Mercury from Coal

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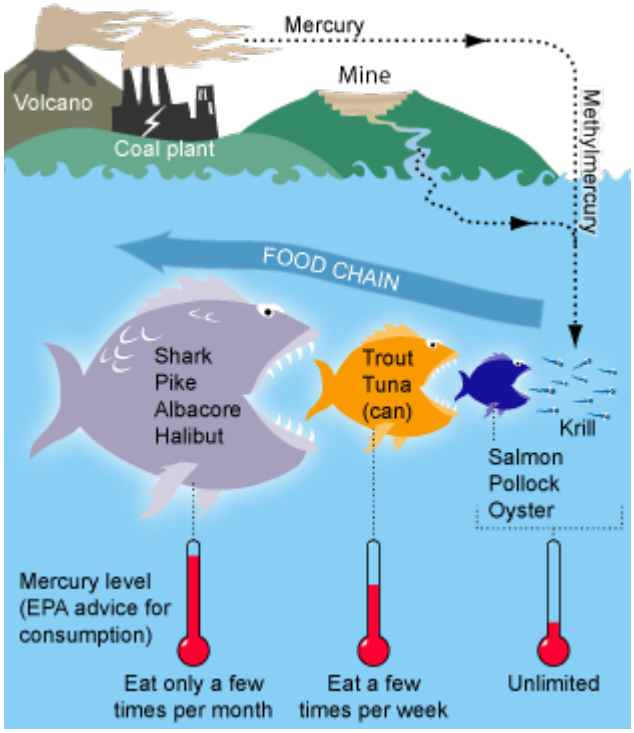
Mercury is released into the air from the combustion of coal. This mercury accumulates and concentrates in the food chain, where it is ingested by people (often through eating fish). Mercury is a toxic chemical that can affect the nervous system, immune system, and reproductive system, and is especially damaging to developing fetuses.

Mercury is a pollutant with a global range. Alaska produces relatively little mercury, but mercury arriving from outside the state has built up to toxic levels in some fish. This mercury reaches the state through the atmosphere and oceans. Therefore even if Alaskan coal is exported, the mercury released when that coal is burned can still come back to harm Alaskans.



HOW DOES MERCURY END UP IN YOUR FOOD? (/figures/MercuryFoodChain/) — Mercury from coal fired power plants and other sources travels through the atmosphere and water.

Human-released mercury

Though mercury is a natural element, most of the mercury that winds up in the atmosphere is released by people, through coal combustion (CoalCombustionMethods.html), incinerators, industrial boilers and gold mining operations. This anthropogenic mercury represents 70% of the mercury added to the global atmosphere in the past 100 years1. Coal combustion is the single highest contributor in the US, responsible for almost 50% of atmospheric mercury (http://www.epa.gov/ttnchie1/conference/ei13/toxics/rackley.pdf) emissions. Approximately 75 tons of mercury (http://

www.epa.gov/mercury/control_emissions/index.htm) are present in the coal used by US coal-fired power plants every year. Of this, more than 50 tons are subsequently released into the atmosphere, while the rest remains in coal combustion wastes (CoalCombustionMethods.html). Mercury in the gaseous form is transported to Alaska year-round from all over the Northern Hemisphere and falls to earth with snow and rain.

Much of this mercury comes from Asia - a heavy user of coal-fired power plants. Over half of all atmospheric mercury in the world, and about 20% of the mercury in Alaska, is attributed to Asian coal plants and industry 2. The business plans for many proposed coal mines in Alaska depend on exporting coal (AlaskaCoalExports.html) to Asia.

Effects of mercury exposure

Exposure to mercury can have a variety of effects on animals and people, collectively known as mercury poisoning (http://en.wikipedia.org/wiki/Mercury_poisoning). High concentrations are lethal, while lower concentrations can lead to reduced immune function, weight loss, and reduced reproduction rate. Well-documented effects on human health also include mental defects and other neurological problems. Fetal exposure presents the greatest risk because mercury particularly targets developing nerve cells.

Mercury in the food chain

The mercury released by burning coal is converted into a far more toxic form when it enters the food chain. Mercury is released into the air from a coal-fired power plant, and falls to the ground with snow and rain. From there, it drains into watersheds, rivers, and lakes and settles into sediment. At this point it is brought into contact with bacteria who can convert elemental mercury into the more toxic methylmercury (http://en.wikipedia.org/wiki/Methylmercury). This process can also take place directly in the oceans, where large amounts of methylmercury are produced.

Small organisms in these water bodies take up the mercury when they consume the bacteria, or feed on the bottom where mercury-laden sediments accumulate. Fish and larger creatures take up even more mercury when they eat the smaller organisms, and with every step of the food chain, the toxic effects are compounded. Plants will also readily take up methylmercury through their roots, which can then be consumed by herbivores. An older animal will accumulate more mercury over its lifetime than a younger animal - this is called bioaccumulation (http://en.wikipedia.org/wiki/Bioaccumulation). Also, animals that eat higher on the food chain accumulate more mercury. Because marine food chains (http://media-2.web.britannica.com/eb-media/99/95199-036-D579DC4A.jpg) are long, marine mammals, predatory fish, and scavengers acquire more mercury than terrestrial herbivores like caribou and moose.

Mercury in fish

Fish are considered the primary source of human exposure to mercury (http://www.epa.gov/mercury/report.htm). Alaska issued a state fish consumption advisory (http://www.epi.hss.state.ak.us/bulletins/docs/rr2007_04.pdf) based on mercury contamination for the first time in 2007. So far, only a few Alaskan ocean fish that are long-lived and high on the food chain (such as large halibut) have reached the FDA recommended maximum mercury concentration of 1000 ng/g (although the EPA recommends a maximum of only 300 ng/g). In July 2009, regulators in Alaska finally added pike from the Kuskokwim and lower Yukon rivers (http://www.epi.hss.state.ak.us/eh/fish/) to the list of restricted species in the state with more freshwater restrictions expected to follow. This change was based on the analysis of a number of detailed mercury surveys undertaken in Alaska. For example, a study of pike in the Yukon found an average mercury concentration of 1500 nanograms(ng)/g3. Similarly, over half the pike in a survey of Nowitna National Wildlife Refuge (http://alaska.fws.gov/fisheries/contaminants/pdf/NowitnaReport.pdf) contained 1000-2900 ng/g. This is a particular issue for subsistence users of the land (/Issues/OtherIssues/Subsistence.html) since they are unlikely to either forgo eating fish or to harvest fish outside their traditional areas. Most of the mercury in these areas came from mercury mines, such as the Red Devil mine (/Issues/MetalsMining/Red-Devil-Mercury-Mine.html) on the Kuskokwim.

Mercury in fish is likely to be an increasing problem, particularly in ocean fish. The amount of methylmercury in the oceans is expected to double by 2050 (http://www.agu.org/pubs/crossref/2009/2008GB003425.shtml). It should be noted however, that the health benefits of consuming fish may still outweigh the negative impacts associated with mercury and that there is certainly debate about the validity of consumption guidelines. In addition the effects of mercury may be mitigated by selenium (/Issues/Fisheries/mercury-hg-selenium-fish-consumption-debate.html) which is often also present in the same tissues, but this effect is not considered in any of the federal consumption guidelines. An abundance of selenium in some fish tissues relative to mercury may even result in a net reduction of health impacts from mercury.

Mercury and markets

Even the image of potential contamination can disrupt seafood markets. The market for Alaskan salmon decreased sharply when the Exxon Valdez Oil Spill occurred, resulting in wholesalers and retailers turning to farmed fish. This event permanently changed the market share for all commercially-caught Alaska salmon. Mercury contamination is already a major concern of consumers seeking the health benefits of fish, and major Alaskan exports such as pollack and salmon currently have some of the lowest mercury levels of any commonly-eaten fish (http://www.epi.hss.state.ak.us/bulletins/docs/rr2007_04.pdf). Many consumers do not realize which fish are high or low in mercury, and therefore limit all fish consumption. Increasing mercury pollution in fish, in the state or worldwide,

could damage markets for Alaskan fish - even if a particular species is unaffected. In addition, a recent study has demonstrated significant negative effects on fish reproduction levels due to mercury exposure which could potentially directly affect Alaskan fish populations 4.

References (These sources are behind pay walls (http://en.wikipedia.org/wiki/Pay_wall).)

1 Schuster, PF, DP Krabbenhoft, DL Naftz, LD Cecil, ML Olson, JF Dewild, DD Susong, JR Green, and ML Abbott. 2002. Atmospheric mercury deposition during the last 270 years: a glacial ice core record of natural and anthropogenic sources. Environ Sci Technol 36: 2303-2310

2 Seigneur, C, K Vijayaraghavan, K Lohman, P Karamchandani, and C Scott. 2004. Global source attribution for mercury deposition in the United States. Environ Sci Technol 38:555-569

3 Jewett, SC and LK Duffy. 2003. Mercury in fishes of Alaska, with emphasis on subsistence species. Chemosphere 50 (3): 383-392.

4 Crump, KL, and VL Trudeau. 2009. Mercury-Induced Reproductive Impairment in Fish. Eviron Tox Chem 28(5): 895-907

Further Reading

> Alaskan Department of Health and Social Services. 2007. Fish Consumption Advice for Alaskans: A Risk Management Strategy to Optimize the Public's Health. (http://www.epi.hss.state.ak.us/bulletins/docs/rr2007_04.pdf)

> Environmental Protection Agency (EPA). 1997. Mercury Study Report to Congress. (http://www.epa.gov/mercury/report.htm)

> A "mercury exposure" calculator (http://www.gotmercury.org/article.php?list=type&type=75)

> Electric Power Research Institute (EPRI). 2006. Sources of Mercury Depositing in the US: issue brief. September. (http://www.epri.com)