such as thermometers, thermostats, old paint (pre-1991) and batteries (pre-1995) from regular garbage.

►Do not remove mercury switches from products, such as thermostats; it is safer to keep or recycle the product when it is intact.

►Take any mercury-containing products that you have collected to your local household hazardous waste depot. Call your local municipality for information on where to bring mercury-containing waste. Be careful to ensure that mercury thermometers are well protected from breakage.

►If you have an old thermostat, contact Honeywell at 1-800-345-6770 to find a retailer near you who will accept it.

## 3. Conserve Energy

►Turn the heat back and use air conditioning only when necessary in order to conserve energy. An electronic programmable thermostat can help do this for you.

► Purchase only energy-efficient products, such as compact fluorescent lights (instead of incandescent bulbs). Even though fluorescents contain a small amount of mercury, they will help reduce energy use and related pollution.

► Ensure your home is properly sealed and well-insulated.

### 4. Avoid Exposure to Mercury at Home, School and Work

► Never play with liquid mercury. If you come into contact with liquid mercury, wash the affected area immediately.

► Do not vacuum liquid mercury spills. If mercury spills in your home or property, carefully collect the mercury using a damp paper towel and place the mercury and all contaminated waste in a sealed container. Contact your local pollution control agency if the spill is serious or if you are unable to collect or contain the mercury.

► Notify your employer or school official if you see stored or spilled mercury.

### 5. Be Aware of Mercury in Fish

► Pregnant women, breastfeeding women and children (under 15) should never consume large ocean fish, especially fresh tuna, shark, swordfish, king mackerel or tile fish. Other fish species should be consumed in moderation.

► If you consume freshwater fish frequently, you should know the local fish advisory guidelines and follow them carefully. Pregnant women, breastfeeding women and children (under 15) should avoid large freshwater fish, especially pike, walleye (pickerel), largemouth bass and muskellunge. As a general rule, smaller fish are safer to eat.

► Continue to eat fish, while following health guidelines and fish advisories. Catfish (farmed), haddock, trout (farmed), salmon (wild Pacific) and flounder are examples of fish that typically have lower mercury levels (www.schs.state.nc.us/epi/fish/whatfisharesafe.pdf).

**box 18**

## Reducing Releases

Reducing or eliminating anthropogenic mercury releases will require controlling releases from mercury-contaminated raw materials and feedstocks as well as reducing or eliminating the use of mercury in products and processes. The specific methods for controlling these mercury releases vary widely, depending upon local circumstances, but fall generally under four groups:

- Reducing mercury mining and consumption of raw materials and products that generate releases;
- Substitution of products and processes containing or using mercury;
- Controlling mercury releases through end-of-pipe controls; and,
- Mercury waste management.

SOURCE: UNEP. 2003. Global Mercury Assessment.

## 9.1 For more information

(All websites were accessed for verification on May 7, 2003)

For more information about mercury, contact the following:

### Fish Advisories —

For a summary, please see "Examining Fish Consumption Advisories Related to Mercury Contamination in Canada" by Mary Ellen Wood and Luke Trip (www.ec.gc.ca/mercury/images/i-d-fcadc-e.PDF).

**Alberta**

Regional Offices of the Fish and Wildlife Division ..... www3.gov.ab.ca/srd/fw/
Alberta Health and Wellness ..... www.health.gov.ab.ca/

**British Columbia**

Ministry of Water, Land and Air Protection ..... www.gov.bc.ca/wlap/
Ministry of Health Services ..... www.gov.bc.ca/healthservices/

**Manitoba**

Water Branch, Department of Conservation
..... www.gov.mb.ca/natres/watres/index.html

**New Brunswick**

New Brunswick Public Health Services, Health and Wellness
..... www.gnb.ca/0051/0053/index-e.asp

**Newfoundland and Labrador**

Department of Fisheries and Oceans ..... www.dfo-mpo.gc.ca

**Northwest Territories**

GNWT Health and Social Services ..... www.hlthss.gov.nt.ca/

**Nova Scotia**

Department of Environment and Labour ..... www.gov.ns.ca/enla/

*For information on consumption advisories in marine waters, contact:*

Department of Fisheries and Oceans ..... www.dfo-mpo.gc.ca

Environment Canada ..... www.ec.gc.ca

**Nunavut**

Nunavut Health and Social Services

..... www.gov.nu.ca/Nunavut/English/departments/HSS/

**Ontario**

Sport Fish Contaminant Monitoring Program, Ministry of the Environment

..... www.mnr.gov.on.ca/MNR/fishing/guide.html

Ministry of the Environment ..... www.ene.gov.on.ca/

Ministry of Natural Resources ..... www.mnr.gov.on.ca/

**Prince Edward Island**

PEI Fish and Wildlife Division, Department of Fisheries, Aquaculture and Environment

..... www.gov.pe.ca/fae/faw-info/index.php3

**Quebec**

Ministère de l'Environnement du Québec ..... www.menv.gouv.qc.ca

**Saskatchewan**

Local Saskatchewan Environment and Resource Management (SERM)

..... www.se.gov.sk.ca

**Yukon**

Health and Social Services ..... www.hss.gov.yk.ca/

## Poison Control Centres —

**Alberta**
Alberta Poison Control Centre ..... 1-800-332-1414

**British Columbia**
Poison Control Centre *(call toll-free from anywhere in BC)* ..... 1-800-567-8911

**Manitoba**
Poison Control Centre *(24 Hour Number)*
..... 1-204-787-2591 *(in Winnipeg dial 911)*

**New Brunswick**
Call 911 for any type of poisoning

**Newfoundland and Labrador**
Poison Information Centre *(Dr. Charles A. Janeway Child Health Care Centre)*
..... 1-709-722-1110

**Northwest Territories**
Poison Control ..... 1-800-267-1373

**Nova Scotia**
Call 911 or Poison Control Centre *(IWK-Grace Hospital)*
..... 1-902-470-8161 or 1-800-565-8161

**Nunavut**
Poison Control Centre ..... 1-800-463-5060

**Ontario**

Poison Control Centres ..... 1-800-268-9017 (Toronto)
..... 1-800-267-1373 (Ottawa)
..... 1-416-597-0215 (TTY)

**Prince Edward Island**

Poison Control Centre *(IWK-Grace Hospital)* .... 1-902-428-8161 or 1-800-565-8161

**Quebec**

Centre anti-poison du Québec ..... 1-800-463-5060

**Saskatchewan**

Saskatchewan Poison Centre *(Free of charge from anywhere in Saskatchewan)*
..... 1-866-454-1212

**Yukon**

Poison Control ..... 1-867-393-8700

## Mercury Product Disposal —

**Municipal:** Please contact your municipality for the location of the nearest Hazardous Waste Depot.

**Honeywell:** Honeywell provides information on mercury thermostat disposal.
See http://content.honeywell.com/yourhome/ptc-thermostats/thermostat.htm for more detail.

## Mercury Spills —

All mercury spills should be cleaned up immediately and properly disposed of. There are some simple guidelines that should be followed should a mercury spill occur (from Pollution Probe's *Switch Out: Auto Dismantlers' Guide* www.pollutionprobe.org/Reports/mercswitchout.pdf):

**1.** Small mercury spills on a hard, non-porous surface can be contained by wiping up the mercury and sealing the cloth or towel in a double plastic bag. This bag must then be disposed of properly, or removed by a hazardous waste handler.

**2.** Mercury spill kits are available at laboratory safety supply stores.

**3.** Never use a vacuum to clean up a mercury spill. Mercury readily becomes a vapour, and a vacuum will disperse mercury into the air where it can be inhaled.

**4.** Never use a broom to sweep up mercury. This will create even smaller beads of mercury, which will be more difficult to collect.

For more information, see Environment Canada's site, Cleaning Up Small Mercury Spills: www2.ec.gc.ca/mercury/r-s-e.html.

## Mercury Ingestion —

The advice given in Pollution Probe's *Switch Out: Auto Dismantlers' Guide* (www.pollutionprobe.org/Reports/mercswitchout.pdf) is **"seek medical attention immediately."**

## To learn more about mercury, visit the following websites —

Agency for Toxic Substances and Disease Registry ..... www.atsdr.cdc.gov

Arctic Monitoring and Assessment Program ..... www.amap.no

Canadian Food Inspection Agency, Food Safety Facts on Mercury and Fish Consumption.... www.inspection.gc.ca/english/corpaffr/foodfacts/mercurye.shtml

Collaborative Mercury Research Network (COMERN) .. www.unites.uqam.ca/comern

Centers for Disease Control and Prevention ..... www.cdc.gov

Commission for Environmental Cooperation, Mercury North American Regional Action Plans ..... www.cec.org/programs_projects/pollutants_health/smoc

Environment Canada, Mercury and the Environment ..... www.ec.gc.ca/mercury/

Great Lakes Binational Toxics Strategy ..... www.epa.gov/grtlakes/bns

Health Canada, Mercury and Human Health ..... www.hc-sc.gc.ca/english/protection/warnings/2002/2002_41e.htm

Mercury Policy Project ..... www.mercurypolicy.org

National Academy of Sciences ..... www.nas.edu/nas

National Ecology Institute ..... www.ine.gob.mx

North American Mercury Deposition Network ..... http://nadp.sws.uiuc.edu/mdn

Pollution Probe, Mercury Programme ..... www.pollutionprobe.org/mercury.htm

Switch Out Programme..... www.switchout.ca

United States Department of Health and Human Services,
Food and Drug Administration ..... www.fda.gov

United Nations Environment Programme, Global Mercury Assessment
..... http://irptc.unep.ch/mercury

United States Environmental Protection Agency, Mercury
..... www.epa.gov/mercury/index.html

United States Environmental Protection Agency, Mercury Action Plan
..... www.epa.gov/pbt/hgaction.htm

Université du Québec à Montréal ..... www.geotop.uqam.ca

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