Mercury in Perspective

Fact and Fiction About the Debate Over Mercury

A Report by Resources Committee Chairman Richard W. Pombo (R-CA) and
Energy and Mineral Resources Subcommittee Chairman Jim Gibbons (R-NV)

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Mercury in Perspective

Executive Summary

1. ***Mercury is a naturally occurring element that is ubiquitous in the environment***. Most of the mercury existing in the environment is released through natural processes. Thus, we are all exposed to trace amounts of mercury no matter what levels are emitted through human activity, including power plant emissions.

2. ***U.S. power plants account for less than 1 percent of global mercury emissions***.

3. ***Mercury emissions in the U.S. have significantly decreased since 1990***. This includes a significant reduction in both mercury usage and emissions over the past 50 years. Industrial use of mercury in the U.S. has dropped by 80 percent since 1970 and emissions from domestic anthropogenic (man-released) sources decreased by 40 percent between 1990 and 1996. Additionally, mercury emissions from power plants were reduced by 38 percent from 1995 to 1999.

4. ***Mercury levels in fish have remained the same or have slightly decreased***. Recent studies comparing methylmercury concentrations in Pacific tuna caught in the 1970s and the 1990s were almost identical. Experts believed they should have increased between 9 and 26 percent as a result of increases in non-U.S. anthropogenic emissions of mercury deposition in the Pacific Ocean.

5. ***There has been no credible evidence of harm to pregnant women or their unborn children from regular consumption of fish***.

6. ***Research has proven the health benefits of regular fish consumption***. Fish is an important part of a healthy diet. Research has demonstrated that a diet rich in omega-3 polyunsaturated fatty acid through fish consumption has beneficial health effects for people with heart disease and various types of cancer, including breast, prostate and endometrial. In addition, fish consumption has beneficial impacts on people suffering from Alzheimer's disease and type 2-diabetes.

7. ***Current, peer-reviewed scientific literature does not show any link between U.S. power plant emissions and mercury in fish***.

8. ***The EPA's reference dose for methylmercury is the most restrictive in the world and is based on results from a single test of children that is not sensitive enough to discern effects from mercury alone***. The study subjects were also exposed to very high levels of toxic organic compounds like DDT and PCBs that mimic mercury's effects and can make them worse. The study is also not reflective of U.S. fish consumption.

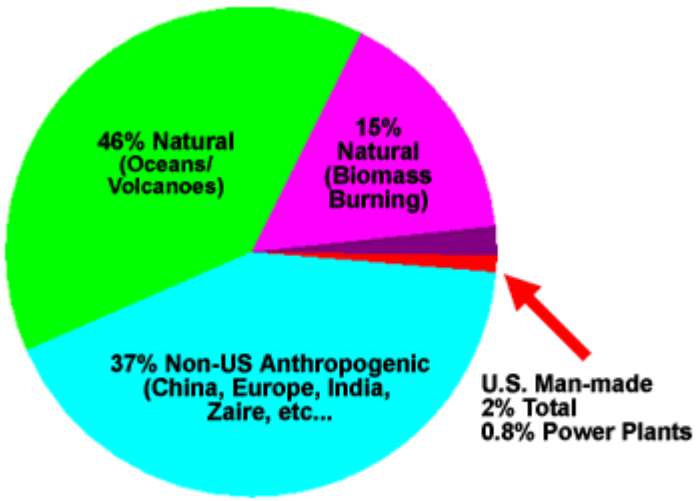
These findings beg a series of questions for us all. If the U.S. has significantly reduced mercury emissions since 1990, why does the "problem" appear to be getting worse? What do the advisories mean, and are they valid? What is the real risk to people from exposure to methylmercury from fish consumption? Are there other health risks associated with not including fish in our diets?

Mercury in Perspective

I. The Basis of Today's Mercury Regulation

In January 2004, the Bush Administration published a draft rule to regulate mercury emissions from coal-fired power plants.[1] According to the Environmental Protection Agency (EPA), power plants currently represent the largest remaining unregulated industrial source of mercury emissions in the U.S.[2] However, it's important to note that these emissions make up less than one percent of the world's mercury budget[3] (Figure 1).

Figure 1: **U.S. Power Plants Emit Less Than 1% of the Annual World Total**



Pacyna et al. 2003, Freidli et al. 2003

While the nation's first mercury regulation for electric utilities is expected to be issued in March of 2005, the history of the rulemaking is a colorful one that dates back to 1990. The amendments to the federal Clean Air Act (CAA) required a scientific study of whether there was a risk-based need to regulate utility emissions, including mercury. When the EPA missed a report deadline imposed under the 1990 CAA Amendments, the Natural Resources Defense Council (NRDC) sued. This litigation forced the EPA into a rulemaking process that could very likely result in costly mitigation measures without providing any environmental benefit, as this paper will explain.

Former EPA Administrator Browner took eight years under the Clinton Administration to determine a course of action. Finally, on December 14, 2000, two days after Bush v. Gore had been decided by the U.S. Supreme Court, Browner announced that the EPA must issue a mercury emissions rule under Section 112 of the CAA.[4] This decision went against the Clinton Administration's own Office of Management and Budget (OMB) that recommended a cap and trade approach under Section 111. Even Browner's "Notice of Regulatory Findings" in the Federal Register recognized cap and trade as an effective control for pollutants and a plausible alternative for reducing mercury emissions.[5] Browner's decision delivered an unexpected blow to American utility companies and their customers. Section 112 (d)(3) of the law requires the strictest regulations using Maximum Achievable Control Technology (MACT) standards – technology that some purport can reduce mercury emissions by 90 percent. However, the Department of Energy (DOE) has stated that this is not currently possible for the full spectrum of coals used by American power plants.[6]

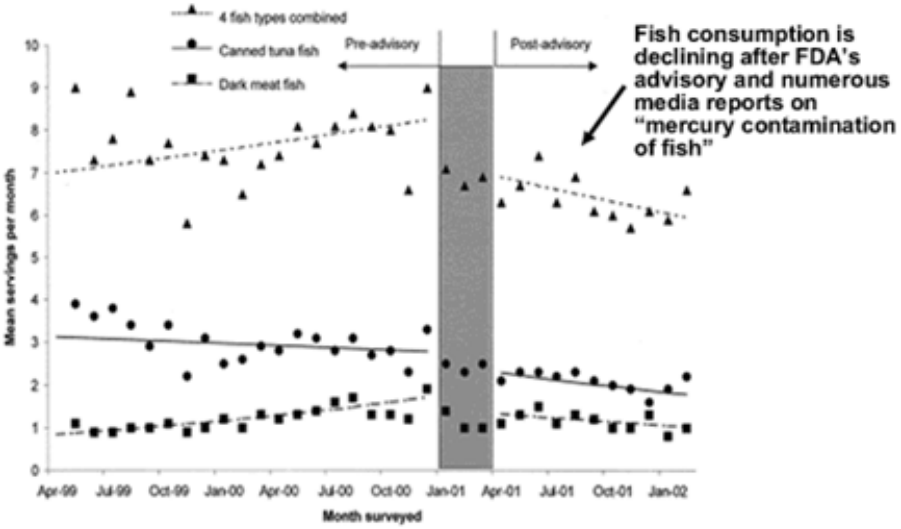
The Bush Administration included both options in the proposed rule (the stricter MACT standards and the more flexible cap and trade) issued on January 30, 2004. The Administration's preferred alternative is the cap and trade program similar to that recommended by Clinton's OMB and touted as an effective control in the Federal Register by Browner.

Nonetheless, national environmental groups now claim the Bush rule falls short of fulfilling the letter of the law. These groups initiated an aggressive public relations campaign advocating the more restrictive MACT rule. Several organizations bought provocative print ads in the Washington Post, the New York Times and USA Today claiming that "…kids are being poisoned by deadly mercury from power plants."[7]

Mercury emissions from U.S. power plants have declined by 38% since 1995.

Likewise, campaign created 527's like MoveOn.Org and others ran TV commercials with a similar message and also dubbed the Bush policy a "roll back". However, given that mercury emissions from power plants will be regulated for the first time ever under the Bush Administration, their claims ring hollow. No President can roll back regulations that don't currently exist. These groups also falsely assert that the Administration is proposing to allow power plants to release "more mercury into the air."[8]

Figure 2: Pregnant Women Respond to Fish Advisories



Okenetal., (2003), Obstetrics & Gynecology, vol. 102, 346-351

As a result of the well-funded effort to push their political agenda, environmentalists have caused American citizens to become unnecessarily concerned about possible adverse health effects from exposure to trace amounts of mercury.

The EPA and Food and Drug Administration (FDA) have stated that for people and animals, the primary means of exposure to mercury is by consuming fish.

Consequently, many people, particularly pregnant women (Figure 2) and children, have greatly reduced their fish consumption or have given it up completely.

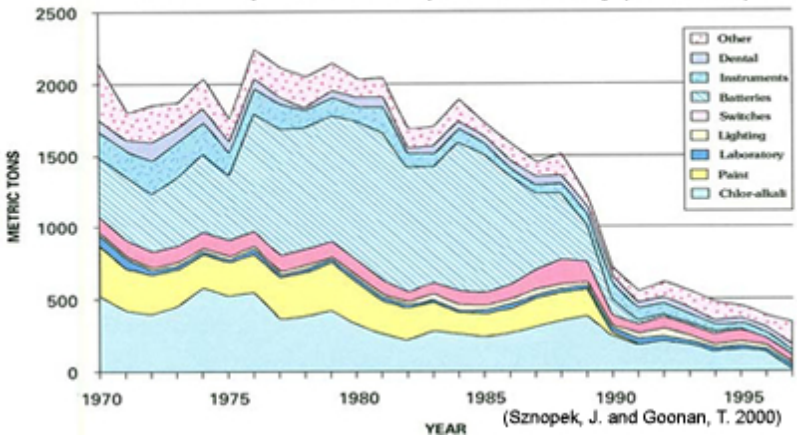
"I enjoyed eating fish, but when I got evidence to the contrary, it just completely destroyed my feelings about its benefits," said Andrew Hayes, 39, of Chicago, who said he used to eat fish once or twice a week. "I understand it's irrational, but it's the way it is."
(New York Times, April 10, 2004)

While these actions seem to constitute a prudent response to information in the public domain, they can contribute to health risks in their own right. Current peer-reviewed research shows that consumption of fish or long chain omega-3 polyunsaturated acids benefits all people from pre-term infants to older adults. Regular fish consumption can reduce the risk of heart attack, contribute to infant eye and brain development, lessen the symptoms of rheumatoid arthritis and may slow the progression of breast and other forms of cancer.

This campaign, which targets coal as the culprit in this "looming" crisis, also serves to exacerbate the nation's existing energy problems and further burdens the economy. More than 50 percent of the nation's electricity is generated from coal-fired power plants. Eliminating this abundant, affordable source of energy would cause dramatic increases in energy costs and threaten the closure of some coal-burning plants that supply energy to critical public infrastructure. These effects could very likely contribute to poor health and delayed medical treatment for those members of our society at the lowest income levels -- single parents, minorities and those without health insurance.

When a solution to a perceived problem has the potential to create as many or more problems than it resolves, a more thorough evaluation of the issue and associated risks is appropriate. Furthermore, it is impossible to craft and implement good public policy in a climate of fear. Reasonable questions that should be asked are often completely overlooked.

Figure 3:
U.S. Industrial Reported Consumption of Mercury (1970-1997)



Policy makers should consider, among other things, the fact that air and water quality in the U.S. has dramatically improved. This includes a significant reduction in the use of mercury for industrial and medical applications, and emissions from those applications over the past three decades. Industrial use of mercury in the U.S. has dropped by 80 percent since 1970 (Figure 3) and emissions from domestic anthropogenic sources decreased

by 40 percent between 1990 and 1996.[9] Additionally, mercury emissions from power plants were reduced by 38 percent from 1995 to 1999.[10] All this occurred with a growing economy and increased energy usage.

This paper will examine what we know about mercury, how it cycles and recycles in the environment, how it gets into the food chain, who is at risk from exposure to mercury, and, finally, the EPA's proposed rule and information about the commercially available technology to reduce mercury emissions.

Fast Facts (1970 – 2000)

Since 1970, emissions of the six criteria pollutants have dropped between 28 and 98%. All this occurred while the U.S. experienced a:

- **164% increase in gross domestic product**
- **37% increase in the U.S. population**
- **42% increase in energy consumption**
- **149% increase in vehicle miles driven**

II. Where in the World is Mercury? All Mercury is Not the Same

Mercury is a naturally occurring element and a part of the earth's crust, oceans and atmosphere. Mercury in rocks and mineral deposits normally occurs as cinnabar, a mercury sulfide (HgS) mineral.[11] Elemental mercury is the unique silver-white metal that is a liquid at room temperature and easily vaporizes.

Most of the mercury existing in the environment is released through natural processes. These natural processes include surface volcanic eruptions; deep sea vents and volcanic activity; hot springs – such as the geyser basins in Yellowstone National Park[12] or those at the bottom of Clear Lake in California; evaporation from the ocean basins, other water bodies and soils; and erosion. The oceans alone contain millions of tons of ***naturally occurring*** mercury. Forest fires and the burning of other types of vegetation also contribute to the world mercury budget.[13] These natural "emissions" contribute approximately 61 percent of the annual emissions that make up the world mercury budget (Figure 1).

New studies are continually reassessing the contribution of natural emissions to the world mercury budget. According to the Smithsonian Institution, there are more than 5,000 surface and submarine volcanoes in the world erupting approximately 50 to 60 times a month. Volcanic degassing may very well be the single largest source of ocean and atmospheric mercury.[14]

For example, in Yellowstone National Park, famous for the Old Faithful geyser and other geothermal features, scientists have found high levels of naturally emitted mercury. In the conclusion of their study, the scientists said Yellowstone's natural mercury emissions may exceed the emissions from all of Wyoming's eight coal-fired power plants.[15]

However, the presence of mercury in Yellowstone National Park and Lake were said to pose no danger to park rangers, visitors and even its wildlife. Native grizzly bears who consume up to 400 pounds of cutthroat trout have exhibited no ill effects according to researchers.[16]

Fast Facts

Sources of Annual U.S. Anthropogenic Mercury Estimated Emissions:

- **Coal-fired power plants release 49 tons - A 38% decrease between 1995 and 1999**
- **Medical, hazardous & municipal waste; and industrial uses & mining combined release 106 tons**

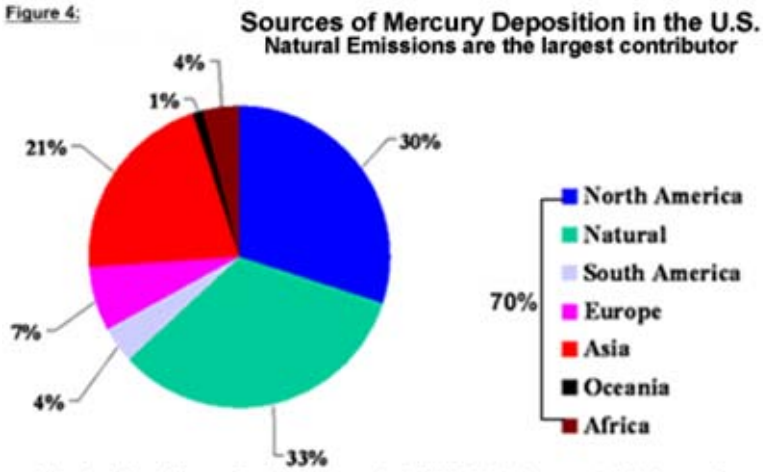
Because mercury is a natural part of the earth's crust, oceans and atmosphere and is ubiquitous in the environment, it also occurs in trace amounts in fossil fuels. As a result, when people use fossil fuels such as coal, oil or gas to generate electricity, mercury is released into the environment.

Other industrial processes such as cement manufacturing, burning of municipal and hazardous waste, medical waste incineration, pulp and paper milling and mining activities also release mercury into the environment. These human activities combined with power plant emissions in the U.S. make up just 2 percent of the total world mercury emissions (Figure 1).[17]

Current studies of mercury deposition in the U.S. indicate that 70 percent comes from natural sources and non-U.S. anthropogenic emissions. Those non-U.S. anthropogenic emissions mostly originate from China and the rest of Asia (Figure 4).[18] China emits approximately 495 tons of mercury annually from power plants and other sources. It is expected to increase emissions over the next two to five years by 20 - 30 tons annually due to its rapid economic growth and industrial expansion. The projected annual growth in China's mercury emissions alone is more than half of the current U.S. power plant emissions in total.

China emits approximately 495 tons of mercury annually from power plants and other sources, and is expected to increase emissions over the next two to five years by 20 - 30 tons annually.

Figure 4:



Adapted from Figure 8 of Seigneur et al. (2004, Environmental Science & Technology, vol. 38, 555-569)

Mercury emissions can behave differently after they are released from power plants and are dependent on the form of mercury. Analyses of emissions from power plants show that about 60 percent occur in the elemental form, which preferentially enters the global atmosphere where it can remain for up to a year or more. The remaining portion occurs in the oxidized (ionic) form, a small portion of which may be deposited locally (within 30 miles).[19]

This is significant since oxidized mercury is water soluble and ultimately available for conversion to an organic mercury compound known as, methylmercury. It is this organic form of mercury that is found in trace levels in fish.

Analyses of actual power plant emissions have shown that less than 4 percent of total mercury (elemental and oxidized) is being deposited within 30 miles of the plant.[20]

In general, the majority of the mercury released from power plants is in the non-water soluble elemental form which enters the global mercury pool and is therefore, not available for conversion to methylmercury. Emissions from medical, municipal and hazardous waste incineration plants on the other hand release a higher proportion as oxidized (water soluble) mercury into the environment which tends to deposit locally.[21]

III. U.S. Emissions: The U.S. has Aggressively Reduced the Risk of Exposure

The U.S. designated mercury a hazardous pollutant in 1971 and a toxic pollutant in 1973 (Table 1). Since these designations, the use of mercury for industrial and medical purposes in the U.S. has declined by more than 80 percent (Figure 3). Anthropogenic emissions of mercury in the U.S. has declined by 40 percent (97 tons) between 1990 and 1996 due to the closure of domestic mercury mines in 1991 and pollution controls for mercury emissions from medical, municipal, and hazardous waste incineration.[22] In addition, air pollution controls on coal-fired power plants also reduced mercury.

The significant reduction of these emissions has left power plants as the largest remaining industry-specific source of anthropogenic mercury emissions in the U.S. Even so, mercury emissions from power plants have declined by more than 38 percent between 1995 and 1999. This reduction resulted from the installation of pollution controls designed to address other types of air emissions.

Fast Facts:

U.S. Coal Fired Power Plants

- **Total in U.S.: 1,100**
- **Used 1.004 billion tons of coal in 2003**
- **Provides 52% of the nation's electricity**

The 1990 CAA Amendments required EPA to conduct a comprehensive study of "hazardous air pollutants" (HAP) emitted from electric utility power plants, including mercury. The CAA allows EPA to regulate HAP emissions from power plants ***only if the studies*** "clearly establish that emissions of any pollutant, or aggregate of pollutants, from such units cause a significant risk of **serious adverse effects** [emphasis added] on the public health."[23]

After numerous lengthy reports with inconclusive evidence, EPA was unable to prove a direct link between power plant mercury emissions and methylmercury contamination in fish.

> "Because of the current scientific understanding of the environmental fate and transport of this pollutant, it is not possible to quantify the contribution of U.S. anthropogenic emissions relative to other sources of mercury, including natural sources and re-emissions from the global pool, on methylmercury levels in seafood consumed by the U.S. population. Consequently, the U.S. EPA is unable to predict at this time how much, and over what time period, methylmercury concentrations in fish would decline as a result of actions to control U.S. anthropogenic emissions."[24]

Table 1:

Year	Domestic Legislation, Regulation & Agreements Related to Mercury
1971	Mercury designated as a hazardous pollutant.
1972	Insecticide, Fungicide, Rodenticide Act banned many pesticides containing mercury.
	Water Pollution Control Act authorized EPA to regulate mercury discharges into waterways.
1973	Mercury designated as a toxic pollutant.
	Standards for mercury ore processors and chlor-alkali plants enacted.
	Dumping mercury and mercury compounds into the ocean was prohibited.
1978	Resource Conservation and Recovery Act (RCRA) established regulations for the disposal of mercury waste.
1992	EPA banned land disposal of high mercury content wastes generated by chlor-alkali facilities.
1993	EPA cancelled the registrations for the last 2 mercury-containing fungicides at the manufacturer's request.
1994	Congress suspended the sale of National Defense Stockpile of mercury because of EPA's concerns with environmental problems related to the toxin.
1995	EPA's new regulation on municipal waste combustors issued. Regulations are designed to reduce mercury emissions from these facilities by 90% from 1990 emission levels.
1996	The Mercury Containing and Rechargeable Battery Management Act: prohibited batteries being sold without recyclability or disposal labels and phased out most batteries containing mercury.
1997	EPA issues new standards for medical waste incinerators which will reduce mercury emissions from these facilities by 94% from 1990 levels once fully implemented in 2002.
	The U.S./Canadian Great Lakes Bi-National Toxics Strategy is created. This agreement sets a goal to significantly reduce human use and release of mercury in the Great Lakes Basin by 2006.
	The Chlorine Institute and the USA mercury cell chlor-alkali producers voluntarily commit to a 50% reduction goal in mercury use by 2005 and to providing EPA with an annual progress report.
1998	The 1998 Protocol on Heavy Metals of the Convention on Long Range Transboundary Air Pollution: Involves the U.S., Canada and all European nations.
1999	EPA's new standards for hazardous waste combustors are designed to reduce mercury emissions from these facilities by 50% from 1990 emission levels.
2000	EPA lowered the threshold level for reporting mercury emissions to the Toxics Release Inventory. Phase II North American Regional Plan on Mercury, under North American Agreement on Environmental Cooperation: Involves U.S., Canada and Mexico.
2002	The Chlorine Institute reports chlor-alkali has achieved the 50% reduction goal three years early and pledges to continue its mercury reduction efforts.
2003	EPA issues its final rule for limiting the emissions from mercury cell chlor-alkali plants under the Clean Air Act. This new rule requires additional reductions in the emission limits from the existing rule.
	The Chlorine Institute and other members of the World Chlorine Council (Euro Chlor and Clorosur) sponsor the first annual workshop on mercury reduction in Sao Paulo, Brazil to discuss best practices to reduce the use and emissions from mercury cell chlor-alkali plants.
2004	EPA developing emission standards for small sources of air toxins including mercury.
	The Chlorine Institute reports the overall mercury usage reduction to date over an eight-year period is 76%.
2005	EPA is scheduled to issue its final rule to regulate mercury emissions from power plants.

Former EPA Administrator Browner's rulemaking decision was driven by a settlement agreement between the NRDC and EPA. Browner announced on December 14, 2000 – two days after Bush v. Gore was settled by the U.S. Supreme Court – that the EPA would issue a rule by December 2003 to regulate mercury emissions from power plants under section 112(a)(8) of the CAA. Browner's decision was based on the findings of EPA's February 1998 "Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units – Final Report to Congress."

In EPA's "Notice of Regulatory Finding," Browner again describes the uncertainties between power plant emissions of mercury and methylmercury concentrations in fish:

> "It is acknowledged that there are uncertainties regarding the extent of the risks due to electric utility mercury emissions. For example, there is no quantification of how much of the methylmercury in fish consumed by the U.S. population is due to electric utility emissions relative to other mercury sources (*e.g.*, natural and other anthropogenic sources)."[25]

Despite these continued and uncertain findings related to mercury emissions, Browner still went forward with implementing new regulations in the waning hours of the Clinton Administration. The Bush Administration is following the law and abiding by the original settlement agreement and will regulate emissions for the first time ever.

IV. Further Reducing Mercury Emissions: A Look at the Technology

Mercury emissions from power plants were reduced by 38 percent from 1995 through 1999 as a result of pollution control technologies put in place to reduce sulfur dioxide, nitrogen oxides and particulate matter. Additional reductions should be achieved as more controls are put in place to meet new standards for this group of emissions under the CAA. However, at present it is not technically possible to reduce mercury emissions by 70 – 90 percent with all types of coal; nor is the technology required to meet these proposed reductions expected to be available within the next several years.

According to the DOE, "… there is no commercially available technology that can consistently and cost-effectively capture mercury from coal-based power plants."[26] During a briefing hosted by the National Wildlife Federation for congressional staff on January 31, 2005, the Institute of Clean Air Companies (ICAC) reinforced the DOE's conclusions. The companies represented by ICAC are involved in the development of technology to address mercury emissions from power plants. They are also developing equipment that will continuously monitor mercury concentrations in the emissions stream. ICAC reported improvements in the reduction of mercury emissions in some long term tests; however, they said at this point in time they were unable to guarantee 70-90 percent reductions on all coal types.

ICAC felt a cap and trade approach would allow the industry and themselves more flexibility in achieving significant reductions in mercury emissions from all power plants. In fact, they stated the cap and trade approach would probably bring more reductions more quickly than a MACT standard.

"… there is no commercially available technology that can consistently and cost-effectively capture mercury from coal-based power plants." (Dept. of Energy)

There are several conditions that create technical challenges for reducing the less than 1 percent of global mercury that U.S. power plants produce. First, there are different types of coal: lignite, sub-bituminous, bituminous and anthracite, which burn at different temperatures, vary in moisture content and other constituents including trace amounts of mercury. The concentrations of mercury found in coal are very minute and can vary within a given mine and even within a given seam or bed of coal. These differences and variations result in significant variability in power plant operations and emissions. It is not surprising then that analyses of power plant emissions and coal used for fuel illustrate the erratic distribution of mercury in the coal and power plant emissions.

Additionally, there are differences in the power plants themselves, including how the boilers are configured and how they are operated. These factors alone present challenges for developing a single technology to address mercury emissions. This is also why a cap and trade approach to reduction makes good sense and good public policy. U.S. utilities would be able to implement control technologies that will yield the best results for their individual plants.

Reducing the less than 1 percent of total mercury emissions consistently and effectively has not yet been proven for the range of fuels and power plants in the U.S., nor have the costs and potential impacts on plant operations been determined. Co-benefit technologies have worked in some situations as observed in some plants with sulfur dioxide (SO_2), nitrogen oxides (NO_x) and particulate matter reduction technologies. The co-benefits technologies' effectiveness is dependent on the type of coal used and other factors.

To put this in perspective, compare the mercury concentrations in emissions from incinerators to mercury emissions from coal-fired power plants. A cubic foot of incinerator emissions, on average, contain a 1000 times more mercury than a cubic foot of power plant emissions. In fact, an incinerator with mercury emission controls in place often emits more mercury than a coal-fired power plant. There are incinerators in Connecticut and New Jersey with activated carbon based mercury emissions controls that have been measured emitting mercury 100 times higher than the proposed MACT standard for bituminous Coals.[27]

The electric utility industry, in partnership with the federal government, has ongoing research programs in place to identify sound mercury control technologies that are effective and consistent.

Several potential technologies are currently in advanced research and development phases. These include advanced coal washing or upgrading, injection of sorbents (materials designed to absorb the mercury; in this case carbon and non-carbon, including chemically-treated carbon), injection of reagents that react with the mercury to form a stable solid particle, systems to recycle activated carbon for reuse and systems designed to trap multiple contaminants (NO_x, SO_2 & Hg).

These demonstration projects are projected to be completed and evaluated for their effectiveness within the next two to three years.[28]

The final rule for power plant mercury emissions is scheduled to be released in March of 2005. If the rule requires MACT standards rather than a cap and trade program, there will be a number of deadlines that will have to be met. Coal-fired electric utilities would have three years to meet the new standards with a possible one-year extension from EPA.

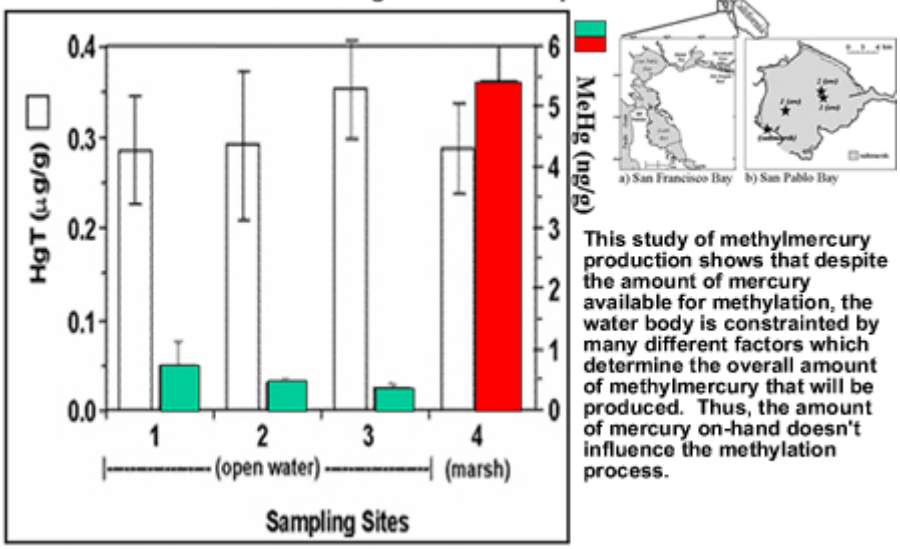
Issuing an inflexible MACT rule without a commercially available and cost-effective technology that has been proven reliable is irresponsible and will force the premature closure of some coal-fired plants and/or encourage fuel switching. Either scenario exacerbates our existing energy problems, aggravating the natural gas supply crisis and laying the groundwork for more price spikes for natural gas and electricity.

V. The Truth about Mercury, Power Plants and Fish

Atmospheric deposition of mercury and other sources of mercury in the environment that enter water bodies can be converted to methylmercury, an organic mercury compound. It is this form of mercury that is found in trace levels in some fish and thought to be harmful to humans if consumed in large enough quantities. The methylation process, however, is very complex and is dependent on many different factors including, but not limited to, water temperature, pH (water acidity), organic matter and aquatic bacteria. It occurs more often in fresh water and wetland areas than in saltwater (Figure 5).[29] This is important since most fish consumed in the U.S. are ocean-dwelling species.

Studies have also revealed that the amount of mercury ultimately available for methylation may be inconsequential. Figure 5 below shows consistent amounts of overall mercury available for methylation, yet the amount of methylmercury produced was dependent on the conditions described above.

Figure 5: **Methylmercury Production in Marsh Wetlands is 25-50 Times Higher Than in Open Water**



This study of methylmercury production shows that despite the amount of mercury available for methylation, the water body is constrainted by many different factors which determine the overall amount of methylmercury that will be produced. Thus, the amount of mercury on-hand doesn't influence the methylation process.

Marvin-Dipasquale et al, (2003), Environmental Geology, vol. 43, 260-267

Studies on the portion of mercury emissions from power plants that were deposited locally on land or water - approximately 2 tons annually from the nation's 1,100 power plants - showed that 97 percent of the mercury was trapped in sediments, 3 percent remained in the water and *only* a very small amount, 0.03 percent was converted to methylmercury.[30]

Methylmercury enters the food chain through microorganisms eaten by fish and other aquatic life. Thereafter, it may bioaccumulate up the food chain, which explains why some larger species of fish and marine mammals can have increased levels of methylmercury. The average concentrations of methylmercury for the top-ten types of seafood consumed in the U.S. (Table 2) range from non-detectable to 0.358 parts per million (ppm), below FDA's action level of 1.0 ppm methylmercury.

Table 2: Top Ten Seafoods Consumed in the U.S. (2003)
Compiled for NFI by H.M. Johnson & Associates

Seafood	Annual Consumption (lb per capita)	Mercury concentration(ppm)
1.) Shrimp	4.0	0.05
2.) Canned Tuna	3.4	0.12 (light) 0.358 (Albacore)
3.) Salmon	2.22	0.01
4.) Pollock	1.71	0.06
5.) Catfish	1.14	0.05
6.) Cod	0.64	0.11
7.) Crab	0.61	0.06
8.) Tilapia	0.54	0.01
9.) Clams	0.53	Non-Detectable
10.) Scallops	0.33	0.05

n.b.: Top ten seafood represent about 87% of the commercial market
(July 2002 testimony of Mike Bolger of FDA)
National Marine Fisheries Institute; U.S. FDA Center for Food Safety and Applied Nutrition, 2004

As noted, human exposure to mercury is generally from the organic compound, methylmercury, and occurs indirectly through the consumption of fish (and, for certain populations, marine mammals). On rare occasions, such as direct poisoning events that occurred in Japan and Iraq, human exposure to extremely high concentrations of methylmercury can cause neurological problems and death.

During the 1950s, 111 people from Minamata City, Japan died or experienced neurological disorders from eating fish contaminated with *very high* concentrations of methylmercury, up to 40 parts per million (ppm). *In this case, an industrial facility was releasing manufactured methylmercury directly into Minamata Bay.* A second incidence in 1965 occurred in Niigata, Japan where 120 people were similarly poisoned.[31] The 1965 poisoning event from Niigata is the last documented case of methylmercury poisoning from fish consumption.

Then two incidents in Iraq occurred in the 1970s. They were caused by the consumption of seed grain that had been treated with methylmercury, which was used as a fungicide (methylmercury

is not used as a fungicide in the U.S.). The grain was to be planted, not eaten; however, the grain had not been distributed early enough in the growing season to be planted. Thousands of Iraqis were hospitalized and 459 died. [32]

The direct poisoning events in Japan and Iraq were very serious and alerted governments and the medical community to the adverse impacts of human exposure to high concentrations of methylmercury. However, these were ***direct*** poisoning events from ***manufactured*** methylmercury that was introduced into consumed food by industrial processes and eaten in large doses, not through accumulation in aquatic environments.

The most current peer-reviewed science does not support conclusions that the U.S. population is at risk from the trace amounts of mercury found in fish.

VI. Putting it into Perspective: Should we be concerned? Is there a link between the mercury released from U.S. power plants and the complex transformation process that produces methylmercury?

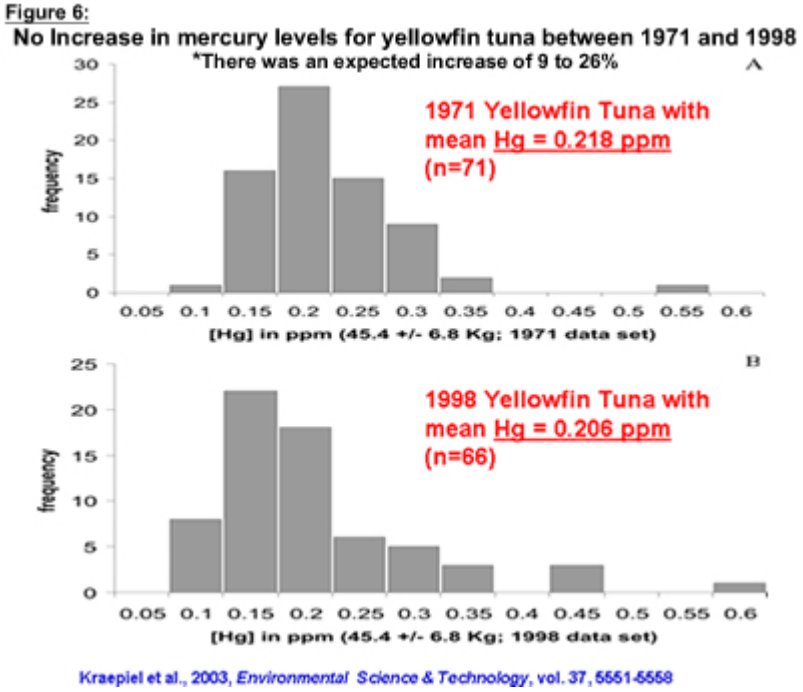
As a result of all the media coverage and environmental campaigning, Americans are concerned about the effects of mercury emissions from power plants on methylmercury levels in fish. Many are unaware that there has been a significant decrease in U.S. mercury emissions and instead are led to believe that U.S. emissions are on the rise and will increase in the future. Still others wonder whether the overall increase in global mercury emissions and deposition mean that Americans will be exposed to higher concentrations of methylmercury in fish.

Recently published and ongoing scientific research can provide some insight to this question:

- A Princeton University study, funded by EPA, compared mercury analysis of recently caught Pacific tuna with similar tuna that had been caught in the 1970s. Princeton found that mercury levels in the tuna had not changed over time (Figure 6).[33] The concluding statement in the paper reads as follows:

> *"The bare fact that the concentrations of Hg [methylmercury] in tuna were identical in 1971 and 1998 either reflects a remarkable coincidence or indicate that, regardless of mechanisms, these concentrations are not responding to atmospheric pollution."*

Figure 6:



Kraepiel et al., 2003, *Environmental Science & Technology*, vol. 37, 5551-5558

- Hair samples from eight 550-year-old Alaskan mummies had concentrations of methylmercury *higher* than Alaska's modern population (i.e., a group of pregnant women). The methylmercury concentrations in hair collected from the mummies ranged from 1.2 ppm to 4.6 ppm. The mean methylmercury concentration in today's Alaska population is 0.6 ppm.[34]

- Analyses of lakebed sediments deposited over the past 11,000 years in Minnesota's Elk Lake show that anthropogenic (man-released) emissions have not been significant or exceptional. Average mercury levels in the lakebed sediments today are 140 parts per billion (ppb). Mercury levels in the sediment have been higher on seven different occasions due to natural causes with the highest being 350 ppb about 8,000 years ago.[35]

- Concentrations of mercury, lead and persistent organic pollutants in the umbilical cord blood of Inuit infants born in Nunavik, Quebec decreased between 1994 and 2001.

> "Inuit inhabitants of Nunavik consume great quantities of marine food and are therefore exposed to high doses of food chain contaminants. …We analyzed 251 cord blood samples collected from 1994 through 2001 for polychlorinated biphenyls (PCBs), dichlorodiphenyl trichloroethane (DDT), dichlorodiphenyl dichloroethylene (DDE), hexachlorobenzene (HCB), chlordanes, lead and mercury. Using an exponential model, we found strongly significant decreasing trend for PCBs (7.9% per year, $p < 0.001$), DDE (9.1% per year, $p < 0.001$), DDT (8.2% per year, $p< 0.001$), and HCB (6.6% per year, $p < 0.01$). No significant trends were detected for chlordanes. A significant reduction of lead and mercury concentrations was found [i.e., by more than 8% decrease per year], ..."[36]

- A twelve-year longitudinal study conducted in the Seychelles Islands reported ***no*** negative effects from dietary exposure to methylmercury through regular fish consumption. The Seychelles population consumes an average of 12 fish meals a week and has hair methylmercury concentrations approximately ten times higher than the U.S. population.[37]

- A new study that compared the rates of atmospheric mercury deposition to amounts of mercury contained in Illinois and other U.S. soils found that: "The amounts of Hg [mercury] in these soils are too great to be attributed mainly to anthropogenic atmospheric Hg deposition."

  For example, the average amount of mercury in the top eight inches of soil is equivalent to what would be deposited in 400 years at the current rate of estimated atmospheric mercury deposition. When the entire soil profile (12.5 feet) is considered, the amount of mercury contained is equivalent to what would be deposited in 9,000 years.

  The results of this study should not be surprising. As the authors point out in their paper, when mercury pollution became a "popular concern" in the 1970s "the common presumption that the principle source of Hg in the environment is anthropogenic" was widely criticized in the scientific literature.[38]

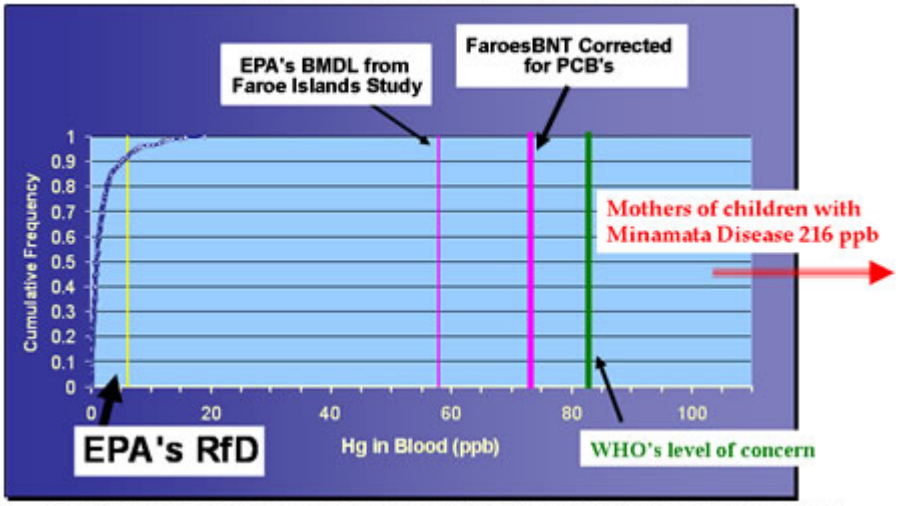
The findings of these studies bring into question several claims made by environmental organizations. Most importantly, the claim that atmospheric deposition of mercury from power plants or other anthropogenic sources is directly related to methylmercury levels in fish. Since there isn't any current, peer-reviewed science which supports that notion, advocating for a MACT mercury emissions rule seems misguided.

VII. The Real Risks to Human Health?

Ads about health risks are, at best, filled with misinformation and half-truths. Some claim that children are being poisoned by mercury emissions from power plants that get into the water and then into the fish. As noted above, this notion is scientifically unsupported. Other ads claim that 8 percent of women of childbearing age are at risk (Figure 7).

Some environmental groups falsely and disingenuously claim that 630,000 children are "at risk" from high mercury levels, a number that has been revised upward frequently in recent months.[39] The original number was postulated by the National Research Council (NRC) committee in its review of the toxicological effects of methylmercury and was estimated to be around 60,000. The chairman of that committee explained what the committee meant by the term "at risk."

Figure 7: **Women in the U.S. NHANES Survey were not remotely near a level for triggering an actual health concern**



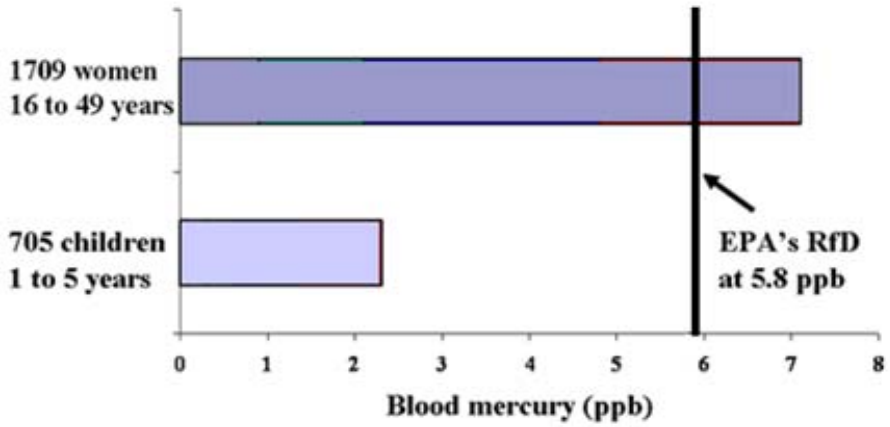
Adapted from chart shown in July 2003 EPA/FDA stakeholder meeting

> "The term 'at risk' refers to children born each year from mothers with a level of methylmercury that is above the current RfD [EPA's number] …The offspring of those mothers are exposed to mercury levels that are not considered safe, and, therefore, the committee considered them to be 'at risk'. The calculation presents an estimate of the number of children at risk because of high exposure (maternal dose exceeding current RfD). *The number should not be interpreted as an estimate of the annual number of cases of adverse neuro-developmental effects.* The committee does not believe it is possible to estimate a meaningful number of children that might be affected within the 'at risk' population. … We hope this clarifies the derivation and meaning of the 60,000 children at risk."[40]

Following this NRC study, the 1999-2000 National Health and Nutrition Examination Study (NHANES) released the first actual blood level measurements of mercury in U.S. women of childbearing age which showed about 8 percent had levels equivalent to mercury ingestion doses at or above the EPA Reference Dose. Using U.S. fecundity statistics, the resulting births to this number of women per year was about 300,000. The later 630,000 number was posited in January 2004 by an individual EPA staff member who cited a study noting possible differences between mother and their babies' cord-blood mercury levels. EPA itself has stated that the adjustment for that difference is already incorporated into the original Reference Dose calculation; therefore the higher number is double-counting.

The available data does not support the 630,000 number used by environmental organizations or the original estimate of the NRC. The analyses of blood-mercury concentrations in maternal-aged females (16-49 years) and young children (1-5 years) participating in the 1999-2000 (NHANES) "…were below levels associated with *in utero* effects on the fetus, or with effects in children and adults." [41] None of the children participating in this study had blood-mercury concentrations above EPA's RfD (Figure 8).

Figure 8:
According to the NHANES study, U.S. children are not being poisoned by mercury from power plants.



Data Source: Schober et al., 2003, JAMA, vol. 289, 1667-1674

None of the children participating in the 1999-2000 U.S. NHANES study had blood-mercury concentrations above EPA's RfD. (Figure 8)

Environmental fundraising groups direct these scare tactics at young mothers and their unborn and infant children. This disingenuous campaign, coupled with numerous newly-issued fish advisories (due to EPA's lowered RfD for methylmercury, better analytical techniques and more sampling) has presented a very scary scenario for pregnant women and other Americans who would normally enjoy fish as part of a healthy diet.

In fact, some of the same groups behind the current campaign were also responsible for the Alar-Apple hoax, a well-funded campaign launched in 1989 that claimed America's favorite natural snack food was laced with "poison"—a pesticide called Alar. However, the FDA, the EPA, the United States Department of Agriculture (USDA), the American Medical Association (AMA), and numerous other medical and agricultural experts concur that Alar never posed a health threat.[42]

A recent study published by scientists from the National Institute for Minamata Disease casts even more doubt on claims that regular fish consumption poses a threat to pregnant women and their unborn children. In a study conducted between 1999 and 2002, mercury hair measurements for over 8,000 Japanese individuals suggested that approximately 74 percent of females of childbearing age (15-49 yrs), had hair mercury levels exceeding EPA's RfD.[43]

This is especially interesting in light of international educational achievement scores in which Japanese children consistently score higher than children in the United States. For instance, Japanese children in the fourth grade scored significantly higher in mathematics. In the eighth grade scores, Japanese children outperformed U.S. children in mathematics and science achievement.[44] Overall, Japanese children are educationally outperforming U.S. children. This fact directly undercuts claims that mercury exposure in utero will negatively affect children's IQ.

The scenario begs a series of questions for us all. If the U.S. has significantly reduced mercury emissions since 1990, why does the "problem" appear to be getting worse? What do the advisories mean, and are they valid? What is the real risk to people from exposure to methylmercury from fish consumption? Are there other health risks associated with not including fish in our diets?

VIII. EPA Reference Dose?

The differences in methylmercury exposure levels between the direct poisoning events in Japan and Iraq and today's American population are significant. The tainted fish from Minamata Bay, Japan had methylmercury concentrations as high as 40 ppm. The fish that we buy at our grocery stores range from non-detectable to 0.358 ppm (Table 2), levels that are significantly less than the tainted fish from Minamata Bay and the level of FDA advisories.

Fast Facts

Hair Mercury Levels in U.S. Women & Children:

- **Averaged 0.2 and 0.12 ppm respectively (NHANES Study).**
- **The lowest level associated with harm in the Japanese people was 50 ppm.**

Hair samples collected from Iraqi women after the seed-grain poisoning event showed mercury concentrations that were less than 12 ppm to greater than 100 ppm with 674 ppm as the highest measurement reported.[45] American women of childbearing age and children that participated in the NHANES study had concentrations of mercury in hair that averaged just 0.2 ppm and 0.12 ppm respectively. Even the mean for the 95th percentile mercury concentration for the NHANES women's sample is 1.4 ppm.[46] The *lowest* concentration of mercury associated with neurological problems in the Japanese people was 50 ppm in hair and 200 micrograms per liter (mcg/liter) in their blood.[47]

The FDA reviewed the available data for Japan, noting that the lowest concentration of mercury in hair samples associated with neurological disorders was 50 ppm, and established an action level of 1ppm methylmercury in fish, or 0.4 mcg/kg/day (micrograms/kilograms of body weight/day), in 1979. In 1985, using the direct-poisoning event in Iraq, EPA established an RfD of 0.3 mcg/kg/day.[48]

Likewise, the U.S. Agency for Toxic Substances and Disease Registry (ATSDR) has set their methylmercury minimal risk level at 0.3 mcg/kg/day and the World Health Organization (WHO) set their risk level for methylmercury at 0.5 mcg/kg/day. Japan has set a risk level of 0.48 mcg/kg/day.

Because mercury is naturally occurring and is ubiquitous in the environment, we are all exposed to it at low levels. The degree of exposure depends on the methylmercury concentrations found in the seafood consumed and the amount consumed. Generally, our bodies eliminate this trace amount of mercury over a period of 1 to 3 months.

However, as a result of the direct poisoning events in Iraq and Japan, governments set safety limits for methylmercury concentrations in fish and funded research to study the possible ***subtle*** adverse health effects of lower concentrations of methylmercury.

Several studies have been conducted on various populations around the world that have been exposed to relatively high doses of methylmercury. The authors of the two most notable long-term epidemiological studies with several hundred cohorts designed to evaluate the ***subtle*** effects of prenatal methylmercury exposure have come to different conclusions. One group of researcher's claim they observed an effect from mercury consumed in fish and pilot whale meat, and the other group saw no adverse effect from mercury consumed in fish, but rather *increased benefits*, from eating fish.

These studies, funded by the U.S. National Institute of Environmental Health Sciences, looked at populations in the Faroe Islands and the Seychelles Islands, both known for their high intake of marine fish and/or mammals. The Seychelles and Faroe Islands studies where designed to test for ***subtle*** effects from *in utero* dietary exposure to methylmercury.

Children participating in the Faroe Islands study were evaluated at birth and at age seven. The Seychelles Islands group was assessed at multiple points over a twelve year period. According to ATSDR, there were *"no clinical signs of neurotoxicity or delayed developmental milestone attainment"* in either group studied. However, the Faroe Islands researchers believed they observed *"equivocal, subtle, functional neuropsychological effects"* as some of the children involved in their study showed impaired performance on the Boston Naming Test.[49]

An RfD is the highest daily dose that the most sensitive in the population can be exposed to without experiencing an adverse effect *over a lifetime of exposure*.

Without taking into consideration the early findings of these epidemiological studies, EPA arbitrarily lowered their RfD to 0.1 mcg/kg per day in 1995. The new RfD was based on a reassessment of the direct poisoning events in Iraq during the 1970s. The NRC in 2000 recommended to EPA that they use the available epidemiological studies to calculate their RfD rather than the direct poisoning event in Iraq.

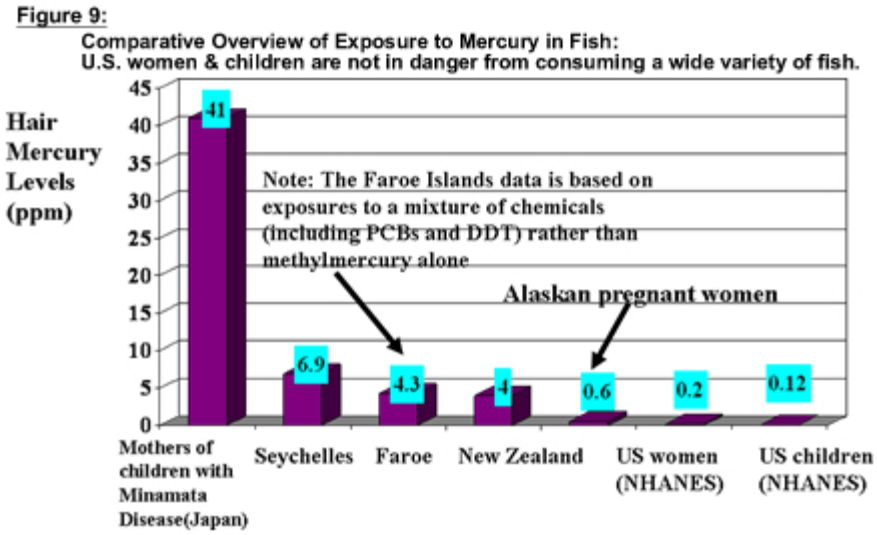
Thus, EPA used the Faroe Island study to justify their RfD since researchers reported they had observed adverse effects from *in utero* exposure to methylmercury. EPA calculated a "benchmark dose lower limit" (BMDL) of 58 ppb mercury in blood (this corresponds to 12 ppm methylmercury in hair) the lowest dose where a ***subtle*** adverse effect was thought to be observed. Once the BMDL was established, EPA used a composite "uncertainty" (safety) factor of 10 to calculate the RfD of 5.8 ppb methylmercury. An RfD is the highest daily dose that the most sensitive in the population can be exposed to without experiencing an adverse effect ***over a lifetime of exposure***.

However, EPA, supported by the NRC, rejected the Seychelles Island study because there was no adverse effect observed. They argued that without an adverse effect they could not establish a BMDL and calculate an RfD. Therefore, EPA had to rely on the Faroe Island study to justify their lowered RfD for methylmercury.[50]

There are several differences between this study and the Seychelles Islands study. The women in the Faroe Islands actually consume less fish than the women in the Seychelles. However, pilot whale is a significant component of the Faroe Islanders' diet. The whale meat is known to have

higher concentrations of methylmercury than fish and contains other contaminants including PCB's and DDT that have also been linked to neurological disorders.

The Faroe Islanders' exposure to PCBs is 600 times higher than EPA's RfD for Aroclor 1254 (a specific chemical in the PCB family).[51] Laboratory *in vitro* research has also shown that PCBs and methylmercury act synergistically in affecting brain tissue and chemistry.[52]



Dr. Gary Myers, the lead researcher for the twelve-year longitudinal study conducted in the Seychelles Islands, found ***no*** negative effects from dietary exposure to methylmercury through regular fish consumption. The Seychelles population consumes an average of 12 fish meals a week and has hair methylmercury concentrations approximately ten times higher than the U.S. population (Figure 9).[53]

In his July 29, 2003, testimony before the Senate Environment and Public Works Committee, Myers stated that:

> "We do not believe that there is presently good scientific evidence that moderate fish consumption is harmful to the fetus. However, fish is an important source of protein in many countries and large numbers of mothers around the world rely on fish for proper nutrition. Good maternal nutrition is essential to the baby's health. Additionally, there is increasing evidence that the nutrients in fish are important for brain development and perhaps for cardiac and brain function in older individuals."[54]

EPA has not revisited their RfD, despite publication of the latest research from the Seychelles Islands in 2003. Their RfD, the most restrictive in the world, has resulted in freshwater fish advisories being issued in almost every state.[55] EPA and FDA have issued new fish advisories as well, specifically targeting the "at risk" populations, pregnant women and non-pregnant women of childbearing age. Unfortunately, many people find the advisories too complicated and have been frightened away from eating fish entirely.

EPA has the most restrictive RfD in the world and it has resulted in fresh water fish advisories being issued in almost every state.

Environmental organizations have shamelessly used these fish advisories to further their political agenda and have created the false impression that U.S. anthropogenic mercury emissions are increasing. Their ads are filled with misleading information and have contributed to a sharp decline in domestic fish consumption.

Scaring people away from consuming fish is creating a public health crisis in its own right. Fish is an important part of a healthy diet. Research has demonstrated that a diet rich in omega-3 polyunsaturated fatty acid through fish consumption has beneficial health effects for people with heart disease and various types of cancer, including breast, prostate and endometrial. In addition, fish consumption has beneficial impacts on people suffering from Alzheimer's disease and type 2-diabetes.

But perhaps the most tragic aspect of this scare is the potential impact on the targeted populations -- pregnant women, infants and young children. A healthy diet that includes fish is known to significantly reduce the risks of pre-term delivery and low birth weight and has shown to have positive impacts on physiological and mental development in children. A recent National Institutes of Health study found that women whose breast milk was rich in omega-3 fatty acids, of which fish is a good source, were less likely to suffer from postpartum depression.[56]

Another recent study evaluated the association between maternal fish intake during pregnancy and children's language and communications skills. In the assessment of 7,421 British children born in 1991 and 1992, data showed that fish intake by the mother during pregnancy and by the infant postnatally was associated with higher scores on developmental tests.[57]

Conclusion

The politicization of the mercury emissions rulemaking process and the ensuing campaign launched by environmental organizations have misinformed and frightened Americans about the impacts of mercury emissions from power plants.

The campaign inaccurately accuses the Bush Administration of allowing industry to increase mercury emissions that will "poison" American children. These claims have placed the Administration and lawmakers in an untenable situation in an effort to force an expensive, prescriptive and currently unachievable emission reduction standard, a standard that will not produce any environmental benefit to the U.S., but promises to burden the economy and exacerbate our energy problems.

Worse, this misinformation has effectively reduced or even eliminated fish from the diets of women of childbearing age out of fear of harming their unborn children. Fish is known to be an important source of protein, omega-3 polyunsaturated acids and other important nutrients. A balanced diet that includes fish is known to significantly reduce the risks of pre-term delivery

and low birth weight, and is known to have positive impacts on physiological and mental development in children.

In addition, people with heart disease and various types of cancer, Alzheimer disease and type 2-diabetes realize many health benefits from including fish in their diet. Studies have consistently shown regular consumption of fish effectively reduces the risk of heart disease. With 320,000 women dying annually from heart disease, women should be encouraged to eat more fish, not less.

Most of the fish consumed in the U.S. are ocean fish harvested from many places around the world and are not impacted by domestic power-plant emissions. The average concentration of mercury in fish that Americans buy in the grocery store ranges from non-detectable to 0.358 ppm (Table 2), below FDA's action level of 1.0 ppm methylmercury. Mercury concentrations in tuna have not changed between 1971 and 1998, strongly suggesting that atmospheric mercury pollution does not influence mercury contamination in fish. Furthermore, EPA has not been able to establish a link between power plant emissions and mercury contamination in fish.

The NHANES blood-mercury concentrations study of women of childbearing age and young children showed that this population had blood-mercury concentrations below levels associated with *in utero* adverse effects in children and adults. This study is the first of its kind in the U.S.

Eliminating the fewer than 50 tons of mercury emitted from U.S. power plants will not impact mercury availability in the ocean basins; this is especially true when the projected annual increase in emissions from China (20 to 30 tons per year) is taken into consideration. The world's ocean basins alone contain millions of tons of naturally occurring mercury. Further, reductions in U.S. emissions are anticipated to have a minor impact on deposition within the U.S., estimates of which range from 2.7 – 3.4 percent in total U.S. mercury deposition to the environment.[58]

Naturally occurring mercury emissions make up approximately 61 percent or more of the world mercury budget while U.S. power plants contribute less than 1 percent of the mercury emissions. In the U.S. mercury usage and emissions resulting from human activity have decreased significantly since 1970 and are expected to decline further.

To date, there is no commercially available, cost-effective and reliable technology designed to consistently reduce mercury emissions on all coal types. The Department of Energy, in partnership with other federal agencies and the utility industry, is currently testing and developing different technologies designed to address these emissions. Several programs are scheduled to be completed and evaluated for their effectiveness and reliability within the next two to three years -- one to two years after the final mercury rule is to be issued.

The mercury emissions draft rule issued by the Bush Administration is the ***first*** attempt by any administration to regulate mercury emissions from coal-fired power plants. Their preferred plan is a cap and trade program that would allow flexibility in technologies required to address mercury emissions from power plants. A cap and trade approach would be less costly than a MACT standard and would achieve reductions in mercury emissions just as effectively. This

approach was favored by President Clinton's OMB and even credited by former EPA Administrator Browner.

A cap and trade approach achieves another important goal. It allows the utility industry to meet new emission standards without fuel switching from coal to natural gas or from one coal type to another or causing the premature closure of existing plants. It will minimize any adverse impacts on the demands to our domestic natural gas supply, mitigate cost increases for electricity to the American consumer and allow for the continued use of our vast domestic coal resources from all parts of the country.

EPA should regulate mercury emissions from power plants in a prudent and effective manner that protects human health without harming our economy or exacerbating our nation's energy problems.

Recommendations:

I. We support a phased, national cap and trade program as the most sensible and cost effective method for regulating mercury emissions from power plants. Moreover, as mercury specific removal technologies are not available at a predictable level of control for all coal types and process configurations, initial reductions in any regulatory program should be based on "cobenefit" reductions achieved through the installation of controls to meet new SO_2 and NO_x requirements.

This phased approach would provide a path to initiate the full development and installation of mercury specific controls prior to a second phase cap.

II. EPA's RfD for methylmercury should be reassessed: It is the most restrictive in the world and is based on an epidemiological study that examined a group of people exposed to multiple pollutants, primarily through the consumption of ocean going mammals.[59] Research on the adverse synergistic relationship between methylmercury and PCBs should be considered in this review. In addition, results from the nine year assessment of the Seychelles epidemiological study have been published showing no effect from exposure to methylmercury from consumption of ocean fish; and other epidemiological studies have shown positive benefits from fish consumption. This should be an independent review conducted under published Data Quality guidelines.

III. We support the use of science as a tool to develop public policy and believe future, ongoing studies can contribute to our understanding of mercury in the environment. These studies should be based upon a transparent and open process, and the data should be available so that other researchers have the opportunity to verify and check the veracity of the findings by being able to reproduce the results.

Glossary

anthropogenic – caused by or related to human activities

aquatic bacteria – one-celled microorganisms that grow or live in or upon the water

bioaccumulate - refers to the net accumulation over time of metals or other persistent substances within an organism from other organisms and soil, air, and water sources

BMDL (benchmark dose lower limit) – the lowest dose where an effect of a substance or compound is observed. EPA uses this dose to calculate their reference dose (RfD) for different compounds.

cinnabar – naturally occurring mercury sulfide mineral (HgS)

coal - a rock derived from vegetable matter through the process of metamorphism, which requires that heat and pressure act over long periods on this matter, altering both its chemical and physical characteristics. The initial stage of coal formation is peat, decomposed organic matter.

Coal Types (ranks)

1. **Lignite** - closely related to peat but has lower moisture content. It has the lowest heating value of any of the ranks of coal
2. **Subbituminous** - also called Black Lignite, dark brown to black coal intermediate in rank between lignite and bituminous coal
3. **Bituminous** - more dense than lignite and is black in color. Bituminous coal is the most commonly used of the ranks of coal for industrial purposes, both for the generation of electrical power.
4. **Anthracite** - the hardest of all the ranks of coal and typically has a lustrous black appearance. Anthracite has the highest carbon content of any of the coals and burns with the cleanest flame.

cord-blood – umbilical cord blood

Data Quality – Congress passed the Data Quality Act, also known as the Information Quality Act, in 2000. The bill was signed into law by President Clinton. OMB has established government-wide data-quality guidelines.

DDT (dichlorodiphenyltrichloroethane) - a pesticide once widely used to control insects in agriculture and insects that carry diseases such as malaria. Its use in the U.S. was banned in 1972. Exposure to DDT occurs mostly from eating foods containing small amounts of these compounds, particularly meat, fish and poultry. High levels of DDT can affect the nervous system causing excitability, tremors and seizures.

elemental – a chemical element in uncombined form

epidemiological (*adj.*) – a study that looks at all of the elements contributing to the occurrence or non-occurrence of a disease in a population

Faroe Islands – part of the Kingdom of Denmark, islands located in the North Atlantic

fecundity – fertility rate

fossil fuels – coal, petroleum and natural gas

fungicide – a substance that kills fungi or checks the growth of spores

HAPs (hazardous air pollutants) - substances that are defined as hazardous by the 1990 amendments of the Clean Air Act. These substances include certain volatile organic chemicals, pesticides, herbicides, and radionuclides that present tangible hazard, based on scientific studies of exposure to humans and other mammals. There is uncertainty in the precise degree of hazard.

in-utero – in the uterus

in-vitro – isolated from the living organism and artificially maintained in a Petri dish or test tube

ion – an electrically charged atom or atoms. This occurs when a neutral atom or group of atoms loses or gains an electron during a chemical reaction.

ionic – being in the form of an ion

kilogram (kg) - a unit of weight and mass equal to 1,000 grams (2.2046 lb.)

liter – a unit of measure in the metric system, the volume of a kilogram of distilled water at room temperature and pressure

longitudinal – studies dealing with the development of an individual or group over length of time

MACT – Maximum Achievable Control Technology standard that establishes specific emission limits. For coal the limits would be based on coal type. Each coal-fired power plant would have to meet these standards by 2008

mercury – a naturally occurring element, number 80 on the Periodic Table of the Elements, part of the earth's crust, oceans, and atmosphere. Mercury in rocks and mineral deposits normally occurs as cinnabar. Elemental mercury is the unique silver-white metal that is liquid at room temperature, vaporizes easily and is heavy

mercury budget – or 'global mercury pool'- Phrases researchers use to characterize the various sources of mercury in the environment, both naturally occurring or released through human activity. Normally the information is illustrated with a pie chart.

methylmercury (MeHg) - an organic mercury compound. It is this form of mercury that is found in trace levels in some fish and thought to be harmful to humans if consumed in large enough quantities. The methylation process is complex dependent on many different factors including, but not limited to, water temperature, pH (water acidity), organic acids and aquatic bacteria. Manufactured MeHg has been used to preserve seed grain.

microgram (mcg) - one-millionth of a gram

neuro-development – brain development

nitrogen oxides (NO_x) - generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. Many of the nitrogen oxides are colorless and odorless. Nitrogen oxides form when fuel is burned at high temperatures, as in a combustion process. The primary sources of NOx are motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels.

organic matter - mass of matter that contains living organisms or non-living material derived from organisms

oxidized - a term used to characterize the degree of oxidation (or reduction) in atoms, molecules and ions. An element or atom in a compound can be oxidized by reaction with oxygen, while it can be reduced by reaction with hydrogen. An oxidized species may be formed also through the loss of electrons.

particulate matter – refers to fine particles released from various types of combustion processes. Pollution controls are required to capture these fine particles. Two ranges are measured: PM2.5 is particulate matter 2.5 micrometers in diameter and smaller. PM-10 concentrations are particles with a diameter of 10 micrometers and smaller.

PCBs (polychlorinated biphenyls) - mixtures of up to 209 individual chlorinated compounds (known as congeners), which are no longer produced in the United States but are still found in the environment. Health effects that have been associated with exposure to PCBs include acne-like skin conditions in adults and neurobehavioral and immunological changes in children.

peer-reviewed - or refereed, meaning that original articles are reviewed by non-editorial staff of a journal before being accepted for publication

pH – symbol for the acidity or alkalinity of a solution. The acidity of a water sample is measured on a pH scale. This scale ranges from 0 (maximum acidity) to 14 (maximum alkalinity). The middle of the scale ,7, represents the neutral point. The acidity increases from neutral toward 0. Because the scale is logarithmic, a difference of one pH unit represents a tenfold change. For example, the acidity of a sample with a pH of 5 is ten times greater than that of a sample with a pH of 6. A difference of 2 units, from 6 to 4, would mean that the acidity is one hundred times greater, and so on.

poison – a substance causing illness or death when eaten, drunk or absorbed

parts per billion (ppb) - 1 part in 1,000,000,000. One drop of ink in one of the largest tanker trucks used to haul gasoline would represent 1 ppb.

parts per million (ppm) - 1 part in 1,000,000. A unit of concentration often used when measuring levels of pollutants in air, water, body fluids, etc. The common unit mg/liter is equal to ppm. Four drops of ink in a 55-gallon barrel of water would produce an "ink concentration" of 1 ppm.

reagent – a substance used to detect or measure another substance or convert one substance into another by means of the reaction it causes

reference dose (RfD) - a numerical estimate of a daily oral exposure of a given substance to the human population, including sensitive subgroups such as children, that is not likely to cause harmful effects during a lifetime

Seychelles Islands - group of islands located in the Indian Ocean, northeast of Madagascar

sorbent - absorbents and adsorbents are referred to as "sorbents" - They are used in environmental, industrial, agricultural, medical, and scientific applications to retain liquids and gases.

sulfur dioxide (SO_2) - a gaseous oxide produced by the burning of fuels containing sulfur

synergistically (*adv*) – the simultaneous action of separate agencies which, together have greater total effect than the sum of their individual effects (esp. drugs)

toxic pollutant - a group of 188 pollutants identified by the federal Clean Air Act that have been associated with a wide variety of adverse health effects, including cancer

toxicological *(adj.)* – the science of poisons, their effects and the antidotes

ubiquitous – present, or seeming to be present everywhere at the same time

water soluble *(adj.)* - that can be dissolved in water

Endnotes

[1] Environmental Protection Agency (EPA). Proposed National Emissions Standards for Hazardous Air Pollutants; and, in the Alternative, Proposed New Standards of Performance for New and Existing Stationary Sources: Electric Utility Steam Generating Units. 69 FR 4652 (January 30, 2004)
[2] http://www.epa.gov/mercury/
[3] Pacyna,J., Pacyna, E., Steenhuisen, S., Wilson, S., 2003 Atmospheric Environment 37, supplement no. 1, S109-S117; and Friedli, H. et al., 2003. Atmospheric Environment, 37: 253 -267.
[4] EPA. Regulatory Finding on the Emissions of Hazardous Air Pollutants from Electric Utility Steam Generating Units. 65 FR 79825 (December 20, 2000)
[5] "There is considerable interest in an approach to mercury regulation for power plants that would incorporate economic incentives such as emissions trading. Such an approach can reduce the cost of pollution controls by allowing for least-cost solutions among a universe of facilities that face different control costs. Trading also can allow for a greater level of control overall because it offers the opportunity for greater efficiency in achieving control….Thus, in developing a standard for utilities, the EPA should consider the legal potential for, and the economic effects of, incorporating a trading regime in a manner that protects local populations."
[6] A Review of DOE/NETL's Mercury Control Technology R&D Program for Coal-Fired Power Plants, U.S. Department of Energy, National Energy Technology Laboratory, April 2003
[7] Friends of the Earth Advertisement in USA Today (March 16, 2004)
[8] NRDC-MoveOn.Org Advertisement in the New York Times (March 26, 2004)
[9] Sznopek, J. and Goonan, T. 2000. The Materials Flow of Mercury in the Economies of the United States and the World. U.S. Geological Survey Circular 1197 (June 14, 2000)
[10] http://www.eei.org/industry_issues/environment/air/mercury/straight_answers_mercury.pdf
[11] http://mineral.galleries.com/minerals/elements/mercury.htm
[12] Stark, M., 2003. Scientists find major mercury emissions in Yellowstone. Billings Gazette. October 22.
[13] Friedli, H. et al., 2003. Atmospheric Environment, 37: 253 -267.
[14] Ferguson, R. 2004. Comments of the Center for Science and Public Policy on EPA's NODA Docket ID No. OAR-2002-0056. (December 2004).
[15] *Ibid*
[16] *Ibid*
[17] Pacyna, ,J., et al. 2003. Atmospheric Environment, 37 (Supplement 1): 109-117.
[18] Seigneur et al. 2004. Environmental Science & Technology, 38: 555-569
[19] Levin, L. 2003. Valuing Externalities Workshop, U.S. Department of Energy. February 21; Levin, personal communication 07/20/04.
[20] Seigneur, C., K. Lohman, K. Vijayaraghavan, J. Jansen and L. Levin, Comparison of grid-based and plume modeling to estimate the local impacts of large mercury point sources, 7th International Conference on Mercury as a Global Pollutant, 27 June - 2 July 2004, Ljubljana, Slovenia.
[21] http://www.epri.com/corporate/discover_epri/news/HotTopics/env_FloridaMercuryRpt.pdf
[22] Sznopek, J. and Goonan, T. 2000. The Materials Flow of Mercury in the Economies of the United States and the World. U.S. Geological Survey Circular 1197 (June 14, 2000)
[23] http://www.epa.gov/air/caa/caa112.txt
[24] EPA 1997. Mercury Report to Congress (Executive Summary), I:3-4 (December 1997)
[25] EPA. Regulatory Finding on the Emissions of Hazardous Air Pollutants From Electric Utility Steam Generating Units. 65 FR 79825 (December 20, 2000)
[26] A Review of DOE/NETL's Mercury Control Technology R&D Program for Coal-Fired Power Plants, U.S. Department of Energy, National Energy Technology Laboratory, April 2003
[27] Monrroe, L. 2004. Commercialization of Emission Control Technologies in the U.S. Utility industry, with a Particular focus on Mercury.
[28] http://www.eei.org/industry_issues/environment/air/mercury/straight_answers_mercury.pdf
[29] Marvin-DiPasquale, M., Agee, J., Bouse, R., Jaffe, B., 2003 Microbial Cycling of Mercury in Contaminated Pelagic and Wetland Sediments of San Pablo Bay, California. Environmental Geology, 43-3: 260-267.
[30] Levin, L. 2003. Valuing Externalities Workshop, U.S. Department of Energy. February 21.
[31] Koenig, H. Mercury in the Environment: The Problems, the Risks, and the Consequences. Annapolis Center for Science-Based Public Policy.
[32] *Ibid*

[33] Kraepiel, A., Keller, K., Chin, H., Malcolm, E., Morel, F., 2003. Sources and Variations of Mercury in Tuna, Environmental Science and Technology, 37: 5551-5558
[34] Middaugh, J. 2002. Testimony before the Federal Drug Administration (FDA) Advisory Committee on Methylmercury (July 24, 2002).
[35] Cannon, W., Dean, W., Bullock Jr., J., 2003. Effects of Holocene Climate Change on Mercury Deposition in Elk Lake, Minnesota: The Importance of Eolian Transport in the Mercury Cycle. Geology 31 (2): 187-190.
[36] Dallaire et al, 2003. Environmental Health Perspectives, 111: 1660-1664.
[37] Myers, G., Davidson, P., Cox, C., Shamlaye, C., Palumbo, D., Cernichiari, E., Sloane-Reeves, J., Wilding, G., Huang, L. and Clarkson, T. 2003. Prenatal Methylmercury Exposure from Ocean Fish Consumption in the Seychelles Child Development Study. The Lancet, vol. 361 (May 17, 2003), 1686-1692.
[38] Krug, E.C. and Winstanley, D., 2004. Comparison of mercury in atmospheric deposition and in Illinois and USA soils. Hydrology and Earth System Sciences, 8(1), 98-102, (2004)
[39] Following this NRC study, the first data from actual blood level measurements of mercury in U.S. women of childbearing age showed about 8% of the women were above the EPA Reference Dose. Using U.S. fertility statistics, the resulting births to these women per year was about 300,000. The later 630,000 number was posited by an individual EPA staff member resulting from differences between mother and fetus cord blood mercury levels. EPA itself has stated that the adjustment for that difference is already incorporated into the Reference Dose calculation, and so using the higher number is essentially double-counting.
[40] Goyer, R. 2000. Letter to Joseph Levitt, Director of CFSAN of FDA from the Committee on the Toxicological Effects of Mercury (December 1, 2000)
[41] Department of Health and Human Services Centers for Disease Control and Prevention, 2003. Second National Report on Human Exposure to Environmental Chemicals, NCEH Pub. No. 02-0716 (Revised March 2003)
[42] American Council on Science and Health, February 1999.
[43] Yasutake et al., 2004, Journal of Health Science, vol. 50 (2), 120-125.
[44] International Association for the Evaluation of Educational Achievement, *Mathematics (Science) Achievement in the Primary School Years: Third International Mathematics and Science Study*, 1997, Table I.I.; International Association for the Evaluation of Educational Achievement, *TIMSS 1999 International Science Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade*, 2000, Exhibit I.I.
[45] Myers, G.J. and Davidson, P.W., 2000. Does Methylmercury Have a Role in Causing Developmental Disabilities in Children? Environmental Health Perspectives Supplements V.108 No. S3 (June 2000); Szwarc, S. 2004. Mothers, Babies and Mercury. Tech Central Station (April 16, 2004). http://www.techcentralstation.com/041604D.html
[46] http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5008a2.htm; McDowell, M.A., Dillon, C.F. Osterloh, J., Bolger, P.M., Pellizzari, E., Fernando, R., Montes de Oca, R., Schober, S., Sinks, T., Jones, R.L., and Mahaffey, K.R., (2004). Hair Mercury Levels in U.S. Children and Women of Child Bearing Age. National Institute of Environmental Health Sciences, Environmental Health Perspectives, volume 112, 1165-1171.
[47] Myers, G.J. and Davidson, P.W., 2000. Does Methylmercury Have a Role in Causing Developmental Disabilities in Children? Environmental Health Perspectives Supplements V.108 No. S3 (June 2000); Szwarc, S. 2004. Mothers, Babies and Mercury. Tech Central Station (April 16, 2004). http://www.techcentralstation.com/041604D.html
[48] Sills, H., 2003. The Path to Mercury MACT Regulation;
http://risk.lsd.ornl.gov/tox/profiles/methyl_mercury_f_V1.shtml
[49] National Center for Environmental Health and the Agency for Toxic Substances and Disease Registry (NCEH/ATSDR), 2004. Methylmercury Toxic Effects FEB 2004.doc. NCEH/ATSDR Briefing on Mercury (February 6, 2004).
[50] National Research Council (NRC), 2000. Toxicological Effects of Methylmercury. National Academy Press (2000).
[51] Dourson et al., 2001, Neurotoxicology, 22, 677-689.
[52] Bemis, J., and Seegal, R., 1999. Polychlorinated Biphenyls and Methylmercury Act Synergistically to reduce Rat Brain Dopamine Content *in Vitro*. Environmental Health Perspectives, Volume 107, Number 11 (November 1999), 879-885.
[53] Myers, G., Davidson, P., Cox, C., Shamlaye, C., Palumbo, D., Cernichiari, E., Sloane-Reeves, J., Wilding, G., Huang, L. and Clarkson, T. 2003. Prenatal Methylmercury Exposure from Ocean Fish Consumption in the Seychelles Child Development Study. The Lancet, vol. 361 (May 17, 2003), 1686-1692.
[54] Myers, G. et al 2003. Statement by the University of Rochester research Team Studying the Developmental Effects of Methylmercury Before the U.S. Senate Committee on the Environment and public Works (July 29, 2003); http://epw.senate.gov/108th/Meyers_072903.html

[55] EPA. Fact Sheet: National Listing of Fish Advisories. EPA 823-F-04-016 (August 2004): Sampling programs designed to assess methylmercury levels in fresh water fish since EPA's revised RfD in 1997 have resulted in fresh water fish advisories being issued in almost every state. The fish advisories have given the false impression that U.S. anthropogenic mercury emissions are increasing. Environmental organizations have shamelessly used these fish advisories to further their political agenda.

[56] July 14, 2004 Press Release, New Evidence Shows Benefits of Eating Fish During Pregnancy. U.S. Tuna Foundation

[57] Daniels, J., Longnecker, M., Rowland, A., Golding, J. and the ALSPAC Study Team, 2004, Epidemiology, 15 (4), 394-402.

[58] Levin, L. 2003. Valuing Externalities Workshop, U.S. Department of Energy. February 21.

[59] Weihe, P, 2004. Letter to the editor, Boston Herald, 09 February 2004.