HOW SAFE ARE WE FROM THE FISH WE EAT?

A Review of the Current Literature on Mercury, Fish and Human Health

by Robert Ferguson
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“The greatest challenge facing mankind is the challenge of distinguishing reality from fantasy, truth from propaganda.

“We must daily decide whether the threats we face are real, whether the solutions we are offered will do any good, whether the problems we’re told exist are in fact real problems, or non-problems.

“...Our struggle to determine what is true is the struggle to decide which of our perceptions are genuine, and which are false because they are handed down, or sold to us, or generated by our own hopes and fears.

“I am thoroughly sick of politicized so-called facts that simply aren’t true. It isn’t that these "facts" are exaggerations of an underlying truth. Nor is it that certain organizations are spinning their case to present it in the strongest way. Not at all---what more and more groups are doing is putting out lies, pure and simple. Falsehoods that they know to be false.”

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Fish and Human Health

by Robert Ferguson  |  September 2004

EXECUTIVE SUMMARY

The preponderance of the latest scientific literature strongly suggests that at historic consumption levels we have always been, and will continue to be, safe from the fish we eat. All sectors of the U.S. population, especially pregnant women, children and the elderly, should continue deriving critically needed nutrition from fish.

There is no sound scientific evidence to suggest that the American public, especially infants and young children, have been exposed to harmful levels of mercury.

The EPA Reference Dose, the root of the recent alarm and confusion, should be re-examined. EPA’s Reference Dose of 5.8 ppb is an ultra-precautionary level that was derived by introducing an added safety factor of 10 from the EPA’s chosen Benchmark Dose Lower Limit (BMDL) value of 58 ppb. In turn, that BMDL value was derived from statistical analysis of limited data from the critically flawed Faroe Islands children study.

Strong scientific evidence does suggest that most, if not all, of the trace amounts of methylmercury contained in ocean fish are not connected to the inorganic form of mercury emitted by power plants. That is because mercury is ubiquitous in our environment, the oceans alone containing tens of millions of tons of mercury - deep ocean vents likely being the regions for production of the methylmercury that ends up naturally and persistently over time in ocean fish.

In other words, current levels of methylmercury production and aquatic uptake could simply continue unchanged even if all U.S. coal-powered plants were shut down, resulting in zero Hg emissions.

Both epidemiological and clinical data suggest no actual danger to average American women and children from consuming a wide variety of fish from our restaurants and grocery stores, but there is much potential harm from avoiding or restricting fish. Therefore, scientifically weak and distorted campaigns of alarmism are an irresponsible endangerment to public health.
CLAIMS ABOUT MERCURY: THE 2004 CAMPAIGN

What is the science surrounding the many disturbing health warnings we have heard this year about mercury in the fish we eat?

A highly coordinated campaign of fear began the year with a January 20, 2004 Sierra Club ad in the Washington Post, the same day the President’s State of the Union speech was scheduled. It asks: “Want to make the State of Our Union Healthier? Then why expose American women and children to toxic mercury?”

This was soon followed by a March 16, 2004 Friends of the Earth ad in USA Today, making an even more extreme claim: “Your kids are being poisoned by deadly mercury from power plants.”

Quick on the heels of the ad by Friends of the Earth was the March 26, 2004 New York Times ad by MoveOn.org and the National Resources Defense Council (NRDC), flashing the headline, “First Arsenic Now Mercury.” The claim was that President George W. Bush’s EPA tried to allow higher levels of arsenic in drinking water, and was now likewise lowering health standards on mercury. This proved too much for journalist Greg Easterbrook, who wrote that the claim about arsenic “…simply isn't true—in fact, it’s a flat-out lie.”

Easterbrook explained:

“When the Bush administration took office, federal standards said drinking water could contain up to 50 parts per billion arsenic. Late in the 1990s a National Academy of Sciences study found that standard too high; Bill Clinton’s EPA Administrator Carol Browner responded by writing a new standard that reduced allowable arsenic to 10 parts per billion. The new standard was set to go into effect roughly as George W. Bush was taking office. In March 2001, Bush suspended for review all regulations published in the closing days of the Clinton administration. (This is standard practice when the White House changes parties; taking office in 1994, Clinton suspended for review all regulations published in the closing days of Bush, Sr.) The stricter arsenic rule was among the suspended regulations. Bush’s [Jr.] EPA administrator Christine Whitman reviewed the arsenic rule and ordered that it go into effect.”

Easterbrook then asked:

“Where in the above succession of events is the point where George Bush tried to allow more arsenic in drinking water? So while Bush acted responsibly on arsenic, many have been conditioned to believe that he acted irresponsibly, and what people can be tricked into believing may be all that matters to a political fundraising campaign. Still, it’s not comforting that MoveOn.org has to lie to make its case. When the organization lies about arsenic, how can you believe it about mercury?”
Setting aside the issue of political motives, does the underlying science support or refute the widespread alarmism about dire harm from the fish we eat?

**SCIENCE FINDINGS ON MERCURY EXPOSURE THROUGH EATING FISH**

Here are a few scientific facts about exposure to mercury through eating fish.

During the 1950s and 1960s there were two tragic incidences of direct methylmercury poisonings from industrial waste dumping in Minamata Bay and Niigata City, Japan. Minamata Disease (methylmercury poisoning) resulted when the population ate highly contaminated fish. The blood mercury levels of mothers and children in that well-known case are estimated to have been about 216 parts per billion (ppb). But those direct poisoning cases differ radically in a number of ways from the chronic, low-level human exposure to micro-traces of methylmercury from regular fish consumption – a natural condition of exposure existing for hundreds of years with no recorded widespread epidemics or deaths.

The first important difference is that the inorganic form of mercury released from power plants is not the biologically active form of methylmercury affecting human health at high dose levels, as in the Japanese incidents.

**Figure 1**

**No increase in mercury levels for Yellowfin tuna caught in 1998 relative to a similar sample caught in 1971**

- **1971 Yellowfin Tuna** with mean Hg = 0.218 ppm (n=71)
- **1998 Yellowfin Tuna** with mean Hg = 0.206 ppm (n=66)

Expected increase of 9 to 26% in mercury levels for the Yellowfin tuna between 1971 and 1998 because of man-made mercury emissions but none was observed.

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

Fig. 1: No increase in mercury levels for Yellowfin tuna caught in 1998 relative to a similar cohort caught in 1971.
Secondly, the most recent scientific literature is clear that the long, complex chain of physical, chemical and biological processes (biomethylation and bioaccumulation) required to convert various forms of inorganic mercury into the form of methylmercury ultimately accumulated in fish seems not related to, nor limited by, the amount of raw inorganic mercury available (i.e., as emitted from power plants and natural sources). This is why it is not surprising to find (see Figure 1) that a group of geochemists from Princeton University and the University of Louis Pasteur found no significant increase in the mercury found in similar cohorts of Yellowfin tuna caught off Hawaii in 1971 and 1998, despite the continued and increased use of coal-fired power plants around the world (particularly Asia) over this 27-year period.

Likewise, in an upcoming research paper for Science of the Total Environment, experts from the San Francisco Estuary Institute and California Department of Fish and Game reported no obvious increasing trend for the mercury (Hg) concentration in tissues of the popular and long-lived sport fish species of striped bass (Morone saxatilis) caught off three widely dispersed locations throughout the San Francisco Bay area over the 1970-2000 period (see Figure 2).

**Figure 2**

**No evidence of increasing trend in Hg concentration in striped bass caught off San Francisco Bay area from 1970-2000**

[Graph showing no increase in mercury levels for striped bass caught off San Francisco Bay area from 1970-2000]

*Note that although no increasing trend was found for Hg, significant declines were noted in the fish tissue’s DDT and chlordane in the late 90s. Those declines may be related to the use curtailment of these two chemicals in the 70s and 80s.*


Fig. 2: No increase in mercury levels for striped bass caught off San Francisco Bay area from 1970-2000.
The study reveals another important finding. Even though no accumulation trend was noted for mercury in striped bass, significant declines were noted for other contaminants like DDT and chlordane in San Francisco Bay’s fish tissues in the late 1990s. The authors suggest the declines may be linked to known curtailed usage of those two chemicals in the 1970s and 1980s. Thus, the combined findings suggest a more complicated and complex chain of biomethylation and bioaccumulation for mercury in fish. That is, compared to other contaminants it appears that the pathway and behavior of mercury transformation and accumulation in fish differs significantly.

A similar tendency was recently reported for levels of contaminants in fish from upper River Thames in Britain by a group of zoologists from Oxford University and Cornell University. These authors concluded that although the environmental contamination level of PCBs may be partly associated with industrial and human activities, it was difficult to find such associations for mercury.

An in-depth, scientific understanding and explanation about the nature of bioaccumulation of methylmercury in the food web is highlighted by Francois Morel and colleagues. 

“[T]he average proportion of MeHg [methylmercury] over total Hg increases from about 10% in water column to 15% in phytoplankton, 30% in zooplankton, and 95% in fish. The accumulation of MeHg in higher organisms results mainly from the ingestion of MeHg-containing food rather than direct uptake from MeHg from the water. The structure of the food web determines the efficiency of transfer from algae to top predators. To yield high concentration in fish, mercury must not only be taken up efficiently by the organisms that are at the bottom of the food chain, it must also be retained by these organisms and passed on to their predators. Many trace metals are efficiently accumulated in planktonic bacteria and microalgae, but most are not biomagnified: Their concentrations in the biomass do not increase (they often decrease) at high levels in the food chain. A key to understanding mercury bioaccumulation is provided by the contrast between Hg^0 [elemental mercury], Hg (II) [ionic mercury], and MeHg [di-methylmercury], which are not bioaccumulated, and MeHg [methylmercury], which is. Hg^0 and MeHg are not bioaccumulated, simply because they are not reactive and thus are not retained in phyto- or bacterio-pico-plankton: They diffuse out as readily as they diffuse in [cell membranes].”

It is thus reasonable to conclude that the combined weight of the latest scientific research adds confirmation to the findings that levels of trace methylmercury concentration in fish are likely not controlled or predetermined by any amount of mercury emissions from power plants. In other words, they support findings that the environmental cycling of trace mercury is, and has always been, dominated by natural processes largely beyond human influence; and there has been no significant or consistent rising trend of mercury in fish that could be considered truly alarming or worrisome for American public health.

Broad-brush, alarmist claims that U.S. power plants are “poisoning” the fish we eat appear recklessly void of convincing scientific support, and may provoke a real health crisis epidemic
by denying frightened consumers dietary and nutritional benefits. The dangers of being mislead are particularly acute for pregnant women and their children.

**HEALTH FACTS ABOUT MERCURY**

What about claims of exposure for American women of childbearing age and children to harmful levels of mercury through the consumption of a wide variety of ocean fish?

Figure 3 offers a few important facts and clarifications. It displays the latest results from the 1999-2000 Center for Disease Control (CDC)’s National Health and Nutrition Examination Survey (NHANES) for mercury content in blood samples drawn from 1709 U.S. women of childbearing age (16 to 49 years old). The data show that the mean level of blood mercury in this group of U.S. women is about 1 ppb (see the summary in Figure 4) while some women in the sample can have blood mercury levels as high as 20 ppb.

Figure 3 also shows that 92% of the women in the NHANES study had blood mercury levels below 5.8 ppb, the so-called EPA’s Reference Dose (RfD) as marked by the yellow line in Figure 3.

What is EPA’s RfD and what about the 8% of the NHANES sample above this dose level?

EPA’s Reference Dose of 5.8 ppb is an ultra-precautionary level that was derived by introducing an added safety factor of 10 from the EPA’s chosen Benchmark Dose Lower Limit (BMDL) value of 58 ppb (marked as the first thick purple line in Figure 3). In turn, that BMDL value was derived from statistical analysis of limited data (i.e., the Boston Naming Test, BNT) from the critically flawed Faroe Islands children study.

The most extensive and appropriate epidemiological study available is the government funded Seychelles Island Child Development Study. Unlike the Faroe study, Seychelles’s epidemiological setting was not plagued by confounding factors such as PCBs or DDT in the diets of test subjects. Also, the Seychelles fish consumption patterns are similar to those of U.S. diets, but at much higher levels ranging from 10 to 14 fish meals per week. Key is that the Seychelles study has consistently failed to uncover any adverse effects of mercury on child development from maternal fish consumption throughout the systematic examinations of Seychellois infants and children at 6, 19, 29, 60 months and 9 years of age. Instead, positive health effects were detected in those children due to fish’s rich nutritional benefits.
No woman in the NHANES survey has blood mercury higher than EPA's chosen Benchmark Dose Lower Limit value and the actual level for triggering an actual health concern is much higher than EPA’s RfD level of 5.8 μg/L (ppb).

Fig. 3: Blood mercury levels for 1709 US women of childbearing age (16-49) from the CDC’s NHANES survey. No single woman has mercury level higher than the actual level for triggering an actual health concern (see text for discussion).

Importantly, Figure 3 shows that when EPA’s Faroe Island BNT results are mathematically adjusted for non-mercury chemical contamination, the actual mercury-only level for triggering health concerns jumps to 71 ppb. Thus, Figure 3 illustrates that the current NHANES survey results are really telling us that U.S. women and children are not exposed to harmful levels of mercury.

Results in Figure 3 support claims that the actual level of mercury for health concerns is arbitrary and not well defined. Additionally, chief of FDA’s contaminants branch, Michael Bolger, actually commented during a July 2002 FDA mercury advisory meeting that the NHANES results suggest that “92 percent of women of child-bearing age already consumed below [EPA’s] reference dose, while the top 8 percent still have a safety margin of about eight-fold.”
If one adopts the CDC’s own Agency for Toxic Substances and Disease Register’s (ATSDR) “minimum risk level” of 13.6 ppb as a measure of precautionary concern in Figure 3, then only 1% of US women in NHANES survey are above the “health level of concern,” rather than the 8% arising from adopting the EPA’s reference dose level of 5.8 ppb. With this class of women, a recommendation of restricting fish intake to allow lowering of mercury in the blood (which takes roughly 50 to 200 days to reduce by half) during pregnancy may be a worthy precaution. In such incidences of worry about high mercury exposure, it is certainly reasonable to heed the warning from the March 2004’s joint EPA/FDA fish advisory for pregnant women and young children to avoid “Shark, Swordfish, King Mackerel, or Tilefish because they contain high levels of mercury.”

However, one would be acting irresponsibly by not properly balancing the relatively low level of manageable risks in context of the many known health benefits of fish consumption both for daily sustenance and pregnancy. In addition to women, dietary fish is especially important for the health of children and the elderly.

**Fish Consumption and Known Health Benefits**

Even a cursory literature survey reveals the following list of serious health conditions that could benefit from omega-3 polyunsaturated fatty acids available in a fish-rich diet:

- (a) cardiovascular disease + coronary heart disease (CHD) + sudden death
- (b) breast cancer
- (c) prostate cancer
- (d) endometrial (inner lining of uterus) cancer
- (e) Alzheimer disease
- (f) rheumatoid arthritis
- (g) treatment of kidney disorders
- (h) type 2 diabetes in women and CHD in type 2 diabetic women
- (i) pre-term delivery and low birth weights + physiological and mental development of infants.

In other words, any call for a restriction in fish consumption must account for the potential for widespread public health threats as listed above.

In this light, Eric Rimm, Professor of Epidemiology and Nutrition at the Harvard School of Public Health, expressed serious concerns:

“The message of fish being good has been lost and people are learning more about the hypothetical scare of contaminant than they are of the well-documented benefit of coronary disease reduction. The danger of the tuna fish is not well documented compared to the potential dangers for a 50-year old male or female who are at much higher risk of coronary health.” [Emphasis added.]

Rimm’s concerns are well supported by the July 27, 2004 publication of “Fish Intake and Risk of Incident Atrial Fibrillation” in the American Heart Association’s journal, *Circulation.* In
studying a 12-year follow-up database for a cohort of 4,815 men and women over 65, Mozaffarian and colleagues found that compared to those who ate fish less than once per month, adults consuming tuna or other broiled or baked fish 1 to 4 times per week had 28% lower risk of developing atrial fibrillation (irregular beating of the heart). Those eating fish five times or more per week enjoyed a 31% lower level of risk.\textsuperscript{xvi}

In addition to the above benefits for adult health, there are also important health rewards of fish-rich diets for infants and young children.

Dr. Charles Lockwood, now chairman of the Obstetrics and Gynecology at the Yale School of Medicine, commented in his previous capacity as the chairman of the 45,000-member American College of Obstetricians and Gynecologists’ panel on obstetric practice:

“[W]e are concerned that, in fact, we don’t know enough about the neuro-developmental effect of mercury. The literature has been, at best, unconvincing. Reviewing the data from Faroe Island and the Seychelles Islands ... leaves us a little more lost. It is unclear whether or not you can set a specific exposure level that would be safe and, conversely, one that would represent the lower limit of absolute risk. ... We would like to urge the NIH [National Institute of Health] and other federal agencies to support research to establish in a much more rigorous way what mercury does to the developing infant’s brain. ... I suppose at this point, if we are left with increasingly concerning information about the lack of a lower limit of mercury exposure, pregnant women will stop eating fish, but there are a lot of health benefits of eating fish and it is a relatively cheap source of protein. There may be some additional benefits of reducing oxidative stresses that might induce pre-eclampsia or pre-term delivery; may affect fetal growth restriction by impairing placentation. So, there are lots of reasons to think that fish might be useful for pregnant women to take in...”\textsuperscript{xvii}
Also, a group of scientists from the National Institute of Environmental Health Sciences and the Institute of Child Health at the University of Bristol, UK reported an important conclusion about the beneficial effects of marine fatty acids on the well being of young children in the July 2004 issue of the scientific journal, *Epidemiology*:

“Fish intake by the mother during pregnancy and by the infant postnatally, was associated with higher mean [child] development scores [in a cohort of 7421 British children]. For example, the adjusted mean MacArthur [vocabulary] comprehension score for children [15 months old] whose mothers consumed fish four or more times per week was 72 ... compared with [a score of] 68 among those whose mothers did not consume fish. ... Although the total cord mercury levels increased with maternal fish intake, our data did not suggest adverse developmental effects associated with mercury. In a small study of subjects in [this] ALSPAC [Avon Longitudinal Study of Parents and Children] study, maternal DHA levels were associated with improved visual stereoaucity among offspring at 3.5 years of age. ... Fish intake during pregnancy has the potential to improve fetal development because it is a good source of iron and long chain omega fatty acids, which are necessary for proper development and function of the nervous system.” [Emphasis added.]

In addition to numerous health benefits of fish-derived omega-3 polyunsaturated fatty acids noted in the scientific literature, Figure 4 further emphasizes why an average American consuming a wide variety of ocean fish is in no danger of being harmed by residual mercury. Compared to the average 216 ppb blood levels of mercury found in the Minamata Bay case, the results from the women in the U.S. NHANES survey indicate only a mean blood mercury level of about 1 ppb.

Figure 4 also shows the rarely reported fact that the blood mercury for young children of ages 1-5 surveyed by the NHANES is only 0.34 ppb. The 95th percentile level of mercury for this population of NHANES young children is known to be 2.3 ppb—a level far below even EPA’s ultra-cautious RfD level of 5.8 ppb and certainly a level low enough to expose as false the Friends of the Earth advertised claim, “Your kids are being poisoned by deadly mercury from power plants.”

Moreover, Figure 4 compares the mean blood mercury levels obtained by several other surveys and studies across a wide spectrum of the U.S. population. For example, the December 2002 survey of mercury levels in pregnant Alaskan women, as conducted by the State of Alaska Office of Epidemiology (see endnote 6), shows a mean level about 2 to 3 times higher than women in the NHANES report, which most likely is a result of the relatively higher frequency of fish consumption in the Alaskan population. No ill effects were reported for these pregnant Alaskan women.

In a recent *Risk Analysis* paper,*xx “Human Mercury Toxicity and Ice Angler Fish Consumption: Are People Eating Enough to Cause Health Problems?” Colleen Flaherty and colleagues at the University of Wisconsin-Madison reported:
“We interviewed [138 male] ice anglers in Monona Bay, Wisconsin during the 2001-2002 ice fishing season to determine risk associated with fish consumption and methyl mercury (MeHg) intake. The majority of anglers (95%) were not at risk of mercury toxicity because they ate less fish than would be required to create health problems. The remaining 5% of ice anglers barely exceeded the mercury toxicity threshold, with the exception of one angler who exceeded the threshold by 0.926 ppm. ... Fish consumption by ice anglers was independent of awareness of consumption advisories, education, income, and age.”

**Figure 4** shows two patient populations with very high mean levels (15 ppb and 28.4 ppb) of blood mercury compared to the U.S. NHANES survey results. But there is no scientifically verified mercury poisoning cases in any of those two patient groups.\(^{xxi}\)

As for results from the Cambridge, MA patient group (the 28.4 ppb group), doctors from the Harvard Medical School, Stephen Kales and Rose Goldman, explained: \(^{xxii}\)

“... In the context of controversies surrounding fish consumption, amalgams, and commercial hair testing, we reviewed all cases from an occupational and environmental medicine clinic that had undergone mercury testing. Sixty-nine of 71 (97%) patients had no known mercury exposures other than diet or amalgams. Of these 69, 48 had blood mercury tested ... Regular-to-heavy fish consumption explained 10 of 11 cases with blood mercury concentration > 15 [ppb] (19 to 53 [ppb]). Six of these 10 individuals reported regular swordfish consumption. ... **Higher blood mercury concentrations were, however, not associated with specific patterns of health complaints.** ... Fourteen patients were evaluated because they were labeled as mercury toxic by other practitioners after unconventional commercial testing. **Using standard tests of blood and urine, we could not document evidence of mercury in any of these 14 cases.**” [Emphasis added.]

Finally, in an upcoming publication in the journal *Environmental Research*, Suma Vupputuri of the National Institute of Environmental Health Sciences and colleagues,\(^{xxiii}\) utilizing the latest NHANES database, *failed* to find support for claims of harmful association between mercury and blood pressure:

“*We found no significant association* between total blood mercury and systolic and diastolic BP [blood pressure] among [the NHANES] study participants overall. ... **Our findings support the hypothesis that the intake of fish oils may counter the harmful effects of mercury on BP regulation.**”\(^{xxiv}\) [Emphasis added.]

**ADDITIONAL EXPOSURE FACTS**

Two important additional health facts should be clarified regarding exposure to mercury through contacts with air and water:
(1) Global background levels of Hg concentration\textsuperscript{xxv} are about 1.2 to 1.4 nanograms of Hg per cubic meter of air (ng/m\textsuperscript{3}) while levels of Hg as high as a few to 20 ng/m\textsuperscript{3} can be found under various urban and non-urban settings. OSHA (Occupational Safety and Health Administration) sets a limit of no more than 0.1 milligrams of Hg per cubic meter of air (mg/m\textsuperscript{3}) at all times and 0.05 mg/m\textsuperscript{3} for workplace air to protect workers during a 40-hour workweek. So levels of Hg in air we breathe are at least a thousand to a million times lower than the safe limit established by OSHA based on “the risk of central nervous system damage, eye, skin, and respiratory irritation.”\textsuperscript{xxvi}

(2) Both EPA and FDA set a safe limit of 2 parts of Hg per billion parts of water (or 2 ppb) for drinking water and EPA recommends that levels of Hg in lakes, rivers and streams to be no more than 0.14 ppb.\textsuperscript{xxvii} Such safety levels are also about hundreds to a thousand times higher than Hg levels ranging from 1 parts per trillion (ppt) to 10 ppt in water sampled over 90 agricultural, background and urban sites in the U.S. by scientists from the US Geological Survey. Mean level of Hg in 14 abandoned Hg mine areas is significantly higher at about 84 ppt.\textsuperscript{xxviii}

CONCLUSION

The preponderance of the latest scientific literature strongly suggests that at historic consumption levels we have always been, and will continue to be, safe from the fish we eat, through which we derive critically needed nutrition.

There is no sound scientific evidence to suggest that the American public, especially infants and young children, have been exposed to harmful levels of mercury. In contrast, strong scientific evidence\textsuperscript{xxix} does suggest that most, if not all, of the trace amounts of methylmercury contained in ocean fish are not connected to the inorganic form of mercury emitted by power plants. That is because mercury is ubiquitous in our environment, the oceans alone containing tens of millions of tons of mercury - deep ocean vents likely being the regions for production of the methylmercury that ends up naturally and persistently over time in ocean fish.

In other words, current levels of methylmercury production and aquatic uptake could simply continue unchanged even if all U.S. coal-powered plants were shut down, resulting in zero Hg emissions. Again, more important is the fact that both epidemiological and clinical data suggest no actual danger to average American women and children from consuming a wide variety of fish from our restaurants and grocery stores, but there is much potential harm from avoiding or restricting fish. Therefore, scientifically weak and distorted campaigns of alarmism are an irresponsible endangerment to public health.
ENDNOTES

   A phrase-by-phrase scientific examination of this ad entitled, “Analysis of Sierra Club’s Alarming Claims About
   Health Impacts of Mercury” by the Center for Science and Public Policy can be found at http://www.science
   andpolicy.org.


vi Examination of ancient human remains confirms significant natural exposures to methylmercury through fish
   and marine mammals in the diet. For example, eight Alaskan mummies dated to 550 years ago show a
   methylmercury mean value in four infants of 1.44 parts per million (ppm) and a mean value of 1.2 ppm for four
   adults, with one as high as 4.6 ppm! In contrast, Alaska’s current population of pregnant women shows a range
   of methylmercury exposure with a mean of only 0.6 ppm. (State of Alaska Epidemiology Bulletin No. 29,
   December 11, 2002).

vii U.S. power plant mercury emissions are less than 1% of the annual world emissions budget; natural sources
   account for in excess of 50%. (See papers at www.scienceandpolicy.org.)

viii A transparent attempt by Michael Aucott of the New Jersey Dept. of Environmental Protection to undermine
   the implications of this study was soundly turned back by the original authors.


x Yamaguchi et al., 2003, Chemosphere, vol. 50, 265-273.


xii It is well known, even to experts on the prestigious 2000 National Research Council methylmercury committee,
   that the Faroe Islands children study is an inappropriate epidemiological database for deriving health dose and
   response levels for exposure to methylmercury. The reason is that the Faroe Island study has a methylmercury
   exposure profile that differs drastically from that of the US population, mainly because the Faroese mothers
   and children consume significant quantities of whale meat and blubber (fat). That unique whale fat diet
   exposed the study subjects to high levels of other chemicals like PCBs and DDT, thus overwhelming the ability
   to isolate potential effects of methylmercury.


xiv As quoted in the April 10, 2004’s New York Times article “Fears (Real and Excessive) from Warning on Tuna” by
   Jennifer Lee.

xv Mozaffarian et al., 2004, Circulation, vol. 110 (no. 4), 368-373. Atrial fibrillation is a condition of irregular heart
   beat affecting more than 2 million Americans, especially the elderly.

xvi However, in an earlier study, Mozaffarian and colleagues pointed to the importance of types of fish meal
   consumed, finding that fried fish or fish sandwiches may not offer the same level of protection for the heart as
   broiled or baked fish.

xvii From the July 24, 2002’s FDA food advisory committee on methylmercury with the transcript available at
   http://www.fda.gov/OHRMS/DOCKETS/ac/02/transcripts/3872t2.htm.

xviii Daniels et al., 2004, Epidemiology, vol. 15, 395-402.


xxi It is important to note that results reported in the Hightower and Moore (2003, Environmental Health
Perspectives, vol. 111, 604-608) paper shown in Figure 4 are internally inconsistent (hence their phrase, “no
scientifically verified mercury poisoning cases in any of these two groups of patients.”). Although patients in the
Hightower and Moore (2003) study who consumed swordfish (with a mean Hg of 0.95 ppm) had been used to
suggest that “a substantial fraction of patients had diets high in fish consumption,” a high proportion had blood
mercury levels exceeding maximum level recommended by U.S. EPA and NAS.” It must be pointed out that
Table 2 of Hightower and Moore (2003) showing an increase in patient blood mercury levels with increased
consumption of swordfish, simultaneously suggests that when patients consumed more red snapper (with
mean Hg of 0.25 ppm) or sole, their blood mercury levels actually decreased—which is both opposite to and contradictory of the swordfish result promoted by Hightower in popular fora and media (see for example, http://www.nrdc.org/health/effects/mercury/hightower.asp). Hence, the Hightower and Moore (2003) paper is internally inconsistent. Furthermore, the authors admitted “cause and effect regarding symptoms was not fully addressed ... because comparative analysis for the purpose of controls is not available ... and subjective nature of symptoms makes standardization difficult.”

Vupputuri et al., 2004, Environmental Research, in press (available online July 14, 2004).
Vupputuri and colleagues continued that “However, among those [NHANES] women who had not consumed fish in the previous 30 days, we observed elevated levels of systolic BP with increasing mercury exposure.” But it is important to point out that for those NHANES samples with low total blood mercury levels (i.e., say roughly from 0 to 4 ppb), it is known that the relative amount of methylmercury (the organic form of mercury associated with fish consumption) in blood declines dramatically as shown in Figure 1 by Mahaffey et al., 2004, Environmental Health Perspectives, vol. 112, 562-570. Thus, those statistical observations by Vupputuri et al. for low total blood mercury cases would require further confirmation and clarification from the understanding of exposure risk to inorganic mercury.